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Investigating Factors Behind Student Silence in the Presence of Learner-centered Instruction

Soyhan EGITIM

ᵃ Toyo University, Faculty of Human Life Design, Department of Health Care and Sports
48-1, Oka, Asaka-shi, Saitama 351-8510, Japan, Soyhan@toyo.jp, +81-48-468-6361
ᵇ Northeastern University, College of Professionals, Doctor of Education in Organizational Leadership,
Boston, MA, The U.S.

Abstract

This research aims to investigate potential factors behind student silence in oral communication activities when learner-centred instruction is employed. The existing literature indicates that Japanese students develop passive learning habits due to teacher-controlled educational approaches during their primary and secondary education. In recent years, the ministry of education has introduced a number of policies to promote communicative language teaching (CLT). Due to the increasing number of foreign language teachers, communicative language teaching and learner-centred instruction started to attract more attention in higher education institutions. The benefits of learner-centred instruction in oral participation are clearly indicated in the existing literature. However, silence is still commonly observed in Japanese university second language classrooms. Thus, the proposed study will attempt to understand English teachers' view of potential factors behind student silence when learner-centred instruction is present and strategies to engage silent students in oral communication activities. For this purpose, a series of face-to-face interviews will be held with university English language teachers from different backgrounds. Findings may lead to heightened awareness of the phenomenon among language professionals at Japanese universities and thus, more effective strategies to enhance active participation.

Keywords: silence, learner-centered, oral participation, psychological, Japanese students.

1. INTRODUCTION

1.0 Proposed Research/Background

Despite the official national education policy of the government (Ministry of Education, Culture, Science and Technology, 2003), traditional teacher-centred instruction is still dominant in Japanese educational institutions (Edwards, 2004). Although, teacher-centred, grammar translation methods may be effective in helping students achieve high test scores, research (Alderson & Hamp-Lyons, 1996) has shown that "they can result in less pair work, more teacher talk time and reduced opportunities for students to speak" (as cited in King, p.71, 2013). Therefore, it is safe to assume that teacher-directed instruction may not be ideal to produce competent English speakers in Japanese classroom settings.

Due to an increasing number of non-Japanese educational professionals in recent years (MEXT, 2004) and new educational policies introduced by MEXT (2003), learner-centred instruction has started to attract more attention in Japanese higher education. Current research suggests that oral interaction and production of target language can significantly aid second language acquisition (e.g. de Bot, 1996; Ellis, 1999; Gass, 1997; Iwashita, 2003; Izumi, 2003; Long, 1996; Mackey et al).

Swain's (1995, p. 125) comprehensible output hypothesis indicates that active engagement in oral communication activities serves second language acquisition not only by improving learner's fluency, but also it can help with the development of learners' inter language accuracy. In theory, learner-centred instruction seems optimal to achieve higher oral engagement in second language classrooms. However, even when learner-centred instruction

is employed, silence is still observed in Japanese university second language classes. Although second language teachers, who are proponent of learner-centred instruction, may dedicate ample time and energy to engage students in oral communication activities, some students persistently remain silent. Silence may become a source of frustration and it is often interpreted as a negative phenomenon. Nakane's (2006) study concludes that although silence would be an unmarked, off-record strategy in the Japanese educational system, other cultural contexts may perceive lack of response as "rude" or "impolite" (cited in Hinkei, 2011, p. 338).

Nakane (2007, p.25) emphasizes the importance of language difficulty and its effects on learner confidence as a generally ignored cause of silence. Perhaps, limited oral proficiency in the language is one of the various factors behind this phenomenon. For instance, beginner English speakers need more time to form sentences than their advanced level peers as they lack the necessary linguistic input.

Loucky & Ware (2016, p. 119) note that "Japanese students develop a learning habit which makes them overly passive and dependent on teachers for learning decisions". This learning style is so deeply entrenched that even when learner-centred instruction is employed, students may still hold onto their passive roles. Helgesen's research (1993, p. 38) is "representative of the widespread belief among many language practitioners in Japan that "the wall of silence meeting most teachers in university classrooms exists because students are simply not taught to speak in English" (as cited in King, 2013, p. 71).

According to Hofstede (2005, p. 89), silence is employed by Japanese speakers of English as a strategy to avoid losing face in cross-cultural communication. For instance, students may remain silent instead of risking wrong answers or explicitly admitting the inability to answer. In Nakane's (2006) study, the findings also suggested that silence is employed by Japanese participants as a face-saving strategy for the speaker (cited in Hinkei, 2011, p. 338).

In another study conducted by Harumi (2001), Japanese and English informants were shown a video extract featuring a Japanese student using prolonged silences in response to her native English teachers' questions. While the English informants regarded silence as a negative phenomenon, the Japanese viewed as a difficulty avoidance strategy. The English informants even described the silence as "rudeness, laziness, lack of interest, and passivity". Japanese informants, on the other hand, viewed silence as an indication that the student was waiting for help from the teacher (cited in King, 2013, p. 60).

As indicated in the previous research studies, lack of language proficiency, cultural and psychological factors may play a role in students' lack of engagement. Thus, certain underlying factors inhibiting learners from participating in oral communication activities need to be addressed. Findings from this study may lead to further awareness among teachers and thus, more effective teaching strategies can be adopted to overcome this challenge.

The following research questions are addressed to investigate the phenomenon within English language classroom settings at Japanese universities:

1) How does learner-centred instruction help with Japanese university students' oral engagement in English language classes?
2) Why does silence occur even when learner-centred instruction is employed?
3) What psychological and cultural factors need to be understood in order to raise teachers' awareness of student silence in the presence of learner-centred instruction?
4) What strategies can be implemented to engage silent students in oral communication activities?

2.0 Proposed Methods

Since the main goal of this study is to understand factors behind Japanese student silence and propose potentially effective strategies to address the issue, receiving teachers' perspectives through qualitative data is likely to prove beneficial for our understanding. Therefore, series of semi-structured open-ended interviews will be held with foreign language teachers from various Japanese universities. The interviewees will purposely be selected with different living and teaching experiences in Japan. The aim is to synthesize different perspectives to gain a thorough understanding of the factors behind the phenomenon and potential strategies to enhance learner-engagement.

During the interviews, all participants will be asked seven open-ended questions and several follow-up questions in order to elicit further detail. The interviews will also involve a number of ethical steps to ensure the participants are aware of the purpose, the protocol and the potential benefits and risks associated with the interview. This step is necessary to avoid negative consequences that may affect the subject in the future.

Interview Questions

1. What mode of instruction do you usually prefer to use in your English communication classes, such as learner-centered instruction, teacher-centered instruction or mixed method?
2. What makes you think using that instructional method would be beneficial for students in your classes?
3. In English classes some students may tend to avoid engaging in oral communication activities. What factors do you think are behind this silent behavior?

4. What do you do to engage silent students in oral communication activities? For instance, think of a quiet student you managed to engage in an oral communication activity. What approaches did you use to have the students engaged?

5. In what ways do you think your understanding of the Japanese culture can help you determine the needs and expectations of your students?

6. As a foreign language teacher, who works at a Japanese university, how do go about building rapport and mutual trust with your students?

7. Think about a time you were able to build strong rapport with a student or a group of students. How do you think building strong rapport helped with their engagement in oral communication activities?

3.0 Research Time Scale

2018: *Jan-May:* Literature review
June-July: Holding interviews with language teachers.
August-September: Transcribing the interviews.
October-December: Analysis of the data from the interviews.
2019: *January-April:* Identifying necessary themes.
April-June: Relating findings to the theory.
July-September: Completing the first draft.
October-December: Revising for final submission.

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Concrete English Study Reasons: A Crucial Prerequisite For De-Motivated Japanese Efl College Learners

Yuichi TODAKA[c]

Miyazaki Municipal University, Faculty of Liberal Arts, Department of Intercutural Studies

1-1-2 Funatuka, Miyazaki, Japan, todaka@miyazaki-mu.ac.jp

Abstract

Hasegawa (2004) reports that 71% of junior high school students and 77% of senior high school students are not motivated to study English. Among the reasons for de-motivation are the lack of any perceived relevance for learning English and the lack of confidence in capabilities. This study provided students with ample samples of concrete English study reasons that motivated Japanese learners of English have, and of future jobs that they can hold with EFL skills. In addition, intervention activities with an emphasis on imagery (Dorynei, 2013), and with an emphasis on cooperative social networks in class (Sampson, 2012) were conducted. Based on the findings of the present study, our activities helped almost three times as many freshmen this year as last year to sustain their motivation to study English during the two-month summer break. In addition, the number of students who were able to sustain their motivation to study EFL increased throughout the 2017 academic year, regardless of their English proficiency levels. It is however important to note that *establishment of concrete English study reasons is a powerful prerequisite* for intervention activities that focus on imagery to help Japanese college freshmen set short-term/long-term goals and sustain motivation to study English.

Keywords: concrete EFL study reasons, cooperative social networks in class, possible future EFL selves, self-efficacy beliefs

1. INTRODUCTION

In recent studies, many intervention activities with an emphasis on imagery have been proposed. The L2 Motivational Self System (Dörnyei, 2005, 2009) stresses the importance of L2 learners' self-perception of their desired future self-states. Furthermore, the intensity of that motivation partly depends on learners' ability to produce mental imagery (Dörnyei and Chan, 2013). Markus and Nurius (1987: 159 cited in Dörnyei, 2013: 440) report that "*possible selves encompass within their scope visions of desired and undesired end states*". Dörnyei and Chan (2013) assert that L2 learners with a vivid ideal self-image are more likely to motivate themselves and carry out necessary tasks to realize their desired 'future selves' that are associated with English skills. In other words, if L2 learners can visualize their future in which they utilize their English skills in their careers, they tend to motivate themselves and to sustain motivation to study English. Thus, L2 learners may need to carefully consider their concrete English study reasons that are associated with their future careers (Todaka, 2017b).

In addition, Morris and colleagues (2005: 6) suggest that agency and past memory are also involved in imagery production:

Imagery, in the context of sport, may be considered as the creation or recreation of an experience generated from memorial information, involving quasi-sensorial, quasi-perceptual, and quasi-affective characteristics, that is under the volitional control of the imager and which may occur in the absence of the real stimulus antecedents normally associated with the actual experience (Cited in Chan, 2014: 45).

Furthermore, Ottingen et al. (2001) reports that mental contrasting can only be effective for those who have high outcome expectations, and the opposite was found in the case of students with low outcome expectations. Previous studies also indicate that psychological temporal distance affects motivation in a way that providing students with proximal future activities instigates more motivation to study (Peetz, Wilson, & Strahan, 1999 cited in Chan, 2014: 55). Research has found that if a goal is considered to be more 'psychologically imminent rather than remote', it may have more motivational impact (Perunovic & Wilson, 2009: 356 cited in Chan, 2014: 242). Wilson et al. (2007) report if learners can see proximal future success in the present self, it can help learners boost confidence in the current self (cited in Perunovic and Wilson, 2009).

The use of imagery training has become conventional in sport psychology, and imagery training involves 'a specific set of dimensions (e.g. vividness, controllability, duration, the difficulty in evoking an image, the ease of formation of an image, perspective taken) and modalities (e.g. visual, kinesthetic, auditory, tactic, gustatory and olfactory (Chan, 2014: 56).' In addition, research indicates that imagery abilities can be improved through training, which implies that imagery abilities are skills instead of abilities, making full use of the six senses (i.e. visual, kinesthetic, auditory, tactile, gustatory, and olfactory (Morris et al., 2005 cited in Chan, 2014: 56).

However, little is known regarding how learners use their imagination or how it can be utilized to facilitate learning (Ryan & Mercer, 2013); and since only a few possible selves/visionary motivational programs have been carried out (e.g. Magid, 2011; Munezane, 2013), future investigators could conduct interventions with an emphasis on imagery. These investigations could examine the effects of the different conditions (e.g. perspectives, frequencies of imagery use, process versus outcome, the use of technology) on L2 motivation.

Falout and colleagues (2013) advocate the use of classroom activities that are specifically designed to emphasize the three-minded frames (past, present, future).These activities include language learning histories (Murhey and Carpenter. 2008), action logs (Murphy, 1993) and a 10-year class reunion (Fukada et al, 2011). Magid (2013: 230), in his first session, asked his participants to remember ideal English teachers they had had in the past as their role models in order to help them build possible future EFL selves. Fukada et al. (2011: 338) report that how learners perceive English study in the present is an extension of previous experiences and as such, the present extends through the past and future and cannot be separated from the present, (Rogoff, 1995: 155). Sampson (2012) had students write ideas about 1-year/15-year future ideal-selves under different life areas. Students mingled with other students guessing about their future selves in the various areas. Sampson reports that social malleable, i.e., the input from other classmates, helped learners better perceive their future ideal selves.

Chan (2014) indicates the importance of some examples that support imagery use to help students understand both the benefits and the process of imagery use. Furthermore, Chan (ibid: 241) explains that the benefits of imagery use can be attained if imagery can be linked with a strong desire, specifically grounded in reality, and accompanied with a concrete plan. Nonetheless, Todaka (2013, 2017b) reports on the importance of establishing new and concrete English study reasons and time management skills to help Japanese college freshmen sustain their motivation to study English. We speculate then that *the establishment of concrete English study reasons can be a crucial prerequisite for intervention activities that focus on imagery to help Japanese college freshmen set short-term/long-term goals and sustain motivation to study English.*

A goal is a desired result that an EFL learner would like to achieve. It is, however, important for any EFL learner to truly understand why she/he wants to study English in the first place. This is because Agawa et al. (2011, p. 13, cited in Sampson, 2016, p. 16) reported the following:

In a university setting uncovered amotivation, in which the participants noted 'no interest in foreign languages, cultures or people' and 'not understanding for what purpose English is being studied' (my translation, Sampson, 2016:16).

Sampson (2016, p. 17) also reports the following:

The literature suggests perceived relevance of English study to be an integral influence on the motivation of Japanese students. Sitting in classrooms week in week out as part of a set of compulsory subjects, many learners may have only a vague idea of the purpose of their EFL studies and be uncertain as to how they might use English in the future.

Because most Japanese high school students study English only to pass college entrance exams, Todaka (2013) reports on the importance of concrete English study reasons for college students.

As our 2016 study reveals, it takes quite some time for Japanese college freshmen to realize the importance of concrete English study reasons/purposes. The study also suggests that it might be important to provide students with concrete samples that show why motivated Japanese EFL learners are able to sustain their motivation to study English. For even though students understood the importance of concrete English study reasons, many still couldn't sustain their motivation to study English. In other words, it is just as difficult for Japanese college freshmen to *perceive the relevance of English study*, as it is for secondary school students. Jahedizadeh et al. (2016) also indicate that students' perceptions of interest and joy affect their mastery of goal orientation. Also, because there is actually little use of English in day-to-day life in Japan, it is important for instructors to carefully plan to provide Japanese college freshmen with

ample samples of concrete English study reasons so that they might be able to visualize their 'future EFL selves' by the second year of college (Yashima, 2000, 2002, 2009).

Thus, our intervention activities with an emphasis on imagery were carefully planned based on the above findings.

The following interventions were conducted in the present study to answer the following question:

If we focus on helping our students truly understand what their reasons are behind English study and help them perceive the relevance of English study, would activities focusing on developing possible EFL selves help our students set short-term/long-term goals and sustain their motivation to study English even during the summer break and the fall semester?

2. Intervention strategies conducted in the present study

Lesson 1

Students were asked to establish new and concrete English study reasons, as Todaka (2013) found the importance of Japanese college freshmen establishing these new and concrete English study reasons to be motivated to study English. Two samples of English study reasons gathered among 1419 motivated Japanese EFL learners (https://ceburyugaku.jp/42159/;   https://www.marshresearch.co.jp/mini_research/mr201402english.html)   were distributed to students in groups of four.(Activity 1) The students reviewed the summary of reasons why some of those 1419 Japanese EFL learners study English and discussed what their own English study reasons could be. The instructor had group leaders report on the possible English study reasons that each group found relevant to themselves. Each of the students was then asked to think carefully about his/her own English study reasons until the next class and to write them down on a sheet of paper (Activity 1). Reminders to carefully consider their own English study reasons were then given throughout the spring semester.

Students were then asked to complete the Language Learning Autobiography (see Sampson, 2010 for a detailed description), and they talked about the pros and cons of their past English experiences. Because social-interactive types of activities were found to help students become motivated to think about their future EFL selves (Sampson, 2012), students, arranged in groups of four, discussed the above points and presented their opinions to the class. This in order for students to understand how their classmates had thought of their past English experiences. The instructor summarized the pros and cons of their past English experiences and told students that he would be teaching his classes in a manner that promotes their positive past English experiences and to help students reframe their past experiences to find their capabilities to positively use English in the present and the future (Activity 2).

Students were next asked to think about ideal English teachers they had met in the past, and look to them as role models in order to help build possible future EFL selves (Madrid, 2013: 230 (Activity 3). Chan (2014: 58) reports that drawing students' attention to the sensory details of actual stimuli (e.g. images of a person's close friend) can help train weaker imagers before employing any imagery-based interventions. Student groups were reassigned each week to expand students' social networks in class (Activity 4).

Lesson 2

Students were provided with two sample lists that describe the merits of English study skills for the future (*eigotextbook.com/mindet/English-master-advantage-tops3*; and *https://www.kaplaninternational.com/jp/blog/30-jobs-which-require-english-skills*) and the types of future jobs students can hold with EFL skills. This is because Dorynei and Kubanyiova (2014) indicate that students cannot create a new ideal self from scratch with any motivational intervention. Student each read the samples. They then worked in groups of four to talk about the possible jobs they can hold in the future with English skills. The instructor had group leaders report on the jobs that each group found interesting. The instructor reminded students to consider their own English study reasons when they thought about possible future jobs with English skills (Activity 5).

Each group wrote down their new and concrete English study reasons and possible future careers with EFL skills, and presented them to their classmates. All of the information was collected, to be distributed in the next lesson. Group activities can help students broaden student thinking, help them connect themselves with the information and provide support for thinking about their future selves (Sampson, 2012: 328, (Activity 4, and Activity 6).

 Students were then provided with information on how Olympic athletes make use of image training to enhance their performance. Students read the information in groups of four to help them understand the importance of visualization for realizing their possible future EFL selves. That is, students were told how important it is to form vivid and controllable images (Morris, 1997: 37 cited in Chan, 2014: 56) utilizing different modalities (i.e. visual,

kinesthetic, auditory, tactile, gustatory and olfactory). Having discussed the importance image training in groups and in class, students were asked to find image training techniques that their favorite athletes utilize to realize their goals. They were then asked to make use of image training to realize their own possible future EFL selves (Activity 7).

Student groups were then asked to imagine and write about their 'possible' selves 5 years in the future to understand that choices have positive and negative consequences (Sampson, 2012: 323). The instructor collected the student groups' 'possible' selves 5 years in the future to be distributed in the next lesson (Activity 8). Towards the end of lesson, students were again reminded of the importance of having concrete English study reasons that are associated with future careers and of image training to realize their future EFL selves (Todaka, 2013, 2017a,b).

Lesson 3
Each student first read the list of new and concrete English study reasons and ideal future jobs with EFL skills gathered during the previous lesson as a reference for the establishment of their own concrete English study reasons and their future EFL selves. Each student then carefully modified his/her own new/concrete English study reasons and possible future jobs with EFL skills. We discussed the importance of establishing new/concrete English study reasons that can help students realize their future careers with EFL skills in class.

Finally, students were asked to think about how to deal with distractive factors that might happen along the way to realizing possible future EFL selves. Student groups discussed possible ways to overcome difficulties and wrote them down. The instructor collected them to be distributed in the next lesson (Activity 9). Towards the end of class, students were again reminded of the importance of image training for realizing their ideal future EFL selves and of having concrete ways to deal with demotivation factors along the way to realizing their possible future EFL selves

Lesson 4
Students were asked to visualize their possible EFL selves based on what they wrote down the previous week in order to remind themselves of the importance of imagery training (Activity 7). This reminder was conducted throughout the rest of the spring semester because the motivational effects of visualization were found to be short-lived, and personalized imagery scripts can be used to keep students vision alive (Chan, 2014:242-243).

Each student then read a list of effective measures for dealing with distractive factors that student groups wrote the week prior, and he/she was asked to fill in social network maps (see Fukada et al., 2011 for detailed description) that were targeted for the spring semester. This is because research has revealed that seeing proximal future successes instigates confidence in the current self (Wilson, et al., 2007, cited in Perunovic & Wilson, 2009).

Finally, students were asked to think about their concrete study reasons, short-term/long-term goals and study plans.

Lesson 5
Students were first asked to visualize their ideal EFL selves based on what they had written in the previous weeks (Activity 7). Next, student groups shared their social network maps to understand how groupmates deal with distractive factors (Activity 9). Student groups were then asked to discuss and write about their possible EFL selves 4 months in the future (i.e. the end of the spring semester) utilizing the visualization techniques. This activity was conducted because seeing proximal future success can exert more motivational impact and bring out a confidence boost in the current self (Wilson et al., 2007; Perunovic and Wilson, 2009). The instructor collected what student groups had written down to be distributed in the next lesson. Class discussion was conducted about how to effectively improve English listening skills. Based on the class discussion, student groups wrote down the ways they had thought were effective. What student groups wrote down was collected, to be distributed in the next class. Students were also asked to think until the next class meeting, about when would be appropriate times to improve their English skills based on their own weekly class schedules. They were asked to bring their weekly class schedules with them to the next class meeting.

Lesson 6
Based on the information gathered during the previous week on effective strategies to improve English listening skills, each student wrote down how they would improve their English listening skills. In addition, each student circled the class periods on a spring-semester weekly English study time-schedule sheet during which they have no classes.. Each student was asked to choose one class period a day, Monday through Friday during which they would carry out necessary English study (Activity 10).

In addition, because our students are obligated to take TOEIC during their first two years in college, students in groups of four talked about how to improve their performance in the listening sections of a TOEIC test. Each group presented their opinions on how to improve their listening scores to the other groups' members. The

instructor commented on the students' opinions, and provided advice on how to improve TOEIC listening scores based on the strategies of several teaching assistants who scored perfectly on the listening sections of previous TOEIC tests. Students were asked to write down how they thought they might improve their listening skills during the time slots they had selected from Monday to Friday (Activity 11).

From Lessons 7 to 13
Students studied some important phonetic features (i.e. stress, rhythm, sound adjustments, and intonation) to improve their English listening skills. Because Japanese students rarely study English sound adjustments such as linking and assimilations, they have difficulty understanding even simple utterances that contain sound adjustments. In addition, based on Todaka (2009) and Todaka and Misono (2009), prominent learning constructs/strategies for promoting English listening skills were taught. Specifically these constructs/strategies were (1) background knowledge of various topics, (2) phonetic knowledge of English, (3) working memory capacity: ability to recognize, perceive, and memorize short segments of incoming speech, (4) knowledge of various dialects of English, (5) use of written materials to assist learners in understanding spontaneous speech, and (6) use of various tasks to provide learners with ample opportunities to listen to authentic English (Activity 11). Also, over the course of lessons 7 through 13. All the intervention strategies practiced during lessons one through six were reviewed and discussed during the first twenty minutes of each lesson.

Lesson 14
Students were provided with a 2017 summer calendar for the coming summer break in a daily timetable format. Students first filled out the timetable with activities that they already had planned (e.g. club activities, part-time jobs, and travel plans). Then, students discussed how they could allocate time for English study. Students agreed that they should study before doing any other activities. Finally, each student, depending on their own summer schedule, assigned a daily time slot dedicated to the study of English (Activity 12).A questionnaire about all of the intervention strategies conducted in the present study was distributed to students. Students answered each question on a Likert scale of 20 (i.e. totally disagree) to 100 (i.e. totally agree).

Lesson 15
A questionnaire regarding students' perceived self-efficacy beliefs about their own English skills was distributed and students responded to each question on a Likert scale of 20 (totally disagree) to 100 (i.e. totally agree). A listening section of a new TOEIC test was next administered. Finally, students were reminded that they should make use of their summer timetables during the upcoming summer break.

3. Methodology
3.1 Participants

205 Miyazaki Municipal University freshmen students participated in this study. They were categorized into four groups according to their university English program placement test scores: (1) 54 students were grouped as introductory level students; (2) 102 students were placed in two intermediate classes; (53 students in intermediate I class and 51 students in intermediate II class), and; (3) 49 students were assigned to an advanced class. Regardless of the study grouping however all of the participants should be considered as low introductory to low intermediate level students, as their mean TOEIC listening test scores ranged from 315.9 to 326.5 among nine TOEIC tests that had been officially conducted in Japan in 2015.

The study participants attended both CALL and language acquisition classes throughout the entire academic year, in 15 weekly classes over the spring and fall semesters. They attended the CALL classes in the groupings described above and the language acquisition classes as one entire freshman group seated in a large lecture hall.

3.2 Additional Instruction aside from intervention strategy activities

The CALL classes were taught by the author in the following way: (1) lectures on important English suprasegmental features (e.g., Vance 1987; Todaka 1995); (2) various exercises specifically designed to teach phonetic features; (3) advice on various listening strategies for the needs of individual students; (4) shadowing training using DVD movies; and (5) evaluation of progress according to self-assessment checklist items.
In this study, we also focused on the following:
(1) The four sources of self-efficacy proposed by Bandura (1977):

We ensured that each student gained confidence by having him/her experience some kind of achievement in each class period. In particular, various strategies were employed to ensure that all students would understand the listening materials that was presented in each class period so that they could get a boost in confidence in their capability for English listening (i.e., performance outcomes).

(2) Positive role models:

Six teaching assistants, juniors at the same university, participated in all classes and functioned as role models for the study participants. The instructor provided positive verbal feedback to each student to support each in their belief in their capabilities and to promote active engagement in each listening activity. Furthermore, the instructor ensured that participants were provided with positive physiological and emotional sensations to help them develop high self-efficacy in class (i.e., vicarious experiences).

(3) Relaxed classroom environment:

The instructor carefully provided a classroom environment in which students could feel free to ask questions and where students were not afraid of making mistakes (i.e., physiological feedback).

(4) Verbal support:

Because our self-efficacy is affected by what others say to us about what they believe we can and cannot do, the instructor always reminded students that anyone can improve his/her English listening skills if he/she understands and employs appropriate learning strategies.

(5) The importance of understanding the learning process:

During the first half of the term, students were taught and reminded what an effective learning cycle is in order to help them engage in actual tasks to improve their English listening skills.

(6) Appropriate and interesting class materials:

Materials were specifically designed and adjusted to students' proficiency levels so that the students could retain confidence in their English listening skills throughout the term. In addition, the instructor made sure to utilize instructional procedures that ensure the students understand step-by-step strategies to improve their English listening skills.

(7) Team work:

Classroom activities were mainly carried out in pairs or in small groups so that students could assist one another in understanding effective ways to improve their English listening skills. Members of pairs or groups were changed weekly so that students had opportunities to work with many different classmates.

(8) Regular assessment:

Weekly quizzes were given. All the question items on each quiz were taught in advance. The objective of the weekly quizzes was to make sure students incrementally understood the important strategies for improving their English listening skills.

(8) Reminders of the importance of concrete English study reasons, time management skills, regulated English study cycle, visualization techniques, and of self-efficacy beliefs were given during the fall semester. The author did not however teach the CALL classes in the fall semester. Because of this, these constant reminders of the importance of the above points were presented throughout the fall semester at the beginning of the lecture in the author's language acquisition class.

3.3 Assessment Tools

Students' English listening skill improvement was evaluated using the results of TOEIC. The listening portions of two different TOEICs were administered at the beginning and end of the spring semester in 2017. In addition, we formulated a ten-item self-efficacy questionnaire to further assess our students' English listening skills. Because self-efficacy perceptions are both context- and task-specific (Maddux 2002) and cultural context-specific (Oettingen, 1995), we specifically designed this self-efficacy questionnaire to assess our students' motivational level during the spring, summer, and fall semesters of the 2017 academic year (see Appendix 1).

In addition, we formulated two other questionnaires to evaluate 1) what motivated our students to improve their English listening skills during the spring semester; and (2) to assess our students' motivational level during the spring, summer, and fall semesters of the 2017 academic year (see Appendix 2).

4. Results and Discussion

The following table indicates the results of our students' self-efficacy scores regarding their listening skills in 2017. The questionnaire consisted of 10 questions, each scaled from 20 (totally disagree) to 100 (totally agree). The entire questionnaire produced results that range from 200–1000.

Table 1. Self-efficacy scores in April, July, October, and January 2017-2018

Times/ Prof. level	April	July	October	January	P value F value
Introductory	740(124)	780 (89)	760 (109)	740 (92)	P<.97 F=.002
Intermediate I	755 (95)	793 (97)	741 (112)	753 (123)	P<.64 F=.236
Intermediate II	731 (88)	799 (98)	778 (100)	713 (98)	P<.08 F=3.14
Advanced	755(108)	776 (99)	780 (109)	769 '89)	P<.55 F=.44

As seen above, our students' perceived self-efficacy beliefs about their English listening skills were relatively high throughout the 2017 academic year, similar to the results in our 2016 study. However, the number of students who were able to sustain their motivation changed drastically from semester to semester.

Matumoto et al. (2013, cited in Lamb, 2017) tested the positive effects of key reading strategies on motivation and self-efficacy beliefs in 360 English minor Japanese college students. They reported that their students' extrinsic and intrinsic motivation as well as reading self-efficacy improved.

Even within the same Japanese EFL context, different results were reported on the impact of self-efficacy beliefs on Japanese college EFL learners' English skills. Furthermore, different results based on motivation intervention activities for Japanese college students were found. Thus, as Ushioda (2007) states that motivation studies need a 'person-in-context approach' (p.23).

Let us now examine the questionnaire about all of the intervention activities *we* had employed during this project. The following is a list of brief descriptions of each of the intervention activities we carried out in this project.

Activity 1: Establishing new and concrete English study reasons
Based on two samples of concrete English study reasons among motivated
Japanese students of English, students thought carefully about
their own concrete English study reasons for the next four years of college

Activity 2: Reflecting on Past English experiences
Students reflected on the pros and cons of their past English experiences to help them reframe their past experiences and to find their capabilities to positively use English in the present and the future.

Activity 3: Considering attainable English skills
Students thought about Japanese English teachers they had respected in the past and were told to look at them as role models so as to help establish their own attainable English skills in college.

Activity 4: Expanding social networks in class
Student groups were reassigned each week so as to expand social networks in class and create more opportunity to talk to as many classmates as possible. In addition, individual students' responses to various intervention activities were collected and redistributed to students so that they could learn what other classmates thought about their own concrete English study reasons, possible EFL selves, how to manage time appropriately, how to improve English listening skills, how to use visualization techniques, how to deal with distractors and so forth.

Activity 5: Learning what kind jobs students can hold with their future EFL skills
Students read from two sample lists about how certain EFL skills can be utilized in the future so as to visualize their possible selves with EFL skills in the future.

Activity 6: Establishing possible selves with EFL skills
Based on activity 5, each student carefully thought about his/her possible selves with EFL skills after they graduate from college.

Activity 7: Making use of visualization techniques that students favorite athletes use to accomplish their goals
Students in groups of four shared what information they had gathered about each student's favorite athlete's visualization techniques. Each student then selected the visualization techniques they liked

and was asked to utilize those techniques to attain and maintain a possible self with EFL skills throughout the 2017 academic year.

Activity 8: Imagining 'ideal' selves 5 years in the future

Students in groups of four were asked to imagine their 'ideal' selves 5 years in the future and to write about them to understand that choices have positive and negative consequences.

Activity 9: Learning how to deal with distractors

Students in groups of four shared their social network maps to understand how to groupmates deal with distractive factors.

Activity 10: Establishing time management skills/Understanding how to improve TOEIC listening scores

Based on a spring-semester weekly time schedule sheet students circled the class periods during which they have no classes. Students chose one class period per day from Monday to Friday during which they would carry out their English study to improve their English listening skills. The instructor and teaching assistants advised students on several ways to improve their TOEIC listening scores, and students chose the strategies they liked to improve their own TOEIC listening scores.

Activity 11: Promoting English listening skills by learning prominent learning constructs/strategies

Based on recent studies, effective learning constructs and strategies used to improve English skills were introduced and demonstrated so as to help students exactly understand how to improve their English listening skills.

Activity 12: Establishing summer English study plans

Students were provided with a 2017 summer calendar with daily timetables for the coming summer break. Students first filled out the timetables with activities that they already planned to do (e.g. club activities, part-time jobs, and travel plans). Then, students discussed how they can allocate time for English study. Each student, depending on their own summer schedule, wrote down the daily time slot that they would study English.

The following table (Table 1) indicates students' responses to our questionnaire regarding each of the activities to sustain motivation to improve English skills. The questionnaire consisted of 13 items, each scaled from 20 (totally disagree) to 100 (totally agree). The standard deviations are indicated in the parentheses.

Table 2. Students' ratings on class activities

Activity numbers/ proficiency groups	Introductory class	Intermediate I class	Intermediate II class	Advanced class
1	83.04 (16.31)	90.48 (11.03)	82.04 (14.29)	80.4 (14.84)
2	72.61 (14.82)	78.57 (15.55)	70.20 (17.65)	75.6 (13.58)
3	72.17 (14.29)	79.05 (17.64)	73.88 (16.43)	76.4 (18.38)
4	81.30 (16.00)	80.00 (19.25)	82.45 (20.67)	85.2 (15.02)
5	84.78 (15.31)	90.95 (13.40)	84.65 (18.99)	86.8 (15.96)
6	76.52 (16.50)	86.67 (14.43)	79.18 (14.69)	80.4 (13.69)
7	73.04 (16.98)	80.48 (12.87)	70.20 (17.85)	73.6 (15.35)
8	72.17 (16.04)	80.00 (15.93)	73.88 (16.43)	75.6 (18.20)
9	73.48 (17.41)	77.62 (16.05)	82.45 (20.67)	67.2 (15.5)
10	76.96 (16.31)	84.29 (15.64)	84.65 (18.99)	75.6 (17.75)
11	75.21 (12.78)	87.62 (12.46)	79.18 (14.69)	76.4 (16.99)
12	78.70 (12.93)	85.24 (14.69)	74.69 (20.73)	78.40 (14.48)

As can be seen from the table, all of the intervention activities conducted were rated as useful, except activity 9, as rated by advanced students. We speculate that many of the advanced students must have learned how to deal with distractors in secondary school.

Among all of the intervention activities, activities 1, 4, and 5 were found to be the most useful by students across all proficiency groups. In activity 1, we focused on the importance of establishing new and concrete English

study reasons for English study in college. In this study, we did this by providing students with two sample lists of English study reasons that motivated Japanese English learners possess; in activity 4, student groups were reassigned each week to expand social networks in class so that students increased their chances of talking to as many classmates as possible. In addition, individual students' responses to various intervention activities were collected and redistributed so that students were able to learn what their classmates thought about their own concrete English study reasons, possible EFL selves, how to manage time appropriately, how to improve English listening skills, how to use visualization techniques, how to deal with distractors and so forth; and in activity 5, students were provided with ample samples of future job possibilities with EFL skills so that they could see exactly what types of jobs they could hold with EFL skills. Thus, these three activities might have helped our students think carefully about their possible future EFL selves.

It is, however, interesting to note that except for students in intermediate I class, students did not consider activities 8 and 9 very useful. Both activities were intended to introduce visualization techniques to help our students sustain motivation to study English. Nonetheless, the mean values of the two activities among students in all the proficiency groups were only slightly higher than 70%. Therefore, we speculate that our students were not accustomed to utilizing visualization techniques for English study, so that the positive effects of the two activities might only be seen later during the 2017 academic year.

The following table shows the percentage of students in each proficiency group who were able to sustain their motivation to improve their English listening skills. The data were collected three different times: (1) July; (2) October; and (3) January. The numbers in parentheses indicate the results obtained last year.

Table 3. The number of students who sustained their motivation to improve English listening skills

Months/Groups	July 2017	October 2017	January 2018
Introductory	57% (71 %)	24% (12 %)	74 % (26 %)
Intermediate I	68% (67 %)	29% (10 %)	69% (50%)
Intermediate II	57% (75%)	33% (6 %)	59% (42%)
Advanced	57% (77 %)	30% (19 %)	59% (67 %)

As seen above, when compared to the results last year, the number of students who were able to sustain motivation during the spring semester, decreased; however, the number of students, who were able to sustain their motivation during the summer break, increased considerably. Especially, the number of students in intermediate II class, who were able to sustain motivation to study English, increased from 6% last year to 33% this year; the number of students in introductory and advanced classes, able to sustain motivation to study English, increased approximately twofold; the number of students in intermediate I class, who were able to sustain motivation to study English, increased threefold. Thus, as speculated above, the positive effects of intervention activities on learning motivation can be seen in the summer break.

Except for advanced students, the number of students who were able to sustain motivation during the fall semester also increased. The number of introductory students who were able to sustain motivation increased from 26% last year to 74% this year; the number of intermediate I students who were able to sustain motivation increased from 50% last year to 71% this year; the number of intermediate II students who were able to sustain motivation increased from 42% last year to 57% this year. The number of advanced students however, who were able to sustain motivation decreased from 67% last year to 59% this year.

In terms of the entire 2017 academic year, students in all of the proficiency groups, who were able to sustain motivation, increased from the spring semester to the fall semester. One possible reason is that the actual number of students who were able to sustain motivation to study English in the spring semester this year was smaller than that of last year. This might be because we conducted various intervention activities, most of which our students were not familiar with. Thus, it may have taken some time to digest the objectives of our interventions during the spring break. The positive effects of our activities on learning motivation however, can indeed be seen during the summer and the fall semesters.

Let us now examine the reasons why some students were able to sustain their motivation to study English this year during the two-month summer break, while others could not.

The following tables indicate the reasons for our students' ability/inability to sustain motivation during the summer break.

Table 4. Primary reasons for students' ability to sustain motivation during the summer break
(12 introductory students)

Reasons
As I learned the importance of establishing concrete objectives to realize my future EFL self in CALL A, I was able to sustain motivation to study English. (8 students)
I had a chance to meet with friends from high school, and we discussed our future dreams together. (1 student).
As I learned how to study English with DVD movies/YouTube in CALL A, I was able to sustain motivation to study English with movies. (2 students)
I wanted to be better at English than other students. (1 student)

Table 5. Primary reasons for students' inability to sustain motivation during the summer break
(38 introductory students)

Reasons
I prioritized other activities over study. (22 students)
I gave in to temptations. (10 students)
I still couldn't establish English any study reasons. (2 students)
I tried to study English, but I just couldn't continue. (2 students)
My study plans were not appropriate enough for me to study English during the break. (2 students)

Table 6. Primary reasons for students' ability to sustain motivation during the summer break
(14 intermediate 1 students)

Reasons
As I learned the importance of establishing concrete objectives to realize my future EFL self in CALL A, I was able to sustain motivation to study English. (5 students)
I didn't study English during the spring term; however, I was able to realize the importance of sustaining motivation to improve English skills. (1 student)
I had plenty of time to study English. So I was able to sustain motivation to study English. (1 student)
I had a chance to speak with foreigners during a part-time job. So, I was able to sustain motivation to study English. (1 student)
I had a chance to meet with friends from high school, and we discussed our future dreams together. (1 student)
I visited Canada for one month. So, I was able to sustain motivation to study English. (2 students)
I was able to study English with friends. So, I was able to sustain motivation to study English.
As I learned how to study English with DVD movies in CALL A, I was able to sustain motivation to study English with movies. (2 students)

Table 7. Primary reasons for students' inability to sustain motivation during the summer break
(34 intermediate I students)

Reasons
I was thinking about my future career. (2 students)
I thought I still had time to study English before I graduate from college.
I prioritized part-time jobs or getting a driver's license over study. (7 students)
I was sick during the break.
I gave in to many temptations. (23 students)

Table 8. Primary reasons for students' ability to sustain motivation during the summer break
(13 intermediate II students)

Reasons
As I learned the importance of establishing concrete objectives to realize my future EFL self in CALL A, I was able to sustain motivation to study English. (9 students)
I had a chance to meet with friends from high school, and we discussed our future dreams together. (1student)
As I learned how to study English with DVD movies/YouTube in CALL A, I was able to sustain motivation to study English with movies. (2 student)

Table 9. Primary reasons for students' inability to sustain motivation during the summer break
(26 intermediate II students)

Reasons
I prioritized other activities over study. 10 students)
I gave in to temptations. (15 students)
I tried to study, but I just couldn't continue.(1students)

Table 10. Primary reasons for students' ability to sustain motivation during the summer break
(14 advanced students)

Reasons
As I learned the importance of establishing concrete objectives to realize my future EFL self in CALL A, I was able to sustain motivation to study English. (10 students)
I had a chance to meet with friends from high school days, and we discussed our future dreams together. (1 student)
I believed in my capabilities to accomplish my future goals. (1 student)
I was able to establish English study habits in the spring semester. So, it was easy to sustain motivation to study English. (1 student)
As I learned how to study English with DVD movies in CALL A, I was able to sustain motivation to study English with movies. (1 student)

Table 11. Primary reasons for students' inability to sustain motivation during the summer break
(32 advanced students)

Reasons
I gave in to temptations. (9 students)
I still don't know what I want to be in the future. (1 student)
I played with my friends when I went back to my home town. (1 student)
I prioritized part-time jobs and getting a driver's license over study. (9 students)
I was able to study in accordance with my study plans in August, but I started working part-time in September. So, I couldn't study English. (2 students)
I could not manage my time appropriately. (1 students)
I was able to study English in August, but I just couldn't continue. (5 students)
I had to get a driver's license. So, I had no time to study English. (4 students)

As seen above, various reasons for students' ability to study English during the summer break were found. Nonetheless, many students mentioned that our intervention activities did help them sustain motivation to study English. Similar to last year however, reasons for students' inability to study English during the break were because they either gave in to temptations or prioritized other activities over English study. Some of the students indicated however that they had tried to study English in August, but for several reasons they just could not sustain the motivation to do so in September. According to Dörnyei and Kubanyiova (2014), all of the reasons reported by students for an inability to sustain motivation could be attributed to their inability to truly envision their 'future EFL selves'. Nonetheless, we still believe that it is a powerful prerequisite for fostering a full understanding of English study and it must be recognized by individual students. This is because some students, and especially Japanese students, who had never been asked to think about their own English study reasons, and who had just been *told* to study English, don't truly understand the objectives of English study. Thus, most students feel as though *they are being forced to study English, just to pass high school or college entrance exams.* Once students understand why they want/need to study English, and it is for their own benefit, each of them can establish their English study goals. In addition, some students were able to sustain motivation through intervention activities with an emphasis on imagery, while others were able to maintain motivation to study English because they realized that their concrete English study reasons were associated with hobbies such as listening to English songs or watching movies.

Let us now examine the reasons for students' ability/inability to sustain motivation to study English during the fall semester.

Table 12. Primary reasons for introductory students' ability to sustain motivation during the fall semester
(40 introductory students)

I now understand my own English study reasons. (33 students)
I like English. (4 students)
With concrete English study reasons, I imaged my future self. (2 students)
I had chances to talk with foreigners.

Table 13. Primary reasons for advanced students' inability to sustain motivation during the fall semester
(14 introductory students)

I can't manage time effectively. (4 students)
I haven't found my own English study reasons. (6 students)
I lost to temptations or prioritize part-time jobs.
I lost interest in English or dislike English. (2 students)
I'm more interested in other foreign languages.

Table 14. Primary reasons for intermediate I students' ability to sustain motivation during the fall semester
(29 intermediate I students)

My English skills improved.
I like English, English movies, or English songs. (2 students)
I have concrete English study reasons. (23 students)
With my concrete English study reasons, I always imaged my future EFL self. (3 students)

Table 15. Primary reasons for intermediate I students' inability to sustain motivation during the fall semester
(13 intermediate II students)

I haven't found my own English study reasons, yet. (7 students)
I lost to temptations, or prioritized part-time job. (6 students)

Table 16. Primary reasons for intermediate II students' ability to sustain motivation during the fall semester
(29 intermediate II students)

I have concrete English study reasons. (26 students)
I started teaching English to junior high school students. So, I needed to study English.
I studied English because of positive influences from my friends.
I still have difficulty managing time.

Table 17. Primary reasons for intermediate II students' inability to sustain motivation during the fall semester
(22 intermediate I students)

I still haven't found my own English study reasons. (8 students)
I just can't find college English classes useful.
I prioritized part-time jobs or lost to temptations. (9 students)
I still can't manage time effectively. (3 students)
I simply don't like English.

Table 18. Primary reasons for advanced students' ability to sustain motivation during the fall semester
(29 advanced students)

Reasons
I now understand my English reasons. So, I was able to associate my hobbies with English study so that I was able to enjoy English study. (2 students)
I now have my own English study reasons. So, I understand what English skills I want to improve, and I was able to sustain motivation to study English. (20 students)
I have concrete English study reasons. So, I utilized image training techniques to sustain motivation to study English. (5 students)
I realized the importance of English study. (2 students)

Table 19. Primary reasons for advanced students' inability to sustain motivation during the fall semester (20 advanced students)

Because of a long break during the summer, I wasn't able to study English as much.
My concrete English study reasons have become vague or changed. (2 students)
I'm not interested in studying English at all.
I still haven't mastered time management skills.
I haven't found my concrete English reasons yet. (8 students)
I spent time studying other subjects.
I spent all of my time working part-time. (2 students)
I lost to temptations. (2 students)
I have concrete study reasons, but I had to deal with my family issues. (2 students)

As shown above, students, who were able to sustain motivation to study English, have found their own English study reasons. They also indicated that English listening activities utilizing English movies and songs helped them realize that they can study English with audio-visual materials that they are interested in. In addition, some students mentioned that they imagined their future EFL selves throughout the fall semester.

The reasons for our students' ability and inability during the summer and the fall semesters are associated with concrete English study reasons. Once they established their own English study reasons, some students continued to study English utilizing their favorite materials such as music, while others studied to score better in TOEIC or visualized to realize their future careers. A few students however mentioned that they just simply don't like English so they don't have any concrete reasons to study English.

Next, we examined the participating students' TOEIC scores from April, July, October, and January during the 2017 academic year.

The following four tables indicate the results. The maximum score for the listening test was 495. The numbers in parentheses indicate standard deviations.

Table 20. TOEIC scores in April 2016 and January 2017 (entire academic year)

Times/Proficiency level	April	January	P value F value
Introductory	191 (51.9)	252 (44.8)	P<.0001 F=30.47
Intermediate I	224 (45.1)	282 (53.0)	P<.0001 F=29.1
Intermediate II	233 (46.5)	293 (55.4)	P<.0001 F=24.2
Advanced	277 (60.2)	334 (55.7)	P<.0001 F=18.1

As Table 19 shows, students in all proficiency groups made significant improvements in their TOEIC listening scores during the 2017 academic year.

The next table indicates their TOEIC scores in April and July (spring semester).

Table 21. TOEIC scores in April and July 2017 (spring semester)

Times/Proficiency level	April	July	P value F value
Introductory	191 (51.9)	248 (41.3)	P<.0001 F=34.1
Intermediate I	224 (45.1)	276 (46)	P<.0001 F=31.5
Intermediate II	239 (46.9)	277 (45.4)	P<.0001 F=17.2
Advanced	277 (60.2)	324 (52.4)	P<.0001 F=16.7

As seen above, students in all proficiency groups made significant improvements in their TOEIC listening scores during the spring semester in 2017.

The following table compares their TOEIC scores in July with those in October (after the summer break).

Table 22. TOEIC scores in July and October 2017 (summer break)

Times/Proficiency level	July	October	P value F value
Introductory	247 (40.3)	223 (46.7)	P<.008 F=7.26
Intermediate I	278 (45.3)	251 (43.3)	P<.005 F=8.31
Intermediate II	275 (43.6)	258 (46.9)	P<.08 F=3.08
Advanced	321 (53.4)	295 (58.7)	P<.02 F=5.24

As seen above, TOEIC scores significantly worsened after the summer break. Even though more students were able to sustain motivation to study English this year, TOEIC scores worsened. This is because TOEIC scores of those students who could not sustain motivation to study English negatively affected the overall TOEIC scores.

The following table shows student TOEIC scores in October 2016 and January 2017 (fall semester).

Table 23. TOEIC scores in October 2016 and January 2017 (fall semester)

Times/Proficiency level	October	January	P value F value
Introductory	223 (46.7)	252 (44.8)	P<.004 F=8.6
Intermediate I	251 (43.3)	284 (52.3)	P<.001 F=11.1
Intermediate II	258 (46.9)	293 (55.4)	P<.01 F=6.4
Advanced	295 (58.7)	334 (55.7)	P<.01 F=6.6

The table above indicates that students in all proficiency groups made significant improvements in their TOEIC scores over the fall semester.

As described in the methodology section, lectures on second language acquisition were given once a week throughout the fall semester in a large room in which all the freshmen attended. During these lectures, students were constantly reminded of the importance of establishing concrete English study reasons, time management skills, possible future EFL selves, and of self-efficacy beliefs. Thus, we can speculate that these reminders had a huge impact on students as they were able to *re*-motivate themselves to improve their English listening skills during the fall semester. We can also speculate that once students truly understand their English study reasons, some utilize visualization techniques, while others make use of their favorite hobbies such as English songs and movies to study English. Still others focus on improving TOEIC or other English test scores to maintain motivation to study English. English is often considered to be non-relevant to students for their daily lives and as mentioned earlier, some of *our* freshmen could not decide what they would like to be in the future. Nonetheless, many of our students made use of listening materials that they are interested in to sustain motivation to study English. Thus, it is important to take into account the degree to which English is relevant is to students for their daily lives (Donitsa-Schmidt, Inbar & Shohamy, 2004). As mentioned earlier, students, and in particular Japanese students, who have not had an opportunity to think of their true English study reasons, tend to study English only because they are told to do so or to pass entrance examinations. Since Japanese college freshmen no longer have to take entrance examinations into consideration, most of them no longer have any clear reason or find any relevance to study English in college.

For teachers, motivational strategies such as displaying appropriate teacher behavior, fostering good teacher-student relations and promoting learner self-confidence have also been found to be important to help students motivate to study English. For instance, Dorynei and Csizer's (1998) 10 Commandments for Motivating Language Learners can be utilized in class to motivate students to study English. Many studies have been conducted to investigate motivational strategies based on Dorynei's 2001 framework (see Lamb, 2017 for detailed descriptions of major studies). It also found that it is important to help "students perceive their teachers as giving them choice in what and how to learn, and that by providing helpful friendly feedback on progress, they will be encouraged to put more effort into study" (Lamb, 2017:315).

In this study, we therefore carefully employed various strategies to help our students promote learner self-confidence and foster good teacher-students relations in the spring semester, as mentioned earlier, in the fall semester, the author did not teach the CALL classes, but he gave lectures on language acquisition to all the freshmen in a large lecture hall. Thus, constant reminders of the importance of concrete English study reasons, time management skills, regulated English study cycle, visualization techniques, and of self-efficacy beliefs were presented throughout the fall semester, at the beginning of weekly lectures.

Compared to our 2016 study, though the number of students who were able to sustain motivation in the spring semester decreased, that number increased during the summer and the fall semesters in this study. We speculate that our intervention activity, which provided students with samples of English study reasons found among motivated Japanese learners, helped our students carefully consider concrete English study reasons throughout the spring semester. In addition, our activities to expand social networks in class helped students understand what concrete English study reasons other classmates have. The activities also helped students understand their possible future EFL selves by providing them with samples of jobs with EFL skills which assisted them in understanding what their future jobs with EFL skills could be. In addition, around 50% of our 2016 students could not sustain motivation during the fall semester.

In this study however, 60% to 70% of our students were able to sustain motivation to study English during the fall semester. The four crucial differences in pedagogy between the 2016 and 2017 studies were as follows: (1) in this study, we provided our students with samples of concrete English study reasons among motivated Japanese students of English, and we utilized those samples to help our students carefully consider the true reasoning behind their English study throughout the academic year; (2) we provided students with samples of possible jobs they could obtain with EFL skills in the future; (3) students shared information on their responses to various intervention activities so that they were able to understand what their classmates had thought about their concrete English study reasons, possible EFL selves, visualization techniques, and so forth; and (4) we incorporated various intervention activities with an emphasis on imagery.

As the responses to the questionnaire at the end of the fall semester indicate, some students were still unable to decide on the reasons why they want/need to study for their own benefits. Thus, it takes more than one academic year to help some of our students realize their concrete English study reasons. It is also important to note that some students were able to sustain motivation to study English because their concrete English study reasons were to be able to understand English songs or English movies, which have no relations to their future EFL selves. Because our students were freshmen, it was either simply too early for some students to visualize their possible future EFL selves or their English study reasons had nothing to do with possible future EFL selves. Nonetheless, they were able to sustain motivation to study English because they had realized that their concrete English study reasons were associated with their hobbies. We believe that our findings are important in the sense that intervention activities with an emphasis on imagery can assist students in realizing their possible future EFL selves, which in turn can help them sustain motivation to study English. Nonetheless, individual students' English study reasons differ from student to student; thus, as long as students themselves can realize the reasons why they want to study English, their reasons can be different from possible future EFL selves during the freshmen year. Those students, who maintained English study by listening to English songs or watching English movies, may eventually consider their possible future EFL selves with their improved English skills in the future.

Hadfield & Dornyei (2013) and Dornyei & Kubanyiova (2014) provide teachers with practical ideas for helping ESL/EFL students develop their future EFL visions with six stages:

1. Initially constructing the desired future self
2. Enhancing the image
3. Making the image plausible
4. Developing an action plan
5. Activating the vision to keep it alive
6. Counterbalancing the vision

It is important however to add the importance of concrete English study reasons, at least for our students, to the above stages.

As the findings of other studies indicate (e.g., Ushioda, 2007, 2009: 23), individual students react differently to the same intervention activities, so we need to keep in mind that motivation is not the product in a chain of cause and effect. In fact, within the Japanese English education context, different results were found. For instance, Johnson (2013 cited in Lamb, 2017: 329) indicated that "awareness of its instrumental value for work was the single most important motivator among second year Japanese university students of Engineering, suggesting that teachers should try to reinforce the relevance by, for example, focusing on vocational relevant genres." Fukada et al. (2011) conducted a semester-long study with students from 25 departments in six universities, and they found that visions of possible selves correlated with motivation and learning behaviors, regardless of academic major (p. 341).

Our university, located in the countryside of Japan, offers only one Intercultural Department within which around 1000 students study. Since our students have few opportunities to communicate with foreigners in English outside of faculty members, most students do not have a sense of relevance of English for their daily lives. In addition, based on our discussion of English study reasons during lesson 1, most students mentioned that they only studied English to pass college entrance examinations in high school. Thus, they no longer have any clear English study reasons after enterning college. In addition, since they only just entered college, most students had not given any thought about their future careers. And since our university offers mostly interdisciplinary programs, most of our graduates, except for those who go on to become junior high school and high school English teachers, only find work at Japanese companies where no English skills are required. Thus, many of our students have difficulty understanding the relevance of English for their future lives, which in turn makes it hard for them to even consider English study reasons. Thus, it might be important for students such as ours to consider concrete English study reasons that are for their own personal benefit (something other than passing English classes) carefully, and also that concrete study reasons can also be associated with hobbies such as "I want to be able to understand English songs or I want to be able to understand English movies because I like them." Still also some students might just want to be able to converse with foreigners in English. Nonetheless we do understand the importance of offering what future jobs they can hold with possible EFL skills, since some of our students mentioned that the visualization techniques we had introduced to them in class helped them sustain motivation to study English.

Recent studies focusing on future selves (e.g., Dornyei, 2009; Magid & Chan, 2012; Chan, 2014) seem to focus more on goals rather than purposes. For instance, Lamb (2017: 317) says that "Future selves have their origins in the social role models and media images available to young people in childhood and early adolescence; in many global societies, the valorization of English language skills and the association of the language with desirable cosmopolitan lifestyles means that by the time they enter secondary school, many pupils do already have incipient ideal English-speaking selves (Ryan, 2006; Lamb, 2012)."

Based on our study, the difference between reasons/purposes and goals seems self-evident, but it *is* important however to make a clear distinction between the two for EFL study. *A purpose refers to why something is being done, while a goal simply states something that is meant to be done and achieved.* Most of our students do indeed understand the benefits of English skills for their future careers; however, understanding of EFL skills for future benefit alone cannot help our students take necessary actions to carry out English study in their daily lives. The understanding of the importance of EFL skills cannot be the only motive to study English because many students don't have any concrete English study reasons to begin with. As this study indicates, the establishment of individually tailored English study reasons is an important prerequisite to setting future goals for English study. Only when students truly understand the reasons behind their English study, will intervention activities with an emphasis on imagery and the establishment of cooperative social networks in class help *our* students set appropriate short-term/long term goals and sustain motivation to accomplish their goals.

5. Conclusion

Aside from the obvious contributions this article strives to add to the current body of research on motivation, we also believe that our projects themselves, performed as action research, provided a certain amount of motivation to our students as well.

Indeed, Lamb (2017) reviews the major articles on teacher and learner motivation conducted in the last decade, and states as follows:

A further reason why practicing teachers need to be involved in L2 motivation research is that the process of researching can itself be motivating, for teachers and learners. Proponents of action research and exploratory practice 'e.g., Farrell 2008; Allwright & Hanks 2009) claim that systematic investigation of their own classes helps teachers develop a feeling of control and competence, a stance supported by some of the practitioner researchers cited in this review (e.g., Mearns 2012; Sampson 2012; learners too can be motivated by involvement in classroom research as they gain insight into aspects of their own practices and thought processes (e.g., Murphy & Halout 2010; Coyle 2014).

Our projects during the last five years have had one common goal: to help *our* students understand that their English study reasons can, and probably should after they enter college, be something other than to simply score better on tests. As the findings of this study indicate however, most of *our* students have, from the beginning, almost never deeply considered the reasons behind their study of English. And given that our university is a small municipal institution in which most of our students go on to graduate and work for companies where no English skills are required, many continue on in college with no more consideration for why they should study English than before. It is important then to help our students understand that there are other reasons for the study of English, be it for the purpose of finding a more fulfilling career in the future, or for simply the pursuit of a personal hobby, and that they have the right to decide for themselves the reasons for their own English study and the potential future use of English in their own lives.

This study, in addition to focusing on Todaka's (2017b) four areas to help de-motivated students become re-motivated and to enable them to sustain that motivation to study English, provided students with the following: 1) various samples of concrete English study reasons that motivated Japanese learners of English have; 2) a list of future jobs that they can hold with EFL skills; 3) intervention activities with an emphasis on imagery; 4) classroom activities that emphasized cooperative social networks.

The study found that if we focus on helping our students truly understand what their reasons are behind English study and help them perceive the relevance of English study in their lives, then activities that focus on developing possible EFL selves will help our students set short-term/long-term goals and sustain their motivation to study English.

The present study can be thought of as progress in the pursuit of helping our students sustain the motivation they need to effectively study English. In spite of this continuing pursuit, there are still some students who will find themselves at a loss when asked to consider their reasons for English study in college. It is therefore important for us as teachers and researchers to continue to search for better ways to help students realize that their present and future English study in college can be something they can make use of to enrich their future lives.

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Appendix A. A Questionnaire on EFL Learners' Self-efficacy in Listening Skills

(1) I have the ability to improve my listening skills if I try hard.
(2) I have the ability to concentrate on the content to which I listen.
(3) I believe that my proficiency in listening will improve by practicing it.
(4) I am sure that if I practice listening more often, I will be able to understand English movies without subtitles.
(5) Sometimes the listening practice in the class is difficult and I cannot understand it completely. But I believe that I can understand it if I listen to it many times.
(6) I can sustain my motivation to improve my English listening skills.
(7) I believe in my own capabilities to overcome difficult listening tasks.
(8) I won't be stressed out even if I make mistakes in listening tasks.
(9) I know I can deal with any unexpected difficulties I may face in listening tasks.
(10) I know I can improve my listening skills if I continue my study.

Appendix B. English study motivation questionnaire items

Q1. Have you been able to sustain your motivation to study English since you entered university?

Q2. If so, let us understand why you were able to do so. If not, let us understand why you weren't able to do so.

Q3. For those students who were able to sustain motivation to study English, do you always make concrete plans to accomplish study objectives?

Q4. For those students who were able to sustain their motivation to study English and always make concrete plans to accomplish study objectives, do you reflect on your study strategies to see if your learning strategies are working or not?

Q5. For those students who have completely lost interest in English study, what caused you to lose interest in English study?

Using Item Response Theory to English Grammar Assessment to Foster Learning

Ho U KEI[a], Elisa MONTEIRO[b], Joao NEGREIROS[c]

[a] *University of Saint Joseph, Faculty of Education, Macao-China, ho.u.kei@usj.edu.mo*
[b] *University of Saint Joseph, Faculty of Education, Macao-China, elisa@usj.edu.mo*
[c] *University of Saint Joseph, Faculty of Business, Macao-China, joao.garrot@usj.edu.mo (corresponding author)*

Abstract

This ongoing research reports a quasi-experimental research in the implementation of Item Response Theory with Macao secondary students. The intervention exemplified the principles of the Construct Modeling approach and the Rasch Model analysis to investigate the feasibility of those two theories in daily classroom context and its effectiveness in terms of optimizing the learning results. The purpose of this study is to seek an alternative way to evaluate students' learning by locating their zone of proximal development so as to provide instructional support to meet students' learning needs. According to our first impressions (among others), students are more motivated and more accountable for their own learning when their needs were addressed directly. Moreover, time is better utilized when students only dealt with the content they have not yet mastered. In the near future, it is hoped that this study will provide insights and suggestions which will be useful to maximize the effectiveness of such implementation.

Keywords: Macao, Zone of Proximal Development, Item Response Theory, Rasch model, English assessment

1. INTRODUCTION

Even though English has never been an official language in Macao during or after the colonial period, it has been placed significant importance. The language can be found in many curricula in Macao schools as a compulsory subject in addition to Chinese, one of the official languages. Since the casino concessions in 2002, expatriates and more foreign visitors were attracted to work and visit this place and, hence, the use of English has become an imperative language.

Schools design and teach English based on their own interests following routines and practices of their own (Young, 2009). As a result, the learning outcomes are not significant (Sansom, 2016). There are also gaps between the levels of secondary graduates and requirements of tertiary level (Young, 2009). More importantly, many students fail the subject, which has even become a concern in Macao. In order to cope with this problem, many schools have applied subsidies to provide additional tutorial lessons. Nevertheless, the selection of the students attending such tutorials is based on traditional summative assessment. As it can only inform the overall result of a particular test and does not provide sufficient evidence and information indicating the difficulties and the learning gaps of each student, teachers are unable to make instructional adjustment. As a result, investment on such supplementary tutorial lessons to promote English learning only results, quite often, in the waste of time and human resources.

According to Vygotsky (1978), the Zone of Proximal Development (ZPD) is the gap between what a child has already mastered and the knowledge he or she can achieve through guidance from an adult or a more able peer. By locating the learner's ZPD, teachers will be able to understand what the learner already knows and what level of knowledge he or she is able to master if given instruction, thus, enables teachers to make efficient instructional decision and provide assistance accordingly.

The Rasch model is said to be the most widely used model in Item Response Theory (IRT) family (Heydari, 2015). It measures the relationship between the items and the examinees' performance by placing the item difficulties and the person's ability on one logit scale (Li & Luo, 2014) to make it possible to locate the ZPD of a person (Yao & Mok, 2013).

The Construct Modeling approach, another theory developed from IRT, is being integrated with the Rasch Model analysis to examine the hierarchies of the learning content (Rittle-Johnson, Matthews, Taylor & McEldoon, 2011). With such information, teachers are able to understand the needs of any student, design and provide learning support accordingly.

As traditional Summative Assessment practices do not provide efficient feedback for teachers to make instructional decisions, this present study seeks to implement the Construct Modeling approach (Wilson, 2003) and the Rasch Model analysis as Formative assessment (Yao & Mok, 2013) to assess learning. Winsteps (Linacre, 2011), the assessment tool of the Rasch Model family, is being used to analyze the results of English Grammar quizzes so as to examine what information can be generated to help teacher check the hierarchy of English grammar knowledge within the overall scale. These results are being used to locate the ZPD of each student in order that teachers can make efficient instructional support to optimize the learning outcomes in a daily classroom practice.

Quasi-Experimental design has been applied to conduct this current study. By administrating the intervention and collecting data for comparison, it sought to answer the four next research questions: (A) What information can the Construct Modeling approach and the Rasch Model analysis generate to help teachers check the hierarchy of English grammar knowledge within the overall scale? (B) How can the information generated by the Rasch Model analysis locate the ZPD of each student and help teachers generate instructional support? (C) In what way can the instructional support based on the Construct Modeling approach and the Rasch Model analysis foster learning? (D) What suggestions can be made in terms of applying IRT in teaching process to promote learning?

Regarding the significance of the present study, these authors believe that if teachers can make more efficient instructional decisions, all students with various needs can be catered in the same classroom simultaneously. Thus, no other supplementary tutorial lessons of English will be needed and the time for such classes can be saved and utilized for other educational purposes. Additionally, the hierarchy of knowledge generated by the results of Winsteps can help set up item banks by indicating the items of the same level. The items can then be stored under different categories. Such item banks will be a useful tool to generate sub-tests of the same topics (Heydari, 2015) and make teaching more efficient and effective. At last, with better guidance of teaching and evaluation provided by the educational administration, schools of Macao can create item banks together and thus, the real collaboration among schools can be fulfilled to form a real learning community and help improve the learning of the students together.

2. Literature Review

2.1. Summative and Formative Assessment as Assessment for Learning

The aforementioned phenomena are the setback of summative assessment (assessment of learning) used in Macao (Sansom, 2016), where results of exams are only used to fulfil the purpose of reporting and recording (Harlen, 2005). Moreover, even though the results of tests are used as feedback to instruct what action to be taken next, such instruction is efficient only when the learning progress of a learner is located clearly and supported accordingly (Black & William, 2010). Nevertheless, teachers tend to locate the learning progress through raw scores. Also, Yao and Mok (2013) indicated raw scores could not be assumed as interval-level data. Students gaining the same marks from different groups of test items do not result in the same level of ability.

According to Black & William (2010), researchers agreed that assessment should happen more frequently with a strong intention, that is, to provide effective feedback to allow learners to succeed in certain degree. If so, these results of formative assessment could be used as data to inform the future learning needs. By managing this data carefully, diagnostic feedback like the gaps of learning could be acquired, thus, instructional adjustment could be more effective (Stiggins, 2005).

Lee (2007) believed the results of formative assessment could produce positive response of the students if managed effectively with clear, student-friendly learning goals and support with guidance by teachers. Nevertheless, whether the information is valid depends very much on the quiz quality. Questions of good quality present strong relevance to the main learning objectives and ability to communicate with the students, that is, to inform their current state of learning. Thus, formative assessment requires scrutiny and careful planning (Black & William, 2010).

Moreover, the choice of tasks is important (see Figure 1) and must be able to remain consistent with the learning objectives they serve (Black & William, 2010). Owen (2016) concluded in his research that there should be a number of progressive, low-stakes assignments in the process of learning so that students were allowed to reflect their own works and to have enough time to develop strategies confidence for the final tasks. Additionally, in the process of formative assessment, students must be allowed to express their own ideas. Wilson (2014) agreed by mentioning the most important part of formative assessment was the instructions and guidance from the teachers to assist students to develop appropriate strategies.

	Where the learner is going	Where the learner is right now	How to get there
Teacher	1 Clarifying learning intentions and criteria for success	2 Engineering effective class-room discussions and other learning tasks that elicit evidence of student understanding	3 Providing feedback that moves learners forward
Peer	Understanding and sharing learning intentions and criteria for success	4 Activating students as instructional resources for one another	
Learner	Understanding learning intentions and criteria for success	5 Activating students as the owners of their own learning	

Fig. 1. Aspects of formative assessment (Black & William, 2009)

2.2. Item Response Theory

Item Response Theory (IRT) is a modern measurement theory based on the possibility of a person with certain latent trait succeeds on an item of specific difficulty. Basically, it describes the relationships between an examinee's abilities and item response (Heydari, 2015). Thus, by studying the response of an examinee in a test with items of various difficulties, the level of ability of the examinee can be located and tests can be tailored to individuals' level of ability (Myers, 2015).

2.2.1. The Rash Model

This one-parameter model is the simplest in the whole IRT family (Myers, 2015), for there is only one parameter, item difficulty, to be considered along with person ability and, thus, it is more comfortable to work with (bin Khairani & bin Abd Razak, 2012). Additionally, the Rasch Model analysis can be implemented with the Winsteps software.

Another common Rasch Model analysis is the generation of the Wright Map (see Figure 2). This diagram is a visual representation of the distribution of the examinee's abilities corresponding to the distribution of the item difficulties. The examinees' abilities and the item difficulties are placed on one vertical straight line with two panels: right and left. The examinees are placed on the right and the items are placed on the left. Both are plotted on a Wright Map based on their abilities and difficulties.

The most able examinees and the most difficulties are found on the top of the scale. On the contrary, the examinees and the items found at the bottom of the scale are those of lowest ability and lowest difficulty. The mean of item difficulty and the mean of the student ability are also placed on the scale (Linacre, 2011). If both means are close to each other, it means there is good alignment between examinee ability and item difficulty, which indicates that the test is suitable for the group of examinees and that the items are not too difficult and too easy for them. Additionally, by locating the examinees' abilities in accordance with the item difficulties, teachers can obtain information of the ZPD of students and foresee their sequent learning needs (Yao & Mok, 2013).
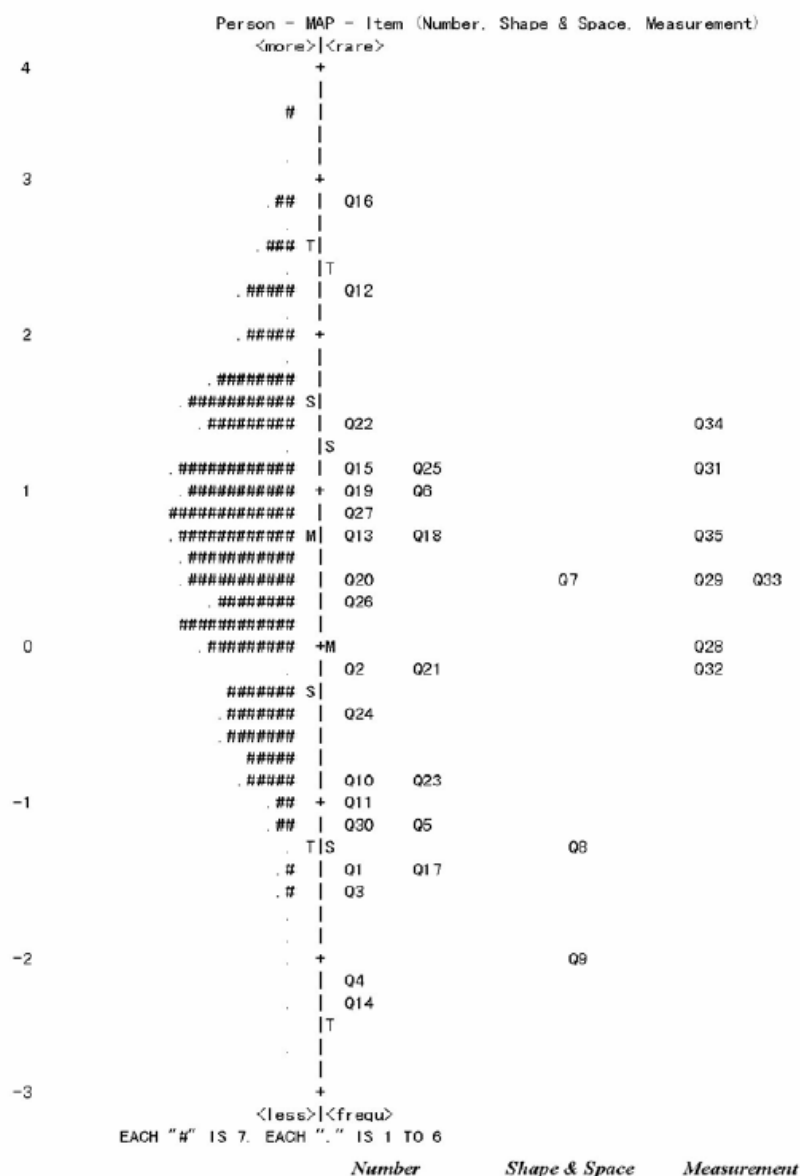
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Fig. 2. Sample of Wright Map of Items and Persons (Yao & Mok, 2013)

2.2.2. The Construct Modeling Approach

Another model, namely, the Construct Modeling approach is also developed from IRT (Duckor, Draney & Wilson, 2009). A Construct Map is a well-designed sequence of qualitatively various levels of performance focusing on one characteristic of the content (Wilson, 2009). In the Construct Map, the content of teaching and learning is placed on hierarchical levels in accordance of the learning progression (Briggs, Alonzo, Schwab & Wilson, 2006).

Next, classroom instruction and the different types of assessment should be selected carefully to match the various levels in the Construct Map so that a student's responses to items of certain level can be seen as an estimate of his or her level of understanding. These four researchers mentioned that the Construct Map helped locate the current progression of the student and provide diagnostic information of misconception.

Additionally, student responses for the items should be categorized according to a particular progress variable, which are scoring guides for student responses to assessment tasks (Wilson, 2009). Finally, the items and the student responses could be examined by a Wright Map.

Researches showed that careful construct of the model was able to match the result of the Wright Map (Rittle-Johnson *et al.*, 2011). Thus, it also helped teachers locate the current learning progress of students and provide diagnostic information of the sequent learning goals (Taylor *et al.*, 2009). Yet, researchers agreed that the

implementation of such model was not easy and that professional training should be provided to teachers (Rittle-Johnson *et al.*, 2011).

3. Methodology, Participants & Ethics

This ongoing study comprised of three cycles addressing three different topics of English grammar (see Figure 3). It began with a pilot study to establish the conceptual ideas of this empirical study. The establishment of the Construct Map where the division of each level was made in accordance with the extensive study of the instructional sequences in the textbooks as well as the researcher's experiences. This map was served as guidance for teaching and design of the preliminary test. More importantly, it was the benchmark for the comparison with the Rasch Analysis in the latter phase of this empirical study.

After the teaching progress of each topic, the preliminary tests were given to students to evaluate their learning. The generation of Wright Map as the Rasch Analysis was also conducted at this stage in attempt to evaluate the previously established Construct Map and locate the students' understanding. The results of the analysis are being compared with the previously created Construct Maps to make revision, if necessary.

Supplementary exercises referring to various hierarchies in the revised Construct Maps were then designed accordingly and provided to the students. They were placed on a single worksheet but assigned to students based on the location of their ZPD and illustrated on the Wright Map.

At the accomplishment, a second test was given to the students a week after the preliminary test and the results of it were served as comparison with the preliminary test to evaluate the effectiveness of the intervention. In order to explore the holistic picture of the impacts of the treatment, semi-structured interviews were being conducted before and after the second tests to investigate students' perceptions of the tests and the intervention. Additionally, research diary entries are being logged throughout the whole administration to provide descriptive data from the researcher's perspectives.

Experimental design refers to researches in which a group of participants are randomized to undergo different researcher-imposed treatments or intervention (independent variable) followed by the evaluation of such treatments or measures the outcomes (dependent variable) (Cohen *et al.*, 2007). However, it is difficult for researchers to have complete control of the experiments and to randomize the participants in educational natural settings. Quasi-experimental design is similar to the laboratory experiment in which variables are controlled, isolated and manipulated. However, the setting is natural rather than the artificially established environment of the laboratory (Cohen *et al.*, 2007). Therefore, the response of the participants becomes more realistic and adopted under this current study.
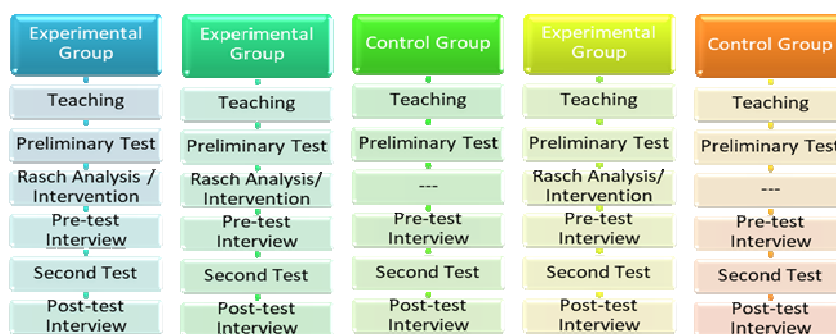

Fig. 3. The sequence of the study

The location of the ZPD through the Construct Modeling approach and the Rasch Analysis as Formative assessment and supplementary exercises (corresponding to a particular ZPD) were served as the intervention or treatment within this quasi-experiment. The researchers desired to discover students' learning needs during the interval of instruction and to identify their learning goals so that instructional support can be provided to address to their needs precisely.

Concerning the ZPD allocation, two processes needed completing. The first one concerns the division of the teaching content which involved the creation of Construct Maps. This process was important as it was used as guidance of teaching and creating relevant tests. The second process was the Rasch Analysis in which the results of the preliminary test in each cycle were input and processed by Winsteps.

Regarding to the instructional support, the revision of the Construct Maps with the results of the Rasch analysis was administrated. The purpose of such procedure was to ensure that the supplementary exercises were designed in

related with the students' performances so that they were able to address to the needs of them. The newly revised Construct Maps were being then utilized as guidance for teachers to include items and exercises of various hierarchies illustrated on them. At the end of each cycle, a second test is being given to investigate the effectiveness of the intervention.

This pilot study started to be undertaken for three weeks in October 2016. The subjects were Senior One students from a Chinese-medium secondary school in Macao. As the Differentiation Methodology was applied to the English subject in senior one grade, students were grouped in accordance with their English examination results in the previous academic year (2015/2016). They were assigned into three groups, namely, higher, medium and lower level. Moreover, such division is revised every term based on the students' academic results of that term.

Participants of the pilot study comprised of 3 experimental groups, a sample of 54 students from this grade. There were 13 students of lower ability (7 boys and 6 girls), 41 pupils of higher ability (23 boys and 18 girls) from three English Classes. Random sampling was utilized to respect statistical assumptions. All of the participants are Chinese and largely speak Cantonese or Chinese in their lives.

The Construct Map of the selected grammar topic (Simple Present Tense and Present Continuous Tense), was created followed by the two-week teaching process. The target learning content was divided into four levels and the questions of the preliminary test given after the teaching process were designed based on the Construct Map. The intervention, namely, the supplementary exercises were also created at this stage.

At last, the preliminary test was given to students at the end of the two-week teaching and the results are being analyzed with Winsteps. Alteration of the Construct Map was made based on the Wright Map of the preliminary test. The supplementary exercises were then given to students according to their ZPD, illustrated by the Wright Map. Finally, the students were given a second test of the same learning content. It is also crucial to stress that research diaries are being logged on weekly basis.

Ethics is regarded as one of the essential factors to be considered when conducting researches that may cause dilemma and problems in the process of research (Cohen *et al.*, 2007). Under this present study, five measures have been taken place to respect this topic:

1. Access and acceptance: As the present research is being taken place in a secondary school in Macao, the principal and the administrators were informed. A meeting was held while the purpose of the study, the duration, the subjects, the data to be collected and the procedures were reported in detail. Upon the approval of the school administrators, the research plan was then reported to the panel of English subject as suggested by researchers.

2. Students' right to learn: The selected participants were also informed of the implementation of this research. The usual weekly meetings were held to ensure the coverage of content and the similarity in teaching instruction, thus, the right of learning for the remaining students excluded the research were secured and protected. Simultaneously, while supplementary exercises were developed and provided to the experimental groups, English teachers of the same grade were informed of its existence and given antonymous to develop exercises of their own.

3. Privacy: The data collected were confined into the tests results and the students' perspectives of this intervention. Additionally, meticulous attention was given when maintaining the privacy of information received and was kept anonymously.

4. Anonymity: Codes were utilized to identify the participants (both the experimental and the control groups) and only the researchers have the full record of the quizzes results of the participants. Additionally, the record for the semi-structured interviews was handled with great care to prevent the reveal of the respondent's identities.

5. Confidentiality: All the data collected for the present study are being handled with meticulous attention and are only served for the purpose of this study only.

4. First Ongoing Conclusions and Limitations

Although this study has not been concluded, some curious inferences can be already drawn. First, for the content that was regarded as manageable was found more difficult for the students. The researchers predicted that the students were able to put the verbs of the Simple Present Tense and the Present Continuous Tense into the negative

and the interrogative form. However, the results of the Rasch Analysis showed the questions referring to this part of content (Q3 and Q4 in the preliminary test) were in a higher hierarchy, meaning students found it difficult.

Findings from the semi-structured interviews showed students had higher opinions on the intervention than students who are ZPDs were not located. When asked for their perspective on the intervention, students in the experimental groups welcomed the intervention and claimed to have better understanding through practices. Additionally, the number of the exercises was not overwhelming. They revealed higher motivation of accomplishing exercises which were not assigned to them or were more difficult for them when responding to the sub-question whether they would finish all the exercises. Competent students were found satisfied with the exercises since they were challenging for them.

Finally, higher receptivity of additional exercises and motivation in learning were found in those students. They would accept extra work and welcome additional exercises as the result of the higher expectation in the intervention. Students echoed assurance of the necessity and the effectiveness of the intervention. They stated they had better understanding of the learning contents and were more confident about their answers as they developed the habit of applying the grammar rules to look for indicators. They also utilized the intervention as revision or pre-tests for the second tests.

Similar to other research studies, some limitations can be found including (A) The study was only involved students from one Chinese-medium secondary school in Macao; (B) The limited number of items in each test prevented in-depth examination of the effectiveness of the intervention (the duration ran for only one week, which may not be sufficiently long to maximize the effectiveness of it); (C) The researchers do not have complete control in the tests arrangement as school announcement might emerge, which caused postpone of tests and affected the performance of the students; (D) There was a lack of in-depth responses in semi-structured as the result of limited available time for the interviews (some were conducted after school when the students wished to leave, thus, some of them gave hasty and brief responses); (E) The study has been focusing on the perception on the intervention and did not measure other factors, such as motivation, self-esteem and the relationship with the teachers, which may also cause the influence on the learning outcomes.

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Learning from learning: Pitfalls and opportunities when using personal learning experience to inform in-service teacher development

Malcolm PRENTICE[a]

[a] Soka University, World Language Centre, Tokyo, Japan. prentice@soka.ac.jp

Abstract

This presentation describes a method for effectively helping teachers to use their own personal learning experience to inform an in-service professional development project. While the literature is clear that teachers' learning experiences have an impact on their practice, there are significant obstacles to drawing effectively on that resource for deliberate in-service teacher education. Teachers might have no recent learning experiences, might not reflect on experiences they do have, might not act to change practice following reflection that does occur, or might act without critical attention to the difference between the contexts of their learning and their practice. In this presentation, a review of the literature is given, and a solution is outlined: a structured guide developed to help teachers avoid these obstacles, following a modified Action Research pattern and using Narrative Frames to elicit reflection. Several case studies will be presented of language teachers in Japanese universities following this guide to re-examine their approach to homework and self-directed learning. The aim is to develop a process which professional development coordinators in institutions can adapt, to help teachers critically reflect on personal learning experience in order to improve their practice, while avoiding the obstacles mentioned above.

Keywords: Effective Teaching Pedagogy, Language Education, In-Service Teacher Education, Reflective Practice, Action Research, Higher Education

Student Preferences for Peer Feedback Partners

Tanya ERDELYI [a]

[a] International Christian University, English for Liberal Arts Program, Tokyo, Japan, tanyae@icu.ac.jp

Abstract

Peer feedback (PF), providing suggestions on the written work of fellow peers, is widely used in L2 writing instruction for its benefits in improving writing and promoting collaborative learning. An important, but underemphasized, element of PF is peer group dynamics. PF researchers use various methods for arranging PF groupings in their studies, such as teacher-assigned groupings and student-selected formations. However, PF group arrangement is rarely the focus of these studies. Little attention is given to student preferences for feedback groupings, the characteristics they seek in their partners, and the criteria they use to make partner choices. This case study involving three Japanese university students explored student preferences in feedback groupings through semi-structured interviews. The interview findings, combined with the findings from ongoing action research survey data, showed that student preferences are rich and varied. Several key factors were identified and used to construct the Peer Feedback Partner Survey. This survey can help raise awareness of and promote discussion about the various writing traits that are important to students. In turn, the survey can help students form their ideal PF triad, a group of three carefully selected individuals who rely on each other to make improvements to their academic writing collaboratively.

The value of education of Ukrainian and Czech teachers

Pavlína KOBZOVÁ

Palacký University Olomouc, Faculty of Education, Žižkovo nám. 5, 771 40, Olomouc, The Czech Republic
pavlina.kobzova01@upol.cz

Abstract

This article deals with the comparison of the value of education of Ukrainian and Czech teachers teaching pupils in the area of secondary education in the Czech Republic and Ukraine. The aim of the research was to find out how teachers - Ukrainians and Czechs perceive the value in their countries and what are the consents, similarities and differences in their attitudes towards education. The target group consists of teachers of Ukrainian nationality teaching in Ukraine and teachers of Czech nationality teaching in the Czech Republic. These are teachers with an average of 20 years' experience teaching at grammar schools, high school and general elementary and secondary school. The research is carried out through a qualitative design using the semi-structured interview method. The contribution is part of a larger research on the issue of value of education among pupils from a different socio-cultural environment, focusing on pupils from Ukraine who are educated in Czech schools.

Key words: value, education, attitude, teacher,

1. INTRODUCTION

The text deals with the issue of the value of education, viewed from the point of view of Ukrainian and Czech teachers in their mutual comparison. The aim of the research was to compare the value of the education of teachers of both nationalities to find out what are contents, similarities and differences in their attitudes towards education and the education system in their countries.

We assume that the value of education and attitudes towards it are linked to different areas of the educational process, ie the teacher's relationship to the various aspects of the educational process, including relations with pupils, attitudes towards education or the education system as the overall context of the problem. Since we have devoted time to the issue of the value of education of pupils from a different socio-cultural background with a focus on Ukrainian pupils in schools in the Czech Republic, we were interested in what kind of school environment and value background in schools in Ukraine these pupils come from. Emphasis of Ukrainian and Czech teachers in the field of education and educational process we have tried to compare each other and to get an outline of the situation in which pupils from the Ukrainian value background come to the Czech one.

In the theoretical part of this article, we define the main concepts of value, attitude, education and the teacher that we are dealing with. In the second part of the text, we describe the methodological part. For research of our issue we use a qualitative approach with a semi-structured interview method. Obtained data were analyzed by the open coding method. To compare the two phenomena, teachers of Ukrainian and Czech nationality, we applied the comparative research method in pedagogy [1]. The phenomena of Ukrainian and Czech teachers teaching in

their countries we compared each other in four attributes, the areas that represent the teacher's relation to the teaching profession, the attitudes of the teacher to pupils in their country, the position and the role of the teacher in the educational process, and the evaluation of teachers of the local educational system.

2. Theory

For the purposes of our research, we define the central concepts of the article, which are the terms value, education, attitude and teacher. Part of human existence is the ritual of evaluation where we evaluate everything we see, perceive what we learn, including human actions, relationships, and behaviors. The attitudes of man to the world are therefore not just "cognitive relationships, but more often just our assessment ... Evaluation represents the perception of things, events and our actions through our values."[2]

According to Zbořil [3] who dealt with the question of values from a philosophical perspective, the evaluation is a certain type of cognition, but it also includes an emotional component. The evaluation is always done through our judgment. Zbořil [3] tried to develop a scientific approach to values, and concluded that values cannot be either things or events, properties, even qualities, but the relationship between the subject and the object. "The essence of value is therefore in relation to the tendencies of living totality." [3] Our research is description of the relationship and attitudes of teachers of two nationalities to the value of education. Zbořil [3] further dealt with the question of the objective value criterion and defined it as an objective universal value which he formulated as a practical demand for "humanity to live in the world with only positive values." Based on the outlining of the general human ideals and goals which, according to the author, is the well-being of all people, combined with perfect knowledge, freedom and morality and beauty, has created this sorting of values:

- eudaimonistic (absolute beatitude)
- cognitive (knowing, when the ultimate goal of a person is perfect knowledge)
- ethical (perfect freedom of action, but not desirable without perfect morality)
- aesthetic (perfect beauty)
- the religious (the combination of all the ideals that can be called the ideal of absolute perfection)

Zbořil [2], the first four classes of values perceive equally, none of these categories of values are higher than others. Only religious values have a higher value because they are the synthesis of the previous values categories. If we want to place the value of education in these categories, it would certainly belong into the category of cognitive, since the aim of education of individuals is to gain knowledge, instruction and understanding of the phenomena around them. Education undoubtedly also belongs to the ethical category, since education is embedded within moral principles. If the process of education and the achievement of the education bring to individuals a feeling of satisfaction, the fulfillment of his goals it can also be into the category of eudaimonistic.

Significant philosophers in their time (in the 17th and 18th centuries) spoke about the sphere of values, which they perceived differently. While Kant put values and morals in the field of mind, Hume considered the essence of all values as a feeling. Dorotíková [4] adds that "without feeling people would be indifferent and lose sense for morality", ie their orientation to goodness and for sense to values. Value in terms of sociology characterizes Jandourek [5] as "a conscious or unconscious idea of what is desirable." According to the author, the value can indicate our attitude towards the object and can also be a scale for decision-making and dealing. Jandourek [5], like Zbořil [3], emphasizes that there is a relationship between the individual in which a person takes a stance towards value. These are our relationships and attitudes to the values that are subject of change, but the value itself remains unchanged. The value of education as well as other values such as family, peace, friendship, cohesion, individuality and so on last. What is changing is our attitude and relation to these values and the purpose that society gives them in different historical periods. We fully unite with the author's opinion and it will be the starting point for us in the following text.

About the persistence of values in time and their usability Prudký [6] states that an individual has a wide range of values, and that some of the less important individuals are rarely exploited. Others, on the other hand, are

crucial for human life. These "values of life" are like pillars that support and to affect human life and tend to be constant, unchanging. As such pillars or fundaments, we see the education that represent, at least for the surveyed group of respondents, a key and lasting value with positive meaning for their lives. Göbelová [2] considers value as a concept which "includes other concepts that deal with the dynamic and social characteristics of a person - such as goals, preferences, motives, ideals, thoughts, actions, adaptation processes." The specific objectives of teachers in education are, for example, their educational goals, the essential facts that they want to pass on to their pupils in the educational process. It may also be self-education goals such as updating knowledge in their field, increasing professional competencies, inclusion of new methods in teaching, etc. Ideal of teachers are undoubtedly pupils intelligent, understanding, devoted, showing respect to the teacher, but also creative and self-contained in thinking, with a positive attitude towards learning and knowledge. A very obvious feature of values for Fajkus [7] is the fact that they are realized in the personal identity of an individual. It constitutes such an essential element of the personal and social identity of man. Values are therefore strongly associated with the inside of a person. For both groups of respondents, the educational process at the external level is part of their social identity, which is connected with the performance of the profession. For many of the teachers-respondents, is education a personal mission inseparable from their personality. So, if they had to do another job, they probably would not feel satisfied.

The attitudes of humans are closely related to the question of values. The relationship between values and attitudes is dealt by Hayes [8], who states that "values are relatively stable personal preconditions that lie in the very basis of attitude. Attitudes are related to general principles such as what is morally and socially desirable." For this reason, personal values have the role of standards by which we assess the behavior of ourselves and others. "Values are therefore closely linked with attitudes, so human attitudes are usually derived directly from the basic value system of individual".

Another key concept is education that is a precondition for the development of man and whole society. Education is the sum of the knowledge and skills, attitudes and values which we acquire during public education and self-study. Its value and at the same time the goal, in line with Göbel's definition [2], is the transfer of thought between people and the ability of critical thinking. Well-educated people are less influential and manipulative, seeing things in context. According to Průcha [9] education can be viewed as a result of learning from a number of points of view. From the point of view of personality (cognitive component of personality), content (summary of information and activities contained in curricular documents), institutional (socially organized activity distinguishing level, degrees and types of education), socio-economic (education determined by social and economic factors) and education as a process (education as a process that includes the previous aspects of education).

In this paper, we focus primarily on the first point of view, ie personality education concept with an emphasis on attitudes and values in relation to the value of education in the Czech Republic and Ukraine. Perceiving education as a value of teachers may vary with respect to different preferences of values, including own value preferences. Differences in attitudes to the value of education can also include acting of teachers within a school institution in their homeland.

The third starting point is a teacher, to whom Strouhal [10] states that one of the proclaimed roles of the teacher is "to be the bearer of education." To the problem of the nature of the teaching profession the author discusses the thesis that in the past teachers were considered "to be primarily a guarantor of cultural transmission, to pass to coming generations the forms of cultural life usual in a society and time, stand up for the generally accepted moral...as someone who is involved in the consolidation of social bonds ". Following this idea, Strouhal [10] further debate over the role of the teacher in the current pluralistic society, where there are loose social relations. Whether the teacher should be someone who "indoctrinate the so-called shared values of each individual ... or to recognize in each person his unique determinants, the profession for a certain type of activity ... or the teacher should to serve to develop individualities or even the needs of labor market. We agree with these ideas and we note that all of these ideas form the basis of the professions of a teacher and contribute to the fulfillment of the teaching profession.

3. Methods

Due to the nature of the research focus, a qualitative approach was chosen. To obtain data was used the semi-structured interview method. Data material was analyzed by the open encoding method.

The comparative research method in pedagogy was used to compare the value of education of teachers of both nationalities. "In order to make comparisons at the level of the scientific method, the phenomena to be compared must be more, it must be comparable, and it must be a systematic explanation of the findings and the search for causality in the overall context that has a scientific character" [1]. The principles that Vlček [1] states in his research are:

• Plurality
• Comparability
• Contextuality
• Science

In order to respect the principle of pluralism, it is necessary to compare at least two specific phenomena. Comparable phenomena in our text are Ukrainian teachers with Czech teachers (see table 1. and 2.). According to Váňová [11], a relationship based on consent, similarity or difference is formed between phenomena of the same kind. To obtain new knowledge in the comparison, it is necessary to look for similar but also different phenomena [1] (Vlček, 2015).

The aim of comparing the value of the education of teachers of both nationalities is to point to possible consents, similarities and differences in the perception of the value of education, the attitudes of teachers to education and the educational system in both countries. The basic consent of both systems in the Czech Republic and Ukraine is the predominant traditional system of education with frontal method and with a more or less main figure of teacher. Differences between the Czech and Ukrainian educational system are in the degree of requirements for some taught subjects (especially mathematics), the perception of teacher's attitudes towards pupils is different, we also observe differences in the behavior of pupils to teachers and the fundamental difference is paying for secondary school sometimes and for university studies in Ukraine. While in the Czech Republic the study is free of charge.

The principle of comparability also calls for a clear definition of phenomena that we will compare and which attributes of both phenomena will be taken into account [1].The phenomena to be compared are three teachers of Czech origin teaching at two grammar schools and a secondary school in the Czech Republic. The second compared group consists of three respondents of Ukrainian origin teaching at a grammar school and general elementary and secondary school which is in the 9th – 11th grade comparable to the Czech secondary school. Based on the analysis of the text by the open coding method, have been determined the following attributes, which we will compare with both groups of teachers:

• Teacher's relationship to the profession

• Teacher attitudes towards pupils in their country

• Position and role of the teacher in the educational and training process

• Assessment of teachers of the local education system

Contextuality is another crucial feature of comparison, because "pedagogical phenomena must be compared in the overall context" [1] (Vlček, 2015).

Table 1. Description of Ukrainian teachers

Ukrainian teachers	Age	Subject	The length of practice	Type of school
Anna	54	English	24 years	Grammar school
Uljana	65	Health education	40 years	General elementary and secondary school
Natalya	40	English	15 years	General elementary and secondary school with deeper tuition of foreign languages

Table 2. Description of Czech teachers

Czech teachers	Age	Subject	The length of practice	Type of school
Jana	51	History	17 years	Grammar school
Petr	56	Technical subjects	25 years	Secondary technical school
Adriana	42	German and Czech language	19 years	Grammar school

4. Findings

This chapter brings results from semi-structured interviews with Ukrainian and Czech teachers. The first four subchapters (4.1 - 4.4) deal with the values of education of teachers of Ukrainian nationality and the following four subchapters (4.5 - 4.8) deals with the results of the research conducted with Czech teachers according to the above four characteristics.

4.1. The relationship of Ukrainian teachers to the profession - teaching and education as their prime role

Teaching profession as a mission, perceive Ukrainian respondents identically regardless of whether teaching was their dream or not. Teaching is seen as a difficult profession because the teacher works with different pupils' characters and social backgrounds of them, but if teacher sees the results as successful and motivated pupils, it is a very grateful profession. Teacher's authority should not be based on manipulation with the pupils, in the sense of "breaking upbringing of a child" (Anna). The teacher only corrects different pupils' deviations from good school benefit and standard of behavior to the extent to which the pupil permits it and assists the pupil in choosing the right life priorities. The position of teachers in current society is perceived by the respondents in a traditional way, which means that the character of teachers should be a model for their pupils not only in their words but above all a personal example of their good life. The limits of their profession are perceived by respondents in the impossibility to provide and teach all knowledge all pupils. However, Ukrainian respondents see the sense of this profession that even a few pupils who really care about the subject are enough to give teacher strength and motivation to teach further.

According to respondents, the ideal teacher is one who, despite various disappointments, loves his work and has an understanding for the pupils. At the same time, it should be teacher whose qualities and virtues in his professional and personal life his pupils overcome. The professional and social role of a teacher is still highly

appreciated in the territory of Ukraine because teachers are consider to be who not only educate pupils´ mind, they also care about upbringing pupils and influence their personal development.

4.2. The attitude of the Ukrainian teacher towards the pupils in his country

Our respondents in relation to their pupils talked about their graduates who successfully completed their studies and continue in studies at universities. As the success of their pupils, teachers considered self-realization of their pupils in what they dreamed about. Last but not least, the positive result of teachers' work and the ability of pupils to better take care of their family, eg due to knowledge of English, without the need to emigrate abroad for better income.

Respondents primarily aimed to educate pupils as citizens, patriots who will be devoted and faithful to their country and whose lives will be in accordance with moral principles and conscience. Moral quality and a healthy way of life were also values which our respondents tried to pass on their pupils and which support positive attitude of pupils to the education. Respondents have no doubt that if they are trying to cooperate with their pupils they will certainly be able to maintain discipline and good manners among pupils. The teacher also emphasizes the need to check and correct pupils. According to Ukrainian respondents, it is also essential that the teachers showed pupils their interest in pupils´ opinions, interests and talents. Teachers stimulate pupils' interests through attending thematic conferences, school Olympiads or out-of-school activities. If Ukrainian respondents see an interest and effort of less successful pupils, they support them. Among those pupils often belong those who have one or both parents abroad for work and their relatives care about them. Respondents call these pupils as "the orphans of living parents" (Natalya, Anna).

A characteristic feature in the relationship of some Ukrainian teachers - practicing Christians to their pupils is the teacher's pointing out to respecting the God´s commandments and God's Word. These methods, according to respondents Uljana and Anna, work with some problem students. It is not just about placing emphasis of teachers on good manners (apologize, do not deceive, greet, do not speak vulgar words) which should be standard in schools, but teachers tries to lead their pupils humility, not to follow only their good, but to can give up it in the benefit of the other individual or group, not to find a mistake in the behavior of the other, but first at itself, not to argue, to be able to forgive another, etc. However, this behavior can only be achieved among pupils by living personal example of their teacher.

All Ukrainian respondents – teachers are intensively involved in education, which doesn´t consist in 8 hours of teaching, but their activity often continued beyond school education and interfered with teachers' leisure time. For example (Natalya, Uljana), lead groups of interests, they discuss various questions with pupils through social networks (Natalya) and they are also interested in family situation of pupils (Anna, Uljana).

4.3. The role of the Ukrainian teacher in the educational and educational process in Ukraine

The learning process must not lack the necessary self-reflection according our respondents. Ukrainian teachers regularly try to analyze lessons, possible failures, communication and negotiation with pupils, and their evaluation. Without reflection, the next hours will not bring favorable results. Teachers emphasize the importance of self-education that motivates them to work on themselves, but also to develop pupils' preconditions. Respondents use the opportunity to attend seminars, courses, conferences where they meet with foreign teachers, learn new methods of working with pupils within the subject (for example, the Method of the Brettonian Council in the subject English, based on the communication of pupils in a group and in pairs).

Ukrainian teachers pay much attention to work in so-called methodical, subject groups, where colleagues share mutual knowledge and recommendations. The objectives in teaching of our respondents are different and depend

on the nature of the subjects being taught, for example in the subject of English, the teacher tries to open up opportunities for the pupils to apply in the world, to motivate them to travel and work abroad, to be able to talk fluently with foreigners, to broaden pupils' views and enrich them about the knowledge of the new culture. The aim of teaching of Uljana - Teacher's Health education is to pass her interest in healthy eating and a balanced lifestyle on her pupils in an interesting form and to wake up an interest in healthy way of life and sports.

Respondents do not question the fact that the educational process influences their life. Two respondents (Natalya and Anna) were so responsive in their beginnings to teach that they neglected the time with their family. However, the time spent with studying methodical literature and searching for suitable topics for pupils did not regret (about 15 years ago was lack of methodical literature in teaching of English in Ukraine). At present time, such literature is already available.

4.4. Evaluation of the local education system by Ukrainian teachers

To domestic school system in Ukraine respondents often expressed critical views that touched upon several areas. On the one hand, there was a critique of school programs, which are glut by unnecessary materials from the point of view of all three respondents, and pupils are also overload great amounts of learning in subjects. However, teachers are able to reduce unnecessary topics within their subject. Respondent Anna mentioned that the high-ranking scale in the evaluation is also having difficulties in reaching out for even capable pupils, who are achieving unnecessarily lower scores. The high demands of Ukrainian education are on the pupils, even with regard to the termination of education in the general elementary and secondary schools (the general elementary and secondary school in Ukraine lasts for 11 years and its graduation is roughly at the level of the Czech leaving examination). In Anna's opinion, there is no education for education but for its use in the pupil's life. It should be noted that graduates in Ukraine unfortunately often face the problem of getting a job.

Another phenomenon of the Ukrainian system of education, especially for pupils who find themselves before the final exam, is a need for a lot of extra tutoring. Tutoring can help pupils achieve high grades at the final exam and help him get a state-paid place at a university. Paid university studies for the vast majority of Ukrainian students is another criticized point in the education system along with the presence of bribes at universities. Currently, a reform of education is in progress in Ukraine and it brings, for example, the merging of several subjects into one, and some forms and methods of teaching that take the pattern of western European states. Teacher Natalya has become "agent of change" at her school, to quickly promote news to schools. The respondent speaks of herself as a conservative person that is not too convinced about the benefits of these innovations, so she tries to introduce them into teaching gradually. She and the other respondent Uljana, despite the criticism above, are assured of the successes of their education system, which has brought out so many great Ukrainian personalities.

Positives of the school system in Ukraine teachers see in the promotion of family and family values, which they consider to be the inseparable foundation of health society. Great emphasis is also put on the promotion of patriotism in Ukrainian education, whose presence in schools is perceived ambivalently by respondents (Natalya and Anna). As a clear positive of education for patriotism among pupils, they perceive in educating pupils about their native land, about the lives of Ukrainian famous people and heroes who often died for the freedom and independence of Ukraine and its values. But they have negative attitude to agitation pupils in schools by some political parties who ask the pupils to attend their meetings.

4.5. The relationship of the Czech teacher to the profession - the fulfillment and self-realization of teachers for rising price.

Regarding the relationship of Czech teachers to the teaching profession, respondents declare their liking in their profession, which for them represents fulfillment and self-realization. Respondent Peter considers teaching to be a generally beneficial and responsible activity, but often carried out at the expense of the teacher and his family, if he takes the teaching really seriously and honestly. Respondents Adriana and Petr believe that the teaching

profession is currently underrated, in other words, is strongly underestimated, not only in terms of financial evaluation, but also in the pupil's relationship with the teacher and the acceptance of the teacher with his way of teaching by parents. Respondent Peter compares the position of three, in an earlier society, highly respected professions, such as the priest, doctor and teacher to their current position, of which only a good doctor remained a respectable profession in current society. According to respondents, the model and ideal teacher should meet the criteria of justice, empathy for pupils, believe in the meaning of their work, have a natural authority, and to be enthusiastic about the education of pupils and themselves. The teacher should also be not only officially, hence having a clean criminal record, but also in his personal life to be as morally perfect as possible, to be an example for those he educates.

4.6. *The attitude of a Czech teacher towards pupils in the Czech Republic*

In general, the attitude of Czech teacher-respondents towards pupils characterizes their efforts for pupils' preparation for life, their desire to share with them the historical heritage, as well as the effort to instruct pupils not to forget certain historical events that have caused the suffering of many people (eg holocaust, communist ideology etc.), that they were able to remind them and assign it the right meaning. The teacher, in the opinion of our respondents, strongly influences the memory and thinking of his pupils not only by passing the learning content, but by making them to think, and teaching them to form their own opinions. A significant part of the relationship between the teacher and the pupil takes out-of-school activities, trips and other events organized by the initiative of the teacher himself, what teachers get closer with pupils. Teacher Jana tries to lead her pupils to interest in social and public life in the municipality and region by participation of pupils in council meetings, using help of pupils at events reminiscent of national history, traditions and customs..). A teacher is an important part of the pupil's external motivation, and the right impulses can provoke interest in his subject, topic.

Teacher Jana tries to pass on her pupils the ability to think independently, to teach them to learn and to feel a satisfaction in this. In particular, she applies elements of research in teaching and tries to make pupils to work independently to experience the joy of the newly discovered knowledge. Pupils should realize that every knowledge is a certain effort, but it gives satisfaction to man. Respondent Petr put emphasis in the teaching on the formation of responsibility and caution in pupils who are prepared for manipulation and work with electricity. For the reason of protection of health and life, emphasis is also placed on developing self-discipline of pupils. Apart from teaching he tries to pass moral principles and values on more attentive and thoughtful pupils.

Influence the pupils by teacher is according our respondents undoubted. The respondent Petr believes that in the current social crisis, which is in progress simultaneously with the crisis of values and traditions, the teacher have little influence on his pupils in this respect. According to Jana, a teacher is to affect his pupils by his mood, how he responds, motivates and whether he is actively interested in the development of his field. With the retention of discipline in teaching, the experience of our respondents is not a problem when the pupils are given free space for discussion. Another time, teachers stated that for more discipline, it is necessary to change the teaching methods and to employ pupils with specific tasks such as activities with worksheets, difficult questions, to which they are forced to respond immediately and promptly.

Pupils respond positively and with greater discipline if the more challenging topic in the lesson is lightened by funny commentaries, a glossary, or a short video. The approach to the pupils that respondents support is supposed to be friendly and welcoming, but at the same time it is necessary to set the pupils "rules of the game" at the beginning of the year. Pupils must know what requirements they are asked to know what to do. Relations of our Czech respondents to pupils are warm but at the same time, education and discipline and strictness are necessary in the upbringing as mentioned above. In order to be able to pass on knowledge to pupils, it requires pupils to be willing to listen not only to the teacher's interpretation in lessons but also to follow his instructions.

Regarding the emphasis on education respondent Jana considers as especially important pupils' ability to face

with problems and failures, but also to be able to enjoy success. Respondent Petr considers the moral principles as the most important in the educational process. So pupils are able to "think about their own life and its sense, about what priorities I have and what I want to achieve" (Peter).

According to their time and interest, Czech respondents also devote some pupils out of lesson in individual interviews. Teachers try to encourage their pupils to become independent and responsible in education, by the personal example that attracts them at most and also by pointing to successful graduates of school. In the case of grammar school there is not a big problem with the motivation to study and "it goes quite from the heart" (Jana). Adriana motivates her pupils to attend thematic events, exhibitions and excursions abroad. Petr has pupils who are more interested in topics in the technical field, prepared materials in digital form and he tries to support these pupils to the continuation in the higher study.

4.7. Czech Teacher in the Educational-Educational Process

The general aim of teaching of our respondents is to lead pupils to joy from learning and to the joy that this knowledge can share and discuss with other people (Jana). Teachers want to teach students responsibility in attitude to their future work and their own health, giving them at least minimum of the most important knowledge (Peter). Respondents agreed that if there is offered themes currently discussed in the contemporary society, such as social issues, political issues, or are reminded of significant historical national and global events, teachers for their benefit leave the prepared subject and try to mediate knowledge of topical issues as well as important historical milestones.

The motivation to teach pupils is for the respondents to explore the different culture and mentality of the people (Adriana) through the teaching of foreign language and they also deal with their field of study in their leisure time. Czech teachers, in the first place, are preparing their pupils for life, learning to use their knowledge for further education, including the knowledge of what our ancestors have done in the sphere of culture, knowledge, but also "the danger that threatens to ignore some historical events "(Jana). A rational concept of teaching, which means well-taught lesson, to prepare pupils for entry to higher education and for the life prevails in the attitude of Czech teachers. According to teacher Peter, however, it is important that the teacher, in addition to the rational component of his work, perceives his profession as a mission and has been truly rooted in it. Because, as a experienced teacher of the technical subjects with a minimum interest of students of these practical field he knows that the teacher does not have to withstand this situation.

In the opinion of the respondents, the educational process is undoubtedly also influenced by the fact that teachers often learn from pupils a new technologies and ways of communication. At the level of behavior the teacher Jana tries to give pupils an example of what they are educating "I do not smoke, I greet people, I try to smile people and do not transfer my worries to others ... I sort waste", especially trying to give pupils a pattern of behavior "I participate in commemorative acts, respect the heroes of our time, meet them and give them public respect, respect the state symbols, give honor to the anthem". According to Peter, the attitude of most young people to study on practical types of schools leads in a number of older teacher to resignation, dullness or burn out syndrom. The respondent adds that he "is increasingly convinced in the view that only Christianity and its values and pattern in following Jesus is meaning. Those who have not reached it are gradually losing motivation and sense of overcome oneself and starting again. "

The ways in which Czech respondents try to pass on their values, attitudes and beliefs in the educational process include individual interviews with pupils, class discussions, following the questions they have been discussing in the classroom, the teacher himself tells his life experiences and, last but not least, teacher example. Respondent Jana teaches her pupils not only to rational reasons for value but she leads pupils to personal experience of value. Among the values that respondents pass on pupils are respect for parents, family, ancestors and people without difference of race, religion, respect of the nature, for cultural values, language and patriotism.

4.8. Evaluation of the local education system by Czech teachers

The perception of the Czech education system respondents evaluate differently. While respondent Adriana considers the general knowledge provided by the Czech education system to be the best in the world, the respondents, Petr and Jana, complain that the system is subject to political pressures and in particular to the pressures of the parent community which according to Jana intensively influence Czech education. The criticisms of Jana and Peter are directed at the unreasonable acceptance of fashion trends in education from abroad, where Western education systems and their negatives are copied regardless of the national context. The system is also significantly influenced by alternative teaching directions, which do not yet have proven better results compared to regular school pupils, provide a relief for pupils and tend to be less demanding for them (Jana). Respondent Jana critically assesses the views of some laics and also experts on how to restrict school education from so-called unnecessary curriculum, knowledge and information on predominantly practical things that can be applied in practice, which would make the system of education to come back to" prehistoric thinking"... already from my point of view 'the people getting stupid, people cannot think and seek relief in thinking' (Jana).

Other critical moments of the Czech educational system according to the Czech respondents are high administrative burden of teachers, the insufficient definition of the absurdly defined FEP (Framework educational program) which contributes to the difficult implementation of SEP (School educational program), the neutral ground of education is increasingly burdened by business - ie projects that financially feed many managers and in many cases it is about parallel issues in individual schools, an unbalanced system of graduation, unfair for vocational schools, instead of teaching moral principles, pupils are rather demoralized, enforcing meaningless inclusion - "a healthy athlete cannot train with the disabled, nor can be carry out a violent inclusion without reducing the quality of teaching ... I have in the first year of study a pupil who the PPP (advisory body) wrote, that he confuses digits 0, 6 and 8 and he should by an electrician!?"(Petr) According to Petr, the influence of liberalism, both in the field of expertise and in morality, is increasingly reflected in the Czech educational system.

5. Comparison of the value of education of Ukrainian and Czech teachers

In the fifth chapter we present the comparison between a group of Ukrainian and Czech teachers. Comparison we can compare to the research stage, referred to as secondary interpretation, which means rethinking the already analyzed material with respect to what our data really tells ... why these symptoms occur "[12]. We have found following consents, similarities and differences in four selected areas:

1) Teacher's relationship to the profession

Ukrainian teachers speak about their profession as a mission. In spite of various difficulties, teaching problem pupils, low financial awards for their work, or more limited working conditions, respondents do not complain about these facts and are very grateful for their profession. The attitude of Czech teachers differs from the Ukrainian respondents by the fact that just one respondent of them expressed her profession as a mission, and the other two respondents stated that their work is fulfilling them. This is also related to the question of respect for the profession of teaching, which is diametrically different in both countries. In Ukraine, regardless of the financial and material conditions of teachers, the teaching profession is still highly valued, and is considered a meritorious employment. While in the Czech Republic teachers, according to two respondents, have not received enough appreciation and lost his original dignity, eg compared to the medical profession.

An interesting difference between both groups of teachers emerged in the question of teacher's financial valuation. While in the case of Ukrainian teachers it is a financially underestimated profession and their work is often performed under simpler conditions (for example, the Gymnasium in Ukraine does not own data projector and teachers borrow a notebook among themselves to show pupils a presentations or short videos). Ukrainian teachers have never complained about low pay and mentioned only the lack of equipment at schools.

While Czech teachers are also financially underestimated compared to other European countries, but compared to the lifestyle in Ukraine, and the salaries of Ukrainian teachers, Czech teachers are much better at it. As for the qualities of the teachers in the statements of Czech and Ukrainian respondents, they slightly differ. Czech teachers emphasize the natural talent for education of pupils, empathy and the overall friendship between teacher and pupils. Ukrainian teachers aim at educating and at the same time raising pupils, helping them to choose their life priorities and to be a personal example as a teacher. Also, two Czech respondents require that teachers should be equipped with the best moral qualities. This is clearly consistent with the view of Ukrainian teachers, who strongly emphasize the personal example to follow and exemplary life of the teacher.

2) Teacher attitudes towards pupils in their country

The attitude of Czech teachers towards pupils lies in the best possible preparation of pupils for life and the transfer of good knowledge to the pupils. Teachers are trying to teach their pupils that the achievement of knowledge always requires a certain effort from pupil side, but it will return him as personal satisfaction and joy from learning. Czech teachers trying to teach their pupils think independently and critically, to be able to create their own opinions, trying to encourage a personal example. The Ukrainian respondents are primarily trying to raise citizens and patriots of Ukraine with their pride in their country. Great emphasis is also put on the correct behavior of pupils in accordance with their conscience and moral principles.

It can be said that the differences in both attitudes are that Czech teachers more emphasize the rational, intellectual component (emphasis on consciousness, critical, independent thought, counsiousnes attitude to historical data ...) in attitudes and communication with their pupils. While Ukrainian teachers more emphasize the field of emotions and the spiritual sphere, but they do not forget the cognitive component.

Consent with both groups of respondents was found in the case of active organization of out-of-school activities by teachers (tutoring of pupils, conducting personal groups of interests, individual interviews with pupils, participation of some pupils at the meeting of the council with their teacher ...). Attitudes and relationships with pupils do not differ much in both groups. Both, Ukrainian and Czech teachers focus on understanding pupils' needs while setting requirements and demands on them.

3) Position and role of the teacher in the educational process

Ukrainian teachers place emphasis in teaching on the passing of knowledge on pupils in their field (love for other culture and language, healthy lifestyle). They also highlight the need for regular self-reflection of lessons and self-education. Like Ukrainian teachers, Czech respondents also desire to transmit to their pupils their special knowledge, but also to encourage a lively interest in their pupils. There is consent.

Czech and Ukrainian teachers agree that in the education of pupils they underline the principles of ethical behavior and general decency, honesty and the ability of pupils to face problems. In addition, Czech teachers emphasize autonomy and openness to new things, while Ukrainian respondents emphasize patriotism, respect and loyalty to their country. Both groups of teachers are trying to communicate these values and attitudes in a similar way, ie through individual interviews, a personal example and an example of people who have achieved something and have pupils´ authority and discussions in lesson. According to one Czech respondent, it is necessary to lead pupils not only to understand the meaning of the value but also to live it.

Both groups of respondents clearly perceive the impact of the educational process on them, but each in a different way. Differences exist among the respondents themselves within groups. While one Czech respondent gives a specific example to her pupils, eg through his participation in the memoirs, meeting with contemporary Czech personalities, another Czech respondent feels disappointed about the current state of pupils' behavior and their relationship to education, and the sense and source of motivation for education he is looking for in the

Christian faith. Within the Ukrainian group, one respondent spoke about some pupils, who cannot reach out for words or personal example because they are so involved in information technologies, they don´t hear, they don´t see, which makes her very sorry.

4) Evaluation of teachers of local education systems

When evaluating their own education systems, respondents from both groups were predominantly critical, but they also outlined some positive moments that included their education system.

The general opinion of Ukrainians about the system and organization of education in Ukraine is strongly negative and therefore many of them leave the country and study at foreign universities. If we come close to the criticism of Ukrainian teachers, so they criticize the educational system because of the great number of educational subjects within the school curriculum, while high demands on achieving good results. The same criticism relates to the overly demanding final exams (ZNO) that pupils make at the end of the 11th year of general secondary education. Following these exams, the respondents also mentioned the need for pupils to attend a many hours of tutoring to successfully pass the final exams with the best grades and be admitted to university without paying for their studies. Highly criticized by respondents in Ukraine is the necessity of paying higher education and some secondary vocational schools, with the existence of system of bribery, especially at universities.

Czech teachers among themselves slightly differ in their evaluation of the Czech educational system. One respondent rated the system as excellent, with which no other system can be compared. Two other respondents mentioned a number of critical comments, which concerned mainly unwise acceptance of modern influences regardless of the overall context, influencing Czech education by alternative systems with no certainty that it brings at least comparable results as classical teaching. Further they talked about the negative influences not only of the laic but also of the professional public, who speak about redundancy of the subject and the unnecessary burden on the pupils. While respondent is watching with concern the gradual reduction of demands on pupils and education in schools and the overall degradation of the thinking of the Czech population. Two respondents also stated a number of critics, including inclusion, burden on teachers by the administration, injudicious system of final exams etc.

In the first place, there is a big difference between the Czech and Ukrainian systems in free of charge of Czech studies as well as for secondary and higher education. Another significant difference between the two groups of respondents is their point of view of the difficulty of learning process at the primary and secondary level of education. While the Ukrainian respondents expressed their displeasure over the overloading of pupils with a wide range of subjects, the Czech teachers group mentioned the efforts to reduce the overall volume of learning, which is referred to by some teachers as an unnecessary relief from the formerly common requirements for pupils. Consent can be found in the implementation of demanding final examinations of ZNO in Ukraine and Czech state leaving examinations, which Czech teachers find difficult, especially at practically focused secondary schools.

6. Conclusion and discussion

In the text of the paper we paid attention to the value of education, which was found through a comparative method in pedagogy in two groups of respondents - teachers of Ukrainian and Czech nationality.

The aim of the method of comparing teachers of both nationalities was to point out possible consents, similarities and differences in the perception of the value of education. The comparison was carried out in four attributes, which represented the teacher's relation to the profession, the attitudes of the teacher to the pupils in his country, the position and role of the teacher in the educational process and the evaluation of the teachers of the local educational system, namely in Ukraine and the Czech Republic.

At this point we briefly summarize how basic consents, similarities and differences we found in the researched areas:

1) Area: Teacher's relationship to the profession

The difference in the relationship between Ukrainian and Czech teachers to the teaching profession, consist of the fact that Ukrainian teachers perceive their work intensively as a mission. More often than the Czech teachers expressed it as a mission for which they are grateful, despite the difficult financial and material conditions in their profession. To a large extent, this is probably related to how teaching in the Czech Republic and Ukraine is perceived. While in the Czech Republic, according to our respondents, teachers are poorly paid and this profession is missing its previous prestige, which would equate, for example, to the medical profession. In Ukraine is the profession of a teacher is widely appreciated and respected by the public and the teacher is authority.

2) Area: The attitude of the teacher towards pupils in their country

In terms of attitudes towards pupils, Ukrainian and Czech teachers do not differ significantly and we can talk about similarities in their approach. The weaker difference lies only in a more rational concept of the relationship between Czech teachers and pupils they emphasize the need for independent and critical thinking among pupils. Ukrainian teachers of more encourage pupils to patriotic attitudes and on the first place teach pupils to honor Ukrainian personalities, love their homeland, and family and emphasize the behavior of pupils in accordance with ethical principles and conscience. We found consent with teachers of both nationalities in that they regularly devote their time to pupils after schooling. Both groups of respondents respect pupils and their needs and, at the same time, require fulfilling of study duties.

3) Area: Position and role of the teacher in the educational and educational process

In this area we found consent of both groups of respondents in the desire to pass, together with their knowledge, the taste and the relation to education and mainly to their subject. We have found similarities both in the way and in the values and attitudes of teachers to pupils. Each group of respondents is influenced the educational process, but in another way. The differences were also found among the respondents themselves. While some Ukrainian respondents felt regret of the situation they could not positively influence some pupils. Another Czech respondent talked about the crisis of values in society and among youth, and he perceives that in this social atmosphere it is almost unrealistic to pass on pupils a love for education and respect for values.

4) Area: Evaluation of teachers of local education systems.

Respondents - Teachers of both nationalities agreed in a critical attitude to the education systems in their countries. The biggest criticisms of the Ukrainian respondents concerned paid education, the existence of bribery and the complexity of final exams at the end of general secondary education. The Czech respondents most criticized fashion trends, on the first place the influence of alternative education systems and the criticism were also directed at the system of state leaving examination in the Czech Republic.

At the conclusion of the research it can be said that the value of education is a highly prized value for all respondents, which almost no one doubts in the case of a teacher. What the new results have brought are less or greater consents, differences and similarities in perceiving the value of education among surveyed groups of teachers that we have at least partially tried to describe in this research.

From the findings on the value of education and attitudes to the education of Ukrainian and Czech teachers, we will proceed in further exploration of our framework topic of the value of education among pupils from Ukraine in the Czech school. The current knowledge of teacher values will help us to identify the possible educational needs of a Ukrainian pupil and to understand his position in the context of the Czech educational system.

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Self- and peer assessments in PBL: A higher education example

Tolga ERDOGAN[a]1, Irfan YURDABAKAN[b],
Nuray SENEMOGLU[c]

[a] National Defense University, Army NCO Vocational College, Balikesir, Turkey, terdogan@msu.edu.tr
[b] 9 Eylul University, Faculty of Education, Izmir, Turkey,irfan.ybakan@deu.edu.tr
[c] Hacettepe University, Faculty of Education, Ankara, Turkey,n.senem@hacettepe.edu.tr

Abstract

The present study set out to examine the self- and peer assessments at the end of five PBL modules undertaken in a higher education course in Turkey. The participants were 36 senior students enrolling at Language Teaching Department in a state university. Self- and peer assessment forms were used to collect data. The Pearson correlations considering the self- and peer assessments undertaken during PBL sessions showed that students were consistent in assessing themselves and their peers. However, students' self-assessments were lower than their peer assessments. No evidence was obtained considering which achievement groups (low or high) evaluated themselves lower (or occasionally higher) than their peers. Besides, in line with other studies in literature, peer assessments were more accurate than self-assessments. Considering accuracy and consistency of both type of assessments, it is concluded that students need time and experience in their practices. Extra training on alternative assessment practices could enhance attainment of desired outcomes.

Keywords: peer assessment, self-assessment, problem-based learning, PBL tutorial

1. Introduction

The pedagogic shift from the traditional teacher centered approach, in which the emphasis is on teachers and what they teach, to a student centered approach, in which the emphasis is on students and what they learn, requires a fundamental change in the role of the educator from that of a didactic teacher to that of a facilitator of learning. In addition to that shift, academics and instructors as practitioners have attempted to devise and use alternative assessment procedures to complement the general or traditional ones, which will not be enough alone to evaluate students' development in numerous skills and abilities required of them in a changing and vocational climate [1]. Assessment of student progress in such a student-centered curriculum, however, has remained challenging [2].

Boud and Falchikov [3] argued that "assessment practices should not only address the immediate needs of certification or feedback to students on their current learning, but also contribute in some way to their prospective learning" (p. 400). Students in present time, after graduation will find themselves in situations where they will have to make judgments about their own work or work of others, with whom they will be working together collectively. So, use of self- or peer assessment practices during schooling is believed to contribute the development of skills individuals will need in the future as professionals [4]. As Harlen and James [5] suggest, formative and summative assessment should be linked "whilst preserving their separate functions". Besides course content, assessment practices should also involve evaluation of student development in skills such as group work, communication, leadership, presentation, etc.

On the other hand, problem-based learning (PBL) is one of those student-centered approaches, which has its roots in constructivist epistemology [6]. Self- and/or peer assessments are considered essential parts of PBL tutorials [7],

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* Corresponding author.

where students not only evaluate their contribution to the problem solving process, but also they have the chance to assess their group members' performance. Despite their importance as essential elements in PBL sessions, the use of self- and peer assessments has not been investigated enough. The present study aims to investigate students' self- and peer assessments in PBL tutorials in higher education institution in Turkey, where students were new to the PBL process itself and the self- and peer assessments involved. With this study, the authors expect to contribute to the understanding of alternative assessment, research findings on which are already not clear, decisive and conclusive.

1.1. Self- and peer assessment

Formative assessment is defined as "all those activities undertaken by teachers, and/or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" [8]. As a formative assessment type, self-assessment is "the involvement of learners in making judgments about their own learning, particularly about their achievements and the outcomes of their learning" [9], whereas Falchikov [10] defines peer assessment as the process where groups of individuals rate their peers.

The analysis results of 62 studies by Sluijsmans, Dochy and Moerkerke [4] reveals that self-, peer, co-assessments can be effective tools in developing those skills and competencies needed by professionals. Holroyd [11] points to the fact that there has been less reliance on assessment by teaching staff alone and more involvement of self, peers and workplace assessors; however, he adds that such a development "requires an institutional environment which encourages collegiality and communication; it should have, embedded within its codes, the values of equity, integrity and justice". Rourke [12] suggests the need for students to have training in the assessment process, to have a clear picture of both course and teacher expectations, and to be provided with enough activities to practice assessment.

1.2. Research reviewed

Research results on self- and peer assessments have not been consistent and conclusive. In the next part, some of those findings are summarized.

In their study at the University of Queensland; Papinczak, Young, Groves and Haynes [13] explored the self-, peer, and tutor assessment of performance in tutorials among first year medical students in a PBL curriculum. They found that (a) the scores obtained from tutor assessment correlated poorly with self-assessment ratings, (b) students consistently under-marked their own performance to a substantial degree, (c) students with greater self-efficacy scored their PBL performance more highly, (d) peer assessment was a slightly more accurate measure, with peer-averaged scores correlating moderately with tutor ratings initially and improving over time, (e) students consistently over-marked their peers, (f) peer over-marking led to less divergence from the tutor scoring than under-marking of one's own work. According to these results, they concluded that first-year medical students in a PBL curriculum were better able to accurately judge the performance of their peers compared to their own performance. They also added that although self-assessment was not an accurate measure, it could play an important role in supporting the development of skills in reflection and self-awareness.

Exploring the consistency of and differences among teacher, self- and peer assessment results in a web-based portfolio assessment practice, Chang, Tseng and Lou [14] found that self- and teacher assessments were consistent compared with each other and with the end of course examination results, while they observed no consistent results for the peer assessments. In another study, Lanning et al. [15] explored the correlation of student and faculty assessments of second-year dental students' communicative skills during simulated patient interviews. Their findings indicated that mean assessment scores for peers were the highest, whereas the self-assessment mean scores were the lowest. They also found that self- and peer-assessments were not significantly correlated with faculty assessments.

Analyzing the self- and peer assessments during group projects carried out by a class of 130 first-year undergraduate, Butcher, Stefani and Tariq [1] found that self- and peer assessments appeared to provide more norm referenced assessments than corresponding staff assessments. Hence they concluded that peer and self-assessments were reliable and valid alternatives or complementary strategies to staff assessments in a university context. They also discovered that self-assessments were higher than peer assessments 'within groups', while during "between group" assessments students graded the other groups higher, though those differences were not significant in either case.

In their qualitative research investigating student views on self- and peer assessment, Hanrahan and Isaacs [16] found that students had difficulty in their assessments because they had had no such experience before and the issue of objectivity was a real challenge. According to students' views, they gained better understanding of marking, they

were uncomfortable having their works assessed by their peers, the experience helped them develop some skills such as critical thinking and empathy towards their tutors/teachers, they had the chance to read their peers' works, and finally they had higher motivation to impress their peers with their work/product.

One of the widespread reservations held about self-assessments is that individuals might tend to over-mark themselves. In their review Boud and Falchikov [9] found that good students tended to under-mark themselves, while poor students were inclined to over-mark themselves. They also discovered that students in upper classes could estimate their achievements better than their counterparts in lower classes and that skilled students had more realistic self-assessments than the less skilled ones. In their study, Violato and Lockyer [17] also identified that those students over marking themselves were high achieving students. However; Kaufman, Felder and Fuller [18] observed that students who had training on self-assessment had no tendencies of under/over marking and they also reported high conformity between self- and peer assessments. Langendyk [19] also discovered that students in their third year of higher education evaluated themselves and their peers accurately and consistently.

On the other hand, some other research [20, 21] has provided evidence on peer assessments being more accurate than self-assessments. The reason can be explained as students who are able to differentiate good and poor performance fail to use the same rules or standards on their own performance [22]. Some authors [22, 23, 24, 25, 26] have pointed to the lack of metacognitive skills or poor self-regulated learning skills as possible causes of failure in assessment of self-performance considering standards, criteria or other peer assessments. Additionally, some other authors [27, 28] stated that the skill or talent under consideration could play a role during assessments. Accordingly, the higher or advanced the abilities/skills get, the less accurate they are assessed and vice versa.

Finally, as expressed by Sullivan, Hitchcock and Dunnington [7], it is not viable to expect accurate and consistent self- and peer assessments from learners at their initial experience of both PBL and self- and peer assessments as its essential components. It is better to expect more accurate and consistent assessments as students advance their experience both in PBL and self- and peer assessments.

2. Method

2.1. Participants and procedures

Thirty-six senior students enrolling at Middle East Technical University (METU) Language Teaching Department were recruited to participate in a study of PBL, which included peer and self-assessments. Quantitative data were collected from the self- and peer assessments during a total of five PBL tutorial settings. The assessments took place concurrently during class hours at the end of each module.

2.2. Instrumentation and data analysis

The form used for self- and peer assessments was formerly adapted by Das, Mpofu, Dunn and Lanphear [29] from the original version developed by Rangachari and Crankshaw [30]. The peer assessment form was similar to the self-assessment form, with appropriate changes made (see Appendix A and B). The forms were presented for validation purpose to 5 specialists in subject areas, a Turkish language specialist and an assessment expert. Then, 15 students were asked to review the items on clarity, ease of understanding and use for assessment purposes. In line with the comments received, it was seen that students had no difficulty understanding the items and using the forms to rate themselves and their peers. Additionally, Cronbach's alpha values were found 0.90 and 0.95 for self- and peer assessment forms respectively.

Analysis of the data was implemented using statistical software SPSS Version 20. Scores on all five sub-scores of the peer assessment instrument were averaged to give an overall score, with a maximum score of 75. For each marking session, data for each student consisted of a self-assessment score and up to seven peer assessment scores. Peer assessment scores were calculated by taking the averages of the scores given by the other members. Descriptive statistics for self- and peer assessment scores of the participating students through all assessment sessions at the end of each module (1-5) are presented in Table 1. The distributions of self- and peer assessments for each tutorial/module are shown in Figure 1.

Table 1. Descriptive statistics for self- and peer assessment scores

| Assessments	n	$\overline{X}$	Sd	Minimum-Maximum	Median
Self-Assessment 1	36	67.19	6.27	52-75	69
Self-Assessment 2	36	69.03	6.80	51-75	71
Self-Assessment 3	36	69.81	5.18	55-75	71
Self-Assessment 4	36	71.22	5.09	55-75	74.5
Self-Assessment 5	36	69.89	7.72	39-75	73
Averaged Peer Assessment 1	36	71.11	3.14	58-75	72
Averaged Peer Assessment 2	36	70.19	6.40	47-75	73
Averaged Peer Assessment 3	36	71.94	3.79	63-75	73
Averaged Peer Assessment 4	36	70.92	4.99	58-75	73
Averaged Peer Assessment 5	36	71.50	4.34	60-75	72
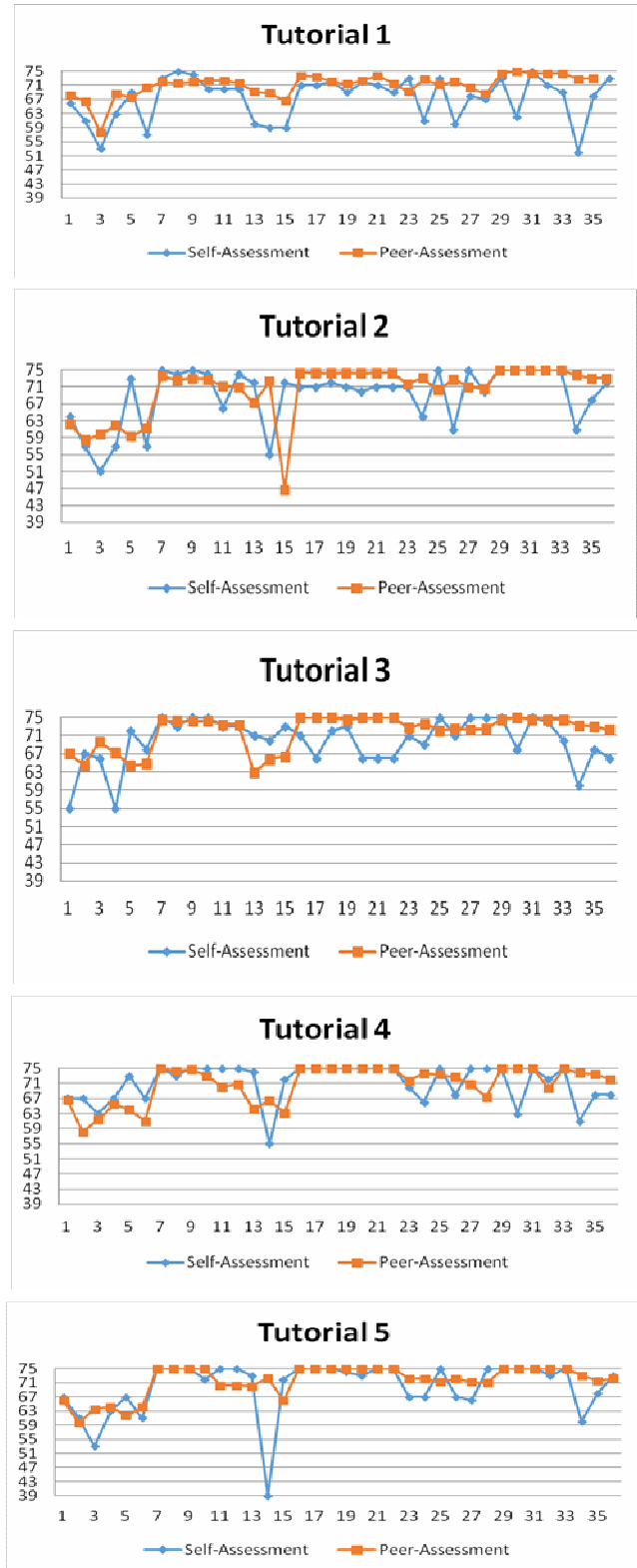
Fig. 1. The distribution of self- and peer assessment scores

3. Findings and discussion

A Shapiro-Wilk's test (p<0.5) [31, 32] and a visual inspection of their histograms, normal Q-Q plots and box plots showed that the self- and peer assessment scores were normally distributed for all assessment sessions (1-

5).Therefore, Pearson correlation statistics technique was utilized during analyses. The correlation results are exhibited in Table 2.

Table 2. Pearson correlations of self- and peer assessments

	SELF_1	SELF_2	SELF_3	SELF_4	SELF_5	PEER_1	PEER_2	PEER_3	PEER_4	PEER_5
SELF_1										
SELF_2	.758**									
SELF_3	.427**	.572**								
SELF_4	.730**	.741**	.512**							
SELF_5	.684**	.818**	.354*	.834**						
PEER_1	.511**	.579**	.180	.324	.564**					
PEER_2	.499**	.415*	.239	.221	.345*	.731**				
PEER_3	.551**	.499**	.277	.402*	.557**	.631**	.809**			
PEER_4	.597**	.598**	.201	.385*	.564**	.780**	.844**	.886**		
PEER_5	.534**	.600**	.348*	.356*	.495**	.736**	.875**	.845**	.904**	

** $p < .01$
* $p < .05$

Accordingly, positive significant relationships were detected among self- and peer assessments (1 to 5). Pearson correlations of self-assessments ranged from medium (r=.354, $p < .05$) to high (r=.834, $p < 0.01$). Likewise, peer assessments correlated with each other from medium (r=.631, $p < .01$) to high (r=.904, $p < .01$) levels. This finding provides evidence to the consistency of self- and peer assessments.

Also, the findings show that self- and peer assessments and positive significant relationships (except for self-assessments 3 and 4). The existing positive significant correlations ranged from .345 ($p < .05$) to .600 ($p < .01$). It can be stated that students performed consistent self- and peer assessments. The same result was obtained by Langendyk [19], where majority of third year medical students assessed themselves and their peers accurately and consistently.

However, compared to other relationships, there was no positive significant correlation between self- and peer assessments in the third and fourth tutorials. Tutorial 3 and 4 were considered the most challenging tutorials, where students were asked to create and prepare their own materials and present them to the class afterwards. Because of this challenge and heavy workload, the students might have failed to evaluate either themselves or their peers accurately and consistently. Hence, while the students tended to over mark their peers in other tutorials, in the third and fourth tutorial they had the tendency to under mark their peers, compared to their self-assessments. The reason could be dedicated to difficulty or challenge level of the work done during those tutorials. As stated by Ackerman, Beier and Bowen [27], the more challenging or difficult a task gets, the less consistent or accurate the assessments occur. In their study, Violato and Lockyer [17] found that those students under marking themselves were the high achieving students. In the present study, there was no evidence about whether the students under scoring themselves were high achievers or not. Nevertheless, taking all the self- and peer assessments in all tutorials into account, it can be stated that students in majority tended to give themselves lower scores compared to the scores they gave to their peers. Same results were also observed in other studies [13, 15].

Finally, in accordance with Sullivan, Hitchcock and Dunnington [7], it is not reasonable to expect accurate and consistent assessments from learners in their initial experience both in PBL and self/peer assessments. Van Zundert, Sluijsmans and van Merriënboer [33] also reported that students' peer assessment skills and attitudes towards it improved by training and experience. Rourke [12] points to the same need of students' training on self- and peer assessment. In the present study, though students had no prior experience both in PBL and self/peer assessment at all, their performance still can be considered an achievement.

4. Conclusion

The present study set out to examine the self- and peer assessments at the end of five PBL modules undertaken in a higher education course in Turkey. The Pearson correlations considering the self-peer assessments undertaken during PBL sessions in the treatment group showed that students were consistent in assessing themselves and their

peers. However, students' self-assessments were lower than their peer assessments. No evidence was obtained considering which achievement groups (low or high) evaluated themselves lower (or occasionally higher) than their peers. Besides, in line with other studies in literature, peer assessments were more accurate than self-assessments. The reason for this could be that even though students could discriminate good and bad performances, they failed to use the same standards when it came to evaluate themselves.

Though they didn't have any prior experience at all, the students in the treatment group did fairly well and were consistent in their self- and peer assessments. Reflecting similar results found in literature, their self-assessments were lower than their peer assessments. Overall, more frequent exposure to such assessments would help students become more accurate and consistent in their evaluations and they would learn to successfully apply those standards on their own performance eventually, as they do on the performance of their peers.

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Appendix A

Self-Assessment Form

Name of the student: Date:

PBL Group Number:

Indicate the strength of your agreement/disagreement on the five point scale given with each statement, 1 representing disagreement and 5 agreement.

	1	2	3	4	5
A. Responsibility					
1. I completed all assigned tasks to the level appropriate for the tutorial.					
2. I participated actively in the tutorial.					
3. My behavior did not impede the tutorial process.					
4. My behavior facilitated learning of others.					
5. I was punctual in each PBL session.					
B. Information Processing					
1. I brought in new information.					
2. The information I brought in was relevant to the discussions.					
3. I used a variety of sources to obtain information (texts, review articles, video, talking to peers etc.)					
C. Communication					
1. I was able to communicate the ideas clearly.					
2. My comments did not confuse other students.					
D. Critical analysis					
1. I justified the comments made.					
2. My comments promoted understanding of the subject by the group.					
3. I am interested in the problem-based learning approach.					
E. Self-awareness					
1. I assessed own strengths and weaknesses.					
2. I am able to accept and respond to criticism gracefully.					

Appendix B

Peer Assessment Form

PBL Group Number: Date:

Name of the student:

Give points to your peers in the tutorial group from 1 to 5, 1 representing disagreement and 5 agreement about your peers.

	Peer Names						
A. Responsibility							
1. He/She completed all assigned tasks to the level appropriate for the tutorial.							
2. He/She participated actively in the tutorial.							
3. His/Her behavior did not impede the tutorial process.							
4. His/Her behavior facilitated learning of others.							
5. He/She was punctual in each PBL session.							
B. Information Processing							
1. He/She brought in new information.							
2. The information he/she brought in was relevant to the discussions.							
3. He/She used a variety of sources to obtain information (texts, review articles, video, talking to peers etc.)							
C. Communication							
1. He/She was able to communicate the ideas clearly.							
2. His/Her comments did not confuse other students.							
D. Critical analysis							
1. He/She justified the comments made.							
2. His/Her comments promoted understanding of the subject by the group.							
3. He/She is interested in the problem-based learning approach.							
E. Self-awareness							
1. He/She assessed own strengths and weaknesses.							
2. He/She is able to accept and respond to criticism gracefully.							

Suppression Effect of Sensation Seeking on the Relationship between General Self-Efficacy and Life Satisfaction among Emerging Adults

Eyüp ÇELİK[a], Lokman KOÇAK [b]

[a] *Dr. Sakarya Üniversitesi, Faculty of Education, eyupcelik@sakarya.edu.tr*
[b] *Doctoral Student, Institute of Education Science, Sakarya Üniversitesi, lokmankocak@msn.com*

Abstract

The aim of the present study is to examine suppression effect of sensation seeking in the relationship between general self-efficacy and life satisfaction among emerging adults. The data were gathered using Satisfaction with Life Scale, General Self-efficacy Scale, and Brief Sensation Seeking Scale (BSSS-8). Correlation and regression analysis performed to determine whether there is the relationship among variables and to test whether sensation seeking has suppression effect in the relationship between general self-efficacy and life satisfaction. The findings of the study demonstrated that general self-efficacy positively related to life satisfaction and sensation seeking, but the life satisfaction didn't relate to sensation seeking significantly. Although no significant relationship was found between sensation seeking and life satisfaction after the correlation analysis, after the regression analysis sensation seeking variable was found to both significantly predict life satisfaction and increase general self-efficacy's capability to predict life satisfaction. These results prove that sensation seeking has suppression effect in the relationship between general self-efficacy and life satisfaction.

Keywords: Suppression effect, Sensation Seeking, General Self-efficacy, Life Satisfaction, Emerging Adult

The Relationship between Early Maladaptive Schemas and Social Anxiety in University Students: Comparison of Turkey and Belgium

Sueda RADA[a], Ümit SAHRANÇ[b]

[a] Dr. Sakarya Üniversitesi, Faculty of Education, sakarya@sakarya.edu.tr
[b] Master Student, Institute of Education Science, Sakarya Üniversitesi, radasueda@gmail.com

Abstract

The aim of this study was to examine the relationship between early maladaptive schemas and social anxiety among University students in Turkey and Belgium; whether there are significant differences between both countries' schemas related to social anxiety. 319 students (Turkey, 127 F, 39 M; Belgium, 77 F, 76 M) were the participated. Liebowitz Social Anxiety Scale Turkish and French form and Young Schema Scale-Short Form Turkish and French form were administered as data collection tools. Correlation analysis was used to determine the relationships between the variables. Regression analysis was applied to determine which early schemas predicted social anxiety. For the Turkish study group, the results revealed that social anxiety had a significant relationship with pessimism, social isolation, feelings of repression and dependence/incompetence schemas. On the other hand, dependence/incompetence schema predicted social anxiety. For the Belgian study group, social anxiety had a significant relationship between, emotional deprivation, abandonment and insecurity schemes, and emotional deprivation, abandonment and insecurity, suppression of feelings, high standards schemas. In the Belgian study group, the level of social anxiety of female students was found to be statistically higher than that of males. Results also showed that the social anxiety of Turkish students were higher.

Keywords: Social anxiety, Early maladaptive schemas, Schemas, Schema therapy.

Possibilities for Ongoing Education of Workers in Social Field in the Area of Multicultural Competence

Roman ŠPAČEK[a]

[a] Tomas Bata University in Zlín, Faculty of Humanities, Department of Health Care Sciences, Štefánikova 5670, 760 01 Zlín, Czech Republic, rspacek@utb.cz

Abstract

Daily practice necessitates social workers to be culturally competent and sensitive in order to ethically and effectively work with diverse client populations. The study focuses on finding the level of multicultural competence of these workers (n = 108) in social field. The analysis of the findings revealed that there were only 2 statistically significant differencies – in subscales of "Multicultural knowledge" and "Multicultural activity", while the general "Multicultural competence" showed no differencies among these social workers. The paper also provides discussion and implications of findings for further education in this field.

Keywords: multicultural competence, social field, social worker, education

1. INTRODUCTION

Multiculturalism is very often discussed in the Czech Republic in relation to the migration crisis, although some people might say that this country is not as multicultural as countries like Germany, France, Great Britain or even United States of America and Canada. However, there is a certain possibility that our country will be the final destination for people seeking better life in Europe. (Hladík, 2014)

This situation mostly affects the field of helping professions including pedagogical, health, social and psychological disciplines. The aim of these professions is to provide a support and help during intensive contacts with their clients. Though helping professions recognize culture as a source of strenght for individuals and communities, cultural differences can also create challenges in professional social work practice, which can lead to cultural tensions between social workers, clients and organizations. Some of these tensions come out from the culture of the profession itself. Just like other helping professionals, social workers can view and treat clients´ problems from their own cultural perspective. As a result, these workers can be guilty of imposing their own cultural worldview on clients. (Yan, 2008)

This cross-cultural challenge can be the most complicated and critical area of tension that social workers have to encounter in their daily practise. (Sue, 2016)

Being successful in these professions means having a certain degree of multicultural sensitivity and a relevant competence for this culturally diverse society. Deardorff (2009) defines multicultural competence as the ability to communicate appropriately and effectively in intercultural situation, which is based on intercultural knowledge, skills and attitudes.

A great number of research ascertaining the topic of multicultural competence aim the focus on the area of education – elementary schools, high schools. (Hladík, 2014; Kostková, 2012; Zerzová, 2012). That is the main reason why our research is aimed at the social field, more specifically to find out the level of multicultural competence of workers in social field and their opinions on this type of education for further work.

2. Method

Sample

The sample of the research was chosen by intentional choice after the approval was obtained from institutions and consisted of social workers (n=108) from 3 types of these institutions:

1. The Labour Office in Zlín (LO): n = 35, The Labour Office in Uherský Brod (LO): n = 12,
2. The Czech Social Security Administration in Zlín (CSSA): n = 30,
3. The Department of Social Affairs in Zlín (DSA): n = 17, The Department of Social Affairs in Uherský Brod (DSA): n = 14.

Instruments

For the purpose of this research 2 questionnaires were combined: MCSHPS - Multicultural Competence Scale in Helping-Profession Students (Hladík, 2014) and CCASQ - Cultural Competence Self-Assessment Questionnaire (Mason, 1995). The MCSHPS is a 20- item Likert-type scale, which includes scales of the following five factors: Knowledge, Understanding of terms, Activity, Awareness and Communication skills. For the research 14 items were chosen, concretely items number 1, 5, 6, 9, 12 and 17 were excluded.

The CCASQ is a 59-item questionnaire designed to assist service agencies working with children with disabilities and their families in self-evaluation of their cross-cultural competence. For the research, item number 17 was chosen for describing the frequency of contacts with clients. This item gave a choice of *Not at all/ Seldom/ Often/ Very often* answer.

To examine workers´ interest and opportunities of the authority to further education in this area two items were added with a choice of *Yes/No* answer.

The resultant questionnaire of Multiultural Competence of Workers in Social Field consists of 17 items, while 14 of them are Likert-type scale (1 = *strongly disagree*, 5 = *strongly agree*).

Data analysis

After the collection procces, the data were analyzed by Statistica (version 12.0) software, using analysis of variance (ANOVA). For the analysis mean scores were used allowing to reduce the variability between responses.

Prior to the data analyses, the data set was examined to fulfill the normality of homogeneity of variance. The Cronbach alpha coefficient was 0.729 for full scale.

3. Results

The data from 108 participants were scored and analyzed. The analysis measured the differences between workplaces and full-scale and subscales score means of the participants.

Subscales:

- Multicultural knowledge,
- Understanding multicultural terms,
- Multicultural activity,
- Multicultural awareness,
- Multicultural communication skills.

General multicultural competence

To assess the general multicultural competence, a full-scale mean score was compared to the 3 categories of participants (LO, CSSA and DSA). A factorial analysis of variance ANOVA was conducted to look at the differences between the full-scale mean score and workplaces of participants. The result shown p = 0.525, which means that there were no statistically significant differences. In general, all participants considered their multicultural competence higher than average level on Likert type scale from 1 to 5.

In fact, beside „General multicultural competence", there were no statistically significant differences in other subscales: Understanding multicultural terms ($p = 0.828$), Multicultural awareness ($p = 0.130$), Multicultural communication skills ($p = 0.109$).

Statistically significant differencies were found in 2 remaining subscales:

Multicultural knowledge

To assess the factor of multicultural competence we measured the knowledge-subscale score with the workplace of our participants. ANOVA, concretely Post-hoc LSD test, supported the result, indicating statistically significant relationship between DSA and CSSA, $p = 0.002$, and between LO and CSSA, $p = 0.001$.

Multicultural activity

The result of this subscale by ANOVA shown score $p = 0.034$. According to the Post-hoc LSD test, statistically significant relationship was found between DSA and CSSA, $p = 0.001$.

Frequency of contacts with minority-member clients

The frequency was ascertained by the item asking: *Do you interact with members of minority within your service area?*

Table 1 shows the frequency of contacts with minority-member clients. As can be seen, participants from LO claim high frequency of contact with these clients, while participants from the other 2 authorities do not interact with minority-member clients very often.

Table 1. The Frequency of Contacts with Minority-member Clients

WORKPLACE	NOT AT ALL	SELDOM	OFTEN	VERY OFTEN
The Department of Social Affairs	1	20	7	3
The Labour Office	0	17	17	13
The Czech Social Security Administration	0	25	5	0

Employer´s approach to extending multicultural competence

This approach was ascertained by the item saying: *My employer allows me to extend my knowledge, skills and abilities related to work with minority-member clients.*

Table 2 shows the employer´s approach to extend a multicultural competence of its workers in social field. As can be seen, DSA and LO allows their workers in social field to extend their multicultural competence, while CSS does not.

Table 2. Employer´s Permission to Extend Multicultural Competence

WORKPLACE	YES	NO
The Department of Social Affairs	29	2
The Labour Office	35	12
The Czech Social Security Administration	5	25

An interest in extending a multicultural competence

The participant´s interest in extending a multicultural competence was examined by item saying: *I am interested in further education in minority-members area.*

Table 3 shows the participants´ interest in extending a multicultural competence. As can be seen, participants from DSA clearly express their interest, answers of participants from LO tend more to interest, while participants from The CSSA are mostly not interested in extending their multicultural competence.

Table 3. The Participants´ Interest in Extending a Multicultural Competence

WORKPLACE	YES	NO
The Department of Social Affairs	25	6
The Labour Office	27	20
The Czech Social Security Administration	11	19

More information about this section is debated in the following Discussion.

4. Discussion

The purpose of this research was to find out the level of multicultural competence of workers in social field and their opinions on this type of education. This topic becomes more current so it is useful to extend the research to other areas and not only stay in the area of education.

Using a factorial analysis of variance (ANOVA), the results shown that there are statistically significant differences in 2 subscales of multicultural competence – multicultural knowledge and multicultural activity.

An interesting fact was found between „Understanding multicultural terms" and „Multicultural activity". Usually, a statistically significant difference in one of these subscales means statistically significant difference in the other. (Hladík, 2014)

However, the results of these 2 subscales were not related. This could be because of the fact that subscale „Multicultural activity" was represented by only 1 item in our questionnaire.

As for opinions on the multicultural education, the interest was shown among participants from DSA and LO, while participants from CSSA are mostly not interested in this type of education.

Beside these goals, our research also examined frequency of contacts with minority-member clients and employer´s approach to extend multicultural competence.

Participants from LO work with these clients more frequently than other participants, while as for employer´s approach to extend examined competence, CSSA does not allow its employees to be more sensitive and competent for culturally diverse society.

Limitations in this research might be seen in the instrument. Working with any questionnaire always brings the possibility of misrepresention of the data, because items are self-reported. However, there is no other way to examine multicultural competence than using a questionnaire.

Application of the research could be useful not only to these examined institutions, but also to the social field as another important area beside the area of education. This paper inspired us to continue exploring the topic of multicultural competence in undergraduate multicultural education of future teachers. The work is based on adapting the MAKSS-FORM-T questionnaire (Multicultural Awareness-Knowledge-Skills Survey-Teachers Form) in the Czech Republic. Beside this quantitative part, our current research has also qualitative part represented by an essay about students experience with minorities and foreign people.

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The need to recalibrate academic writing in English: Challenges for international students and their English language instructors

Mary HATAKKA

ª Khalifa University, English Department, Abu Dhabi, United Arab Emirates, mary.hatakka@ku.ac.ae

Abstract

International students studying in English are expected to learn to articulate their knowledge using the kind of formal English usually referred to as English for academic purposes. Recent studies have shown that more knowledge is being conveyed through a more informal style of writing, so there may be a need to recalibrate the kinds of writing taught at preparatory and university level courses It is also an important matter bearing in mind the number of international students studying in English-medium environments and the global use of English in general and specifically for research. This could mean a move away from the traditionally acceptable way of writing referred to as English for academic purposes. A study of final reports produced by 61 students in teams from an engineering design course in an English-medium university in the Arabian Gulf sheds light on types of writing second year Arab engineering students produce. Three styles emerged; informal, descriptive and academic. One of the reasons students' writing is sometimes confusing or shows a mixture of styles is because students nowadays turn to the kinds of services and digital tools available without having the ability to critically judge the results produced. Producing clear and formal writing that is academically acceptable, requires that students and instructors be aware of the pros and cons of using digital assistance.

Keywords: Academid writing, Informal style, International students, English as a second language, Digital tools

1. INTRODUCTION

Academics and employers often praise the communications skills and critical thinking abilities students acquire in higher education. However, many international students still struggle when expressing themselves in English [1, 2], especially in the traditionally acceptable academic style. The transition from writing personal essays to producing informed opinions supported by references can be quite daunting for First year university students [3]. To cater for the students' needs, universities offer preparatory English language courses for international students, courses in English for academic purposes (EAP), in basic research skills and in academic literacy skills in general [4] in the form of lectures, project-based learning, flipped learning and massive open online courses (MOOCS). The courses focus on improving students' language proficiency, gearing it towards the kinds of genre typical to academia and providing research skills. Students learn to select reliable sources, use databases and understand and produce in-text and end of text citations. From the write up point of view the focus is on summarizing, paraphrasing and rewriting information gained from the sources in a stylistically and grammatically correct way.

This seems like a very complex process for students of engineering, like the ones in the current study, whose main areas of study revolve around numerical information and scientific formulas, already very challenging matters to master, especially if one is studying in a language other than one's mother tongue, typically nowadays in English. In fact, in the USA alone, the number of international students is over one million according to IIE statistics [5] and the numbers in Europe and Australia are very high, too [6].

All these students are expected to show what they know, in other words, to articulate what they have learned, in various formats, including academic essays, project reports and final reports, as well as written exams and oral

presentations. However, students, who are used to regurgitating back to the instructor what they have been taught, find it hard to express themselves using words other than those provided in the lectures, power point slides, textbooks or online materials provided through course management systems. In addition, most international engineering students are mathematically inclined. While they may be proficient in mathematical and scientific knowledge, their English language skills may be weaker than is desirable for studying in English towards an undergraduate degree. These are some of the reasons why engineering students' communication skills sometimes get criticized by employers [7].

This preliminary study investigates some of the coping mechanisms used by second-year, Arab, engineering students in an English -medium environment. The data consisted of 11 design reports written by 61 students in teams and classroom interaction between students and their English language instructor. The reports were studied to find emerging writing styles and the classroom interactions for discovering the ways in which the writing in the reports had been produced.

1.1. Task descriptions for written assignments

To understand why students write in the way that they do, it is important to look at the task description explaining the requirements for the written assignment, which was provided to the students. In this case it was a final report describing how the students executed an engineering design project. The description includes matters concerning the content as well as the layout. The students were given a template with the main headings, as this was seen to be the way many academic papers are written, too. The template was designed by engineering and English language instructors co-operating together. In addition, there was a lecture on the writing of the report and additional materials, such as a checklist, were provided on the course management system for students [8].

By viewing the extent to which the reports show students followed the guidelines provided in the task descriptions and based on discussions in the class during the course, it is hoped that it will be possible to ascertain some of the approaches adopted by students to complete the assignment.

1.2. Grading rubrics

The grading rubrics [8] are directly related to the course outcomes as defined by the department and based on the Accreditation Board of Engineering and Technology [9] criteria. The rubric for the final report is divided into separate sections regarding evidence of a successful project, project management and the drawings and building of the device, as determined by the initial client letter which served as the basis for the design project. The extent to which the students completed the assignment can be seen by looking at the grading rubrics filled in by the instructors for the assignment. Various sections of the rubric can further be used to illustrate the students' level of success in accomplishing the task.

2. Background

The students in the current study are undergraduate students studying towards a degree in mechanical engineering in an English-medium university in the Arabian Gulf. They are 19 to 21 years old and their mother tongue is Arabic. The students are both male and female students but at the time that the data for the current study was collected, the male and female students studied in separate classes. In their first year the focus is on general studies in English, Physics, Chemistry and basic engineering. In the second year the subjects are more strongly geared towards engineering and there is a two-semester engineering design course. In this course the students work in teams and in the first semester they learn the basics of engineering design and make drawings of potential designs. In the second semester they are expected to both produce drawings and a working model of the required design. The course serves as a pre-senior design course with the purpose of familiarizing students with what will be required in the senior design course and to enhance students' teamwork skills. Project documentation in the form of reports, meetings, presentations and demonstrations is all done in English. The data for the current research has been collected from male and female students participating in the semester engineering design course.

3. Methods of data collection

The aim of the study was to investigate the type of English language and the approaches to writing that students used in the final reports due at the end of the course. The students were 61 second year engineering students on a second semester engineering design course. They were grouped in teams of four to seven students per team and they produced a total of 11 final reports following the provided template [8]. The students were allowed to choose their own teams. The reports were each approximately 40 pages long including drawings made in the computer aided design program Solidworks [10]. The sections in the template included the following, as shown in Table 1 below.

Table -1: Content of Final Report

1. Introduction (Problem Statement, Problem Definition, Background)
2. Design Objectives (Metrics for Objectives, Constraints,
   Revised Client Statement)
3. Conceptual Design (Morphological Chart, Description of
   Design Alternatives)
4. Design Selection (Pairwise Comparison, Decision Matrix,
   Justification of Selected Design)
5. Final Design (Detailed Design, Standard Parts).
6. Design Analysis (Simulation results, Engineering changes
   based on analysis)
7. Manufacturing and Assembly (Fabrication of parts,
   Assembly
8. Testing (Prototype testing, Revisions based on prototype
   testing)
9. Cost analysis (Project total cost and cost breakdown,
   Breakeven analysis
10. Human, social and environmental concerns
    (Sustainability analysis and environmental impact)
11. Conclusion (Strengths and Weaknesses of Final Design,
    Recommendation for Design Improvements)

Further data were gathered from the grades in the sections of the grading rubric marked by the engineering instructor and the English instructor. The rubrics included sections on the following course learning outcomes (CLOs); (a) a demonstrated competency in applying the engineering design process to solve open-ended problems, (b) a demonstrated ability to present design solutions in oral presentation and written reports, (c) a practical understanding of applications of computer aided design and analysis tools, (d) an awareness of human, environmental and economic influence of engineering design and finally(e) a demonstrated ability to self-learn, research and use information [8].

4. Results and discussion

The language use in the reports varied from informal writing mainly done by weaker students, who also had some sections missing form their report despite the template provided, to clear, descriptive writing typical of engineering reports and finally there were also examples of competent, academic writing.

4.1. Three types of examples

Examples of the three types of language use from the student reports are as follows;
 Informal writing
The engine and the gearbox were fixed to the plastic box using screw to ensure its stability, and the wheels were attached to box by a long shaft that transfer motor motion to the wheels, and it was tighten with both bearing and nuts. S peed controller and the receivers were glued to the box itself and the battery adapter was taped in order to be remove easily if we want to recharge it.   (1)

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Descriptive writing

The middle wheels are just to support the vehicle while climbing to prevent it from getting stuck on the stairs. As for why the middle wheels have a smaller diameter, this is to reduce the friction that might prevent the car from climbing. (2)

Formal writing

Once all the chosen material was ordered for construction and assembly, it was necessary to run the simulation in SolidWorks on the most critical location in the vehicle to determine the amount of load that it can withstand. Thus, according to Figure 24. present in the Appendix B, upon application of 2.0 Kg of payload, the chassis was under high stress and the point of failure was at the midpoint. (3)

In the first example the slips in English could have been corrected by the students, if they had used a spell checker or any freely available grammar correction software, such as grammarly, as advised by the instructors. Most students have their computers set by default to their own language and unless they change the language to English, the spellchecker will not pick up on mistakes regarding grammar or careless layout. Instructors consider students to be computer savvy nowadays but perhaps instructors overestimate students' skills, ability or interest in availing themselves of existing technology on the one hand.

As for the descriptive writing in the second example, Hyland [11] points out that we can distinguish between a kind of general and specific English for academic purposes. Many pieces of scientific writing involve pure description and as such are easy to write. However, sometimes the descriptions are not produced by the students themselves, as is the case in the example. YouTube is a popular source of information at a time when short video clips seem more attractive to watch than reading pages of text, be it online or in printed form. However, students are often unable to judge the genre of English being used, i.e. whether it is formal enough for an academic assignment. In addition, and on a much more concerning note, students are tempted to write what they hear on a YouTube clip, as is the case in example (2) above. No plagiarism program commonly used in higher education will pick up on this speech-to-text type of 'borrowing'. Moreover, the temptation for students is understandable, as the explanation is clear and to the point, so it would seem like a waste of time to paraphrase it just for the sake of paraphrasing.

Digital tools are being used more and more in academic writing both by instructors and by students and [12] echoes the concern raised by [11] about informality creeping into academic writing. According to [12] "both teens and adults are heavily engaged in consuming and curating online video and pictures, and often remix the content available online into their own creations".

This gives rise to the issue of citing sources. It would have perhaps been more acceptable for the students in sample (2) to have referred to their sources than omit it. On the other hand, had the instructor checked the source, it would have been obvious that the entire section was plagiarized.

The final example does not include in-text citations, but it includes many of the features typical to formal academic writing, including the use of the passive voice, long sentences and a choice of specific vocabulary which is more typically used in writing than in speech, e.g. 'thus' and 'upon', which add to making the piece of writing more formal in style. While it is the style that pleases English language instructors, there is no reason why it could not have been written in the same manner as the second example. It is likely that, as a result, it would be easier for non-technical people to read the text.

The latter is a point that humanities style academic writing has been criticized for. It has been said that it seems that humanities researchers write to each other and not to the general public. In this age when everyone feels entitled to all manner of information and knowledge, it is not seen as a positive trend. In other words, the audience of texts typically written in the genre of academic English has become wider. It is evident also in that more academics in a variety of fields have started publishing for the general public to reach more people. This naturally means that the style of writing is more informal and - what academic writing has been criticized as lacking in - easier to understand. Perhaps there is a need for a more informal writing style in academia for information to reach a wider audience more easily [11]. Moreover, with more and more non-native speakers writing in English, perhaps it is time to let go of the strict, established Anglo-Saxon norms and style requirements academic writing and to agree on the overriding importance clarity and ease of access over stylistic matters.

4.2. The use of digital tools for academic writing

As the writing of the report was a team effort, most of the students scored in the range of 80% to 90% out of 100% in the grading. The advantages of teamwork are that the team can give the good writers more to write. On the

other hand, when the work is divided up among the students, the quality of writing can vary a lot from one section of the report to another, as shown was evident in the scrutiny of the sample reports. Some students can end up only dealing with drawings or figures and tables, which means they get little practice in writing.

Anecdotal evidence among English instructors also reveals that students sometimes rely too much on online tools such as resort to using Google translate without checking whether the translation makes sense grammatically or not. After all, the purpose of this tool is to make the foreign text understandable, not to translate it correctly. Another tool students seem to resort is a document spinner, such as *prepostseo*. This kind of software will find synonyms for every second or fourth word and change it accordingly. Unfortunately, not all synonyms fit the context that the sentence that is being doctored adheres to. The resulting sentence may appear to be correct but often the meaning becomes quite baffling. The following sentence is an example of what a document spinner produced from the first sentence in example (2):

Document spinner example
The middle wheels square measure simply to support the vehicle whereas ascension to forestall it from obtaining stuck on the steps.   (4)

It is disconcerting that English instructors come across such language use with increasing frequency in this digital age and while a student will find it hard to explain the meaning of a sentence such as the one in example (4), he or she may adamantly insist that it was written by him or her. Submitting such writing to an instructor also shows that the students who included it in their assignment are unable to judge the quality of English when it is beyond their own proficiency. In addition, to claim that such as sentence is acceptable also reveals an overreliance on digital technology and its faultlessness – a misguided reasoning that needs to be explained to students. However, it is understandable, too, as a means for producing English that seems formal, especially for students for whom the jump from personal essays and exam answers to academic writing represents as big a change [3]. As a result, students clearly need more support than is currently being provided to overcome these obstacles.

5. Conclusions

Nowadays, international students have more information at hand in English and more tools to assist them in their writing, not to mention websites aimed at students that offer to write assignments for a fee. This is the reality and all these matters – the tools and the websites – should be addressed in EAP and academic literacy courses, so that students are aware of their positive and detrimental effects. After all, copying and pasting only teaches students to copy and paste, whether it is done from one document to another, using Google translate or a document spinner and these are not skills that will generate the kinds of critical thinkers higher education and the working world desire.

The line between formal and informal writing is a current topic of research and some researchers are readily drawing the line between the two of them. However, the differences may not be clear to the increasing numbers of international students who are expected to show what they know or have learned by producing pieces of academic writing in a style determined as 'academic' or 'formal'. Moreover, the tools that students can avail themselves of to produce such writing are many and not all known to instructors of academic writing, e.g. document spinners. The question therefore arises whether the tools should be made available for students, so that they can be trained to use them in a responsible way. This includes the use of sources such as YouTube and other non-text-based ones.

The current study is a preliminary one to a larger one where I want to investigate how students approach academic writing tasks in the field of engineering and in first and second year writing classes. I aim to gather more data using students' written work and semi-structured interviews as data-gathering methods, as well as focus group discussions with students, instructors and writing center staff.

It is recommended that similar studies be done elsewhere and in other academic disciplines, too, with regards to student approaches to completing written academic assignments. It would also be interesting to see whether students' knowledge of digital tools is being underestimated or whether it is well beyond that of their instructors of EAP and academic literacy skills in general. A further area of study is the ways in which instructors incorporate digital tools in their work, as well as the kinds of use of digital tools they encourage their students to use and/or to avoid.

Academic writing in English is the primary means in which information and knowledge is divulged in the world today and it is therefore also essential that the quality of writing and ways of dealing with content be maintained at as high a level as possible without marginalizing interested readers due to highly formalized writing. However,

should the line be drawn in sand or should the position of the one already drawn be adjusted? These are some of the questions that need to be researched in more detail in order to arrive at answers that are viable in today's digital world where information must be accessible to everyone who needs it.

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Promoting a sustainable curriculum for the Universal Basic Education (UBE) in Nigeria

Ajayi C. OMOOGUN

Department of Environmental Education, University Of Calabar, Calabar. Nigeria

omoogun.ajayi@gmail.com

Abstract

It is universally acknowledged that the development of education is a prerequisite for social, economic, political and cultural progress. This recognition has gingered many nations to devote adequate attention and resources to the development of education and in some cases making it free, compulsory and/or universal. The global quest for Universal Basic Education {UBE} seems to affirm the place of education in socio-economic and political evolution. The Universal Basic Education is embroiled with mountain of criticisms. These criticisms always are related to educational variables such as teacher quality, learning facilities, inadequate funding, quality of textbooks, students population etc. Criticisms in these areas have tended to mask a more fundamental area, the curriculum and its contents, structures and relevance. This paper examined the UBE and the problems associated with universalization of education in Nigeria. The opined that curriculum which represents the core and tactical center of the education enterprise has a huge share in crisis confronting universal basic education. The paper proffered areas of emphasis for curricula that will enhance life-long education that is fundamental to the universal Basic Education in world dominated by scientific and epistemological advancement.

Keywords: sustainable, curriculum, Universal Basic Education (UBE)

Introduction

It is universally acknowledged that the development of education is a prerequisite for social, economic, political and cultural progress. This recognition has gingered many nations to devote adequate attention and resources to the development of education and in some cases making it free, compulsory and/or universal. The global quests for Universal Basic Education {UBE} affirm the place of education in socio-economic and political evolution. Modern trend demands certain cognitive levels and technical environment, which is accessible only to a literate populace.

Crisis in educational system are most blamed on variables like population of pupils, untrained teachers, lack of learning facilities, ill motivated teachers, etc. These areas often mask a more fundamental area, which is the curriculum. While curriculum conceptualization seems elusive and subject to usage criteria, it is very important to note that it is more than taxonomy of topics and concepts conventionally called subjects?

Beyond the philosophical, artistic, scientific and technicality of curriculum issues which are confined in what, why and how of educational objectives, question of value in the face of our dynamic environment and epistemological advancement seems to trail our educational system. To put it more succinctly, what should constitute 'basic education'? In other words, what learning skills, value and knowledge are important for the development of the individual and the well being of the society?

Wastage in education is systematically linked to dysfunctional education system producing people with the wrong kind of skills. Most of what children are expected to learn (contents of school curricula) fails to provide them with answers to pressing questions that arise from their generation's outlook on life but often lie outside their school learning.

With the introduction of the Universal Basic Education, many curricula questions vex for concrete answer. How do we educate our children with education that is basic yet universal and then cope with the information age? Is the education system ready to provide the desired change that is required of our school system? Thompson (1981) has

observed that there is a complex relationship between the curriculum, the organization or reorganization of the school and the structure of the system, which must be taken into account. To achieve a change in one of these aspects, changes in all three areas will be necessary. Basically, this paper examined some curricula areas that can enhance the attainment of UBE.

Educational development in Nigeria

Nigerian nation have demonstrated tremendous interest and concern for the universalization and development of education. Realizing the role that education plays in national development, Nigerian governments have continued to venture into various educational policies and programmes with the expectation of meeting the country's need in the areas of human capital development.

Nigeria has subsequently made efforts in the past to provide broad-based education through various programmes (Patrick. 2000). These programmes include:

a.   Introduction of Universal Primary Education (UPE) in Western Region on 17th January 1955.

b.   Introduction of Universal Primary Education in the Eastern Region in February 1957.

c.   Introduction of UPE in Lagos (then Federal Territory) in January 1957.

   d.   The publication of the National Policy on Education in 1977, which is unequivocal in its insistence on

         functional, universal and qualitative education. The Policy declares Governments intention to use a variety of

         strategies for the provision of Universal Basic Education for all citizens.

   e. Launching of Universal Free Primary Education on 6th September 1976 and.

   f. The launching of Universal Basic Education (UBE) on Both September 1999.

The scope of UBE

Universal Basic Education is to cover a very broad area that includes: -

 i.   Early childhood care and education

 ii.   6 years of primary school

 iii.   3 years of junior secondary school

 iv.   Adult literacy and non-formal education

 v.   Skills acquisition programmes and the education of special groups, such as nomads and migrants, girl-child and women Almajiri, street children and disabled groups (UBE, Act 2004).

Fundamentally, UBE scheme is aimed at providing the populace with the opportunity to acquire basic education in a sequential and progressive cycle.

The UBE scheme was launched basically to provide free, universal and compulsory basic education to all children regardless of sex, age, ethnic or religious inclinations, language or status. It is meant to also resolve the issues of high rate of dropouts, narrow curriculum content and half-baked graduates that did not meet the needs of the Nigeria society and further accommodate a comprehensive adult literacy programme. The scheme is therefore designed to ensure adequate and qualitative education that is directed towards the achievement of the nation's objectives [Uche & Okafor 2013]. According to the Implementation Guidelines for the UBE, the scheme stresses the inclusion of girls and women and a number of under served groups; the poor, street and roaming children, rural and remote population, nomads, migrants, workers, indigenous people, minorities, refugees and the disabled. The formal education system is only one of six components included in UBE. Other related areas include early childhood, literacy and non-formal education or apprenticeship training for youths outside the formal education system [FRN, 2000].

The UBE Programme is seen as an expression of the strong desire of the government to reinforce participatory democracy in Nigerian by raising the level of awareness and general education of the entire citizenry (Obayan, 2000)

OBJECTIVES OF UNIVERSAL BASIC EDUCATION (UBE) POLICY IN NIGERIA

Ejere (2011) emphasized that the main objective of the UBE programme is "to lay the foundation for lifelong learning through the inculcation of appropriate learning, self-awareness, citizenship and life skills". Specific objectives of the programme include: -

i. Developing in the entire citizenry a strong consciousness for education and a strong commitment to its vigorous promotion.

ii. The provision of free, compulsory, universal basic education for every Nigeria child of school age group.

iii. Reducing drastically the incidence of drop out from the formal school system.

iv. Catering for the learning needs of young persons who for one reason or another, have had to interrupt their schooling through appropriate forms of complimentary approaches to the provision and promotion of basic education.

v. Ensuring the acquisition of the appropriate levels of literacy, manipulative and life skills as well as the ethical, moral and civic values needed for laying the foundation for lifelong learning (Nigeria, 2000; cited in Ejere, 2011).

Access to basic education has improved. Between 2009 and 2013, the number of primary schools in Nigeria rose from 58,595 to 61,305, an increase of 5 per cent.

The pre – primary education Net Enrolment Ratio (NER) increased from10.9% in 2003/2004 to 18.1% in 2009/2010. About 2,693,323 children were enrolled in pre – primary schools in 2010. Out of this number, 1,366,522 (50.7%) were males while 1,326,801 (49.3%) were females. (NEMIS, 2010). In 2013, the number increased drastically again to 2,994,734 [EFA, 2015].

According to report [UNICEF, 2015] Primary school enrolment has increased in recent years, the net attendance is only about 70 per cent. Unfortunately, Nigeria still has 10.5 million out-of-school children - the world's highest number.

About 60 per cent of these out-of-school children are girls. Many of those who do enrolled drop out early.

Unemployment among school attendee and low perceptions of the value of education for girls and early marriages are among the reasons. Universal Basic Education (UBE) policy in Nigeria has failed to deliver significant success rate. It has been anticipated that the policy will be able to deliver more positive outcomes compare to the ones previously implemented.

The scheme has promised curricula that will enable the learners live a meaningful and fulfilling life, contribute positively to the development of the society, derive maximum social, economic and cultural benefits from the society and discharge their civic obligations competently. This is realistically an 'Enriched Curricula'. But how can we achieve all these within the context of the current antecedents in our education system, that is, the comatose state? What do we teach children that will benefit from the UBE to avoid future shock, and a life long education?

Given that majority of the children will drop out after the compulsory universal basic and free level, what education shall we give them that will be life-long? After all, basic education goes beyond nine years of compulsion. Basic education should be seen as a general education that will enable an individual function effectively for life within and without advancement in human knowledge. In most developing countries (Nigeria inclusive) among the various expectations of education, the economic benefits seem to pre-occupy the consumers' mind. That means employment opportunity after school (economic advancement).

The UBE promise to be the theatre stage for the needed surgical operation with the democratic dispensation providing a convalescing atmosphere (Ogbuka 2000) but one thing is very fundamental; learning must go beyond what Henchy 1981 describes as "random or whimsical" group of learning. There must be utility, form and coherence. Manley 1974 has noted that education by its very nature either tend to preserve the status quo or promote change depending on how it is organized and the purpose to which it is put.

The general assumption is that when we build good schools, provide facilities and then train and pay teachers well, have fewer student-teacher ratios, supervise our schools, then our education will come out right. Certainly, the curriculum will determine not only the process but also the product of the various inputs. For the UBE to conform to the National Policy on Education especially the philosophical dimensions, new models of learning experiences are desirable.

Sustainable Curricula for UBE

Curriculum provides the framework for educational activities in relation to its purpose, experience, organization and evaluation (Tyler, 1949). According to Whitefield (1971), curriculum represents the very core and tactical center of education enterprise. Since it encompasses all that goes on in the school, the curriculum is like the mirror of what an educational system entails. Thus an educational system can only be relevant if the curriculum provides the desired skills and knowledge.

What should we teach in the UBE that will make its recipient get basic education, that is, life-long education? What do we teach in the UBE that will not undermine the philosophical ideology of Nigerian education system? The following areas have been suggested to be core subjects' area in the UBE curricula.

Scientific Literacy

The quality of Scientific and technological knowledge expressed in terms of hard facts is doubling. This exponential expansion in knowledge has made our generation realistically the age of science so much that every man is involved directly or indirectly with science. Understanding the nature of scientific knowledge, its epistemological status and values, its broad principles and application will equip recipient to meet the challenges and social demands of a scientific age. Among other things, science must emphasize the process not the product. Contemporary science curriculum is now recognized as a human activity, which among other things seeks to advance understanding of the world around.

The 2006 PISA report of a survey of more than 400,000 15-year-old students from 57 countries notes that"92% [of respondents] said that advances in science and technology usually improved people's living conditions" (OECD, 2007, p. 6), and noting that: A strong acceptance by students that science is important for understanding nature and improving living conditions extends across all countries in the survey. The 'key point' of the report is: Equipping every citizen with the skills needed to live and work in the knowledge society by giving them the opportunity to develop critical thinking and scientific reasoning that will enable them to make well informed choices. Science education helps fight misjudgments and reinforce common culture based on rational thinking (High Level Group on Science Education, 2007, p.6). Twenty First Century Science stated that they would expect a scientifically literate person to be able to:

• appreciate and understand the impact of science and technology on everyday life;
• take informed personal decisions about things that involve science, such as health, diet, use of energy resources;
• read and understand the essential points of media reports about matters that involve science;
• reflect critically on the information included in, and (often more important) omitted from, such reports; and
• take part confidently in discussions with others about issues involving science. Dillon [2009]

Environmental Education (EE

At the very beginning of the millennium, a year predictably tagged by Weizsacker (1995) as "Century of the environment" our vulnerable earth faced a tidal wave of assault. Basic understanding of the dynamics of the environment is still largely absent among its populace. Man's colonization of the earth is founded on his anthropocentric view as the custodian off earth. As Lynton K Caldwell quoted by Newson (1992) noted, environmental crisis is an outward manifestation of a crisis mind or spirit. This crisis will continue. One has noted that in this century, we shall have two countries (I) our own (ii) the environment. The UBE curriculum must take its product what Patterson (1990) called 'Environmental Troubleshooters". To do this requires that we integrate in the curriculum the precepts of environmental friendliness especially at this foundation level. "Right now, in the second decade of the 21st century, preparing our students to be good environmental citizens is some of the most important work any of us can do. It is for our children, and our children's children, and generations yet to come." [Duncan, Sep 2010]. According to 2017 sustainable forestry initiative report it is estimated that by 2030, the world population of 7 billion will demand twice as many resources as the planet can supply (The Economist). Meeting the needs of our global citizenry—ecologically, economically, culturally, spiritually, and more—requires understanding and creative problem solving. Environmental education equips learners with the knowledge, skills, and motivation to address complex environmental challenges in the 21st Century.

- Fostering Healthier Schools. EE empowers students to lead the way in creating greener and healthier learning environments inside and outside their school buildings.
- Supporting Sound Decision-Making. EE ensures citizens are informed about sound science and equipped to make decisions that are critical to ensuring the US and greater world have the natural resources on which our economy and quality of life depend.
- Contributing to Sustainability. EE builds the knowledge and skills needed to address complex environmental issues, as well as take action to keep our natural world healthy, our economies productive, and communities vibrant.

- Conserving our Natural Resources. Higher levels of environmental knowledge correlate significantly with a higher degree of pro-environment and conservation behaviour. The more people know, the more likely they are to recycle, be energy efficient, conserve water, etc.

Population Education (PE)

Population explosion and associated problem will continue to be an issue of human concern. The international Forum on Population in the 21st century held in Amsterdam in November 1989 recognized the value of information and education about population issues. Population Media Center [2010] cited Colin Power's address that rapid population growth is one of the most serious impediments to development today, and the single largest obstacle to our dream of education for all by the year 2000. It is not just a problem of increasing poverty, growing numbers of illiterates, overgrazing, soil erosion and destruction of rain forests, but population pressures also tend to produce regional conflicts, flow of refugees, and great pressure on developed to admit emigrants from poorer countries.

The Universal Basic Education should help people to understand the nature, cause and implications of population processes as they affect and are affected by groups and individuals. Again population experts must come together and plan what and how we can introduce population education to the recipient of UBE who may not have such opportunities after the first nine years of education. Formal education should prepare the young for adult life by teaching relevant information and skills; it may help to build altitudes and values at an early age; it prepares individuals for roles as community and national leaders; and it supports national social and economic development. If the schools are to perform these vital roles fully, they should include population in the curriculum, since population and family life issues are an important aspect of many personal, community, and national decisions.

Human Right Education (HRE)

Learning is favorable to liberty. A free government can only exist in an equal diffusion of literature (Rush, 1969). Without learning men easily become savages or barbarians and where learning is confined to few, monarchy, aristocracy and slavery thrive. No one however, can consciously obey the laws of reason and duty until he understands them: hence the preliminary need of being clearly explained. Thus the first step towards national obedience is knowledge of the rule to be obeyed, and the reason on which it is founded. The apprentice of democratic principles must begin at childhood. If we are to govern by virtue of a law, which embraces, overlies all-government and the governed, then lessons of obedience should be inculcated in the foundation level in reference to the laws. Human rights education aims to do the following:

· Enhance the knowledge and understanding of human rights.
· Foster attitudes of tolerance, respect, solidarity, and responsibility.
· Develop awareness of how human rights can be translated into social and political reality.
· Develop skills for protecting human rights

In an address to NSW teachers in 2009, prominent human rights barrister Geoffrey Robertson argued strongly for the importance of human rights education: … 'they [human rights] serve to show that privilege is an anachronism, that dogma is destructive, that freedom is a birthright and discrimination is a wrong that should never be suffered' (Robertson, 2009). The Victorian Charter of Human Rights and Responsibilities Act 2007 outlined a set of rights that can be grouped into:
• Right to life, freedom of religion, freedom of speech, freedom of thought, freedom of assembly and association, the right to take part in public life (right to vote), freedom of movement.
Legal Rights
• Right to liberty and security, privacy, equality before the law, humane treatment, protection from torture, property rights, rights in criminal proceedings, right to a fair hearing, right not to be tried or punished more than once, retrospective criminal laws.
Economic, Social and Cultural rights
• Freedom from forced work (slavery), protection of families and children, rights of children, cultural rights.
For many children that will not go beyond the UBE, having knowledge of their fundamental human right will improve participatory democracy and advocacy.

Moral Education

The level of decadence in our society shows that religious education cannot solve our moral laxity. What for instance will the call of Abraham, birth and death of Jesus or Mohammed teach a child relative to moral behavior? Assumedly, religious education has been the bane of religious fanaticism. The secularity of Nigeria should absolve the school from religious education. We must begin to teach values and attitudes such as honesty, self-discipline, respect for truth, respect for other individuals etc. with localized examples. Furthermore, some

school curricula should move away from extremism, racism and hate ideologies and teach perseverance, respecting others, responsibility, national identity and commitment by integrating them with the school's moral education. Moral education should breed attitudes and values needed to bring about behaviour changes that will enable children, youth and adults to prevent conflict and violence, both overt and structural; resolve conflict peacefully; and create the conditions conducive to global peace.

Nutrition Education

Nutrition education is "any combination of educational strategies designed to facilitate voluntary adoption of food choices and other food- and nutrition-related behaviors conducive to health and well-being…it is delivered through multiple venues and involves activities at the individual, community, and policy levels"[Contento, 2007]

Problems of malnutrition are often related to both "economic poverty" and "poverty of knowledge" about nutrition. There is need to improve eating habits especially the proper combination of our local food. Health, they say, is wealth and nutrition education is an extension of health education programme. This type of education can also be built into agro education where children are taught how to grow food those are rich in nutrients. Here children should be taught the various local foods available, their nutritional values and the right combination that would make a balanced diet.

Helps students maintain a healthy weight
•Establishes healthy eating behaviors
•Promotes an overall healthier lifestyle [Contento, 2007]

Conclusion

The Universal Basic Education offers a chance and opportunity of acquiring basic intellectual and mental aptitudes too many who after the nine compulsory schooling, will drop out of school. The products of such schooling need not to be equipped with traditional subjects currently going on in our schools but with curricula that will provide a "life education".

On a very general note government must work the talk. Majority of Nigerians cannot afford the needed books, chairs and tables, school uniform etc. Education cannot function in isolation from the vicissitude of social conditions. Basic life needs should go along with basic education and the right type of curricula. With the population of schools likely to increase school building, laboratories, sport facilities among others must equally expand. If the UBE is to be effectively managed, the current school conditions (dilapidated facilities) must also be immediately replaced as no meaningful learning could take place under such conditions. Teachers must have access to unlimited resources to teach effectively, and schools well equipped with modern facilities (computers, hardware and software) to enable him/her carry out effective management. It is strange that in this age of scientific advancement teaching aids and equipment barely differ from those that existed in the colonial era.

According to Ibrahim [2016] successful implementation requires a huge and substantial amount of resources that no single stakeholder can comfortably provide. The international organization and donor agencies should do the needful to make the programme successful.

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Skills to Succeed in International Business and Competitive Working Environments

Rodolfo DELGADO

Tokai University, International Education Center. Shonan Campus. Hiratsuka-City, Japan
Email: rodolfodelgador@gmail.com

Abstract

This study analyzes Skills to Succeed in International Business and Competitive Working Environments. Many University students have the expectation of getting skills and prepare for their future careers. Meanwhile, sometimes students get prepare to pass an exam to get credits for the courses instead of focusing on gaining skills and experiences that will allow them to succeed in Japan or in International working environments.

Students at universities in Japan, and working professionals discussed the importance of key skills to achieve competitive advantages in a global workforce. These skills are not limited to International Business because can also be transferable skills in diverse working environments and professions in the social sciences.

International and Japanese university students and working professional studied and discussed selected skills as part of their International Business training and competence; these skills varied from presentation to intercultural communications skills on how students can gain efficiency on the workplace by learning the importance of using these skills before and after joining the work force.

Keywords: Skills, International, Business, Competitive, Working

The Impact Of Electronical Tests On Student Pressure, Student Concentration And Academic Dishonesty

Thomas RACHFALL[a*], Soeren DRESSLER[b], Dirk FOERSTER-TRALLO[c], Sandra DRESSLER[d]

[a] Hochschule Merseburg, Fachbereich Wirtschaftswissenschaften, Eberhard-Leibnitz-Straße 2, 06217 Merseburg, Germany,
E-Mail: thomas.rachfall@hs-merseburg.de, Phone: 49 (0) 3461 46 2449
[b] Hochschule für Technik und Wirtschaft Berlin, Fachbereich 4, Ostendstraße 1, 12459 Berlin, Germany,
E-Mail: soeren.dressler @htw-berlin.de, Phone: 49 (0) 30 5019 2888
[c] Hochschule für Technik und Wirtschaft Berlin, Fachbereich 4, Ostendstraße 1, 12459 Berlin, Germany,
E-Mail: dirk.foerster-trallo@htw-berlin.de, Phone: 49 (0) 30 5019 3596
[d] Beuth Hochschule für Technik Berlin, Fachbereich 1, Luxemburger Str. 10, 13353 Berlin, Germany,
E-Mail: sandra.dressler@beuth-hochschule.de, Phone: 49 (0) 30 4504 5539

Abstract

Online or e-tests are an important component of new digital learning approaches. E-tests enable efficient ways to facilitate the examination process and provide immediate feedback to the students. Also, with students being more and more proficient in applying e-learning methods it can be expected that e-tests are generally higher accepted by students. However, aspects such as perceived strain and negative impacts on the concentration performance of students may arise through an online test environment. In addition, the e-test situation potentially invites academic dishonesty as test results are sometimes visible to others on various monitors and not permitted web-resources might be used. Aim of the research was to improve effectiveness of university education by enhancing the examination processes in digital teaching approaches. The authors have analyzed three business courses on bachelor and master levels in which e-tests are applied. The students were asked how comfortable they feel with the test situation and how the e-test situation creates strain and potentially limits their performance. Also, students were asked to compare e-tests against traditional ways of examination. In addition to this, students were surveyed with regards to the possibilities of cheating during an e-test. As a general result, students still prefer slightly paper-based exams but accept and adapt to e-test scenarios. While undergraduate students often feel less strained than graduate students in e-tests, master-level students are in some cases concerned that an e-test situation might limit their opportunities to bring the depth of their knowledge across. Cheating appears to be a problem in particular as long as e-test results are visible to a broader group. Based on the empirical results the authors have derived a set of recommendations on how to overcome major challenges in e-tests and how to increase the effectiveness of this examination approach. Lastly, the paper outlines key requirements on how to limit possibilities of academic dishonesty in e-tests and how to leverage the full breadth of technology opportunities offered by most e-test system.

Keywords: Electronical tests, Strain, Stress, Pressure, Concentration, Academic dishonesty, Digital learning.

1   INTRODUCTION

Digital learning is advancing. More and more scholars supplement their teaching with modern and state-of-the art teaching methods mainly based on new technology. While videos, interactive online sessions and web-based exercises support the learning process instructors apply digital tests for other reasons: time effort and complexity of correcting and grading of exams and tests can be reduced through the technology, error rates in counting points and capturing and aligning all student feedback to the respective questions can be improved, and consistency of the grading can be enabled. Students of all kinds of disciplines are by now experiencing digital teaching methods and as a consequence are faced with the digital testing environment as well. The positive impacts of digital teaching and blended learning have been highlighted in many studies [1, 2, 4]. However, there appears to be a gap in the literature on how students experience a digital e-test environment. A test situation is always a situation that creates strain on the student's side. Learning content and transfer of content need to be

demonstrated and the notion of not being able to bring across the entire knowledge in the test situation often creates nervousness, even fear or panic and leave students in a distressed situation [3, 6, 9]. Purpose of this research is to identity how much psychological strain is been added on the already challenging test situation by providing the test in an e-test environment. There are many factors that increase the complexity of e-tests: the systems have to run flawless, the student need to be able to access and execute the test. Moving forward and backward and navigating in e-tests needs to be mastered without answers getting lost or not getting transmitted correctly to the instructor. Last but not least e-tests can inforce much better time control than paper-based tests as the testing system dictates the time regime for selected questions and the entire test. Also, in contrast to paper-based examinations the use of allowed and not allowed supporting tools differs. As an example, an e-test policy can prohibit the use of any kind of paper, restricting the student to no visible other support such as prepared pages with potential answers. On the other side, e-examinations take place in a digital environment which might enable candidates to apply online resources and use e-mail and/ or chat functionalities in order to get support in answering questions. In theory, the system environment for test and examination purposes can and should be configured in ways that prevent the candidate accessing any not wanted sources. However, in current day testing reality at many universities, colleges and schools the development processes of solid e-test environments have not advanced so far yet.

This paper researches first the general aspects of psychological strain and academic dishonesty in e-examination situations. As a next step the e-test approach as applied by the authors in different classes is been introduced and challenges and activities to improve the testing situations are discussed. In the following chapter the data collection process is presented, and key measures are delineated. The findings of the study are presented and discussed afterwards. In the last chapter the conclusions are derived, and some tangible improvement recommendations are lined out.

2   STRESS AND ACADEMIC DISHONESTY IN E-TESTS

The influence of computer-based tests on student's behavior is an important topic, due to the reason that e-tests are used more frequently. Therefore, this chapter introduces a short section about strain in exam situations (2.1) as well as an introduction to academic dishonesty in e-tests (2.2). This chapter finishes with a section on e-tests in selected business courses (2.3).

2.1   Stress in exam situations

Psychological strain influences the academic performance of students. Students report about psychological strain when taking their exams and that this fact affects their performance [4, 5, 6, 7]. So far, this literature was based on examinations in the traditional way, and not an online test environment. The link between psychological strain and performance in an exam is now taking to the e-test environment, which adds complexity to the exam in terms of the functionality of technical means.

The test and exam situation causes psychological strain on both sides, the student/ candidate and the instructor. While the candidate taking the test is under strain in order to demonstrate his or her knowledge and is in search for a good grade, the instructor feels strain due to other reasons: will all questions be well understood, can all assignment questions be resolved with the data and information provided, will students try to cheat and will all test candidates sustain the examination process without any health issues are just some typical questions an examiner is faced with (figure 1) [8, 9, 10, 11, 12, 13].
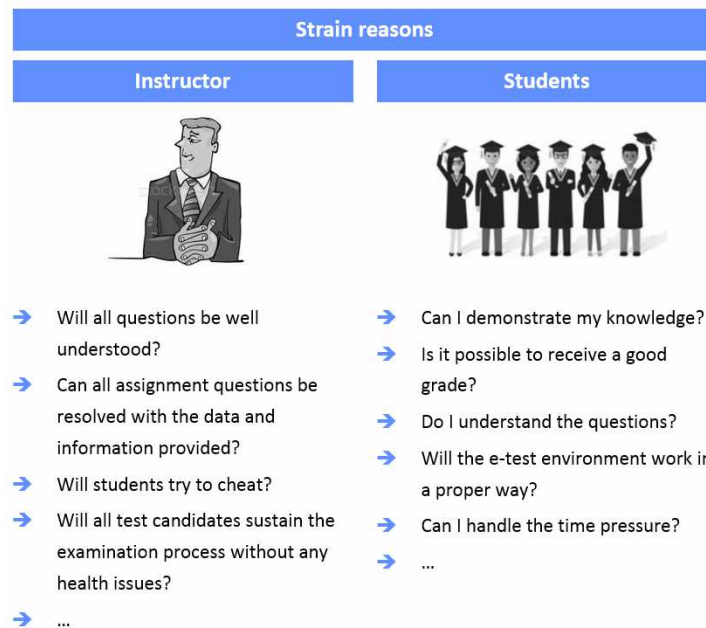
Figure 1: Possible strain reasons (source: authors)

In many disciplines the examination forms have been adjusted in order to increase the effectiveness of checking the knowledge and/ or the transfer of the knowledge of a student correctly. Case work and case presentations are typical examples, in other situations projects and essays are the most effective examination routines. Despite their effectiveness these examination forms are not applicable to all testing strategies. Some disciplines and courses require that a student has understood certain key principles, calculation methods and logic frameworks. Ideally, a student can demonstrate this knowledge and apply it correctly to comparable assignment questions. In this research the latter mentioned examination approach was in the focus and will be called e-test. These e-tests cause the unique set of strain factors as mentioned above while all other forms (case work, essays, projects, etc.) cause other forms of psychological strains such as proper time management, effective team work, data capturing and so on. Although these forms of examinations can also be enabled and supported by digital tools the psychological strain factors to be analyzed here are more applicable to e-tests.

2.2   Academic dishonesty in e-tests

In particular if an examination is focused on knowledge on tools, methods, principles and calculations students are often intrigued to use not allowed supporting tools [10, 13, 14, 15]. In some disciplines and course topics, the wealth of knowledge to be mastered, appears to the students so monumental that they see no alternative in using prepared materials, crib sheets and other illegal sources while they are in the examination situation. In large-scale examinations with hundreds of candidates sitting for an exam it is virtually impossible for an examiner to detect all potential tools of academic dishonesty and therefore, candidates can and still will use them at their own risks [10, 15, 16, 17]. Over the course of their academic careers students have developed their own survival strategies and these experiences have been transferred from one generation to the next one – as long as we talk about paper-based exams. In e-tests this wealth of knowledge in academic dishonesty practices is not so rich yet [13, 17]. It is a fairly young discipline, as digital examinations are not a widespread testing practice yet. In addition, the application of digital methods is multifold – dependent on the systems, exam requirements and the level of experience of the examiner: some examiners just use e-tests for simple multiple-choice test while others have students writing essays, resolve complex cases or run advanced algorithms. Consequently, it is difficult for the student body to identify, hone and transfer proven testing and cheating practices to the next generation.

2.3   Applying e-tests in selected business courses and respective measures

Digital learning methods have been developed and are applied by the authors for more than five years. Supplementing the e-leaning approaches with e-tests started approximately four years ago with first exercise questions on simple calculation models and multiple-choice questions. Since three years e-tests have become an integral part of the classes in Management Accounting (bachelor-level, 3rd semester), Strategic Accounting (bachelor-level, 6st semester), Corporate Finance & International Accounting, master-level), Special Topics on Business Administration/ Business Simulation (master-level). In some of these classes e-test are been used to

cover the entire course requirements. All of these classes are strongly business and finance-related the examination approach need to cover knowledge and transfer of knowledge but at the same time financial modeling, calculation and accounting tasks. These requirements are reflected in the type of e-exam questions which range from multiple choice to short essay writing.

As all classes are facilitated through the campus system Moodle it is used as e-test system environment as well. In the same way students access class materials through the system they can access and complete the e-tests. The e-tests are usually facilitated in the computer labs, students have to be present and are only allowed to complete the tests while they are in the room and under supervision of the examiner. Therefore, all strain factors discussed above can and will occur. In all classes the key metric is the average grade as received by the students (according to the German grading system: 1,0 best grade, 4.0 worst grade, less than 4,0 counts as a fail, grades can be assigned in intervals, (e.g. 1,0; 1,3; 1,7; 2,0 and so on). However, from a methodology point of view differentiation of the attribution of teaching methods and examination methods cannot be done. Thus, focus of this research was on perceived candidate's pressure in e-test situations only.

3 METHODOLOGY

Objective of this paper is to identify the effects of stress in e-test situations and the perceived methods of academic dishonesty. Also, recommendations should be derived that increase the effectiveness of e-tests.

3.1 Sample and data collecting process

Sample of this paper are students of different courses (Introduction to Management Accounting, Corporate Finance & International Accounting, and Special Topics in Business Administration/ Business Simulation) at the HTW Berlin. The students are enrolled either in in the 2nd year of a bachelor course (Industrial engineering) or in the first year of a postgraduate master program (Master of Business Administration and Engineering; MBA&E). The courses are regularly separated into groups of 20 - 40 students. This semester 104 students were registered in both courses. As table 1 reports, 64 students participated (61% of the sample). A questionnaire was used to collect the data. The advantage of a questionnaire strategy is that it provides standardized answers that make it simple to compile data. Because the topic of the paper is a very complex one, quantitative (4-point Likert scales, with an additional field "don't know") as well as qualitative data were collected to triangulate findings. The collected data were analyzed with the objective of establishing links between electronical tests and student's pressure, concentration and cheating behavior. Furthermore, the data were analyzed by SPSS and MS Excel.

Table 1: Structure of the sample (source: authors)

Bachelor in industrial engineering	Master of Business Administration and Engineering	
Course: Introduction to Management Accounting	Course: Corporate Finance & International Accounting	Course: Special Topics in Business Administration
64 Participants		

3.2 Measures

To test the influence of the newly developed electronical tests on the student pressure, concentration and cheating behavior the participants were asked regarding different topics. The used items for the quantitative analysis were fully developed by the authors.

4 FINDINGS

In general, the theses that e-test create psychological strain could be confirmed (figure 2). However, it is required to drive the analysis one level deeper as students on the master-level feel this more relevant. Also, there appears to be a dependency of the experience with the e-test situation and the perceived stress level: the more experience the higher the perceived stress level.
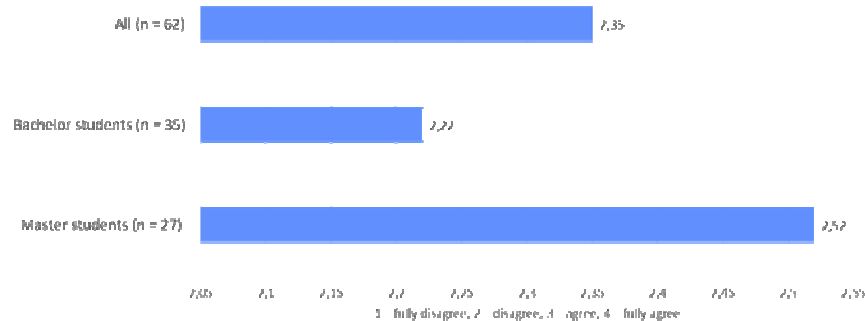
Figure 2: Stress levels of students in e-Tests (source: authors)

However, the results do not indicate significantly increased psychological strain levels. The overall value of 2,35 trend stronger towards a disagree assessment than an agreement. For students examinations are a necessary evil and they know and accept the fact that any kind of testing process needs to be successfully completed. As such the method itself is not supporting apparently the examination perceived stress. Also, the student generations nowadays are digital natives which obtain higher levels of experience, knowledge and proficiency in applying technology in various aspects of life. The e-test situation is likely felt as a standard routine.

A similar analysis can be made for the strain factor time restriction (figure 3). It is the more experienced master-level students which perceive the fact the e-tests are timed more rigorously (through the system) as increasing their perceived stress-levels.
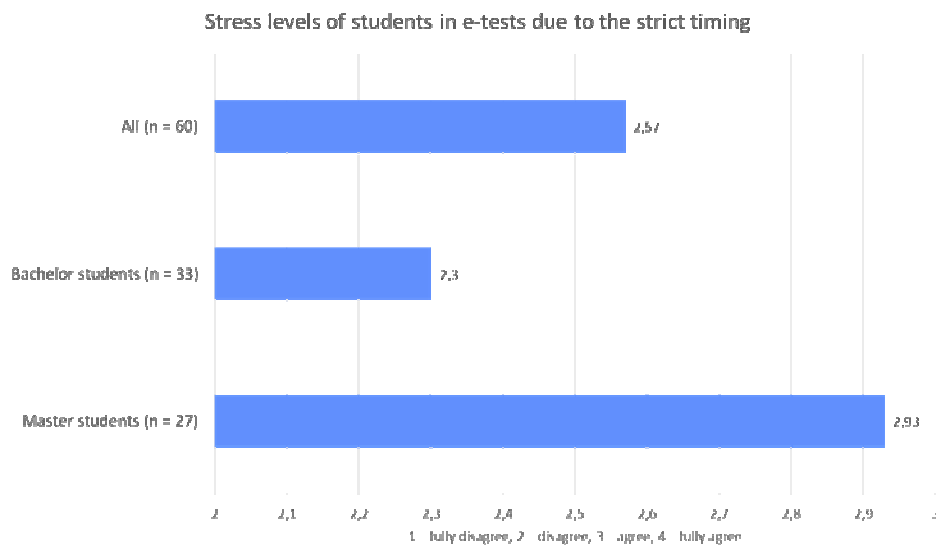

Figure 3: Stress levels of students in e-tests due to strict timing (source: authors)

Whereas bachelor-level students slightly disagree to increased strain (2,30) due to time restrictions master-level students are stronger agreeing to this statement (2,93).

However, the e-test situation does not necessarily improve focus of the master students (figure 4). Compared to paper-based-tests the majority is evenly strong focused in e-tests (2,46). Very likely the digital environment including system control and the time limitations create a vigilance related to the examination which is not given in a regular examination. On the other side the system environment creates a distraction which eliminates focus to a certain extend.
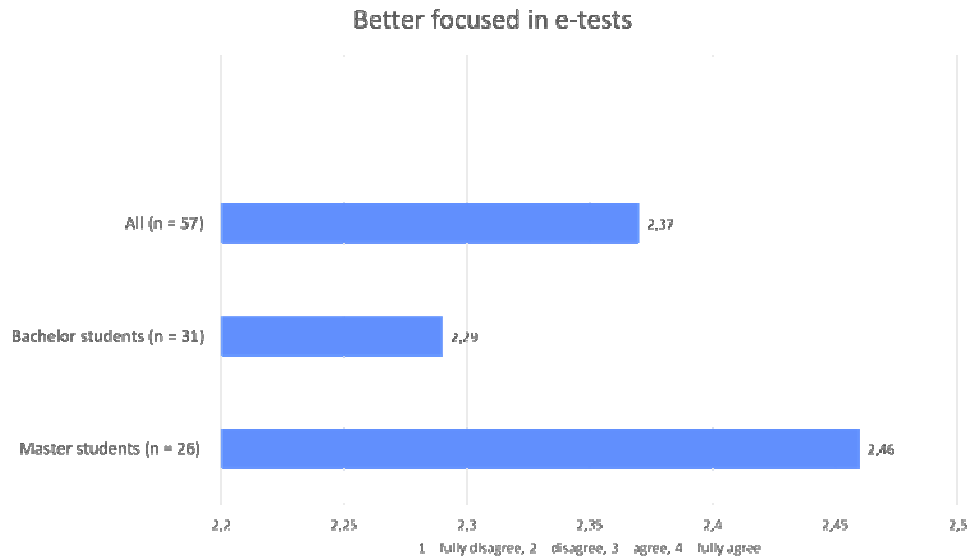
Better focused in e-tests

Figure 4: Focus in e-tests compared to paper-based tests

Bachelor students even disagree to this notion (2,29).

Despite the results regarding stress levels through e-tests so far students regard digital examinations as a state-of-the art testing situation (figure 5). In conjunction with intensified application of e-learning tools examination candidates very likely accept the system-based tests as the logical next step.
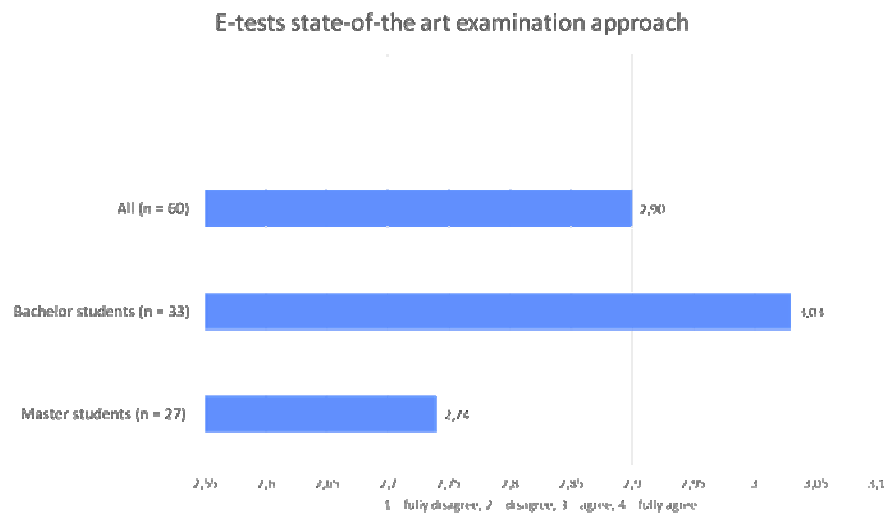
E-tests state-of-the art examination approach

Figure 5: Acceptance of e-tests as state-of-the art examination (source: authors)

Interestingly, the less experienced bachelor students have stronger acceptance than the master students. However, both groups evidently vote in favor for e-tests.

Compared to other examination methods though, the e-tests are not in the lead. Paper-based tests are still preferred by both groups while oral examinations appear to be less attractive to students. The oral exam method is in fact less suited for finance and business-related questions and students very likely feel restricted to explain financial modeling tasks or calculation methods in a verbal conversation. The preference for paper-based tests is very likely driven by the more robust experiences with this examination method.

The analysis related to academic dishonesty reveals that the e-test situation provides less opportunities to cheat with a mean value of 2,00 which means disagree (figure 6). The deep dive on application of different cheating methods demonstrates the preferences for very obvious and simple ways to influence examination results: observing the PC monitors of other candidates is most often applied (mean value 2,86).
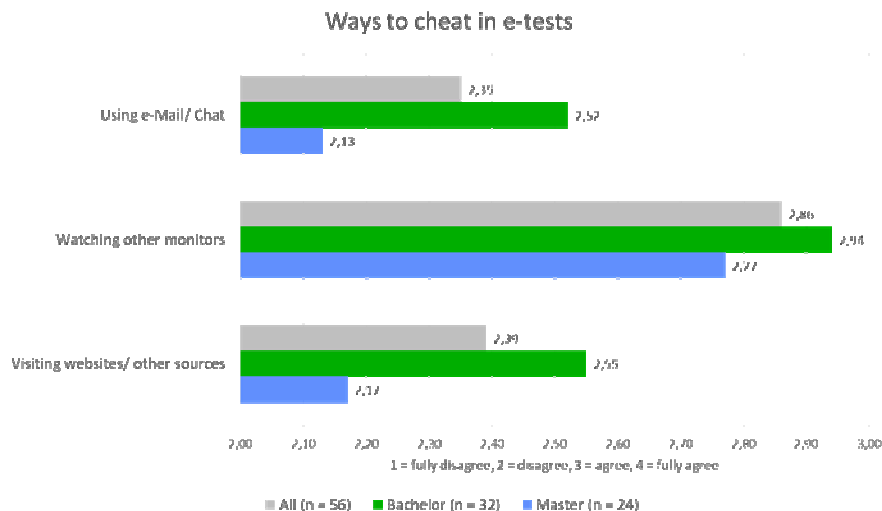
Figure 6: Methods of academic dishonesty in e-tests (source: authors)

Bachelor-students are generally spoken more open towards cheating in e-test which very likely can be attributed to the lower levels of experience.

5   DISCUSSION, CONCLUSION AND RECOMMENDATIONS

In summary, bachelor students are generally less strained through e-tests than master students. Many students have limited exposure to and experience with e-tests and still see them as "pilot tests" which is interesting. For master-level students perceived stress-levels are slightly higher. Qualitative feedbacks indicate as well that this group of students is concerned of being restricted in the e-test environment and cannot bring their entire knowledge across. Also, due to their higher levels of experiences they can anticipate much better a world with digital examinations only.

Most students feel not comfortable in oral examinations. This might be attributed to the course content (mainly finance, accounting and business-related topics) but indicates less interest in demonstrating knowledge in oral communication.

Another qualitative feedback stated the eco-friendly aspect of e-tests. Students appreciate the efforts by the examiners to avoid producing huge amounts of paper for examination purposes.

With regards to academic dishonesty the study did not reveal any substantial differences to regular examination approaches. If cheating takes place it is done in an old school manner by checking the results on other candidates' monitors. The digital proficient students will unlikely use web sites, chat or e-mail functions as they are aware how easy everything can be controlled and detected in a system environment.

There are a number of recommendations further to improve e-tests based on the study results:

It is important that e-tests are not too one-dimensional and do not consist of simple yes/ no or multiple-choice questions only. Open questions reduce perceived stress and enable candidates to provide more contextual feedback. Most testing systems offer a wide variety of different types of exam questions.

Despite the fact that e-learning is advancing many students have limited experiences with e-tests. In order to improve routine and to reduce perceived stress-levels exercise questions should be trained in the e-test environment in class.

Although cheating in e-tests is not a new or substantial issue it can easily be avoided by the use of random questions. The system-based test environment can be configured in a way that each candidate receives his or her individual set of questions. In combination with the time restrictions in e-tests watching others monitors is more or less useless and will be reduced substantially.

This study of perceived stress-levels and academic dishonesty in e-tests has demonstrated that students get more and more acquainted with the digital examination methods. A proper preparation and training in combination with a useful configuration of the system can provide a very effective examination result.

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Knowledge Sharing by Seating Arrangement of The Teachers' Room in Japanese Senior High School. –Focused on Informal Communication and Informal assessment–

Yoshihisa NOMI[a]

[a]Akita prefectural board of Education, Akita City, Japan, nomi_yoshihisa@icloud.com

Abstract

This paper discusses the detailed outcomes of this research. This study explores the knowledge sharing by seating arrangement of the teachers' room in Japanese senior high school. Each school has performed own school based curriculum, subject areas studies and special activities to make school mission and vision possible. In addition, informal communication and informal assessment in teachers' room are one of the important factors to promote school management and students understanding. Seating arrangement is investigated in senior high schools to clarify the above-mentioned. There are several types of seating arrangement are set. For example, "School Grade Teachers cooperation oriented type (GTC type)" and "Teachers' Subject area oriented type (TS type)" and so on. Furthermore, GTC type is divided into three types "Emphasized cooperation between the grade teachers", "Emphasized home-room management" and "Emphasized subject areas". It was revealed that seating arrangement did informal communication and informal assessment more effectively. This study suggests that it is important to set seating arrangement based on aim.

Keywords: Knowledge Sharing, Seating Arrangement, Informal communication, Informal assessment, *Kizuki* (Awareness)

1. INTRODUCTION

Each school has its own educational mission and vision. In order to realize these goals, school have designed the school based curriculum, and have been working to improve it while combining special activities, teaching subjects, club activities and school events.

The knowledge sharing has been done in formal communication at the teachers' meeting and informal communication in the teachers' room. Informal assessment such as informal communication among teachers is connected to school improvement and student understanding.

Kurebayashi, et al (2003), Fujiwara Takeshita (2004), Sato (2012), and Matsui (2008) analyzed characteristics of activities of junior high school teachers, and got some insights of the teachers' room. Informal communication in the high school made it clear that teacher's consciousness to the school reform and the action of the teacher effectively work (Eto 2013). From this, it is shown that the communication and the action of the teacher are important factors for the management of the school organization.

2. AIM OF THIS REASERCH

In Japan, school has a large teachers' room where all faculty staff gather. The teachers' room is used for school clerical works, preparing subject lessons and talking about students. Students spend a day in their homeroom. Classes are held in the homeroom so that teacher move to each homeroom. In elementary and junior high schools, the teachers' seat in large teachers' room which is arranged for each grade year. On the other hand, there are various seating arrangement have set in senior high school, such as by school grade, subject, and other.

If a school focuses on the cooperation between the subjects' teachers, sit near by subjects in teachers' room. On the other hands, if a school focuses on the cooperation between each school grade teachers, sit near by grade. It is thought that seating arrangement based on the aim would promote informal communication between teachers and the change happens to the teacher's individual consideration, the action, and the student's guidance. In this study, the author focuses on the seating arrangement in the teachers' room and considers from the viewpoint of career guidance what kind of seating arrangement would be more functionally and effectively promoting the informal communication in the room.

3. METHODOLOGY

The performance task for 67 students is to research on "crisis of biodiversity in the world", collaborate with other students, in Japanese high schools implementing a biological science curriculum practices focusing in biodiversity. Students investigate the crisis situations and causes of various species in various parts of the world including Japan by using Internet web site, books and magazines, and discuss their remedial measures. There is a list of works produced by the students (Appendix A). It has considered to how students adjusted and improved their learning activities from the questionnaire surveys and interviews. The senior high school where school centered on preparing students to get into university and college was investigated in the Tohoku area of Eastern Japan. A questionnaire was sent to 56 schools and obtained responses from 49 schools (recovery rate : 87.5%).

Questions

➢ What kind of seating arrangement of the teachers' room in your school?
➢ What is the consideration for the arrangement?
➢ What is the merit and disadvantage of the arrangement?

4. DISCUSSION

As a result of the investigation, there are several types of seat arrangement was classified.

➢ School grade Teachers cooperation oriented type: it is called '*GTC type*'   (chapter 4.1.)
➢ Teachers subject oriented   type: it is called '*TS type*'   (chapter 4.2.)
➢ Other types by division of duties, mixed and so on   (chapter 4.3.)

The width and shape of the entire teachers' room, the number of seats that can be placed next to each other and the size of the desk are different from each school. In this chapter, the schematic diagram is shown based on that the staffs of the school grade is about 14 teachers and they are in charge of 7 classes.

4.1. School grade Teachers cooperation oriented type 'GTC type'
Teachers who in charge of each school grade are gathered up sit as below schematic diagram (Figure.1).
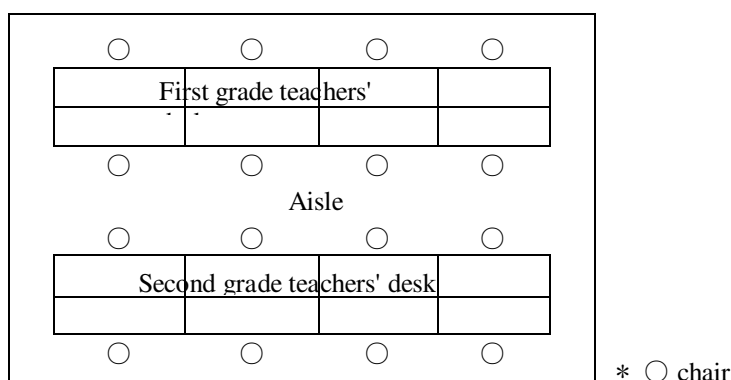

Fig.1   School grade Teachers cooperation oriented type   '*GTC type*'

In addition, *GTC type* can be divided into three types:

- Emphasized cooperation between the grade teachers type (chapter 4.1.1.)
- Emphasized homeroom management type (chapter 4.1.2.)
- Emphasized subject areas in same grade year type (chapter 4.1.3.)

✓ 'Homeroom teacher' is a teacher who is in charge of one of the classes into which a school grade.

4.1.1. *Emphasized cooperation between the grade teachers type*

'Emphasized cooperation between the grade teachers types' divided into two types, such as primary homeroom teacher and secondary homeroom teacher sit next to each other, primary homeroom teacher and secondary homeroom teacher sit back to back.

- *'Sit next to each other style'* is that the homeroom teachers are able to concentrate on the work while looking at each other anytime and always talk about the homeroom management smoothly.
- *'Sit back to back style'* is functional. If teachers have to a short meeting, they turn chairs around backward and could look at each other face to face across the aisle (figure 2.).
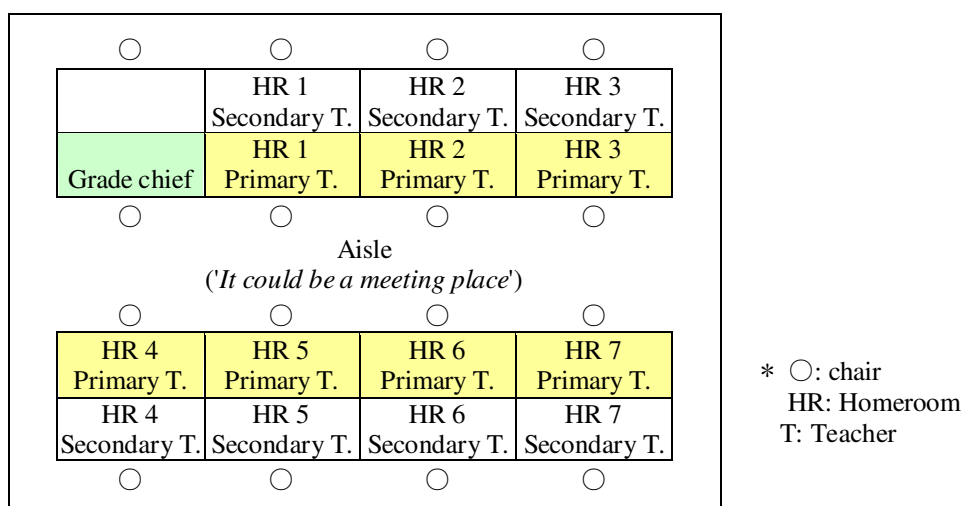
	○	○	○	○	
		HR 1 Secondary T.	HR 2 Secondary T.	HR 3 Secondary T.	
	Grade chief	HR 1 Primary T.	HR 2 Primary T.	HR 3 Primary T.	
	○	○	○	○	

Aisle
('*It could be a meeting place*')

	○	○	○	○	
	HR 4 Primary T.	HR 5 Primary T.	HR 6 Primary T.	HR 7 Primary T.	
	HR 4 Secondary T.	HR 5 Secondary T.	HR 6 Secondary T.	HR 7 Secondary T.	
	○	○	○	○	

∗ ○: chair
HR: Homeroom
T: Teacher

Fig.2   Emphasized cooperation between the grade teachers type. *'Sit back to back style'*

This style is thought to be work the psychological effect and the assessment that is promote '*kizuki* (Awareness)' to 'person of three different position'.

First, it is effect on the grade chief. When the grade chief make previous arrangements for the morning with teachers, they can face to face each other by turn the chair around backward at the aisle. It is seems that the grade chief can be felt the information and common understandings is conveyed. It is thought that it promotes to "consistency of guidance" to the staff of the school year.
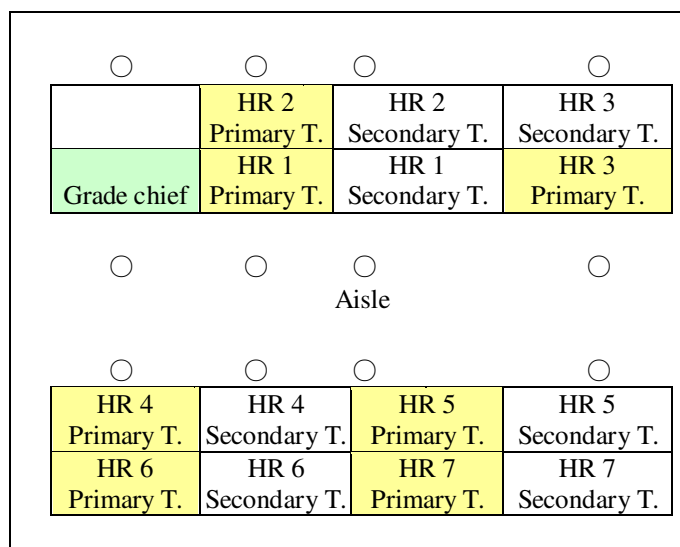
Second, it is effect on the primary teacher. This seating arrangement can be easy to assess the homeroom management. For example, it is felt more sensitive to the interaction between another class of students and teachers on the side and behind, and the work related to class management. Also, when teacher return to the seat, they can check the work from another teacher's desk. It is also thought that there is an effect that helps anxiety relief among teachers' have such as "Is this OK with what I should do for students now?"

Third, it is an effect on secondary teacher. Sometime secondary teacher think that homeroom management should be done by primary teacher. However, the secondary teacher is a still one of the staff member of the school grade. They sit near by homeroom teacher, it is an effect that leads to confirmation of the role as an assistant and fostering awareness to support.

4.1.2 Emphasized homeroom management type

This seating arrangement is emphasized homeroom management (Figure 3). It is thought that this arrangement is effective in the lower grades.

It is seems that new staff and inexperienced teacher are in charge of the first grade school. Veteran staff that grasps the direction of school guidance and the former three-year grade teacher who graduated students in the spring would be placed nearby fresh teachers. They could be a good supervisor. It is thought that this would have the effect of contributing on the succession of the school's policies and know-how of school guidance.

○	○	○		○
	HR 2 Primary T.	HR 2 Secondary T.		HR 3 Secondary T.
Grade chief	HR 1 Primary T.	HR 1 Secondary T.		HR 3 Primary T.

○	○	○		○

Aisle

○	○	○		○
HR 4 Primary T.	HR 4 Secondary T.	HR 5 Primary T.		HR 5 Secondary T.
HR 6 Primary T.	HR 6 Secondary T.	HR 7 Primary T.		HR 7 Secondary T.

4.1.3 Emphasized subject areas in same grade year type

This seating arrangement is emphasized subjects area in the school year grade. In this style, the seating arrangement of teachers' room is oriented school grade year so that the same grade teachers' seat is focused on their subject area and makes the collaboration of the subjects stronger.
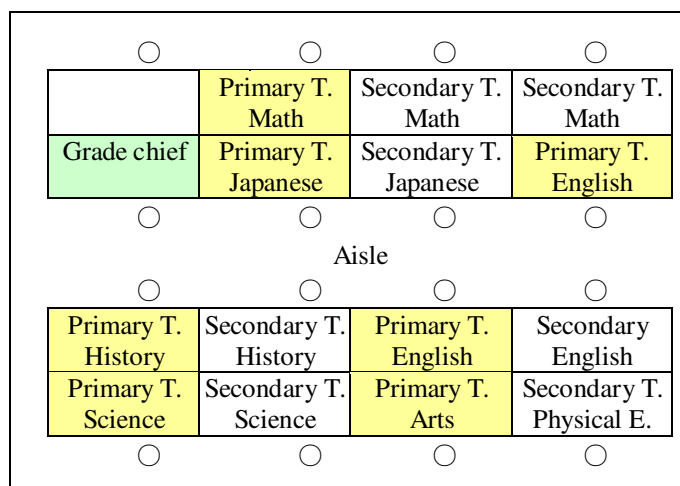
○	○	○	○
	Primary T. Math	Secondary T. Math	Secondary T. Math
Grade chief	Primary T. Japanese	Secondary T. Japanese	Primary T. English

○	○	○	○

Aisle

○	○	○	○
Primary T. History	Secondary T. History	Primary T. English	Secondary English
Primary T. Science	Secondary T. Science	Primary T. Arts	Secondary T. Physical E.

○	○	○	○

Fig.4   Emphasized subject areas in same grade year type.

4.2 Teachers subject oriented   type: it is called '*TS type*'

There are only a small number of schools that arrange the seat by subject, about 10% of the total. There were no schools in the teachers' room that arranged by related to Humanities major and Science major.

This seating arrangement makes previous arrangements with teachers by turn the chair around backward at the aisle anytime (figure 5). It is also easy to assess among each subject area and make collaborative lessons more effectively.
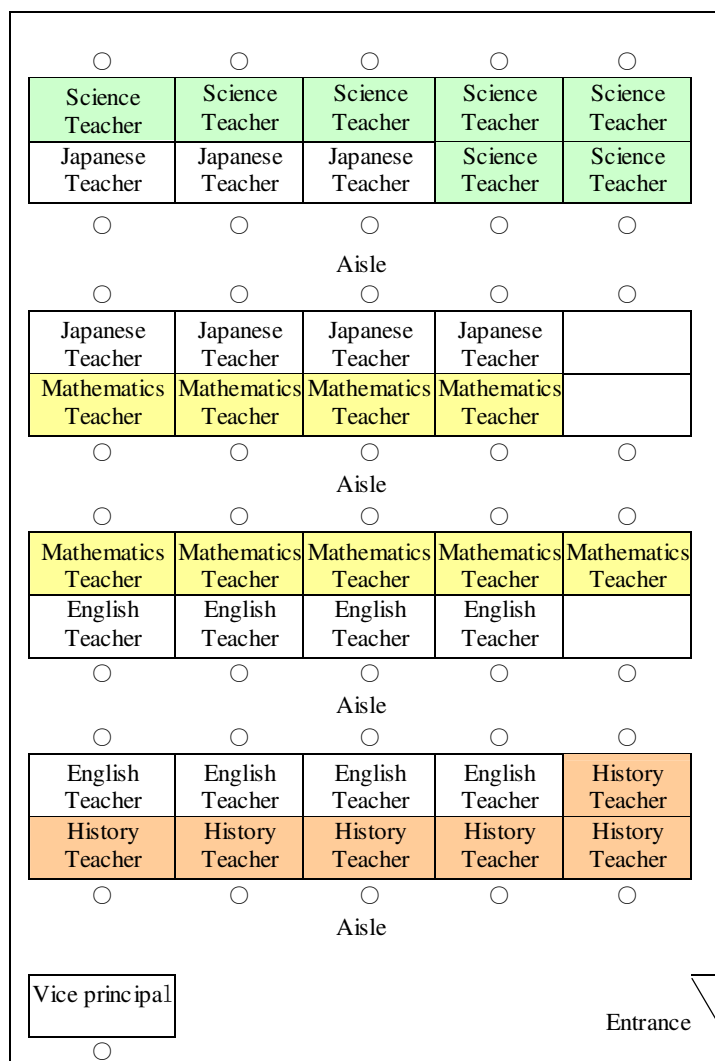
○	○	○	○	○
Science Teacher	Science Teacher	Science Teacher	Science Teacher	Science Teacher
Japanese Teacher	Japanese Teacher	Japanese Teacher	Science Teacher	Science Teacher

○   ○   ○   ○   ○
Aisle

○	○	○	○	○
Japanese Teacher	Japanese Teacher	Japanese Teacher	Japanese Teacher	
Mathematics Teacher	Mathematics Teacher	Mathematics Teacher	Mathematics Teacher	

○   ○   ○   ○   ○
Aisle

○	○	○	○	○
Mathematics Teacher	Mathematics Teacher	Mathematics Teacher	Mathematics Teacher	Mathematics Teacher
English Teacher	English Teacher	English Teacher	English Teacher	

○   ○   ○   ○   ○
Aisle

○	○	○	○	○
English Teacher	English Teacher	English Teacher	English Teacher	History Teacher
History Teacher	History Teacher	History Teacher	History Teacher	History Teacher

○   ○   ○   ○   ○
Aisle

Vice principal

Entrance

○

Fig.5   Teachers subject oriented   type: it is called '*TS type*'
＊There are another teachers' rooms for Health and Physical Education Teacher and Art Teacher.

4.3. Other types by division of duties, mixed and so on

There was a seat arrangement that was devised to enhance the function of school clerical works rather than the school grade. For example, homeroom primary teachers of each grade sat near by and the secondary teachers sat on the other division for concentrating on their clerical works. In addition, seating was arranged by subject area and only the third grade teachers were sat near by in same division. Furthermore, there were some schools where the faculty room was different for each school grade. Some schools have several staff rooms by school clerical, however these case are hard to grasp the entire movement of school.

5. CONCLUSION

Japanese educational curriculum and class styles are different from European. It is also one of the major differences that Japanese students are taking part in school life in the class and homeroom units. In this study, the

author focused on the Teachers' Room, which is a unique educational culture of Japan, and investigated how the seating arrangement was carried out with the aim and how the knowledge sharing was achieved.

It is most important for school management is that to set a school vision of how to foster students ' awareness for the studies and improve academic abilities. It is also desirable to integrate appropriate career guidance and student counselling, and promote to unify the coordination and awareness of the staffs. If a school focuses on the cooperation between the subjects teachers, sit near by subjects in teachers' room. On the other hands, if a school focuses on the cooperation between each school grade teachers, sit near by grade.

It is thought that seating arrangement based on the aim would promote informal communication between teachers and the change happens to the teacher's individual consideration, the action, and the student's guidance. And, it is thought that the change happens to the teachers' individual consideration, the action, and the student's guidance. Informal and formal communication would change the attitudes of teachers and have a good influence on the teaching methods for students. It is also found that the seating arrangement of the teachers' room was designed to enhance '*Kizuki*' (awareness) among staffs and to make informal communication more functional. It is important not setting it unexpectedly, but setting it with intention.

The main seating arrangement of the teachers' room in the Japanese senior high school was 'the School grade Teachers cooperation oriented type (*GTC type*)'. In addition, *GTC type* can be divided into three types, such as 'Emphasized cooperation between the grade teachers type', 'Emphasized homeroom management type' and 'Emphasized subject areas type'.

For example, in order to prevent the difference in teaching among classes in the first grade, the seating arrangement is set by emphasized homeroom management is effective. In addition, placement emphasizing the subject can be one of the effective style when school want to lead a student in the teaching of a subject.

School is a place where students and teacher spend a long time. The school environment would have a significant impact on the moral and awareness of teacher for school goals and the improvement of their awareness is for students. It is thought that seating arrangement of the teachers' room based on the aim might become the help of the smooth operation of the school organization.

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The Gambler's Fallacy in the Stock Markets: Investors' Beliefs in Stock Price Reversals

Andrey KUDRYAVTSEV[a]

[a] *The Max Stern Yezreel Valley College, Economics and Management Department, Emek Yezreel, Israel, andreyk@yvc.ac.il*

Abstract

The present study analyzes stock returns in order to shed light on the effect of the gambler's fallacy on investors' beliefs. I expect that if during several trading days in a row a stock's price rises (falls), then investors whose trading decisions are biased by the gambler's fallacy may believe that the respective stock's price is going to change its direction. This belief in stock price reversals may result in a selling (buying) pressure on the stock's price, and respectively, in negative (positive) abnormal stock returns. I analyze a large historical sample of stocks currently making up the S&P 500 Index, and find that following relatively long sequences of trading days characterized by the same-sign returns for given stocks, the respective stocks' abnormal returns tend to obtain the opposite sign. The effect becomes even more pronounced following longer preceding return sequences. It is stronger for small and volatile stocks and remains significant after accounting for a number of relevant company- and market-specific factors.

Keywords: Abnormal Stock Returns; Gambler's Fallacy; Investment Decisions; Price Reversals; Stock Return Sequences.

Is Agile Approach a Miraculum Cure in Software Development Projects? Potential Areas of Degeneration

Przemysław CHMIELECKI [a]

[a] PhD Eng, CEO of TechBrain company (http://techbrain.pl/ | contact@techbrain.pl)

Abstract

The aim of this paper was to elaborate potential areas of degeneration in Agile methodology usage in software development projects. Author's ambition was to show form his own experience in accordance to many other sources, the issues in practical implementation the Agile approach or some elements of Agile, Scrum, Kanban, Lean mixed methodologies.

The first issue refers to the mismatch between Software Development Team (SDT) aspirations and Business Visionary decisions. How in that matter business decisions affect SDT daily work? Connected to this is the problem of backlog capacity and SDT sprint velocity versus business expectations. Author want to show also the problem of responsibility in general and in particular – how does it looks per team and team members in separation? Also, worth to mention is DevOps Model elaborated in Project Fenix book regarding specialization-less introduced in Agile approach. Autor plans to conclude with team members selection in accordance with specific mindset and soft skills versus technical skills. How does SDT will work when not proper team setup was chosen.

Author want to describe mentioned problem areas and introduce tips to avoid those and possible solution if problem already appear.

Keywords: Process Methodology, Agile, AgilePM, Scrum, Waterfall, Methodology Degeneration Areas.

Used shortcuts:
BS – Business Sponsor
BV – Business Visionary
PM - Project Manager
TC – Technical Coordinator
BA – Business Ambassador
SD – Solution Developer
ST – Solution Tester
SDT – Solution Development Team

1. Introduction and methodology overview

Author is using official AgilePM® approach in accordance with Dynamic Systems Development Method (DSDM). Roles and areas of responsibilities is based on official DSDM graph[1].

This article methodology is based on critical analysis of existing sources, like documentation, processes, case studies. Author is aware that his statements are not and cannot be impartial, but he tried to follow Max Weber appeal to separate scientific research from personal beliefs[2].

2. Software development projects specificity

Each projects got its own specificity – that's trivial sentence. IT projects, and more precise software development projects, act with huge dynamics of people (team setup, technical and soft skills) and technical stuff (i.e. programming language(s), framework(s), tool(s) selection, infrastructure issues). This branch of industry is in constant development and sometimes it is hard to predict how those changes will influence the business site. From the customer perspective the added value is abstraction, but can be count and need to be enclosed in reasonable process. Customer expects that a piece of software will work smoothly and that the promised functionalities will be in place. He only want to use the program and don't take care about technical solution (how it is done and why that way), unit and integration testing or even bug fixing, but those elements must be included if the goal is to deliver working application.

3. Agile Approach Fundamentals

Agile project management is a style of project management that focuses on early delivery of business value, continuous improvement of the project's product and processes, scope flexibility, team input, and delivering well-tested products that reflect customer needs.[3]

Agile is the opposite to Waterfall[4] conception introduced by Winston Royce in book Managing the Development of Large Software Systems (1970). This is the distortion to treat Waterfall as rigid system which does not allow to move to next step till every sub-element is not finished[5]. The main goal of SDT is to deliver the application to the customer which is in accordance to customer's needs and expectations. Developers in cooperation with testers and supporters can achieve this using Waterfall approach and going through the phases of conception, analysis, design, implementation, testing and maintenance in the end[6]. The constitutive feature of this model is rigidity and lack of opportunity to add improvements raised by customer during the software development process. If we use Waterfall with feedback version customers' feedback can be added after each step[7]. Nevertheless generally speaking, changes can be implemented in next iteration. Different point of view present Agile approach, where cooperation between SD, ST and BA within the SDT is very strict and fluent. In general, members of SDT are constantly working together to develop product that meets business need and set technical requirements.

Elements of Agile were applied in many approaches divided into two groups presented in table below[8]:

Table 1. Agile approaches

Lightweight approaches:	Fuller approaches (beyond 1 team):
Scrum	Scrum-of-Scrums
Lean	Scrum at Scale (Scrum@Scale)
Kanban	Large-scaleScrumm (LeSS)
Extreme Programming (XP)	Scaled Agile Framework (SAFe)
Continuous Integration (CI)	Disciplined Agile Framework (DAD)
Continuous Delivery (CD)	Dynamic Systems Development Method (DSDM)
Feature Driven Development (FDD)	Agile Project Management (AgilePM)
Test Driven Development (TDD)	Agile Unified Process (AUP)
Crystal Clear	Open Unified Process (OpenUP)
…	…

In this paper author used Agile Project Management methodology and according to this terminology described fully in DSDM "The Agile Project Framework".

The groundwork of all Agile approaches was expressed in the Agile Manifesto, which was created in 2001, where seventeen software developers (among others Jeff Sutherland, Ken Schwaber, and Alistair Cockburn) met at the Snowbird resort in Utah to discuss these lightweight development methods. Together they published the Manifesto for Agile Software Development. The Agile Manifesto stress out the following rules:

1. Individuals and interactions over processes and tools

2. Working software over comprehensive documentation

3. Customer collaboration over contract negotiation

4. Responding to change over following a plan[9]

Agile approach looks very pro for team members and against the bureaucracy. It points out customer need on the first place, because what need to be delivered is the working peace of software which meets customer expectations agreed in continuous process of being in dialog with customer and checking if provided beta-version of software still fits to his expectations. Normally in traditional project methodology established budget and time to deliver project content are not negotiable. What can be limited is the product scope and amount of functionalities. That is the only factor which can change during the product development lifecycle. Even quality and tests cannot be narrowed. In Agile approach the customer expect features which cannot be limited. This means that, when team cannot deliver value which was agreed then the time and cost will extend but scope of functionalities does not shrink up. This relationship is illustrated by the graph below.
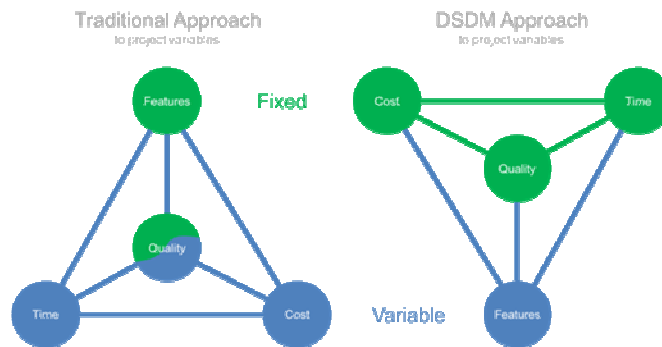
Fig. 1. Project variables – which are negotiable?[10]

AgilePM approach adheres very simple philosophy that "the best business value emerges when projects are aligned to clear business goals, deliver frequently and involve the collaboration of motivated and empowered people"[11]. To proper fit those assumptions SDT need to consist of well and self-motivated people at one site and delivered product must be connected to some specific business need (company strategy generally speaking) and be delivered as much as possible in daily basis work. Members of SDT need to be empowered to make decisions within their area of expertise – this obviously needs mutual trust of the parties. Both sites are also aware that changes are inevitable because understanding of solution and business need comes in time. In second version of methodology, introduced in 2014, two additional factors were added to AgilePM philosophy basis: the common sense and pragmatic point of view.

While the philosophy introduced above is only the set of some general rules which defines how to manage the customer value delivery, then the eight DSDM principles below are very rigid to follow and there is no place for the compromise. These principles act as a guide for the SDT and organization in general (attitude, mindset and culture) to remain flexible, deliver consistently and often and help mitigate the risk. The SDT can expect to get the full benefits of the AgilePM approach if they follow all eight DSDM principles:

5. Focus on the business need

6. Deliver on time

7. Collaborate

8. Never compromise quality

9. Build incrementally from firm foundations

10.   Develop iteratively

11.   Communicate continuously and clearly

12.   Demonstrate control[12]

First principle focuses on PM responsibility to check if SDT understand and follow actual business priorities according to MoSCoW[13] rules, prepare reliable and valid business case, ensure constant business sponsorship and commitment and guarantee delivery of MUST[14]. Delivering a working piece of software on time is one of the most important success factors. To fulfill this rule SDT need to divide work into timebox chunks of time, focus and follow business priorities according to MoSCoW, always meet sub-deadlines and build confidence through predictable delivery. Delay in delivering may undermine the whole project sense. Collaboration requires to involve stakeholders to the project at right time, persuade business representatives to pro-active involvement (BA need to be a part of SDT and participate in daily-basis SDT work), ensure that all team members are empowered to take decisions on behalf of those they represent and also build one-team culture. Rule four stress out that on the project beginning just before development starts the SDT need to agree the level of quality. In that sense the quality cannot become the project variable and it need to be tested early, continuously and constantly reviewed. Also, the acceptance criteria need to be documented. To build incrementally from firm foundations SDT need to carry-out appropriate analysis and EDUF[15] and with each delivered increment formally re-assess priorities and informally re-assess ongoing project viability. Principle six points out the value of feedback from business site after every iteration and follow to implement those responses according to Demming Cycle Plan-Do-Check-Act. SDT need to be aware that most of the details should emerge rather later than sooner because most clients don't know what they want at the project beginning. The right final solution will evolve including changes and modifications. Poor communication during a project run is often mentioned as the biggest single reason while projects fail. To meet communication principle SDT need to took care of informal, honest and transparent face-to-face relations at every level, run daily team stand-up sessions, use facilitate workshops to meet understanding and no-pressure criteria, use visual communication practices (modeling, prototyping), demonstrate evolving solution as often as possible to check if stakeholder's expectations are met. The last principle emphasizes the importance of transparency of progress which is measured through products delivery focus rather than completed activities. In this it is valid to plan ahead and use an appropriate level of formality for tracking and reporting.

4. Potential problem areas in Agile implementation

4.1. SDT and BV different aspiration

According to Agile approach BV is the person who need to agreed technical perspective represented in SDT interests and business perspective represented in BS and end customer expectations concentrated on specific product features and functionalities. BV also decides what is the timebox capacity and what need to be done during agreed worktime in accordance to MoSCoW prioritizing approach. That means that BV obligation is to listen to both sites arguments and create a list of 'to-do' tasks (epics with particular user stories) and set them in specific order. The customer perspective is more important because BS provides budget to cover all expenses. According to AgilePM principles all actions should be focused on delivering working product which provides business value (in that sense working piece of software) as often as possible.

It may happen the situation that approaches of SDT and BV are not going in the same direction. Let's examine a situation that we have got SDT that is working on e-commerce web application like internet store with bikes and all needed accessories. Because of other projects commitment BA in very limited time is involved in SDT daily-work and he is hardly oriented in SDT needs. BS and BV expect that SDT will focus on providing some UX elements to make the application GUI more user-friendly and improve logging page to e-store. BS and other business representatives claims that this change should definitely raise the bikes sell because the webpage will be more attractive to customers. SDT is not happy with this approach because they claim that focus on backend components is needed and it will improve security layer of application and will help to make general performance better in the future. Changes proposed by SDT are not visible for end customer and results will not improve application working immediately. In next two-three timebox there is no possibility to mix those expectations. Which decision should be made by BV? How to solve this issue?

Those kind of different needs are very common in IT projects The communication between business and technical area is disturbed and not transparent because BA is not a member of SDT in daily-basis work and he is not aware about technical expectations and needs of SDT. In that situation the best approach is to implement 'common sense' and 'pragmatic approach' from AgilePM philosophy fundamentals. It is wiser to upgrade third-party components first and then work on UX GUI layer. The reason of that order is to meet security policy which is very

important foundation of every software project and then start working on UX (this also significantly reduce the risk of appearing visual changes after components upgrade).

4.2. Timebox capacity, team velocity and business expectations

In general SDT works based on product and technical backlog (which can be combined into one backlog, but do not have to). The product backlog is the list of all requirements, epics and user stories associated with the project which are created, maintained and prioritized by BV[16]. All new feature plans, reported bugs and other technical stories need to have place in this backlog. SDT uses backlog as a roadmap of what tasks need to be done in which order. During planning some stories from the top of the product backlog are added to particular timebox during which SDT will work on them. The timebox capacity is limited and depends on amount of point possible to fulfill during iteration. The speed at which SDT turn user stories into working software is called the team velocity. It is used for measuring team's productivity and for setting expectations about delivery dates in the future.[17]

Similar to case above is the situation that business expectations do not meet SDT productivity. Team velocity is not constant, but also its changes are rather not significant. Based on average velocity the whole work is planned and divided into minor and major releases of software application. Business site can expect higher team velocity or to introduce changes in planned timebox capacity. According to DSDM AgilePM sixth principle (develop iteratively) changes are inevitable and need to accepted. It does not mean to include all changes without hesitation. DSDM process include evolutionary development which cares about the proper project trajectory and also the appropriate level of flexibility (see Fig. 2 below).
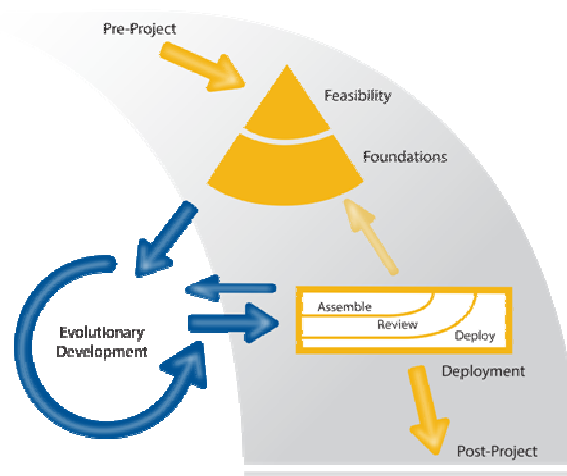

Fig. 2. The DSDM process[18]

New elements included means that some of previous functionalities will be not delivered (fully or partially). The main goal on which every players are focused is the business value, so if new elements need to be added then all release plans need to be reorganized. On the other hand changes in timebox scope needs to be consolidated with rest of backlog.

4.3. Team/individual responsibility

The topic of responsibility within the Agile SDT is one of the most problematic to analyze. From AgilePM and Scrum methodological perspective the team should be formed of people who have high ethical standards and care of collaborators and the good project condition. Team members should be self-motivated and empowered to take decisions on behalf of those they represent and also build one-team culture. It results from implementation of the third DSDM principle called 'Collaborate'. The SDT also need to be self-organized in their work discipline what forces the lighter or even lack (ideally) of management control over the team. In practice when an issue appears the whole team should focus on it and every team member should help each other to mitigate the damages. No one in personally responsible, because the responsibility is within the team. There is no place to blame someone in particular, accuse of making a mistake, pull out the consequences. The whole team is responsible and this

responsibility is internalized, each member is feeling it. It is not forced or external responsibility. If the situation appears that someone from SDT will accuse another member or blame him then this should be the sign to re-think the accuser place within the team. Such behavior is not allowed and should not be tolerated, because it breaks down the one team spirit and divide cross-functional and self-organizing team into separate silos.

4.4. Lack of strict roles in SDT

In traditional approach within the SDT the roles are strictly assigned to specific person. Developer writes a code, QA test it and report a bugs, developer fix it, UX take care about GUI, Manager/Lead drive the whole project, etc. Agile approach blur all those strict boundaries. When it's done right, joining an Agile team recalls working in a mini-startup. People join in and do whatever it takes to make the project successful—regardless of title or role.[19] In the successful Agile project SDT should embrace the following attributes:

13. "Dedicated team: Each scrum team member works only on the project assigned to the scrum team, and not with outside teams or projects. Projects may finish and new projects may start, but the team stays the same.

14. Cross-functionality: The willingness and ability to work on different types of tasks to create the product.

15. Self-organization: The ability and responsibility to determine how to go about the work of product development.

16. Self-management: The ability and responsibility to keep work on track.

17. Size-limited teams: Right-size development teams to ensure effective communication. Smaller is better; the development team should never be larger than nine people.

18. Ownership: Take initiative for work and responsibility for results".[20]

Those attributes if are fulfilled helps to create consolidated, disciplined, creative and dynamic team. This approach fosters building one team and not multiple and isolated silos. Team members still have core competencies, and they generally stick to what they are good at. But generally on an agile project, narrowly defined roles like analyst, programmer, and tester don't really exist.[21]

Such an approach can cause a lot of problems and conflict inside the team. Developers, QAs, Supporters, UXes usually works in isolation and any of that roles are not able to switch into each other perspective. The example of *Project Fenix*[22] book showed that cross-functional teams could work well, but team members are not ready to mix their competences. The distributed skills system can work only if team setup allows for it.

4.5. Incorrect SDT setup

This section refers to the third and fourth point above. The selection of team members is very hard and responsible task and it requires not only technical skills compatibility, but also psychological acceptance of the potential team member. The rest of the SDT need to agree that they are willing to work with such person. The personality match is even more important than superb technical skill, because changes in mental attitude are very complex and long process and on the other hand learning new technology or improve existing technical skill is quite easy to accomplish. Thus the very important is to choose a person with proper mindset (way of thinking and decision-making) and high level ethical standards.

The improper team setup may cause series of problems in team coherence and cohesion. Such person can disturb the sense of trust between team members and destroy the unity of bonds and cooperation necessary in Agile SDT. Therefore it is important to carry out the topic of team building with great care and accuracy. Small oversight may cost a lot and be difficult to rebuild.

5. Agile as pharmakon. Which meaning wins?

Ancient Greek word φάρμακον (read as pharmacon) refers to two opposing meanings: (1) cure and (2) poison. Depends on context it can be understood as a remedy which help to get better or some harmful substance. The same situation is with Agile methodology implementation. In some cases it will bring more harm than help, because this approach is not applicable to some projects. There is no possibility to use Agile as miracle cure for every project issues. It is one of possible methodology approaches to use during project run. Only the full implementation of chosen approach (full like DSDM, AgilePM or reduced like eXtreme Programming, Lean) including all rules and principles can guarantee project management improvement. It is not an order to implement everything without consideration and taking care of best fit to specific project dependencies – sometimes including only few rules and principles will be sufficient, but we need to keep in mind that all elements synergy will grant better final effect.

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TheTurkey's Agricultural Export: An Application of the Gravity Model

Gökhan UZEL[1], Serkan GURLUK[2]

[1] *Research Assistant, Uludag University, Faculty of Agriculture, Agricultural Economics Department, Bursa, Turkey*

[2] *Prof. Dr., Uludag University, Faculty of Agriculture, Agricultural Economics Department, Bursa, Turkey*

Abstract

At the second half of 20th century, all of the World has witnessed a liberalization wave. The Developing countries are influenced and adopted an export oriented industrialization program instead of an import oriented industrialization program. In this direction**,** the need for competitiviness in foreign trade arizing from globalization has led the countries to investigate different geographical areas and different geographies. In this context, the aim of this study is to determine the agricultural export structure of Turkey with the gravity model method and discuss possible policy proposals. In line with this aim an annuel panel of 16 selected countries exported from Turkey fort he period 2001-2030 has been used in the gravity model. According to the estimation results, GDP and population of the countries exported by Turkey are related to the agricultural exports positively while the distance variant related to the exports of agricultural products negatively. It is also known that in recent years the per capita animal protein consumption rates in the world have increased. These increases are in line with the results of the analysis. As the per capita animal protein consumption ratio increase, it can be said that new agricultural export areas can be opened for Turkey. At this point it has been determined that Turkey needs to follow increasing domestic consumption trends and emerging markets. As a result, it is important for policy makers to take into account the relevant determinations of the export strategy of agricultural products.

Key words: Turkey, Agricultural Products Export, Gravity Model

Malmquist productivity index for network systems

Chiang KAO

Cheng Kung University, Department of Industrial and Information Management,
Tainan 701, Taiwan, Republic of China, E-mail: ckao@mail.ncku.edu.tw

Abstract

The conventional Malmquist productivity index (MPI) measures the performance improvement of a production system between two periods, where the system is treated as a black box, ignoring the internal operations of the component processes. Based on a relational model of the data envelopment analysis (DEA) for measuring the system and process efficiencies, this paper develops a methodology for calculating the system and process MPIs in one model. Moreover, relationships between the system and process MPIs are derived. Specifically, it is found that, for series systems, the system MPI is the product of the process MPIs. For parallel systems, the system MPI is a linear combination of the process MPIs, and the former is close to a weighted average of the latter. By defining the ratio of the inefficiencies of a unit in two periods as complementary MPIs, this paper finds that the system complementary MPI is a linear combination of the process complementary MPIs, and the former is also close to a weighted average of the latter. Knowing the relationship between the system and process MPIs helps identify the processes that deter the improvement of the system; amendments to them will improve the system performance in the future.

Keywords: data envelopment analysis, Malmquist productivity index, network system.

1. INTRODUCTION

Efficiency measurement is important for organizations to identify unsatisfactory operations so that making improvements to them will produce more outputs with the same amount of inputs. If an organization is relatively efficient as compared to other similar ones at a point of time, yet it is actually declining as compared to its past performance, certain indexes for alerting the decision maker are necessary. One such index is the Malmquist productivity index (MPI), which measures efficiency changes between two periods for an organization, or any decision making unit (DMU).

The MPI has been widely applied to measuring performance changes between two periods, especially due to an act or policy (Banker et al., 2005; Chang et al., 2009; Kao, 2000). Different forms of the MPI have been proposed in the literature. Suppose the efficiency change of a DMU between periods t and $t+1$ is to be measured. The early work of Caves et al. (1982a; 1982b) calculated the relative efficiencies of the two periods based on the production technology of period t. Since the production technology of period $t+1$ can also be used for calculating the relative efficiencies, and the results are probably different from those calculated from the technology of period t, Färe et al. (1994) suggested using the geometric mean of the two measures as the MPI to solve the problem of disparity.

The linear program for calculating the relative efficiency of a DMU in period $t+1$ based on the technology of period t (or that in period t based on the technology of period $t+1$) is essentially the one used by Andersen and Petersen (1993) for calculating super-efficiencies; however, it can be infeasible under certain conditions (Seiford and Zhu, 1999a; Thrall, 1996; Zhu, 1996). To overcome this difficulty, Pastor and Lovell (2005) proposed a global MPI using the data of all DMUs in both periods to construct the production frontier. It is shown in Pastor and Lovell (2007) that this MPI also possesses the property of circularity.

A system is usually composed of several processes connected in a network structure. The conventional MPI measures the performance improvement of a system considered as a whole unit, neglecting the operations of its component processes. However, for a network system, it is possible that some processes are worsened while the system is improved. It is also possible that the system is worsened, while some processes are improving. Merely looking at the system MPI cannot identify the processes that cause the deterioration of the aggregate performance. The objective of this paper is to develop a methodology for measuring the system and process MPIs at the same

time, and explore the relationship between them so that unsatisfactory processes can be identified. The MPI used for discussion is the global MPI.

The basic component of MPI is relative efficiency, and the data envelopment analysis (DEA) technique (Charnes et al., 1978) has been widely used for its calculation. To calculate the MPI of a network system, a network DEA model is needed. Various network DEA models have been developed in the literature (Castelli et al., 2010; Chen, 2009; Cook et al., 2010b; Färe and Grosskopf, 2000; Kao, 2009a; Prieto and Zofiel, 2007; Tone and Tsutsui, 2009), Kao and Hwang (2010) classified them into three types: independent, connected (or descriptive), and relational. For independent models, the system and individual process efficiencies are calculated independently and separately, without considering the relations among them. The studies of Lewis and Sexton (2004), Seiford and Zhu (1999b), and Wang et al. (1997) are some examples.

For descriptive models, the operations of all component processes are described in the model in calculating the system efficiency. The results obtained are more reasonable; nevertheless, the process efficiencies still need to be calculated separately. The system and process efficiencies do not have any relationship, either. There are many studies of this type, e.g., Färe and Grosskopf (2000), Golany et al. (2006), and Yu and Lin (2008). The third type of models, relational, on the other hand, takes the relations between the system and processes into consideration in developing the model. The system and process efficiencies can be calculated at the same time. Moreover, there exist some mathematical relationships between the system and process efficiencies (Chen et al., 2009a; 2009b; Kao and Hwang, 2008). Due to this property, this paper uses the relational model to calculate efficiencies. Based on the mathematical relationship between the system and process efficiencies, certain relationships between the system and process MPIs will be derived.

The structure of this paper is as follows. In the next section, relational models for different network structures are firstly reviewed. Then, in Section 3, models for calculating the global MPI for network systems are developed. Relationships between the system and process MPIs are investigated. After that, Section 4 uses three examples to explain the methodology proposed in this paper. Finally, in Section 5, some conclusions are drawn.

2. THE RELATIONAL MODEL

Consider a set of n DMUs, each uses the same m inputs to produce the same s outputs. Denote X_{ij} and Y_{rj} as the ith input, $i=1,\ldots, m$, and rth output, $r=1,\ldots, s$, respectively, of the jth DMU, $j=1,\ldots, n$. The CCR model of DEA for calculating the efficiency of DMU k under the assumption of constant returns-to-scale can be formulated as (Charnes et al., 1978):

$$
\begin{aligned}
E_k = \quad \text{max.} \quad & \sum_{r=1}^{s} u_r Y_{rk} \\
\text{s.t.} \quad & \sum_{i=1}^{m} v_i X_{ik} = 1 \\
& \sum_{r=1}^{s} u_r Y_{rj} - \sum_{i=1}^{m} v_i X_{ij} \leq 0, \qquad j=1,\ldots, n \qquad (1) \\
& u_r, v_i \geq \varepsilon, \quad r=1,\ldots, s, \qquad i=1,\ldots, m,
\end{aligned}
$$

where u_r and v_i are virtual multipliers and ε is a small non-Archimedean number (Charnes and Cooper, 1984) imposed to prevent any input/output factor from being ignored in calculating the efficiency.

Usually a system is composed of several processes connected as a network. Model (1) treats the system as a black-box, neglecting the operations of the component processes. Consequently, it is possible that all processes are not efficient while the system, as a whole, is. The network DEA takes the operations of the processes into consideration in calculating the system efficiency so that unreasonable results can be excluded. Network systems have various structures. We will discuss the two fundamental ones, series and parallel, and then the general one.

2.1 Series structure

The series structure is a basic network structure where a number of processes are connected in series as shown in Figure 1. The characteristic of this type of structure is that the inputs used by all processes, except the first, are produced by their preceding one, and the outputs produced by all processes, except the last, are utilized by their

succeeding one. The series structure is the most widely discussed network structure in the DEA literature (Cook et al., 2010a).

Let $Z_{fj}^{(p)}$ denote the fth intermediate product, $f=1,\ldots, g$, produced by process p, $p=1,\ldots, q-1$. Note that the intermediate products produced by the last process, q, are the outputs of the system, Y_{rj}. The relational model for calculating the system efficiency of DMU k is based on Model (1), with the operations of the q processes additionally considered. Moreover, the same factor has the same multiplier associated with it, whether it is the product of a process or the input of another. For a general series structure of Figure 1, the relational model is (Kao 2009a):

$$
\begin{aligned}
E_k^S = \text{ max. } & \sum_{r=1}^{s} u_r Y_{rk} \\
\text{s.t. } & \sum_{i=1}^{m} v_i X_{ik} = 1 \\
& \sum_{r=1}^{s} u_r Y_{rj} - \sum_{i=1}^{m} v_i X_{ij} \leq 0, && j=1,\ldots, n \\
& \sum_{f=1}^{g} w_f Z_{fj}^{(1)} - \sum_{i=1}^{m} v_i X_{ij} \leq 0, && j=1,\ldots, n, \quad (p=1) \\
& \sum_{f=1}^{g} w_f Z_{fj}^{(p)} - \sum_{f=1}^{g} w_f Z_{fj}^{(p-1)} \leq 0, && j=1,\ldots, n, \quad p=2,\ldots, q-1 \\
& \sum_{r=1}^{s} u_r Y_{rj} - \sum_{f=1}^{g} w_f Z_{fj}^{(q-1)} \leq 0, && j=1,\ldots, n, \quad (p=q) \\
& u_r, v_i, w_f \geq \varepsilon, \quad r=1,\ldots, s, \quad i=1,\ldots, m, \quad f=1,\ldots, g
\end{aligned}
$$
(2)
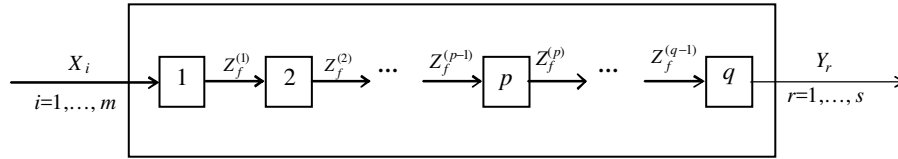
Fig.1. The series structure

Note that the sum of the q process constraints, i.e., those associated with the third, fourth, and fifth constraint sets, is the same as the system constraint, the one in the second constraint set, for each DMU. Hence, the system constraints in Model (2) are redundant, and can be deleted without altering the solution.

After a set of optimal solutions (u_r^*, v_i^*, w_f^*) is solved, the system and process efficiencies can be calculated as:

$$
\begin{aligned}
E_k^S &= \sum_{r=1}^{s} u_r^* Y_{rk} / \sum_{i=1}^{m} v_i^* X_{ik} = \sum_{r=1}^{s} u_r^* Y_{rk} \\
E_k^{(1)} &= \sum_{f=1}^{g} w_f^* Z_{fk}^{(1)} / \sum_{i=1}^{m} v_i^* X_{ik} = \sum_{f=1}^{g} w_f^* Z_{fk}^{(1)}, && (p=1) \\
E_k^{(p)} &= \sum_{f=1}^{g} w_f^* Z_{fk}^{(p)} / \sum_{f=1}^{g} w_f^* Z_{fk}^{(p-1)}, && p=2,\ldots, q-1 \\
E_k^{(q)} &= \sum_{r=1}^{s} u_r^* Y_{rk} / \sum_{f=1}^{g} w_f^* Z_{fk}^{(q-1)}, && (p=q)
\end{aligned}
$$
(3)

Clearly, the product of the q process efficiencies is just the system efficiency:

$$
\prod_{p=1}^{q} E_k^{(p)} = \sum_{r=1}^{s} u_r^* Y_{rk} = E_k^S
$$
(4)

Model (2) usually has multiple solutions that make the efficiencies of the same process of different DMUs incomparable. To have a common basis for each process to compare, Kao and Hwang (2008) suggested calculating the maximum efficiency of the process to be compared in a second stage while maintaining the system efficiency at the level obtained in the first stage. If there are more than two processes, then the same procedure is repeated stage by stage, and, in each stage, requiring the process efficiencies of higher priorities to maintain at the levels obtained in previous stages while maximizing the efficiency of a lower priority process.

2.2 Parallel structure

The parallel structure is another basic network structure which is composed of a number of processes operating independently, without connections between any two processes. As shown in Figure 2, there are q processes, and each applies inputs $X_{ij}^{(p)}$ to produce outputs $Y_{rj}^{(p)}$. The total inputs consumed by the system are $X_{ij} = \sum_{p=1}^{q} X_{ij}^{(p)}$, and the total outputs produced are $Y_{rj} = \sum_{p=1}^{q} Y_{rj}^{(p)}$.
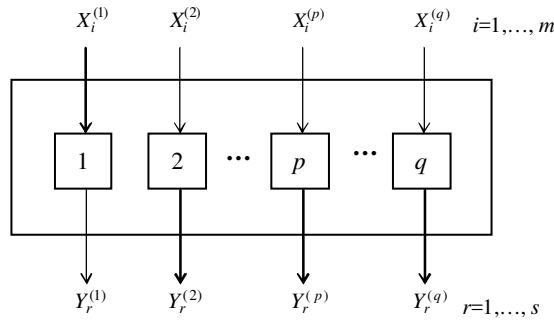
Fig. 2. The parallel structure

The relational model assigns the same multiplier to the same factor, regardless of which process it is associated with. In calculating the system efficiency, the operations of the processes are also considered so that the system will be efficient only if all processes are efficient. The model is (Kao, 2009b; 2011):

$$
\begin{aligned}
E_k^S = \ \text{max.} \quad & \sum_{r=1}^{s} u_r Y_{rk} \\
\text{s.t.} \quad & \sum_{i=1}^{m} v_i X_{ik} = 1 \\
& \sum_{r=1}^{s} u_r Y_{rj} - \sum_{i=1}^{m} v_i X_{ij} \leq 0, \qquad j=1,\ldots,n \\
& \sum_{r=1}^{s} u_r Y_{rj}^{(p)} - \sum_{i=1}^{m} v_i X_{ij}^{(p)} \leq 0, \qquad j=1,\ldots,n, \qquad p=1,\ldots,q \\
& u_r, v_i \geq \varepsilon, \ r=1,\ldots,s, \ i=1,\ldots,m
\end{aligned}
\tag{5}
$$

Similar to the series case, the sum of the process constraints, i.e., those associated with the third constraint set, is the same as the system constraint, i.e., the one in the second constraint set. The system constraints can thus be omitted.

At an optimal solution (u_r^*, v_i^*), the system and process efficiencies are calculated as:

$$
E_k^S = \sum_{r=1}^{s} u_r^* Y_{rk} \Big/ \sum_{i=1}^{m} v_i^* X_{ik} = \sum_{r=1}^{s} u_r^* Y_{rk}
\tag{6}
$$

$$
E_k^{(p)} = \sum_{r=1}^{s} u_r^* Y_{rk}^{(p)} \Big/ \sum_{i=1}^{m} v_i^* X_{ik}^{(p)}, \qquad p=1,\ldots,q
$$

Let weight $\omega^{(p)}$ be the proportion of the aggregate input consumed by process p in that consumed by all q processes: $\omega^{(p)} = \sum_{i=1}^{m} v_i^* X_{ik}^{(p)} / \sum_{i=1}^{m} v_i^* X_{ik} = \sum_{i=1}^{m} v_i^* X_{ik}^{(p)}$. The average of the q process efficiencies weighted by $\omega^{(p)}$ is:

$$\sum_{p=1}^{q} \omega^{(p)} E_k^{(p)} = \sum_{p=1}^{q} \left(\sum_{i=1}^{m} v_i^* X_{ik}^{(p)} \right) \left(\frac{\sum_{r=1}^{s} u_r^* Y_{rk}^{(p)}}{\sum_{i=1}^{m} v_i^* X_{ik}^{(p)}} \right) = \sum_{p=1}^{q} \left(\sum_{r=1}^{s} u_r^* Y_{rk}^{(p)} \right) = E_k^S \qquad (7)$$

That is, the system efficiency is a weighted average of the q process efficiencies.

Model (5) may have multiple solutions. In order to have a common basis for each process of different DMUs to be comparable, the procedure described in the series case can be applied here.

2.3 General structure

Most network systems are a mixture of the series and parallel structures. Theoretically, they can have numerous forms of structure, although the most complicated structure that appears in the literature only has five processes (Lewis and Sexton, 2004). Denote $I_j^{(p)}$, $O_j^{(p)} \subseteq \{1, 2, \ldots, g\}$ as the index sets of the input and output intermediate products, respectively, of process p for DMU j. To be generic, we consider the very general network structure shown in Figure 3, where each process p consumes exogenous inputs $X_{ij}^{(p)}$ and intermediate products $Z_{fj}^{(p)}$, $f \in I_j^{(p)}$ that are produced by other processes to produce exogenous outputs $Y_{rj}^{(p)}$ and intermediate products $Z_{fj}^{(p)}$, $f \in O_j^{(p)}$ for other processes to use. The total inputs consumed and the total outputs produced by the system are $X_{ij} = \sum_{p=1}^{q} X_{ij}^{(p)}$ and $Y_{rj} = \sum_{p=1}^{q} Y_{rj}^{(p)}$, respectively. Let the same factor have the same multiplier; the relational model for calculating the system efficiency is (Kao, 2009a):

$$E_k^S = \text{max.} \quad \sum_{r=1}^{s} u_r Y_{rk}$$

$$\text{s.t.} \quad \sum_{i=1}^{m} v_i X_{ik} = 1$$

$$\sum_{r=1}^{s} u_r Y_{rj} - \sum_{i=1}^{m} v_i X_{ij} + s_j = 0, \qquad j = 1, \ldots, n \qquad (8)$$

$$\left(\sum_{r=1}^{s} u_r Y_{rj}^{(p)} + \sum_{f \in O_j^{(p)}} w_f Z_{fj}^{(p)} \right) - \left(\sum_{i=1}^{m} v_i X_{ij}^{(p)} + \right.$$

$$\left. \sum_{f \in I_j^{(p)}} w_f Z_{fj}^{(p)} \right) + s_j^{(p)} = 0, \qquad j = 1, \ldots, n, \quad p = 1, \ldots, q$$

$$u_r, v_i, w_f \geq \varepsilon, \qquad r = 1, \ldots, s, \ i = 1, \ldots, m, \quad f = 1, \ldots, g$$

$$s_j, s_j^{(p)} \geq 0, \qquad j = 1, \ldots, n, \ p = 1, \ldots, q$$
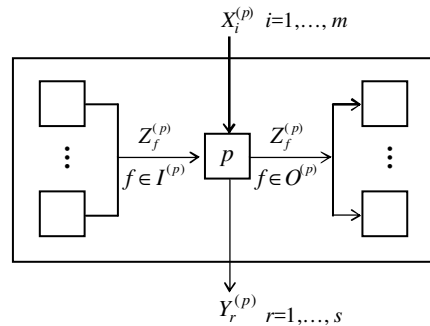

Fig. 3. The general network structure

Since all the intermediate products are produced and consumed in the system, the sum of the constraints corresponding to the q processes is equal to the constraint corresponding to the system for each DMU. This property is similar to the flow conservation in network analysis (Bazaraa et al., 1990)

Based on Model (8), the system and process efficiencies of DMU k can be calculated as:

$$E_k^S = \sum_{r=1}^{s} u_r^* Y_{rk} / \sum_{i=1}^{m} v_i^* X_{ik} = \sum_{r=1}^{s} u_r^* Y_{rk} \qquad (9)$$

$$E_k^{(p)} = [\sum_{r=1}^{s} u_r^* Y_{rk}^{(p)} + \sum_{f \in O_k^{(p)}} w_f^* Z_{fk}^{(p)}]/[\sum_{i=1}^{m} v_i^* X_{ik}^{(p)} + \sum_{f \in I_k^{(p)}} w_f^* Z_{fk}^{(p)}], \quad p=1,\ldots,q$$

where (u_r^*, v_i^*, w_f^*) is a set of optimal solutions. Since the sum of the q process constraints is equal to the system constraint for each DMU, that is, $s_k = \sum_{p=1}^{q} s_k^{(p)}$, we have: $\sum_{r=1}^{s} u_r^* Y_{rk} - \sum_{i=1}^{m} v_i^* X_{ik} = \sum_{p=1}^{q} [\sum_{r=1}^{s} u_r^* Y_{rk}^{(p)} + \sum_{f \in O_k^{(p)}} w_f^* Z_{fk}^{(p)}] - (\sum_{i=1}^{m} v_i^* X_{ik}^{(p)} + \sum_{f \in I_k^{(p)}} w_f^* Z_{fk}^{(p)})]$, or, from the expression of E_k^S and $E_k^{(p)}$ in Equation (9):

$$1 - E_k^S = \sum_{p=1}^{q} (1 - E_k^{(p)})(\sum_{i=1}^{m} v_i^* X_{ik}^{(p)} + \sum_{f \in I_k^{(p)}} w_f^* Z_{fk}^{(p)}) = \sum_{p=1}^{q} (1 - E_k^{(p)}) \omega^{(p)} \qquad (10)$$

where $\omega^{(p)} = \sum_{i=1}^{m} v_i^* X_{ik}^{(p)} + \sum_{f \in I_k^{(p)}} w_f^* Z_{fk}^{(p)}$. That is, the system inefficiency, $1 - E_k^S$, is a linear combination of the q process inefficiencies, $1 - E_k^{(p)}$. Nevertheless, the former is not a weighted average of the latter because the sum of the weights, $\sum_{p=1}^{q} \omega^{(p)} = \sum_{p=1}^{q} [\sum_{i=1}^{m} v_i^* X_{ik}^{(p)} + \sum_{f \in I_k^{(p)}} w_f^* Z_{fk}^{(p)}] = 1 + \sum_{p=1}^{q} \sum_{f \in I_k^{(p)}} w_f^* Z_{fk}^{(p)}$, is clearly greater than 1.

3. MALMQUIST PRODUCTIVITY INDEX

The MPI is an index for representing the efficiency improvement between two periods. Various forms of MPI have been developed. The global MPI proposed by Pastor and Lovell (2005) has several attractive properties and is used in this paper. The basic idea of the global MPI is to use the observations of all periods to construct the production frontier. Based on which, the relative efficiencies of a DMU in two periods are calculated, and their ratio is the MPI. Since all observations have been included in constructing the frontier, the resulting efficiencies for both periods will not exceed one.

The discussion of this section follows the three structures of the preceding section: series, parallel, and general.

3.1 Series structure

Let the superscript h, t, and $t+1$, denote period. The relational model for calculating the relative efficiency of DMU k in period $t+1$ for the series structure based on the technology constructed from the observations of periods t and $t+1$ is:

$$(E_k^S)^{t+1} = \quad \max. \quad \sum_{r=1}^{s} u_r (Y_{rk})^{t+1}$$

$$\text{s.t.} \quad \sum_{i=1}^{m} v_i (X_{ik})^{t+1} = 1$$

$$\sum_{f=1}^{g} w_f (Z_{fj}^{(1)})^h - \sum_{i=1}^{m} v_i (X_{ij})^h \leq 0, \qquad h=t, t+1, j=1,\ldots, n \qquad (11)$$

$$\sum_{f=1}^{g} w_f Z_{fj}^{(p)})^h - \sum_{f=1}^{g} w_f (Z_{fj}^{(p-1)})^h \leq 0, \qquad h=t, t+1, j=1,\ldots, n, p=2,\ldots, q-1$$

$$\sum_{r=1}^{s} u_r (Y_{rj})^h - \sum_{f=1}^{g} w_f (Z_{fj}^{(q-1)})^h \leq 0, \qquad h=t, t+1, j=1,\ldots, n$$

$$u_r, v_i, w_f \geq \varepsilon, \quad r=1,\ldots, s, \ i=1,\ldots, m, \qquad f=1,\ldots, g$$

Note that the redundant system constraints have been omitted. To calculate the efficiency of period t, $(E_k^S)^t$, one simply replaces the objective function from $\sum_{r=1}^s u_r(Y_{rk})^{t+1}$ to $\sum_{r=1}^s u_r(Y_{rk})^t$ and the first constraint from $\sum_{i=1}^m v_i(X_{ik})^{t+1}$ to $\sum_{i=1}^m v_i(X_{ik})^t$.

From the discussion in Section 2.1 and the constraints in Model (11), it is clear that the system efficiency in the series structure is the product of the q process efficiencies: $(E_k^S)^h = \prod_{p=1}^q (E_k^{(p)})^h$, $h = t, t+1$. The system MPI for DMU k, M_k^S, which is the ratio of $(E_k^S)^{t+1}$ to $(E_k^S)^t$, can be expressed as:

$$M_k^S = \frac{(E_k^S)^{t+1}}{(E_k^S)^t} = \frac{\prod_{p=1}^q (E_k^{(p)})^{t+1}}{\prod_{p=1}^q (E_k^{(p)})^t} = \prod_{p=1}^q \frac{(E_k^{(p)})^{t+1}}{(E_k^{(p)})^t} = \prod_{p=1}^q M_k^{(p)} \qquad (12)$$

where $M_k^{(p)} = (E_k^{(p)})^{t+1} / (E_k^{(p)})^t$ is, by definition, the MPI of process p. Hence, we have derived a property that the system MPI is the product of the process MPIs.

This decomposition enables the decision maker to identify the processes that contribute more in improving the system performance and those that deter the improvement from one period to another. Making amendments to those unsatisfactory processes will improve the performance of the system in the future.

3.2 Parallel structure

The way of calculating the system MPI for the parallel structure is similar to that for the series structure. Following Model (5), the model for calculating the system efficiency of period $t+1$ based on the combined technology is:

$$(E_k^S)^{t+1} = \quad \text{max.} \quad \sum_{r=1}^s u_r(Y_{rk})^{t+1}$$

$$\text{s.t.} \quad \sum_{i=1}^m v_i(X_{ik})^{t+1} = 1$$

$$\sum_{r=1}^s u_r(Y_{rj}^{(p)})^h - \sum_{i=1}^m v_i(X_{ij}^{(p)})^h \le 0, \qquad h=t, t+1, j=1,\ldots,n, p=1,\ldots,q \qquad (13)$$

$$u_r, v_i \ge \varepsilon, \quad r=1,\ldots,s, \ i=1,\ldots,m$$

In this model the redundant system constraints have also been deleted. The efficiency for period t is calculated by replacing the objective function from $\sum_{r=1}^s u_r(Y_{rk})^{t+1}$ to $\sum_{r=1}^s u_r(Y_{rk})^t$ and the first constraint from $\sum_{i=1}^m v_i(X_{ik})^{t+1}$ to $\sum_{i=1}^m v_i(X_{ik})^t$.

According to Equation (7), the system efficiency for the parallel structure is a weighted average of the process efficiencies: $(E_k^S)^h = \sum_{p=1}^q [\sum_{i=1}^m v_i^h(X_{ik}^{(p)})^h](E_k^{(p)})^h$, $h=t, t+1$, where $(E_k^S)^h = \sum_{r=1}^s u_r^h(Y_{rk})^h$ and $(E_k^{(p)})^h = \sum_{r=1}^s u_r^h(Y_{rk}^{(p)})^h / \sum_{i=1}^m v_i^h(X_{ik}^{(p)})^h$. The system MPI can then be expressed as:

$$M_k^S = \frac{(E_k^S)^{t+1}}{(E_k^S)^t} = \frac{\sum_{p=1}^q [\sum_{i=1}^m v_i^{t+1}(X_{ik}^{(p)})^{t+1}](E_k^{(p)})^{t+1}}{(E_k^S)^t}$$

$$= \sum_{p=1}^q \left(\sum_{i=1}^m v_i^{t+1}(X_{ik}^{(p)})^{t+1} \right) \frac{(E_k^{(p)})^{t+1}}{(E_k^{(p)})^t} \frac{(E_k^{(p)})^t}{(E_k^S)^t}$$

$$= \sum_{p=1}^q \left(\sum_{i=1}^m v_i^{t+1}(X_{ik}^{(p)})^{t+1} \right) M_k^{(p)} \frac{\sum_{r=1}^s u_r^t(Y_{rk}^{(p)})^t / \sum_{i=1}^m v_i^t(X_{ik}^{(p)})^t}{\sum_{r=1}^s u_r^t(Y_{rk})^t}$$

$$= \sum_{p=1}^q M_k^{(p)} \left(\frac{\sum_{r=1}^s u_r^t(Y_{rk}^{(p)})^t}{\sum_{r=1}^s u_r^t(Y_{rk})^t} \frac{\sum_{i=1}^m v_i^{t+1}(X_{ik}^{(p)})^{t+1}}{\sum_{i=1}^m v_i^t(X_{ik}^{(p)})^t} \right) = \sum_{p=1}^q M_k^{(p)} \varpi^{(p)} \qquad (14)$$

A result that the system MPI is a linear combination of the process MPIs is derived. However, the former is not a weighted average of the latter because the sum of the weights, $\sum_{p=1}^q \varpi^{(p)}$, is not necessarily equal to 1.

Theoretically, if the total weight, $\sum_{p=1}^q \varpi^{(p)}$, in a linear combination is much smaller than 1, then it is possible that all process MPIs are greater than 1, yet their linear combination is less than 1. The opposite situation may also happen, if the total weight is much greater than 1. In practice, the chance of having a very large or a very small total

weight is quite low. The reason is because the observations of DMU k for each process p in period t, $((X_{ik}^{(p)})^t$, $(Y_{rk}^{(p)})^t)$, and period $t+1$, $((X_{ik}^{(p)})^{t+1}$, $(Y_{rk}^{(p)})^{t+1})$, are usually not too different, which make $\sum_{i=1}^{m} v_i^{t+1}(X_{ik}^{(p)})^{t+1}$ approximately equal to $\sum_{i=1}^{m} v_i^t(X_{ik}^{(p)})^t$, especially when they are under the same frontier facet where $v_i^t = v_i^{t+1}$. In this case, the ratio of $\sum_{i=1}^{m} v_i^{t+1}(X_{ik}^{(p)})^{t+1}$ to $\sum_{i=1}^{m} v_i^t(X_{ik}^{(p)})^t$ in $\varpi^{(p)}$ is approximately equal to 1, which simplifies $\varpi^{(p)}$ to $\hat{\varpi}^{(p)} = \sum_{r=1}^{s} u_r^t(Y_{rk}^{(p)})^t / \sum_{r=1}^{s} u_r^t(Y_{rk})^t$. Since $\sum_{p=1}^{q} \hat{\varpi}^{(p)} = 1$, a result in which the system MPI is approximately equal to a weighted average of the process MPIs is obtained, where the weight associated with process p is the proportion of the aggregate output of this process in all processes.

3.3 General structure

For network systems with a general structure of Figure 3, Model (8) can be adapted to suit the combined technology for calculating the efficiency of DMU k in period $t+1$:

$$
(E_k^S)^{t+1} = \text{max.} \quad \sum_{r=1}^{s} u_r(Y_{rk})^{t+1}
$$

$$
\text{s.t.} \quad \sum_{i=1}^{m} v_i(X_{ik})^{t+1} = 1
$$

$$
\sum_{r=1}^{s} u_r(Y_{rj})^h - \sum_{i=1}^{m} v_i(X_{ij})^h + (s_j)^h = 0, \qquad h=t, t+1, j=1,\ldots,n \qquad (15)
$$

$$
[\sum_{r=1}^{s} u_r(Y_{rj}^{(p)})^h + \sum_{f \in O_j^{(p)}} w_f(Z_{fj}^{(p)})^h] - [\sum_{i=1}^{m} v_i(X_{ij}^{(p)})^h +
$$

$$
\sum_{f \in I_j^{(p)}} w_f(Z_{fj}^{(p)})^h] + (s_j^{(p)})^h = 0, \qquad h=t, t+1, j=1,\ldots,n, p=1,\ldots,q
$$

$$
u_r, v_i, w_f \geq \varepsilon, \qquad r=1,\ldots,s, \ i=1,\ldots,m, \ f=1,\ldots,g
$$

$$
(s_j)^h, (s_j^{(p)})^h \geq 0, \quad h=t, t+1, j=1,\ldots,n, \quad p=1,\ldots,q
$$

The efficiency of period t can be calculated by replacing the data of period $t+1$ in the objective function and the first constraint by those of period t. Based on Equation (9), the system and process efficiencies can be calculated, and the ratios between the efficiencies of periods $t+1$ and t are the system and process MPIs, respectively. Due to the variation in forms of the general structure, a mathematical relationship between the system and process MPIs is not obtainable.

From Equation (10), the system inefficiency is a linear combination of the process inefficiencies: $1 - (E_k^S)^h = \sum_{p=1}^{q} (1 - (E_k^{(p)})^h)(\omega^{(p)})^h$ for $h=t, t+1$, where $(\omega^{(p)})^h = \sum_{i=1}^{m} v_i^h(X_{ik}^{(p)})^h + \sum_{f \in I_k^{(p)}} w_f^h(Z_{fk}^{(p)})^h$. The conventional MPI is defined as the ratio of the efficiencies of two periods. A value greater (or less) than 1 indicates that the efficiency has improved (or is worsened). Conceptually, the MPI can also be defined as the ratio of the inefficiencies of two periods. Under this definition, a value less (or greater) than 1 indicates that the efficiency has improved (or is worsened). Term this type of MPI the complementary MPI, and denote it as $\overset{\smile}{M}$. The system complementary MPI for DMU k can be expressed as:

$$
\overset{\smile}{M}_k^S = \frac{1-(E_k^S)^{t+1}}{1-(E_k^S)^t} = \frac{\sum_{p=1}^{q}[1-(E_k^{(p)})^{t+1}][\sum_{i=1}^{m} v_i^{t+1}(X_{ik}^{(p)})^{t+1} + \sum_{f \in I_k^{(p)}} w_f^{t+1}(Z_{fk}^{(p)})^{t+1}]}{1-(E_k^S)^t}
$$

$$
= \sum_{p=1}^{q} \left(\frac{1-(E_k^{(p)})^{t+1}}{1-(E_k^{(p)})^t} \right) \left(\frac{[1-(E_k^{(p)})^t][\sum_{i=1}^{m} v_i^{t+1}(X_{ik}^{(p)})^{t+1} + \sum_{f \in I_k^{(p)}} w_f^{t+1}(Z_{fk}^{(p)})^{t+1}]}{1-(E_k^S)^t} \right)
$$

From the constraints of Model (15), we have $1 - (E_k^S)^t = (s_k)^t$ (because $\sum_{i=1}^{m} v_i(X_{ik})^t = 1$) and $1 - (E_k^{(p)})^t = (s_k^{(p)})^t / [\sum_{i=1}^{m} v_i^t(X_{ik}^{(p)})^t + \sum_{f \in I_k^{(p)}} w_f^t(Z_{fk}^{(p)})^t]$. Denote

$$
\varpi^{(p)} = \frac{(s_k^{(p)})^t[\sum_{i=1}^{m} v_i^{t+1}(X_{ik}^{(p)})^{t+1} + \sum_{f \in I_k^{(p)}} w_f^{t+1}(Z_{fk}^{(p)})^{t+1}]}{(s_k)^t[\sum_{i=1}^{m} v_i^t(X_{ik}^{(p)})^t + \sum_{f \in I_k^{(p)}} w_f^t(Z_{fk}^{(p)})^t]}
$$

$\overset{\smile}{M}_k^S$ becomes:

$$\acute{M}_k^S = \sum_{p=1}^{q} \acute{M}_k^{(p)} \varpi^{(p)} \tag{16}$$

where $\acute{M}_k^{(p)} = [1-(E_k^{(p)})^{t+1}]/[1-(E_k^{(p)})^t]$ is the complementary MPI of process p. Here a property, that the system complementary MPI is a linear combination of the process complementary MPIs, is obtained.

For cases where $(E_k^S)^t = 1$, $\acute{M}_k^S$ is undefined. However, since $(E_k^S)^t = 1$ implies $(E_k^{(p)})^t = 1$ for all p, the system and process MPIs become: $M_k^S = (E_k^S)^{t+1}$ and $M_k^{(p)} = (E_k^{(p)})^{t+1}$. The relationship between the system and process MPIs then is:

$$1 - M_k^S = 1 - (E_k^S)^{t+1} = \sum_{p=1}^{q}(1-M_k^{(p)})\left(\sum_{i=1}^{m} v_i^{t+1}(X_{ik}^{(p)})^{t+1} + \sum_{f \in I_k^{(p)}} w_f^{t+1}(Z_{fk}^{(p)})^{t+1}\right) = \sum_{p=1}^{q}(1-M_k^{(p)})\varpi^{(p)} \tag{17}$$

The value of $\acute{M}_k^S$ in this case is always less than or equal to 1, indicating that the performance is worsened. If, for period t, the system is not efficient, yet a process is, then the corresponding term $\acute{M}_k^{(p)}$ in Equation (16) is changed to $[1-M_k^{(p)}] \times [\sum_{i=1}^{m} v_i^{t+1}(X_{ik}^{(p)})^{t+1} + \sum_{f \in I_k^{(p)}} w_f^{t+1}(Z_{fk}^{(p)})^{t+1}]/(s_k)^t$.

Similar to the discussion in the parallel case, the total weight, $\sum_{p=1}^{q} \varpi^{(p)}$, will not be too different from 1 because the observations of DMU k for each process p in period t, ($(X_{ik}^{(p)})^t$, $(Y_{rk}^{(p)})^t$, $(Z_{fk}^{(p)})^t$), and period $t+1$, ($(X_{ik}^{(p)})^{t+1}$, $(Y_{rk}^{(p)})^{t+1}$, $(Z_{fk}^{(p)})^{t+1}$), will not differ by much, which make $[\sum_{i=1}^{m} v_i^{t+1}(X_{ik}^{(p)})^{t+1} + \sum_{f \in I_k^{(p)}} w_f^{t+1}(Z_{fk}^{(p)})^{t+1}]$ approximately equal to $[\sum_{i=1}^{m} v_i^t(X_{ik}^{(p)})^t + \sum_{f \in I_k^{(p)}} w_f^t(Z_{fk}^{(p)})^t]$. The weight $\varpi^{(p)}$ will be simplified to $\hat{\varpi}^{(p)} = (s_k^{(p)})^t/(s_k)^t$. Since $\sum_{p=1}^{q} \hat{\varpi}^{(p)} = 1$, a result, that the system complementary MPI is approximately equal to the weighted average of the process complementary MPIs, is obtained, where the weight for each process is the proportion of the efficiency slack of this process in the system in period t.

Different from the conventional MPI, where values greater than 1 are preferred, a value less than 1 for the complementary MPI indicates an improvement of the performance. Therefore, processes with a complementary MPI greater than 1 are the ones that the decision maker should pay more attention to in their future operations.

Since the series and parallel structures are special types of the general structure, the relationships derived in this section are also applicable to these two types of structure.

4. EXAMPLES

In this section we use three examples, one for each of the series, parallel, and general structures, to explain how the models developed in Section 3 are used to calculate the system and process MPIs, and the relationships between them.

4.1 Series structure

Consider a series system of three processes shown in Figure 4, where process 1 applies inputs X_1 and X_2 to produce intermediate product Z_1, process 2 applies this intermediate product to produce intermediates Z_2 and Z_3, and process 3 applies these two intermediate products to produce the final products Y_1 and Y_2. Suppose there are eight DMUs to be compared, with the data shown in Table 1. Each DMU has two rows of data entries corresponding to periods t and $t+1$.
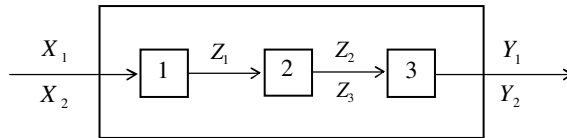

Fig. 4. Structure of the series example

By applying Model (11), the system and process efficiencies for the two periods are calculated as shown in the first two rows of each DMU in Table 2. As expected, the system efficiency is the product of the three process efficiencies. The ratios of the efficiencies of period $t+1$ to period t are the MPI and are shown in the third row. The system MPI is also the product of the three process MPIs.

The system MPI indicates whether a DMU has improved or not between two periods, and the process MPIs show their contribution to the system MPI. Taking the first three DMUs as examples, DMU 1 has an MPI equal to 1,

indicating that the performance of this DMU maintains the same between two periods. However, process 1 has its performance improved, and the other two are worsened. The second DMU is worsened (MPI=0.7369), yet its second process is actually improved. The third DMU is slightly improved (MPI=1.0080), yet its third process is slightly worsened. Decomposing the system MPIs into the process MPIs helps the decision maker identify the unsatisfactory processes. Amendments to these unsatisfactory ones will improve the performance of the system in the future.

Table 1. Data for the series example

DMU	Period	X_1	X_2	Z_1	Z_2	Z_3	Y_1	Y_2
1	t	2	1	6	4	2	2	2
	$t+1$	2	1	7	4	3	2	2
2	t	1	4	8	3	5	2	4
	$t+1$	2	4	8	4	5	3	4
3	t	3	2	8	4	4	2	4
	$t+1$	3	3	9	4	5	4	4
4	t	4	3	9	4	5	5	2
	$t+1$	4	4	10	5	4	5	5
5	t	3	5	10	4	6	4	4
	$t+1$	3	4	10	4	6	4	4
6	t	4	4	9	5	5	4	4
	$t+1$	4	4	9	5	6	5	4
7	t	5	6	12	5	7	5	7
	$t+1$	5	4	11	5	6	5	6
8	t	7	3	11	6	4	7	4
	$t+1$	5	3	10	5	4	6	4

Table 2. Efficiencies and MPIs of the series example.

DMU		Process 1	Process 2	Process 3	System
1	$E^{(t)}$	0.8571	1.0000	0.5325	0.4564
	$E^{(t+1)}$	1.0000	0.9184	0.4970	0.4564
	MPI	1.1667	0.9184	0.9333	1.0000
2	$E^{(t)}$	1.0000	0.8407	0.8450	0.7104
	$E^{(t+1)}$	0.7368	0.9237	0.7692	0.5235
	MPI	0.7368	1.0987	0.9103	0.7369
3	$E^{(t)}$	0.7179	0.8053	0.8821	0.5100
	$E^{(t+1)}$	0.7241	0.8095	0.8770	0.5141
	MPI	1.0086	1.0052	0.9942	1.0080
4	$E^{(t)}$	0.5888	0.8095	0.9242	0.4405
	$E^{(t+1)}$	0.6034	0.8143	0.9809	0.4820
	MPI	1.0249	1.0059	1.0613	1.0941
5	$E^{(t)}$	0.6667	0.7714	0.8283	0.4260
	$E^{(t+1)}$	0.7292	0.7714	0.8283	0.4659
	MPI	1.0937	1.0000	1.0000	1.0937
6	$E^{(t)}$	0.5431	0.9524	0.7455	0.3856
	$E^{(t+1)}$	0.5431	1.0000	0.8074	0.4385
	MPI	1.0000	1.0500	1.0830	1.1372
7	$E^{(t)}$	0.5455	0.8289	1.0000	0.4521
	$E^{(t+1)}$	0.5662	0.8182	0.9706	0.4496
	MPI	1.0380	0.9871	0.9706	0.9945
8	$E^{(t)}$	0.5237	0.8571	1.0000	0.4489
	$E^{(t+1)}$	0.5512	0.8143	1.0000	0.4488
	MPI	1.0524	0.9500	1.0000	0.9997

4.2 Parallel structure

Consider a parallel system with three processes operating independently as shown in Figure 5. The first process uses input X_1 to produce output Y_1, the second process uses input X_2 to produce output Y_2, and the third process uses inputs X_1 and X_2 to produce outputs Y_3. There are eight DMUs to be compared, with the data shown in Table 3.

By applying Model (13), the system and process efficiencies are calculated as shown in the first two rows of each DMU in Table 4. For both periods, the system efficiency is a weighted average of the three process efficiencies, where the weights are the numbers in parentheses next to the corresponding processes. The third row shows the MPIs, which are ratios of the efficiencies in the first two rows, and the weights, which are calculated from Equation (14). The system MPI is a linear combination of the three process MPIs. The sum of the weights used for calculating the linear combination, as shown in the last column (in parentheses) next to the system MPI is close to 1 for every DMU, indicating that the system MPI is approximately the weighted average of the process MPIs. Similar to the series example, a system which is worsened (e.g., DMU 1) does not necessarily imply that all its component processes are worsened (where process 3 is improved). On the contrary, a system which has improved (e.g., DMU 2) need not have all its component processes improved (where process 2 is worsened), either.
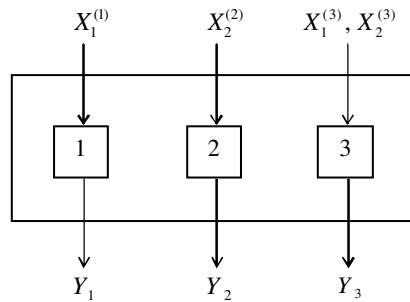
Fig. 5. Structure of the parallel example

Table 3. Data for the parallel example.

DMU	Period	X_1($X_1^{(1)}$ $X_1^{(3)}$)	X_2($X_2^{(2)}$ $X_2^{(3)}$)	Y_1	Y_2	Y_3
1	t	5 (2 3)	6 (3 3)	7	6	6
	$t+1$	6 (3 3)	6 (3 3)	8	6	7
2	t	6 (2 4)	7 (3 4)	8	6	7
	$t+1$	5 (2 3)	8 (4 4)	8	6	6
3	t	8 (4 4)	9 (5 4)	10	10	10
	$t+1$	7 (4 3)	8 (5 3)	9	9	9
4	t	12 (6 6)	10 (6 4)	14	11	15
	$t+1$	11 (6 5)	9 (6 3)	13	10	14
5	t	5 (3 2)	6 (4 2)	5	7	4
	$t+1$	6 (3 3)	6 (3 3)	5	7	6
6	t	6 (3 3)	7 (4 3)	6	9	5
	$t+1$	7 (4 3)	7 (4 3)	8	9	7
7	t	8 (5 3)	9 (5 4)	9	11	10
	$t+1$	9 (5 4)	9 (5 4)	10	11	12
8	t	12 (7 5)	10 (6 4)	12	13	14
	$t+1$	11 (6 5)	9 (6 3)	12	11	13

Table 4. Efficiencies and MPIs of the parallel example.

DMU		Process 1	Process 2	Process 3	System
		Score (weight)	Score (weight)	Score (weight)	Score (weight)
1	$E^{(t)}$	0.8750 (0.2921)	0.8571 (0.1148)	0.6471 (0.5730)	0.7420 (1.0000)
	$E^{(t+1)}$	0.6667 (0.3824)	0.8571 (0.1176)	0.7549 (0.5000)	0.7332 (1.0000)

	MPI	0.7619 (0.4509)	1.0000 (0.1359)	1.1667 (0.4360)	0.9882 (1.0228)
2	$E^{(t)}$	1.0000 (0.2453)	0.8571 (0.1132)	0.5662 (0.6415)	0.7055 (1.0000)
	$E^{(t+1)}$	1.0000 (0.3993)	0.6429 (0.0009)	0.6000 (0.5998)	0.7597 (1.0000)
	MPI	1.0000 (0.5659)	0.7500 (0.0011)	1.0597 (0.4813)	1.0768 (1.0484)
3	$E^{(t)}$	0.6250 (0.3714)	0.8571 (0.1429)	0.8088 (0.4857)	0.7474 (1.0000)
	$E^{(t+1)}$	0.5625 (0.4228)	0.7714 (0.1626)	0.9706 (0.4146)	0.7657 (1.0000)
	MPI	0.9000 (0.3535)	0.9000 (0.1865)	1.2000 (0.4487)	1.0244 (0.9887)
4	$E^{(t)}$	0.5833 (0.0024)	0.7857 (0.5971)	0.8041 (0.4005)	0.7926 (1.0000)
	$E^{(t+1)}$	0.5417 (0.0024)	0.7143 (0.6637)	1.0000 (0.3339)	0.8093 (1.0000)
	MPI	0.9286 (0.0018)	0.9091 (0.6580)	1.2436 (0.3387)	1.0210 (0.9985)
5	$E^{(t)}$	0.4167 (0.0012)	0.7500 (0.6653)	0.4293 (0.3335)	0.6426 (1.0000)
	$E^{(t+1)}$	0.4167 (0.0012)	1.0000 (0.4988)	0.4293 (0.5000)	0.7139 (1.0000)
	MPI	1.0000 (0.0008)	1.3333 (0.5821)	1.0000 (0.3340)	1.1109 (0.9169)
6	$E^{(t)}$	0.5000 (0.0012)	0.9643 (0.5701)	0.3578 (0.4287)	0.7037 (1.0000)
	$E^{(t+1)}$	0.5000 (0.0016)	0.9643 (0.5698)	0.5009 (0.4286)	0.7650 (1.0000)
	MPI	1.0000 (0.0011)	1.0000 (0.7808)	1.4000 (0.2179)	1.0870 (0.9999)
7	$E^{(t)}$	0.4500 (0.0020)	0.9429 (0.5538)	0.5375 (0.4442)	0.7618 (1.0000)
	$E^{(t+1)}$	0.5000 (0.0020)	0.9429 (0.5536)	0.6444 (0.4444)	0.8093 (1.0000)
	MPI	1.1111 (0.0012)	1.0000 (0.6851)	1.1989 (0.3136)	1.0624 (0.9999)
8	$E^{(t)}$	0.4286 (0.0028)	0.9286 (0.5971)	0.7512 (0.4001)	0.8562 (1.0000)
	$E^{(t+1)}$	0.5000 (0.0024)	0.7857 (0.6637)	0.9286 (0.3339)	0.8327 (1.0000)
	MPI	1.1667 (0.0012)	0.8462 (0.7198)	1.2360 (0.2930)	0.9725 (1.0140)

4.3 General structure

Consider a system of three processes connected in a general structure shown in Figure 6, where process 1 applies input X_1 to produce output Y_1, process 2 applies input X_2 to produce output Y_2, and process 3 applies input X_3 and portions of Y_1 and Y_2 to produce output Y_3. There are eight DMUs to be compared, with the data shown in Table 5. Note that the output of process 1, Y_1, is split into $Y_1^{(I)}$ and $Y_1^{(O)}$, where the former is used by process 3 for producing Y_3 and the latter is an output of the system. Similarly, Y_2, is split into $Y_2^{(I)}$ and $Y_2^{(O)}$.
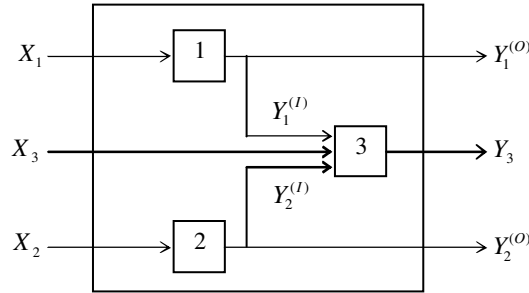

Fig. 6. Structure of the general network example

Table 5. Data for the general structure example

DMU	Period	X_1	X_2	X_3	$Y_1(Y_1^{(I)}$ $Y_1^{(O)})$	$Y_2(Y_2^{(I)}$ $Y_2^{(O)})$	Y_3
1	t	2	4	3	5 (2 3)	5 (2 3)	4
	$t+1$	2	4	2	6 (3 3)	5 (2 3)	4
2	t	3	5	3	5 (3 2)	6 (3 3)	5
	$t+1$	2	5	4	5 (3 2)	7 (3 4)	6
3	t	3	6	3	6 (2 4)	6 (2 4)	5
	$t+1$	4	7	4	7 (3 4)	8 (4 4)	7
4	t	4	6	4	7 (3 4)	6 (3 3)	7
	$t+1$	3	5	3	7 (3 4)	6 (3 3)	6
5	t	5	6	4	7 (4 3)	7 (3 4)	7

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	t+1	4	5	4	7 (4 3)	6 (3 3)	7
6	t	5	7	5	8 (4 4)	8 (3 5)	8
	t+1	5	7	6	9 (4 5)	9 (4 5)	9
7	t	5	8	5	9 (4 5)	9 (4 5)	9
	t+1	6	7	5	9 (4 5)	9 (5 4)	10
8	t	6	9	5	9 (5 4)	9 (4 5)	8
	t+1	5	8	4	9 (5 4)	9 (5 4)	9

By applying Model (15), the system and process inefficiencies are calculated as shown in the first two rows of each DMU in Table 6. As discussed in Section 2.3, the system inefficiency is a linear combination of the process inefficiencies, and the sum of the weights for linear combination is greater than 1 for all DMUs (shown in the last column in parentheses). The ratio of the inefficiencies in periods $t+1$ and t is the complementary MPI, and is shown in the third row and denoted as cMPI. The weight associated with each process is calculated from Equation (16) shown in parentheses next to the complementary MPI. The system complementary MPI is a linear combination of the process complementary MPIs.

Table 6. Inefficiencies, complementary MPIs, and MPIs of the general structure example

DMU		Process 1 Score (weight)	Process 2 Score (weight)	Process 3 Score (weight)	System Score (weight)
1	$1-E^{(t)}$	0.1667 (0.0006)	0.1071 (0.6516)	0.2000 (0.5807)	0.1861 (1.2329)
	$1-E^{(t+1)}$	0.0000 (0.0006)	0.1071 (0.7360)	0.0003 (0.5266)	0.0790 (1.2632)
	cMPI	0.0000 (0.0005)	1.0000 (0.4238)	0.0013 (0.5660)	0.4246 (0.9904)
2	$1-E^{(t)}$	1.2000	1.0000	1.2497	1.1315
	$1-E^{(t+1)}$	0.4444 (0.0009)	0.1429 (0.6988)	0.1668 (0.6001)	0.2003 (1.2998)
	cMPI	0.1667 (0.0006)	0.0000 (0.6370)	0.1430 (0.6357)	0.0910 (1.2733)
3	$1-E^{(t)}$	0.3750 (0.0013)	0.0000 (0.4544)	0.8575 (0.5292)	0.4543 (0.9849)
	$1-E^{(t+1)}$	1.5000	1.1667	1.0285	1.1367
	cMPI	0.3333 (0.0009)	0.2857 (0.7356)	0.0003 (0.4389)	0.2106 (1.1753)
4	$1-E^{(t)}$	0.4167 (0.0012)	0.1837 (0.7085)	0.1250 (0.5798)	0.2031 (1.2895)
	$1-E^{(t+1)}$	1.2500 (0.0019)	0.6429 (0.9612)	391.75 (0.0009)	0.9643 (0.9640)
	cMPI	0.8750	1.1429	0.8753	1.0095
5	$1-E^{(t)}$	0.4167 (0.0012)	0.2857 (0.6758)	0.0003 (0.5646)	0.1938 (1.2417)
	$1-E^{(t+1)}$	0.2222 (0.0009)	0.1429 (0.6988)	0.0001 (0.6001)	0.1001 (1.2998)
	cMPI	0.5333 (0.0019)	0.5000 (1.0304)	0.3521 (0.0009)	0.5165 (1.0332)
6	$1-E^{(t)}$	1.3333	1.2000	1.0002	1.1162
	$1-E^{(t+1)}$	0.5333 (0.0015)	0.1667 (0.6764)	0.0002 (0.5641)	0.1137 (1.2420)
	cMPI	0.4167 (0.0012)	0.1429 (0.6356)	0.0002 (0.6360)	0.1914 (0.9932)
7	$1-E^{(t)}$	0.7813 (0.0056)	0.8571 (0.9321)	0.8867 (0.0012)	0.8044 (0.9389)
	$1-E^{(t+1)}$	1.2500	1.0286	1.0000	1.0251
	cMPI	0.4667 (0.0015)	0.1837 (0.6612)	0.0001 (0.5401)	0.1222 (1.2028)
8	$1-E^{(t)}$	0.0400 (0.0015)	0.0816 (0.6193)	0.1000 (0.6324)	0.1144 (1.2532)
	$1-E^{(t+1)}$	0.8571 (0.0057)	0.4444 (0.9307)	674.76 (0.0008)	0.9360 (0.9372)
	cMPI	1.1250	1.1250	0.9001	1.0089

A complementary MPI of greater (or less) than one indicates that the performance of the associated unit is worsened (or has improved). When the efficiency of period t, $(E_k^{(p)})^t$, is close to 1, the inefficiency, $1-(E_k^{(p)})^t$, will be close to 0, which may result in peculiar numbers in calculating ratios. The complementary MPIs of process 3 of DMUs 3 and 6 are examples where the former has a value of 391.75 and the latter has a value of 674.76. These large values are difficult for human to interpret how worse the units have performed. A contrary situation is when $(E_k^{(p)})^{t+1}$ is close to 1, which makes the complementary MPI close to 0. For example, both process 1 of DMU 1 and process 2 of DMU 2 have a complementary MPI of 0. There is no way of knowing which one has improved more.

Since the MPI and the complementary MPI have opposite trends intersecting at 1, one can rely on the MPI to help judge the extent of the performance change. The fourth row of Table 6 shows the MPI, which is the ratio of $E^{(t+1)}/E^{(t)}$, of each DMU. Comparing the complementary MPI in the third row with the MPI in the fourth, it is clear that when one has a value greater (or less) than 1, the other has a value less (or greater) than 1. For the example of

391.75 and 674.76 mentioned in the preceding paragraph, we know that both processes are worsened, yet their extents are difficult to judge. Their corresponding MPIs of 0.8753 and 0.90021 make the judgment much easier. Similarly, for process 1 of DMU 1 and process 2 of DMU 2, where both processes have a complementary MPI of 0, the former has an MPI of 1.2 and the latter an MPI of 1.1667, indicating that the former has improved more than the latter. Hence, one may use the MPI to judge the extent of performance changes. The complementary MPI is merely for showing the mathematical relationship between the performance change of the system and the processes.

5. CONCLUSION

A system is usually composed of several processes operating interdependently. The conventional MPI measures the efficiency improvement between two periods by treating the system as a black box, neglecting the operations of the component processes. Once the MPI is calculated, it is not clear which processes cause the improvement of deterioration of the system. More seriously, it is possible that the system shows an improvement while most of the component processes are actually worsened.

This paper adopts the idea of the relational DEA model to calculate the system and process efficiencies at the same time. Most importantly, there exist mathematical relationships between them. Based on the relationships between the system and process efficiencies, relationships between those of MPIs are derived. The relationships show the effects of the process MPIs on the system MPI, and the processes which cause the improvement or deterioration of the system performance can also be identified.

Network systems have numerous forms of structure for which series and parallel are the two basic ones. This paper finds that, for the series structure, the system MPI is the product of the process MPIs. An example shows that for a DMU whose system performance has improved (or is worsened) between two periods, it is still possible to have processes whose performance are worsened (or is improved). By improving the operations of the processes with unsatisfactory MPIs, the system performance will be improved in the future.

For the parallel structure, this paper finds that the system MPI can be decomposed as a linear combination of the process MPIs, and the former is approximately equal to the weighted average of the latter, where the weight is the proportion of the aggregate output of the corresponding process in that of all processes. Hence, the process MPI also shows the processes which are performing unsatisfactorily.

Most network systems are not of the simple series or parallel structure, but are a mixture of them. There seems to be no clear relationship between the system and process MPIs for general network structures. However, by defining the complementary MPI as the ratio of the inefficiencies of two periods, this paper finds that the system complementary MPI is a linear combination of the process complementary MPIs, and the former is approximately a weighted average of the latter. Although the complementary MPI can also be used to judge whether a unit has improved or not between two periods, its magnitude is difficult to interpret as was illustrated by the general-structure example. For these cases, the conventional MPI can be calculated to help the interpretation.

To conclude, this paper proposes a methodology for calculating the system and process MPIs of network systems and decomposes the system MPI to those of their component processes. The process MPI helps identify the processes that cause the deterioration of the system. Concentrating on their performance will be more effective in improving the performance of the system in the future.

The DEA model used in this study is the CCR model under the assumption of constant returns-to-scale. For series systems with only two processes, Kao and Hwang (2011) were able to use the BCC model (Banker et al., 1984) to calculate the efficiency under the assumption of variable returns-to-scale. Its extension to the calculation and decomposition of MPI should be straightforward. For parallel systems, replacing the CCR model by the BCC model is not difficult, as briefly mentioned in Kao (2009b). How to generalize to cases of variable returns-to-scale for series structures with more than two processes and general network structures are not so simple, and is a direction for future research.

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The competitiveness of national economy and competitiveness of an enterprise - the perspective of State aid for small and medium-sized enterprises in the European Union

Piotr PODSIADŁO[a]1

ᵃ Cracow University of Economics, Faculty of Finance and Law, Department of Local Government Finance, Rakowicka 27, 31-510 Cracow, Poland, Email: piotr.podsiadlo@uek.krakow.pl

Abstract

The competitiveness of an enterprise, on the one hand, reflects successful management practices on the part of entrepreneurs, on the other hand, the competitiveness of an enterprise comes from the strength and efficiency of the national economy production structure, its technical infrastructure and other factors determining external effects that may form the basis of the enterprise activity. But it should be also stated that the competitiveness of the national economy can be considered as built on the competitiveness of enterprises operating within its borders, that operate in a specific legal, financial and environmental environment. The subject of the article is to present the conditions of admissibility of State aid in the European Union, taking into account the rules applicable to the State aid for small and medium-sized enterprises. The qualitative analysis of State aid granted by the Member States is carried out under the provisions of the Treaty on the Functioning of the European Union and the rules of State aid admissibility on the basis of the implementing regulations, adopted by the European Commission. Statistical data for quantitative analysis were gathered on the basis of reports published by the European Commission on State aid granted by Member States. This should lead to verify the hypothesis of the influence of State aid on the competitiveness of the EU Member States, which have provided State aid for small and medium-sized enterprises in the years 2000-2016. This analysis is carried out based on the linear regression model. The response variable (dependent variable Y) is the size of the GDP *per capita*, and explanatory variable (independent variable X) is the expenditure on State aid for small and medium-sized enterprises. In the other words, the hypothesis highlights that the volume of expenditure on SME aid in respect of the whole European Union and particular Member States, should be positively correlated with the rate of GDP *per capita*, determining the level of development and competitiveness of the European economy.

Keywords: competition policy, competitiveness, European Union, national economy, SMEs, State aid

1. INTRODUCTION

There is a strong interdependence between factors that affect the increase in the competitiveness of the national economy and the actions of enterprises to improve their own competitiveness. The competitiveness of an enterprise, on the one hand, reflects successful management practices on the part of entrepreneurs, on the other hand, the competitiveness of an enterprise comes from the strength and efficiency of the national economy production structure, its technical infrastructure and other factors determining external effects that may form the basis of the enterprise activity (Chesnais, 1988). On a macroeconomic scale, competitiveness is conditioned by both the actions of institutions at the central level, decisions taken by the legislative and executive authorities, as well as the potential of entrepreneurship, which is diversified depending on the level of socio-economic development of society. In turn, the economic, legal and administrative environment created by the State has a significant influence on the possibilities and way of conducting economic activity, because this environment shapes the external factors of the enterprises competitiveness.

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* Corresponding author.

State aid for enterprises is applied in the European Union as derogation from a rule of creating equal opportunities for starting and running a business in the Single European Market. The rules of State interventionism in the economy has been defined precisely in this field and they tend to seek a compromise between the position of the European Commission and the position of the Member State concerned with the admissibility of State aid. These rules, on the one hand, prohibit providing State aid so as not to lead to distortions of competition in the market of integrating countries, while on the other hand, they allow for providing the aid by public authorities in order to correct the imbalance in development between regions, stimulate or accelerate necessary changes and development of certain sectors of the economy.

Legal regulation of the issue of State aid is an element of protection of the mechanism of competition, which has been recognized in the Treaty on the Functioning of the European Union (TFEU, 2012) as one of the basic tools for the realization of the tasks assigned in it. The general prohibition of providing State aid has been formulated in Article 107 par. 1 TFEU, whereas this provision does not specify the definition of State aid, but indicates the criteria taken into account when assessing the specific actual circumstances. These criteria were formulated in the catalogues of terms defining State aid, i.e. the origin from the State or from State resources, selectivity, economic advantage to the beneficiary or beneficiaries of the aid and the disruption or threat to distort competition and affecting the trade between Member States. The primary objective pursued by the precise determination of the means which form State aid is not establishing an absolute prohibition on their use, but only a selection of the action circle which is subject to testing for their possible negative impact on competition in the Internal market level. Further study mostly comes down to the analysis if the binding specific provisions of the European law allow for providing state aid in the given case.

On the basis of Article 107 par. 3(c)TFEU, the European Commission may consider compatible with the internal market State aid designed to facilitate the development of certain economic activities, where such aid does not adversely affect trading conditions to an extent contrary to the common interest. The policy of the European Union always sought at small and medium-sized enterprises (SMEs). This is why numerous instruments of the Commission policy were aimed at the support of SMEs. This position was also reflected in the processing of State aid for the benefit of SMEs. The Commission always regarded such aid as, in principle, positive and approved it as long as positive effects of such aid overweighed any potential distortion of competition.

The purpose of the article is the analysis of the State aid for SMEs provided by Member States of the European Union from the perspective of the State aid impact on competitiveness of these countries. Adopted measure of competitiveness is GDP *per capita*, which, in relation both to the entire European Union and particular Member State, determines the standard of living of the population and level of economic development. As a test period the years 2000-2016 were adopted, i.e. the period of implementation of the two most important development strategies of the European Union - the Lisbon strategy and the "Europe 2020" strategy (taking the year 2016 as the closing period of observation was due to the available annual data on State aid, which is published by Eurostat). The thesis was accepted that the amount of State aid provided by EU Member States should be positively correlated with the competitiveness of these countries. The positive correlation of GDP *per capita* with the size of State aid for SMEs would mean that with increasing State aid provided in this form there is positive economic growth of the Member States and their competitiveness increases.

2. LITERATURE REVIEW

2.1. The Concept of competitiveness - theoretical approach

Competitiveness is the result of many factors and many institutions activities, among which the state and its economic policy play an important role. The possibility of achieving business success by enterprises is determined to a large extent by the economic environment in which they operate. It is the public authorities that define the economic system, which is the environment more or less favorable to gain a competitive advantage by enterprises (Misala, 2001). The competitiveness of an enterprise can be defined as the enterprise ability to function in a given industry in the free market economy. At the same time, there is a dependence that the greater the competitiveness, the more reliable the position of the enterprise in the market, and its operation is less exposed to external factors and unfavorable economic conditions. The enterprise competitiveness is its ability: 1) to design, manufacture and sell goods with more attractive prices, quality and other values than the corresponding features of goods offered by competitors (Flejterski, 1984), 2) of sustainable development and to achieve, maintain and increase market shares (Lubiński, 1995), 3) to raise the efficiency of internal functioning by strengthening and improving its market position (Jantoń-Drozdowska, 1994), 4) to achieve and maintain a competitive advantage (Gorynia, 1998), 5) to constantly provide a suitable set of competing instruments (Mantura, 2001). In addition, the enterprise

competitiveness is worth considering also in relation to the enterprise ability to increase the value in use perceived by the client (basic competitiveness) and predispositions to gain a lasting competitive advantage in a given market (key competitiveness) (Faulkner, Bowman, 1996). Therefore, in a broader perspective, the phenomenon of competitiveness is multilayered and can be described as the ability of enterprises, industry departments, regions and states to obtain a relatively high and stable income and employment level in conditions of international competition.

The ability to produce and sell goods and provide services should always be in relation to effective, beneficial and economic fulfillment of objectives in a competitive market, and the achievement of such ability can be done thanks to a broad understanding of the concept of competitiveness. It is worth taking into consideration the evolution of the trade trend competitiveness theory, which placed its sources in theories of international exchange – from the concept of absolute differences in the production costs of A. Smith (Smith, 2008) and the concept of comparative differences of D. Ricardo (Ricardo, 1957), R. Torrens and J.S. Mill (Mill, 1965) to the resources abundance theory of E. Heckscher and B. Ohlin (Budnikowski, 2006), developed subsequently by P. Samuelson (Olczyk, 2008). In the 1960s, the achievement of these theories was developed by R. Vernon (theory of the product cycle) (Hill, 2014), S. Linder (theory of preferences similarity) (Frankel, 1997) and J. Stiglitz and P. Krugman (theory of economies of scale) (Serwach, 2011). It should be noted that the indication of these representatives of economic thought is not accidental, as they all were looking for an answer to the question of what is the source of advantage of one economy over another (Daszkiewicz, 2008). Theories of international trade indicated the complexity of free trade processes and searched for variables explaining the possibility of trade between countries. The concept of competitiveness was decisively influenced by new interpretations and new research directions in this area, that were proposed in the 90s of the twentieth century.

The breakthrough moment of questioning the traditional approach to competitiveness was the debate initiated in 1994 by Krugman determining "anew" the definition of competitiveness (Krugman, 1994). He formulated four theses concerning: 1) the lack of a simple analogy between the enterprise and the economy as a whole (hence, the economy competitiveness can not be treated as the sum of domestic enterprises competitiveness), 2) determining the concept of competitiveness through the increase of national productivity (especially for countries with low involvement in world exchange), 3) distinguishing the trade between countries from the trade between enterprises (in the case of enterprises, the increase in the sales of one enterprise is often associated with a decrease in revenues of another enterprise, i.e. it is a zero-sum game, and countries conduct mutual export and import by exchanging in accordance with the principle of comparative advantages, i.e. it is a non-zero-sum game), and 4) a dangerous impact of the pressure of countries in the field of international competitiveness improvement on the global economy (frequent treatment of mutual trade as a zero-sum game, subsidizing own export and limiting import can lead to trade wars and wasting resources on bad trade policy). V. Clyde and J. Prestowitz, L. Thurow and S. Cohen responded to the theses formulated in this way. Clyde and Prestowitz negated the treatment of every international exchange stream as a non-zero sum game, giving, as an example, contracts for the purchase of new aircraft, produced both by American and European corporations – in the case of an order carried out by the American side, the European side will suffer a loss and vice versa, which means a zero-sum game (Clyde, Prestowitz, 1994). L. Thurow, in turn, challenged the thesis of Krugman that the results in international trade do not affect domestic productivity and thus do not determine the living standard of the population in a given country (Thurow, 1994). He emphasized that a given country must first achieve success in the global economy, and only then could it expect an increase in national productivity and the living standard of its citizens. In turn, S. Cohen was of the opinion that productivity should not be focused on as the only appropriate measure of competitiveness, because productivity changes do not answer the question, what contributes to the changes in the competitiveness of the economy and how this competitiveness can be achieved (Cohen, 1994). He postulated the measurement of competitiveness using a number of economic indicators at the same time, which he justified with the fact that analyzed individually do not provide useful information, but together allow to assess the level of competitiveness of a given national economy.

The views presented above indicate a strong emphasis on the dominant role of internal factors in shaping competitiveness and an indication of productivity as the appropriate method of its measurement. A factor approach to the phenomenon of competitiveness was proposed by M. Porter, presenting the model of economy competitiveness based on four factors (Porter, 1990). The diamond competitiveness model indicated: 1) the quality of production factors ensuring proper supply, which determine the position of the country in terms of production factors and have a direct impact on the country specialization in international markets), 2) the impact of demand factors on the competitiveness of individual industries, determining the nature of domestic demand for a given good or service and the way enterprises adapt to the needs of buyers), 3) the environment (groups), that is existing in the economy informally connected, supporting and at the same time internationally competing branches of industry, 4) strategy, structure and competition of enterprises, degree of strategy implementation and competitive struggle between enterprises, i.e. domestic conditions regarding the creation of enterprises, their organization and

management as well as the specificity of national competition. The concept of M. Poter was further developed by J.H. Dunning, who perfected the diamond model with three new elements, i.e. foreign direct investments, government policy and pro-competitive mentality (Dunning, 1993). Whereas D. Cho and H. Moon created a nine-factor competitiveness model based on the diamond competition model, which was applied in the competitiveness study of developing or less developed countries, forced to build their international competitiveness without having any variables listed by M. Porter as a base. The adopted solution in this model consisted in a more detailed division of the existing four competitiveness factors, adding new ones and establishing their mutual relations, emphasizing the importance of human factors (*human factors*), i.e. qualified employees, professional managers and engineers, active entrepreneurs and politicians and officials, that mobilize and use physical factors (*physical factors*) to raise the competitiveness of each country (Cho, Moon, 2000).

Taking into account the above-mentioned discourse on the concept of competitiveness, it should be stated that the competitiveness of the national economy can be considered as built on the competitiveness of enterprises operating within its borders, that operate in a specific legal, financial and environmental environment (Zymonik, 1998). Competitiveness of the national economy depends on the competitiveness of enterprises operating in its system. Along with the increase in the quantity and quality of manufactured goods and services provided by enterprises and shaping their prices at a relatively lower level, the level of competitiveness of the national economy increases and its position in the international market becomes better. This means that the increase of competitiveness on the macroeconomic scale is determined by the creation of the basis for the development of micro-competitiveness. Thus, the competitiveness of the economy and the competitiveness of enterprises and sectors creating this economy are interrelated (Porter, 2001). Sources of competitiveness originate in an enterprise in the process of its development by shaping unique resources and skills. However, the source of the enterprise competitiveness is also the economic, political and social environment. The state policy is of particular importance, which directly affects the size and structure of production resources and the efficiency of their use.

2.2. The Concept of competitiveness - the EU' point of view

The European Union's prosperity is dependent on her capacity to compete in the global market (Citi, 2015). For this reason, we need to measure EU economy's positions in terms of competitiveness. Competitiveness creates the necessary conditions for sustainable development, for the creation of new production activities and new jobs - and for a better quality of life. But when we talk about competitiveness, what do we really mean? If we refer to business competitiveness, then we mean market success and the acquisition of new market shares. The European quest for competitiveness is qualified: it should be compatible with the European dream (Rifkin, 2004). Europeans value quality of life higher then the accumulation of wealth and have a vision of the society they want to live in as a society that values solidarity, the well being, and the personal development of her citizens; that respects the environment, the less favoured individuals and the less developed countries (Bakker, de Vreese, 2016). Broad understanding of competitiveness can also be found in studies of Organization for Economic Cooperation and Development (OECD). In terms of this organization the competition is: "the degree to which, under open market conditions, a country can produce goods and services that meet the test of foreign competition, while simultaneously maintaining and expanding domestic real income" (OECD, 1992). For such a definition of competitiveness positively relate, inter alia: Jan Fagerberg, Martin Srholec and Mark Knell, Norwegian economists, who add that "the concept usually has a double meaning, it relates both to the economic well-being of its citizens, normally measured through GDP *per capita*, and the trade performance of the country" (Fagerberg, Srholec, Knell, 2007, p. 1595).

In terms of the European Union development strategies – of Lisbon Strategy implemented till 2010 and the currently implemented "Europe 2020" - the competitiveness of the European Union is a potential competitiveness in the ten-year term. In so-called pyramid of competitiveness proposed by the European Commission in 1997 a set of factors was presented on which it is possible to build models of competitiveness in not only macroeconomic but microeconomic term (Zielińska-Głębocka, 2000, p. 14). At the top of this pyramid as the main factor of competitiveness there was the standard of living, which synthetic measure is GDP *per capita*. In turn two factors, i.e., the employment rate and productivity have the impact on quality of life. Further decomposition of the pyramid allows for the identification of more precise determinants characterizing the level of employment and productivity, so factors affecting the overall level of competitiveness. One of them is the economic policy of the State, which is carried out, among others, through the instruments of State aid, having a substantial impact on both the competitiveness of the economy as a whole and on particular enterprises operating within it. Beside human, capital,

and natural resources and the international environment the State intervention is undoubtedly one of the most significant determinants characterizing the competitiveness of the national economy.

According to the definition used by the European Commission, the competitiveness is defined as "the ability of the economy to provide residents with high and rising standard of living and a high level of employment and productivity, based on a solid basis" (European Commission, 2001). The measure of competitiveness is here the indicator determining the size of the GDP *per capita*. The size of GDP *per capita* in relation both to the entire EU and individual Member States determines the standard of living and level of economic development. The higher is the value of GDP *per capita* the higher the country competitiveness. At this point, it seems reasonable, therefore, to conduct a comprehensive analysis of the relationship between the EU Member States expenditure on State aid for Small and Medium-sized enterprises and the size of GDP *per capita*. The response variable (dependent variable Y) is the GDP *per capita*, and the explanatory variable (independent variable X) is the expenditure on SME aid.

2.3. SME aid admissibility in the European Union' countries

The legal basis for the admissibility of State aid in order to promote the increase of competitiveness of small and medium-sized enterprises is art. 107 para. 3 lit. c) TFEU. According to this provision, aid is allowed to facilitate the development of certain activities, provided that it does not affect competition in the internal market and does not change the conditions for trade between Member States. State aid for small and medium-sized enterprises fulfils the conditions for the application of this exemption from the Treaty prohibition of granting State aid, as this sector plays an important role in the economy of the country. It is a source of income for the State budget and budgets of local governments, has a significant impact on GDP, creates new jobs and contributes to the creation of social and functional changes in individual regions.

Small and medium-sized enterprises play a critical role in the EU development strategy for economic growth and social welfare (Bacon, 2009). The European Commission sees SMEs as crucial for the development of the internal market, because SMEs are regarded as important for the development of jobs and encouraging an entrepreneurial drive throughout the European Union (Florio, Vallino and Vignetti, 2017). The promotion and nurturing of SMEs allows new and smaller businesses to be created, develop and grow, which increases the pool of competitors (Vasin and Gamidullaeva, 2015). Better competition drives down consumer prices, increases innovation and efficiency and adds to the long term stability of the EU. But SMEs usually have difficulties obtaining and securing capital for all types of expenditures. This is due to financial institutions being unwilling to accept the risk against the limited guarantees that SMEs are able to provide. In addition, due to their size SMEs will have limited access to certain types of information, such as new technology and new markets.

Small and medium-sized enterprises are specified as including any entity engaged in an economic activity, irrespective of its legal form, including self-employed persons and family businesses, and partnerships or associations regularly engaged in an economic activity (Kekelekis, 2008). The category of SMEs is sub-divided in three classifications. The category of micro, small and medium-sized enterprises is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding €50 million and/or an annual balance sheet total not exceeding €43 million. Within the SMEs category, a small enterprise is defined as an enterprise which employs fewer than 50 persons and whose annual turnover and/or annual balance sheet total does not exceed €10 million, and a micro-enterprise is defined as an enterprise which employs fewer than 10 persons and whose annual turnover and/or annual balance sheet total does not exceed €2 million. SME must be autonomous. An autonomous SME is any enterprise which is not classified as a partner enterprise or as a linked enterprise.

In line with the strategic importance of SMEs, the Commission has consistently taken a favourable approach to aid to encourage the development and sustainability of SMEs. In other words, the particular interests of SMEs entitle the Commission to afford them special consideration, whilst noting that the Commission need not approve systematically all schemes giving special and preferential treatment to such enterprises. On the basis of its experience in assessing aid to SMEs, the Commission issued guidelines on the compatibility with the common market of investment and start-up aid in 1992 (OJ 1992 C 213/2), which were revised and extended in 1996 (OJ 1996 C 213/4). Council Regulations No. 1588/2015 (OJ 2015 L 248/1) - earlier Council Regulations No. 994/98 (OJ 1998 L 142/1) - now provides for the Commission to adopt regulations declaring certain aid for SMEs to be compatible with the internal market and not to be subject to the notification requirements of Article 108 par. 3 TFEU. On the basis of this power the Commission adopted a block exemption for certain types of State aid to SMEs, i.e. Regulation (EC) No. 70/2001 on aid to SMEs (OJ 2001 L 10/33) and first general block exemption regulation (GBER), i.e. Regulation (EC) No. 800/2008 (OJ 2008 L 214/3), which contained specific provisions concerning SMEs in relation to investment and employment aid, regional start-up aid for small enterprises, aid for small enterprises created by female entrepreneurs, aid for consultancy and for participation in fairs and aid in the

form of risk capital, as well as preferential provisions concerning aspects of environmental protection and research and development. This has now been superseded by the new general block exemption in Commission Regulation No. 651/2014 (OJ 2014 L 187/1). SMEs are also afforded preferential consideration under many other European Union State aid policies, such as regional aid, employment aid, training aid, aid for research, development and innovation, and aid for environmental protection.

The GBER, together with the Commission's general rules for the approval of aid measures, establishes the following methodology for the assessment of aid for SMEs.

Firstly, a number of SMEs support measures do not constitute State aid. For State aid to arise, all of the criteria under Article 107 par. 1 TFEU must be met. In most cases involving aid to SMEs , it will be straightforward to establish the existence of aid within Article 107 par. 1. The doubtful cases are likely to be those where the nature of the SMEs business makes it questionable whether the aid would affect trade between Member States, and cases of *de minimis* aids. The criterion of effect on inter-state trade may well not be satisfied where aid is granted to enterprise in relation to products or services which by their nature are not traded between Members States. This may well be the case for SMEs, particularly micro enterprises, providing local services for example. Aid to SMEs may also fall within the scope of the *de minimis* block exemptions, i.e. Commission's Regulation No. 1998/2006 (OJ 2006 L 379/5), which was replaced by Regulation No. 1407/2013 (OJ 2013 L 352/1). In such cases, the aid is deemed not to meet the criteria of Article 107 par. 1 TFEU and does not need to be notified under Article 108 par. 3 TFEU. *De minimis* aid may be granted up to a ceiling of €200,000 per enterprise, over any period of three years, or €100,000 per enterprise in the road transport sector. The aid must also be "transparent", such that it is possible to calculate precisely the gross grant equivalent of the aid ex ante without need to enterprise a risk assessment.

Secondly, where there is aid, the GBER enables aid to SMEs that complies with certain substantive and transparency requirements to be implemented without prior notification and approval. The GBER contains exemptions of categories of SME aid that are similar to the exemptions in the SME block exemption, i.e. investment aid and aid for the participation in fairs (Podsiadło, 2014). In addition the GBER covers a number of new categories of aid to SMEs, such as aid for consultancy in favour of SMEs, aid for cooperation costs incurred by SMEs participating in European Territorial Cooperation projects, risk finance aid, aid for start-ups, aid to alternative trading platforms specialised in SMEs, aid for scouting costs (Nicolaides, 2014). SMEs also generally benefit for more favourable treatment under other GBER exemptions for horizontal aid and regional aid.

Thirdly, SME aid measures not eligible under the GBER may still be individually approved by the Commission under Article 107 par. 2 and par. 3 TFEU. Of these, the main provision under which State aid for SMEs is likely to be approved is Article 107 par. 3 point c. In addition, some forms of aid to SMEs may fall under the derogation in Article 107 par. 3 point d for aid to promote culture and heritage conservation, or the categories in Article 107 par. 2 of aids which are always exempted such as social aids and disaster aid.

3. PROBLEM FORMULATION AND METHODOLOGY

3.1. Model and data

From the perspective taken in this paper, adopted measure of competitiveness is the size of GDP *per capita*. As a test period the years 2000-2016 were adopted, i.e. the period of implementation of the two most important development strategies of the European Union - the Lisbon strategy and the "Europe 2020" strategy; taking the year 2016 as the closing period of observation was due to the available annual data on State aid, which is published by Eurostat (Eurostat, 2018a, Eurostat, 2018b). The thesis was accepted that the amount of State aid for SMEs provided by EU Member States should be positively correlated with the competitiveness of these countries. The response variable (dependent variable Y) is the size of GDP *per capita* in real terms, and the explanatory variable (independent variable X) is the expenditure on State aid for SMEs. The positive correlation of GDP *per capita* with the size of SME aid would mean that with increasing State aid provided in this form there is positive economic growth of the Member States and their competitiveness increases.

Statistical analysis will be carried out based on two source tables.

The first table shows the calculations for the linear regression model concerning respectively the slope parameter (directional factor β). t Stat is a test of linear relationship occurrence between expenditure on State aid for SMEs and the size of the GDP *per capita*. This statistical test allows to verify the authenticity of the so-called null hypothesis that the parameter of the regression function I type β is equal to zero, with the alternative hypothesis that it is not equal to zero (H_0: $\beta = 0$; H_A: $\beta \neq 0$). The acceptance of the null hypothesis that the parameter $\beta = 0$ would mean that the increase in the value of expenditure on State aid by €1 million will not cause any changes in the size of the GDP *per capita* which means the lack of any relationship between expenditure on State aid for SMEs and the size of

the GDP *per capita*. In other words, the acceptance of the null hypothesis means the lack of the influence of the SME aid provided by the Member States of the European Union on the size of their GDP *per capita*. From the perspective taken in this paper it will be essential to reject the null hypothesis in favor of the alternative hypothesis which states that between the studied phenomena - expenditure on State aid and the size of the GDP *per capita* - there is a significant statistical relationship. From the tables of critical values of t-Student it is seen that $\pm t_{\frac{\alpha}{2}}$ = ± 2.1315 for $\alpha = 0.05$ and n - 2 = 15 degrees of freedom. The null hypothesis can be rejected in favor of the alternative hypothesis only when $t_b < t_{\frac{\alpha}{2}}$ or $t_b > t_{\frac{\alpha}{2}}$, that is when $-t_b < -2.1315$ or $+t_b > +2.1315$.

The second table contains regression statistics. Among the regression statistics are: the correlation coefficient, determination coefficient, standard error and the parameters of F test, that is the value of F-test and the probability of making type I error, when the hypothesis is verified concerning the lack of impact of expenditure on State aid on the size of the GDP *per capita* (irrelevance of State aid expenditure in the regression model). F-test, similarly as described above t-test, is used for testing the significance of linear regression coefficient β evaluation. The checking of this test is a statistic F having F-Snedecor distribution of k_1 and k_2 freedom degrees. When rejecting the null hypothesis F > of no relation between expenditure on State aid and the size of the GDP and accepting the alternative hypothesis of the existence of a statistically significant relationship between the variables. From the table of critical values of the F-Snedecor for k_1 = 1 (1 independent variable) and k_2 = n – 2 = 15 degrees of freedom and $\alpha = 0.05$ we read $F_{0.05}$ = 4.543. Thus, the alternative hypothesis can be adopted only when F > 4.543.

3.2. Model calibration

Member States granted aid earmarked for small and medium-sized enterprises of about €87.6 billion in 2000-2016: EU-15 - €84.3 billion, EU-12 - only €3.3 billion (Eurostat, 2018a). The largest amounts of SME aid have been granted by France (€24.8 billion), Italy (€17.6 billion), Germany (€13.9 billion) and United Kingdom (€13.4 billion). In the Central and Eastern Europe area the countries that provided the greatest SME aid are Czech Republic, Hungary and Poland - respectively €1.0 billion, €0.8 billion and €0.6 billion. Does State aid for SMEs provided by Member States have an adverse effect on the condition of their competitiveness, leading to a decrease or increase in the size of the GDP *per capita* of these countries? Or does such aid not have any impact on the GDP *per capita*? Answers to these questions will be provided by the regression analysis.

The most important statistical test in the simple regression analysis is a test of whether the regression coefficient equals zero. If in a specific case it could be concluded that the directional coefficient of the real regression line in the population equals zero, it will mean that between expenditure on State aid and the size of GDP *per capita*, there is no linear relation, or expenditure on State aid and the size of GDP *per capita* are not linearly dependent. Therefore, there should be a test of the linear relation occurrence between expenditure on State aid for SMEs in the Member States and the size of their GDP *per capita*. Statistics on this test are shown in table 1.

On the basis of the calculations set out in table 1, it should be distinguished that the statistical basis for the recognition of the occurrence of a linear relation between expenditure on State aid and the size of GDP *per capita* exist in the case of 11 Member States, i.e. Bulgaria, Czech Republic, Denmark, Greece, Italy, Lithuania, Luxembourg, Netherlands, Slovenia, Spain and United Kingdom. This relation occurs also at the level of the European Union (EU-28).

For the five countries there is a negative relation between the variables analyzed. For Czech Republic, Italy, Netherlands, Slovenia and Spain regression coefficients are negative, which means that expenditure on State aid for SMEs have a negative impact on GDP *per capita* in these countries. The increase in expenditure on SME aid by €1 million comes together with a fall in GDP *per capita* - respectively – with an average of €41.68, €1.92, €63.91, €194.15 and €13.83. At the level of the EU-28 decrease in the value of GDP *per capita* is: - €1.88. Estimation errors are respectively €11.10, €0.48, €21.90, €76.79 and €3.55. For the EU-28 it is €0.71. Taking into account however the confidence interval for the regression coefficient it can be said with a probability of 95% that the increase of granted SMe aid with €1 million will cause fall in GDP *per capita* by the value of the interval (€18.03; €65.33) for Czech Republic, (€0.90; €2.93) for Italy, (€17.22, €110.60) for Netherlands, (€30.47; €357.83) for Slovenia, (€6.26; €21.39) for Spain and (€0.30; €3.31) for EU-28. It should also be noted that the probability of type I error (p-value), involving the rejection of a true null hypothesis that, in the case of these countries providing State aid for SMEs do not significantly affect the size of the GDP *per capita* of the countries, is below the accepted level of significance, i.e. 0.05. The consequence is that the result of the study in relation to these countries, may be considered important, and thus the null hypothesis can be rejected in favour of the alternative hypothesis.

Table 1. The size of SME aid and the GDP *per capita* – the analysis of variance: the line "variable X"

EU Member States	Regression coefficient b	Standard error Sb	t Stat tb	p-value	Lower 95%	Upper 95%
Austria	-1,6E-05	1,89E-05	-0,8436	0,412145	-5,6E-05	2,43E-05
Belgium	-2,4E-05	1,88E-05	-1,29861	0,21369	-6,5E-05	1,57E-05
Bulgaria	**0,000435**	**0,000168**	**2,597303**	**0,020207**	**7,81E-05**	**0,000792**
Croatia	-	-	-	-	-	-
Cyprus	-0,00018	0,000114	-1,55837	0,139991	-0,00042	6,55E-05
Czech Republic	**-4,2E-05**	**1,11E-05**	**-3,7566**	**0,001905**	**-6,5E-05**	**-1,8E-05**
Denmark	**0,000206**	**8,64E-05**	**2,386597**	**0,030616**	**2,2E-05**	**0,00039**
Estonia	-0,0007	0,000905	-0,77181	0,452217	-0,00263	0,00123
Finland	-9,6E-06	9,66E-05	-0,09982	0,921812	-0,00022	0,000196
France	-3,3E-06	2,28E-06	-1,455	0,166277	-8,2E-06	1,55E-06
Germany	-1,9E-06	3,49E-06	-0,55297	0,588428	-9,4E-06	5,51E-06
Greece	**3,91E-05**	**6,2E-06**	**6,295588**	**1,43E-05**	**2,58E-05**	**5,23E-05**
Hungary	8,11E-06	1,27E-05	0,639893	0,531895	-1,9E-05	3,51E-05
Ireland	3,88E-05	3,72E-05	1,043522	0,313234	-4E-05	0,000118
Italy	**-1,9E-06**	**4,78E-07**	**-4,00667**	**0,001144**	**-2,9E-06**	**-9E-07**
Latvia	8,02E-06	1,3E-05	0,615511	0,547443	-2E-05	3,58E-05
Lithuania	**0,00037**	**0,000159**	**2,323937**	**0,034584**	**3,06E-05**	**0,000709**
Luxembourg	**0,003839**	**0,000991**	**3,875757**	**0,001493**	**0,001728**	**0,00595**
Malta	-0,00124	0,000683	-1,80868	0,090587	-0,00269	0,000221
Netherlands	**-6,4E-05**	**2,19E-05**	**-2,91782**	**0,010604**	**-0,00011**	**-1,7E-05**
Poland	-8E-06	1,2E-05	-0,66554	0,515812	-3,4E-05	1,76E-05
Portugal	-7,3E-06	9,52E-06	-0,76643	0,455314	-2,8E-05	1,3E-05
Romania	-8,9E-05	6,73E-05	-1,32016	0,206574	-0,00023	5,46E-05
Slovakia	5,98E-05	0,00019	0,314641	0,757369	-0,00035	0,000465
Slovenia	**-0,00019**	**7,68E-05**	**-2,52829**	**0,023173**	**-0,00036**	**-3E-05**
Spain	**-1,4E-05**	**3,55E-06**	**-3,89416**	**0,001438**	**-2,1E-05**	**-6,3E-06**
Sweden	-0,0002	0,00014	-1,43453	0,17194	-0,0005	9,73E-05
United Kingdom	**5,01E-06**	**1,22E-06**	**4,108228**	**0,000931**	**2,41E-06**	**7,61E-06**
EU 28	**-1,8E-06**	**7,06E-07**	**-2,56263**	**0,021649**	**-3,3E-06**	**-3E-07**

Source: Own calculations.

In the case of Bulgaria, Denmark, Greece, Lithuania, Luxembourg and United Kingdom, the regression coefficient takes a positive value. Consequently, the increase in expenditure on State aid by €1 million is accompanied by an increase in GDP *per capita* by average: €435.28, €206.12, €39.06, €370.03, €3839.14 and €5.01. Margin of error is: €167.59, €86.37, €6.20, €159.23, €990.55 and €1.22. Bearing in mind however the confidence interval for the regression coefficient, it can be with a probability of 95% said that the increase of granted State aid for SMEs by €1 million will cause an increase of GDP *per capita* of: Bulgaria from €78.07 to €792.49, Denmark from €22.04 to €390.21, Greece from €25.84 to €52.29, Lithuania from €30.65 to €709.42,Luxembourg from €1727.83 to €5950.44 and United Kingdom from €2.41 to €7.61.

Occurrence of the linear relationship between expenditure SME aid in the above-mentioned Member States and the size of their GDP *per capita* is also confirmed by the F test parameters, i.e. the value of F-test and the probability of type I error when the hypothesis is verified on the lack of impact of expenditure on State aid to the size of GDP *per capita* (irrelevance of State aid expenditure in the regression model). For all the indicated countries (also at the level of the European Union) F-test values are higher than the applied critical value of 4.543, and the probability of type I error is less than 0.05. The calculations in this regard are presented in table 2.

In the case of Czech Republic, Italy, Netherlands, Slovenia and Spain, the values of the correlation coefficient are included in the interval (0.55; 0.72). These countries are characterized by weak and medium negative relationship occurring between the amount of provided State aid and the level of their PKB *per capita*. Moreover, there can be no satisfactory adjustment of the regression line to the empirical data. The determination coefficients for these countries equal: 0.48, 0.52, 0.36, 0.30 and 0.50. In the case of Spain, for which the determination coefficient has the highest value, the variability of the size of GDP *per capita* was explained only in 50.27% by variability of expenditure on State aid for SMEs. The remaining 49.73% is the effect of random and non-random factors (other non-aid variables, imprecise fit of a straight line to the empirical data etc.).

For the Greece the correlation indicator is very strong: 0.851732 and the determination coefficient is 0.725448. Therefore, variations in GDP *per capita* in this country were explained in 72.54% with variations in expenditure on SME aid, while the remaining 27.46% result from the impact of other factors. If the coefficient of determination takes the values less than 0.5, the regression explains only less than 50% of the variation in GDP *per capita* and predictions based on such a regression model may be unsuccessful because the regression model explains then very little. This means that the predictions can be created basing on the Greek model, because the regression model is

characterised by a satisfactory fit and is little burdened with the estimation error, which provides grounds for precise forecasting.

Table 2. The size of SME aid and the GDP *per capita* - regression statistics and F-test

EU Member States	Regression statistics			Test F	
	Correlation indicator	Determination coefficient	Standard error	F	Significance *F*
Austria	0,212826	0,045295	4630,64	0,711661	0,412145
Belgium	0,317904	0,101063	3845,99	1,686376	0,21369
Bulgaria	**0,556972**	**0,310218**	**1426,93**	**6,745985**	**0,020207**
Croatia	-	-	-	-	-
Cyprus	0,373285	0,139342	2499,798	2,428517	0,139991
Czech Republic	**0,696239**	**0,484749**	**2510,633**	**14,11201**	**0,001905**
Denmark	**0,524611**	**0,275217**	**4316,057**	**5,695847**	**0,030616**
Estonia	0,195437	0,038196	3879,318	0,595689	0,452217
Finland	0,025764	0,000664	4212,584	0,009963	0,921812
France	0,351681	0,123679	2809,082	2,11702	0,166277
Germany	0,141344	0,019978	4000,234	0,30578	0,588428
Greece	**0,851732**	**0,725448**	**1383,554**	**39,63442**	**1,43E-05**
Hungary	0,16301	0,026572	1906,079	0,409463	0,531895
Ireland	0,260158	0,067682	7627,187	1,088938	0,313234
Italy	**0,719**	**0,516961**	**1276,188**	**16,0534**	**0,001144**
Latvia	0,156954	0,024635	3242,904	0,378854	0,547443
Lithuania	**0,51452**	**0,26473**	**2935,239**	**5,400682**	**0,034584**
Luxembourg	**0,70736**	**0,500358**	**9772,759**	**15,0215**	**0,001493**
Malta	0,423133	0,179042	3231,081	3,271333	0,090587
Netherlands	**0,601725**	**0,362074**	**3394,747**	**8,513683**	**0,010604**
Poland	0,169358	0,028682	2344,14	0,442938	0,515812
Portugal	0,194127	0,037685	1619,64	0,587416	0,455314
Romania	0,322635	0,104094	2250,649	1,742821	0,206574
Slovakia	0,080973	0,006557	4021,841	0,098999	0,757369
Slovenia	**0,546637**	**0,298812**	**2359,983**	**6,39227**	**0,023173**
Spain	**0,709032**	**0,502726**	**1858,286**	**15,16445**	**0,001438**
Sweden	0,347335	0,120641	5542,261	2,057885	0,17194
United Kingdom	**0,727633**	**0,529449**	**2251,098**	**16,87754**	**0,000931**
EU 28	**0,551812**	**0,304496**	**2462,348**	**6,567093**	**0,021649**

Source: Own calculations.

In the case of Bulgaria, Denmark, Lithuania, the values of the correlation coefficient are: 0.56, 0.52 and 0.51. These countries are characterized by weak positive relationship occurring between the amount of provided State aid and the level of their GDP *per capita*. Moreover, there can be no satisfactory adjustment of the regression line to the empirical data. The determination coefficients equal: 0.310218, 0.275217 and 0.26473.

Luxembourg and United Kingdom are characterized by occurring between the amount of provided SME aid and the level of GDP *per capita*, strong positive correlation - respectively 0.71 and 0.73. But for these countries the determination coefficient assumes low values and amounts to 0.500358 and 0.529449. This means that there can be no satisfactory adjustment of the regression line to the empirical data.

For all countries of the European Union (EU-28) between the amount of State aid for small and medium-sized enterprises and real GDP *per capita* there is a negative correlation (r = -0.55). The determination coefficient is only 0.304496.

4. CONCLUSIONS

In the process of creation and distribution of GDP a significant function is performed by the State, which by taking in the form of taxes and other public levies some part of the revenue generated by households and enterprises, changes the structure of aggregate demand in the economy. The taxes imposed on enterprises limit their investment opportunities, but revenues from taxes and other levies are directed by the State to both households (social assistance, unemployment benefits, scholarships etc.) and to enterprises (public aid in the form of grants), forming the basis of demand for consumer goods and investment goods. State expenditure policy, which includes the policy of State aid to enterprises, can thus give an impulse to GDP growth and increase the indicator GDP *per capita* (growth of competitiveness of the national economy) even if the State spends more money than the accumulated revenue in the budget. This situation means the appearance of budget deficits, which accumulation in the coming years leads to the formation of public finance sector debt. The source of financing deficits, and as a result public

debt, are domestic monetary savings, relatively foreign. This process is accomplished by a loan taken out by the state in the form of debt securities, which buyers are banks, investment funds, insurance companies, etc., that is, institutions that accumulate monetary savings of the economic system entities, mainly households. Fiscal policy therefore plays an important role in economic growth, especially in a situation where enterprises, commercial banks, for various reasons, e.g. increased risk of capital loss, are not willing to support real economic processes (investment processes) and economic growth. The savings accumulated in commercial banks and other financial institutions are thus borrowed by the state, which creates the demand for consumer goods and investment goods, consequently stimulating the processes of economic growth.

The proposed research thesis in the paper, according to which, both in relation to the European Union and its individual Member States, the amount of expenditure on State aid for small and medium-sized enterprises is positively correlated with the rate of GDP *per capita*, determining the level of development and competitiveness of the European economy, should be rejected. It cannot be considered as a true the thesis that with increasing the amount of SME aid the competitiveness of the EU economy increases. It was incorrect to assume that this correlation occurs for all Member States, because of the amount spent on State aid for SMEs are very different at the level of individual Member States. Different is also the proportion of aid actually granted in the aid approved by the European Commission.

Each enterprise operates in a specific environment that provides the means necessary to conduct an economic activity and is a recipient of goods and services offered by enterprises. This environment is the source of the factors shaping the competitiveness of an enterprise for which it has no real impact. These are different types of standards, which on the one hand regulate technical and technological processes (technical and ecological standards), and on the other hand regulate market behavior, which is covered by international and national legal regulations (legal norms). This means that external factors of the enterprise competitiveness are determined by the rights resulting from the application of the standards regulating the economic system, according to which enterprises are obliged to conduct their economic activity. In turn, internal competitiveness factors are associated with activities that are the result of making specific decisions in the company.

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The Evolution Analysis on the Value of Mobile Internet Industry

Wenqian WANG[a]

[a] Beijing University of Posts and Telecommunications, Ph.D,School of Economics and Management ,Xitucheng Road,Beijing,China,wangwenqian_79@bupt.edu.cn

Abstract

The evolution and prospects of research on value creation in the mobile Internet industry have been studied. The co-occurrence of keywords is used to build a keyword co-occurrence matrix and a keyword co-occurrence network map is formed. Then use the social network analysis method tool UCINET software to form a co-occurrence network map. Using the co-occurrence relationship of high-frequency keywords and social network analysis methods to explore the research evolution and prospects of the mobile Internet industry value and to implement prototypes of modeling and model analysis tools, with the main functional modules of the tools introduced. This tool is used to verify the service model, value model and model analysis of marine transportation service.

Keywords: Mobile Internet industry, value creation, Evolution

INTRODUCTION

Since the Internet officially entered China in 1994, it has gone through nearly 20 years. Internet technology has fully penetrated into all areas of social economy and has become a new platform and driving force for public entertainment, production and construction, technological innovation, cultural communication, new platform and driving force for economic transactions (Y. Takagi et al. 2017) [1]. With the rapid pace of people's life, the use of computer-based Internet applications is increasingly unable to meet people's convenience needs. According to the 37th China Internet Development Statistics Report, as of December 2015, the total number of Internet users in China reached 688 million, while the size of mobile Internet users reached 620 million (Anonymous 2018) [2]. With the widespread popularity of smartphones, the soundness of 3G technologies, and the adoption and large-scale deployment of 4G technology standards, the advancement of these technologies has promoted the integration of mobile communication networks and fixed Internet networks, and has enabled the rapid development and popularization of mobile Internet (Cutler, Thomas R 2018) [3]. Various mobile applications have been developed and put into the market. The mobile Internet has occupied an increasingly important position in the socio-economic development, showing an explosive growth trend, it also has triggered a great deal of attention from all walks of life in the world in the field of mobile Internet and actively promoted the research and development of mobile Internet technology (Gorbach et al. 2018) [4]. Since 2011, it has held five sessions of the Global Mobile Internet Conference. From the 16th to 18th of December, 2015, the presidents of Softbank, Facebook, vice president, Ma Yun and other Internet cafes participated in the Mobile Internet Sub-forum to discuss the development trend of the mobile Internet in the future, which is enough to witness that the mobile Internet has received attention from all walks of life in the world (Maura Conway 2016) [5].

2. STATE OF THE ART

The germination of the mobile Internet started at the end of the last century. It developed relatively slowly in the first few years and did not develop until the 21st century. It moved toward and penetrated into human life in 2010. The enthusiasm of the academic community, industry, and government agencies for the mobile Internet has also continued to rise in recent years (Steven A. Taylor et al. 2018) [6]. Some scholars have pointed out that the

development of mobile Internet is mainly focused on mobile smart terminals, games based on mobile network devices, media applications, mobile marketing based on positioning, mobile payment and e-commerce, basic software development, mobile Internet communities and other fields. Some scholars have pointed out that the mobile internet is mainly in the four areas of companies that integrate hardware and software, mobile medical care, mobile e-commerce, photo and video sharing. Some scholars have studied the new challenges that China Mobile faces in the development of mobile Internet, and proposed the challenges China Mobile needs to face in the new era, and gave corresponding solutions to the current problems of China Mobile itself (Alexander Gordon et al. 2017) [7]. Some scholars discuss and analyze the future development of the mobile Internet from five perspectives that are closely related to the mobile Internet, and predict its future development. Some scholars have conducted a research report on the development of the current mobile Internet technology (M.José Garrido Samaniego et al. 2018) [8]. In addition, the Nielsen Online Research Institute conducts independent research on certain special causes that affect the mobile Internet, such as the impact of time fragmentation and user demand on the further development of its development, and analyzes and discusses such phenomena. Next, based on the literature summary at home and abroad, the author sorted out the three stages of the evolution of the value of mobile Internet industry in China. To begin with，during the period of 2000 to 2007,The mobile Internet industry chain in the pre-3G era is an industry chain led by telecom operators(Fu & Fu 2012) [9], which is jointly participated by network infrastructure equipment manufacturers, CP/SP providers and terminal manufacturers. According to their own development needs, network operators re-integrate all parts of each link of the industry chain to concentrate content, networks and terminals (Man et al. 2013) [10]. Serve consumers by applying collaboration between content providers, network operators and terminal providers (Han et al. 2015) [11]. The second evolution stage is begin the Apple's "App Store", which is a disruptive technology innovation operating system. On the basis of iOS open platform, users can download a large number of third-party applications, and consumers' personalized needs are deeply released, which directly promotes the popularity of the application market (Peng et al. 2016) [12]. At the same time, the upstream and downstream of the industry chain have been opened up, and the user value has been successfully acquired with perfect hardware and creative software service platform, breaking the situation that traditional terminal manufacturing enterprises can only obtain profits by manufacturing and selling terminal equipment (Pon et al. 2014) [13]. Finally, the third stage started from 2014 to present, The open information platform provider in the mobile Internet industry leads the enterprise to propose value proposition based on its core resources and capabilities (Sun et al. 2014) [14]. The information open platform maximizes the user's personalized business needs and open requirements. Vendor and customer interaction innovation model, service and customer experience dominate innovation and value creation, customer participation value co-creation has been considered as the most important way of value creation in today's mobile Internet era (Jassen et al. 2014) [15].

3. METHODOLOGY

3.1 Keyword Density Analysis Algorithm

After completing the keyword co-occurrence network map analysis, the density analysis is performed next. Density analysis is an analysis of the overall attributes of hotspot networks. It is an important analysis indicator in social network analysis. The density of the so-called co-occurrence network graph refers to the degree of closeness of the connection between each node and the nodes in the network diagram. For a network graph with the same number of nodes, if there are more connections between the nodes, the more dense the nodes in the network graph are, the greater the density is, and vice versa. In graph theory, the density of a graph is the ratio of the actual edges to the possible edges in the graph, expressed as a formula:

$$\Delta = \frac{L}{g(g-1)/2} \qquad (1)$$

Among them, g is the number of key nodes, L is the number of edges in the graph, Δ represents the density of

the graph, and the density ranges from 0 to 1. If the density value is 0, it means that there are only nodes in the network map, and there is no connection between nodes and nodes, that is, there is no connection; if the density value is 1, it means that all the nodes in the network map are connected to each other. Each node has a certain mutual relationship with each node in the network diagram. At this time, the network diagram at this time can be called a complete diagram. Density analysis in UCINET also uses the principle of graph theory to derive the density analysis results of the keyword co-occurrence network graph. Using UCINET to analyze the density of the overall 0-

1 co-occurrence matrix, the result is 0.0341. The analysis results are shown in the figure. In order to understand the development trend of the mobile internet, the density analysis of the keyword co-occurrence relationships at several time periods is conducted separately. The results are as follows: A density analysis of the co-occurrence relationships for the entire year yields a result of Density of 0.0341. A density analysis of 2014-2015 relationship yielded a result of Density of 0.0578. A density analysis of 2012-2013 relationship yielded a result of Density of 0.0321. A density analysis of the 2010-2011 relationship yielded a result of Density of 0.0267.

A density analysis was conducted on of the relationship between 2008 and 2009 and the result was: Density was 0.0133. A density analysis was conducted on between 2006 and 2007 and the result was: Density was 0.0137. A density analysis was conducted on the relationship between 2000 and 2005 and the result was: Density was 0.0275. From the above results, it can be seen that as time goes on, the density of research on mobile Internet is increasing. Since the time gap between segments is relatively large and the density value is relatively large from 2000 to 2005, this does not affect the analysis. The density value rose from the initial 0.0275 or 0.0137 to 0.0578, indicating that the degree of correlation between the nodes in the keyword co-occurrence relationship network is getting closer and closer, and the cross-domain area is increasing. Compared with the general network, the value obtained is 0.0341, which is obviously low. This shows that the connection between keywords is loose, and it also shows that the research field of mobile Internet is fragmented and involves various fields. The keywords of the mobile internet relate to production, life, entertainment, learning, security, etc. These aspects all form a relationship circle with keywords related to them, and the relationship circles have less connection. This may be due to the fact that the depth of research has not led to systematic integration of the mobile Internet related areas. Therefore, the development of the mobile Internet requires the integration of different branches of research and needs to be continuously extended and extended in depth and breadth.

3.2 Service Value Model Algorithm

In the participant-oriented value model, there has been a large amount of service value, and now it is necessary to analyze the relationship between different service values. The way of describing value changed from the edge in the value-oriented network of participants to the node in the value-dependent model. This is the connection between the value model and the value-dependent model for the participants. The value-dependency model describes the dependencies between different types of values, and the specific value-dependence relationships are listed. The diagram shows some of the VDM views for mobile Internet access services. In this view, the content value provided by the content provider requires the access service value provided by the mobile operator to the customer V7, the hardware support value provided by server hosting provider to the content provider V8, and the advertising company paid advertising fee V13 to the content provider. The value negotiation between the mobile user and the mobile operator also results in a support dependency relationship between the value access fee V1 exchanged between them and the user word of mouth value V6 and the access service value V7. There is a time-dependent relationship between the agency fee paid by the advertiser company V11 to the advertising company and the advertising fee V13 paid by the advertising company to the content provider. In addition, in order to avoid the view is too complicated, different types of dependencies are separated, and the dependencies belonging to the same kind of dependencies constitute a view independently. Thus the VDM has multiple child views as shown.
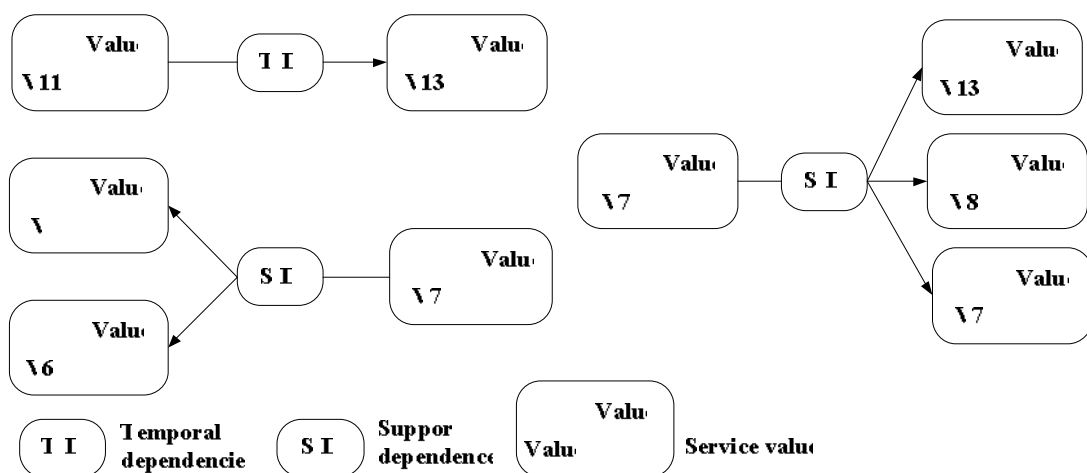
Figure.1 VDM view of wireless network access service

Following the formal description above, a formal description of VDM is also given: Definition: Value Dependency Model (VDM), all value relation sets all its value sets SVDM, the entire character set $R_{VDM} = \otimes$, all value set $RS_{VDM} = \{S-D, C-D, A-D, T-D, P-D\}$, value $v \in S_{POVN}$, V's attribute set S_{attr-v}. A certain value Vq of $v = (ID, VN, T, I_v, P_v, R_v, DM_v, C, IS_v, TS_v)$ and a set of at least two values {V1,..., Vk} constitute a binary relationship <Vq, {v1,... Vk}>=rs.
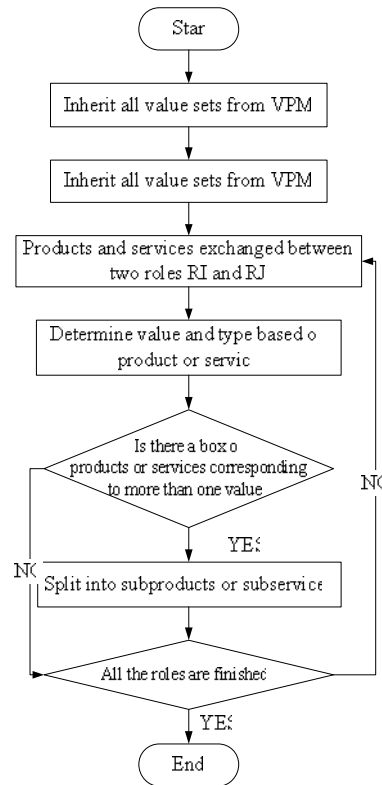
Figure.2 the modeling process of the POVN view

Table.1 Centrality classification

Centrality classification	Centrality		Central potential
Centrality of point degree Centrality	Centrality of point degree Center center degree	Absolute centrality	Point center potential of a graph Center potential of a graph
		Standardization centrality	
Close to centrality Centrality classification	Close to centrality Centrality of point degree	Absolute centrality	Close center potential of a graph Point center potential of a graph
		Standardization centrality	
Centrality of point degree	Center center degree	Absolute centrality	Center potential of a graph
		Standardization centrality	

4. RESULT ANALYSIS AND DISCUSSION

Using China Knowledge Network CNKI as a data source, China HowNet is an exhibition website dedicated to providing knowledge and intelligence services to all walks of life at home and abroad. With more than 40 million readers of China Knowledge Network, the annual download volume of the Center's website and mirror site has exceeded 3 billion times. It is a highly respected knowledge service brand in the world. For this search, first select Advanced Search on the homepage of China Knowledge.com. The deadline for searching data is as of December 31, 2015. The search conditions are: Topic = "Mobile" and "Internet". A total of 30,412 results are retrieved. The number of search results is relatively large. In order to better research the articles closest to the mobile Internet, the search conditions are: Title = "Mobile" AND "Internet", which retrieves 4814 results, removes 2 unrelated records, and finally gets 4812 records. The year distribution of these documents is shown in the table, which shows:

Table.2 The distribution graph of the literature particular year

Particular year	2015	2014	2013	2012	2011	2010	2009
Number of documents	1127	965	787	543	473	264	265
Particular year	2008	2007	2006	2005	2004	2003	2002
Number of documents	131	38	1999	1998	22	25	40
Particular year	2001	2000	3	2012			
Number of documents	46	37	2013	1			

From the above table, it is not clear that the literature changes definitively with the year. Therefore, the year distribution of these documents is plotted as a line graph, as shown in the following figure:
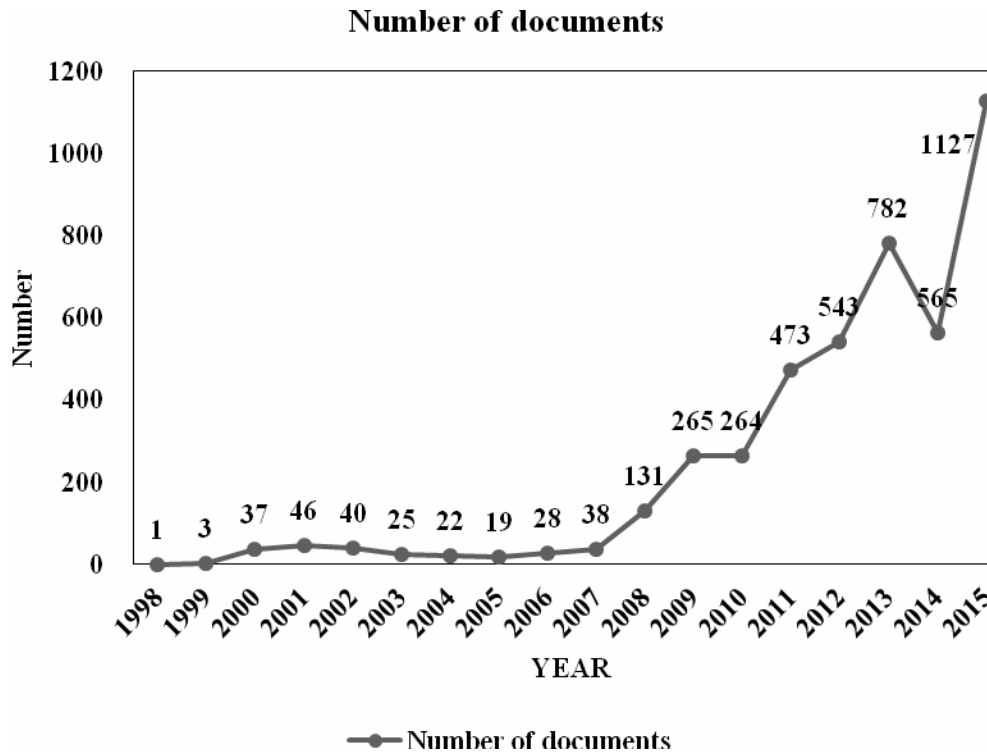
Figure.3 The distributed polyline graph of literature particular year

As can be seen from the figure, the growth trend of the number of documents from 2000 to 2007 is not obvious and relatively flat. From 2007 to 2009, the number of documents began to show a significant growth trend. After 2010, there was an explosive growth trend. They were 264 in 2010, 473 in 2011, and 542 in 2012 were nearly doubled from 2010, especially from 2012 to 2013, there were 543 explosive growth rates from 543 to 787, a growth rate of 44.9%, a growth rate of 22.6% from 13 to 14 years, and a year-on-year growth rate of 1127 in 2015 was 16.7%. Compared to the five years in 2010, it has quadrupled. In order to construct a research hotspot network, after grabbing the data, the nodes of the network need to be determined, and keywords of the articles in the database are used as the key elements for determining the network nodes. Use the co-occurrence relationship between keywords to build a research hotspot network. Key words are the parts that can best reflect the theme of academic papers. Several key words of academic papers cover almost all the main contents, research methods, and themes of the entire paper. The scientific researcher obtains the relevant related papers by searching for keywords, and can also understand the related fields covered by the paper through the key words of the paper. The high degree of co-occurrence of keywords can reflect the current hot research areas.

Therefore, by collating and analyzing the keywords of the captured data, a hotspot network map can be obtained, which can also be referred to as a keyword co-occurrence network map. The word frequency appears as more than 5 times as a high frequency word, a total of 965 keywords, in view of the limited number of analysis software, and the significance of the actual research, only take the top 200 keywords as the analysis node of the research network map. It can be seen from the statistical results that the top 50 keyword frequency words are very high. From the statistics of these keyword word frequencies, It can be seen the key areas reflected in the keywords related to the mobile Internet field. These high-frequency words reflect the current state of the mobile Internet industry research and the related research hotspots to some extent. Since China Mobile, China Unicom, and China Telecom are the names of the three major operators, these keywords mainly appear in some forums and articles. From the word frequency statistics of articles related to the mobile internet, it can be seen that the three major operators have a very important role in the development of mobile internet in China. However, the three major operators do not have much significance for the research of hotspots. Therefore, when the keyword frequency of keywords is statistically studied, the three major operators' keywords are removed. Extract the first 50 words of keyword frequency. Shown from the bar chart, mobile Internet, Internet industry, Internet market, Tencent, mobile Internet services, mobile communications, mobile terminals, mobile payment, user experience, Google, mobile

applications, smart terminals, IoT, Internet, developers, Internet domain, Internet security, mobile search, Android, social networks, and other keywords are the keywords with a frequency of more than 100. The distribution of these keywords shows the research hotspots in the mobile internet field from scratch, and also maps out research hotspots in the future. First, the mobile Internet, mobile terminals, mobile payment, mobile applications, mid-power terminals, the IoT, and Android have become hot spots of the times. The emergence of mobile phones has brought a preliminary development era for the transmission of mobile digital information, and the emergence of smart terminals such as tablet computers, ipads, and iphones has brought the transfer of mobile digital information into a period of rapid development. Secondly, cloud computing and word frequency of data traffic are also quite high. They are active technologies in the current technology market. This is due to the increasing demand for IT resources by humans, such as Baidu's search volume of 10 billion yuan per day in 2014. The demand for IT is increasing, and the old distributed IT resources can no longer meet the demand. Therefore, cloud computing is an inevitable requirement for social development.

The future will also enter the era of mobile communication. All possible objects in space will become mobile terminals. For example, mirrors, desktops, and ceilings will all become mobile terminals. Finally, from the chart information, we can see that the word frequency of Internet security is 104, and the word frequency of information security is 66, which is respectively ranked 22nd and 33rd, indicating that the network security problem is an important issue at the moment. The number of occurrences of keywords is grouped. The group sample is a keyword with a word frequency greater than 5, a total of 965 keywords, divided into four groups of more than 50, 30 to 49, 10 to 29, and less than 10. And draw a corresponding pie chart, as shown.
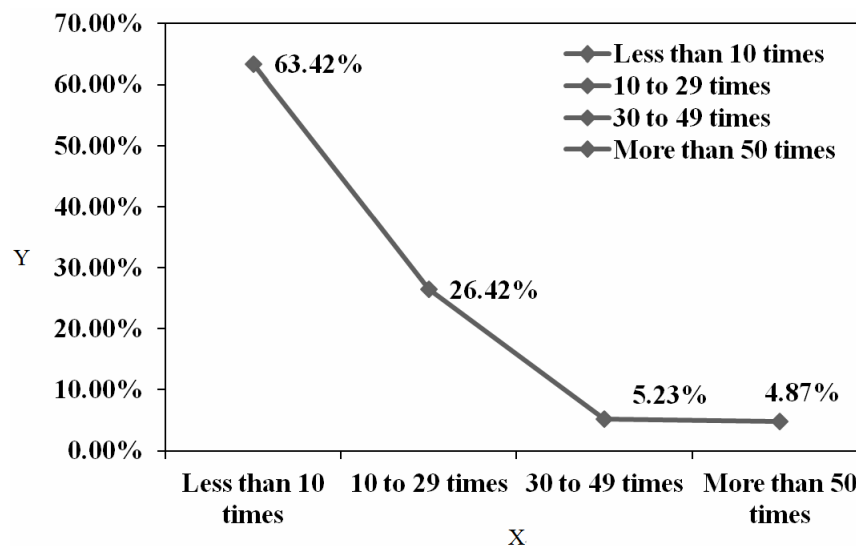
Figure.4 Words frequency distribution statistic

The figure shows intuitively that the grouping module with the frequency of keyword occurrence greater than 50 accounts for the smallest proportion, only 4.87%; and the keyword group with the frequency less than 10 accounts for the largest proportion, as much as 63.42%, and has accounted for more than half of the share. The proportion of keyword groups with frequency between 10 and 29 is the second, which is about 26.42%. Finally, the proportion of the group with frequency 30 to 49 is close to the group with frequency greater than 50, which is about 5.28%. The statistical data of these word frequency distributions indicates that the research hotspots of the mobile Internet may be widely used in certain fields, and the development scope is relatively extensive and involves many fields and is radial. However, from the high proportion of keywords with a frequency of less than 10, it can be seen that there are still many branches of mobile Internet research. Many small areas may have just begun research, but they are only in the conceptual stage and have not yet reached the actual level of actual research. In the future, the mobile internet will appear more and more in all aspects of our lives and work. Closely linked to our lives, it brings great convenience to our lives. By taking the timeline as the baseline, the mobile Internet is analyzed in a time-phased dynamic evolution process, and the evolution of each time period is discussed and studied. In this section, the overall development trend of the mobile Internet industry is studied and analyzed. Over time, from the very beginning, paying too much attention to the hardware infrastructure and various communication equipment companies, the content of mobile Internet content is very small, gradually increasing the content of mobile Internet

content, For example, Internet finance, Internet+, O2O, mobile advertising, mobile payment, and the IoT, the research scope of the mobile Internet has become wider and wider, and the content of previous research has become more in-depth.

5. CONCLUSION

Through social network analysis methods, the research and discussion on the hot issues of the mobile Internet industry and dynamic development trends have reached the following conclusions: First, from the overall qualitative analysis of the keyword co-occurrence network map, the hot areas closely related to the mobile Internet industry are analyzed, such as China Mobile, mobile payment, IoT, social networking, smart terminals, information security, and cloud computing. Then, using the social network analysis and quantitative analysis tool, the key words 0-1 co-occurrence matrix model is quantitatively analyzed, namely density analysis, centrality analysis (point-degree centrality analysis, middle-centrality analysis, near-centrality analysis), etc. They verify the results of the macro analysis of the network map from a quantitative perspective. After conducting an overall static analysis, the analysis is divided into segments according to time, and network graphs are analyzed to dynamically analyze the evolution of the mobile Internet industry development, and the development trend of the mobile Internet industry is obtained. The mobile Internet industry has less content from the initial hardware facilities, evolved to more complete infrastructure hardware, and has more and more mobile Internet content, such as mobile payment, IoT, social networking, smart terminals, mobile applications, and mobile search.

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Revitalisation Of Cultural Heritage Monuments: European Project RESTAURA

Neva MAKUC [1]

[1] PhD, ZRC SAZU – Scientific Research Centre of the Slovenian Academy of Sciences and Arts
neva.makuc@zrc-sazu.si

Abstract

The lecture covers the topic of the revitalisation of cultural heritage monuments, an undertaking for which sufficient public funds are usually not available, with the inclusion of the private sector. In Slovenia, the energy-saving renovation of inefficient publicly owned buildings – prompted by the long-term environmental, energy and economic goals of the European Union – has promoted the implementation of more complex forms of cooperation between public and private sectors for the revitalisation of cultural heritage monuments. The lecture presents an example of good practice in the area of public-private partnership in the Municipality of Črnomelj (south Slovenia). The public-private partnership led to the energy-saving renovation of seven buildings owned by the municipality, among them two historic buildings, namely the Črnomelj Castle and the so-called former student dormitory of Črnomelj.

Keywords: revitalisation, cultural heritage, public-private partnership, Slovenia

The evolutionary game of knowledge transfer between China and other enterprises of countries in "One Belt And One Road" Region -- from the perspective of knowledge brokers

YUNHUI Zhao [a], SHUDAN Zhang [b1], CHUANLI Zhao [c]

(aInner Mongolia University of Finance and Economics，Hohhot, China,zhaoyunhui602@126.com)

(bInner Mongolia University of Finance and Economics，Hohhot, China,zsd0710@163.com)

(cInner Mongolia University of Finance and Economics，Hohhot, China,417242783@qq.com)

Abstract

Under the "One Belt And One Road" initiative, enterprises in China and other countries along the "Belt and Road" route can find the process of knowledge transfer difficult due to political, cultural and legal differences. Therefore, knowledge brokers play a significant role in adapting and transferring knowledge between the parties. Through the construction of an evolutionary game model of Chinese enterprises, knowledge broker, and other "Belt and Road" enterprises, this study explores evolutionary game process of knowledge transfer behavior and the corresponding opportunistic behavior. Research results show that the evolution of the system's steady state is affected by a direct effect on knowledge transfer, knowledge transfer cost, the "Belt and Road" incentive and punishment mechanisms, and the risk of leaking core technology to competitors.

Keywords: "One Belt and One Road"; Knowledge Broker; Knowledge Transfer; Game

1. INTRODUCTION

The "Belt and Road" initiative, as a significant part of the national development strategy, has been enriched by its emphasis on mutual trust, integration and inclusiveness since it was proposed in 2013. Cooperation network of the "Belt and Road" provides a platform for many Chinese enterprises to cooperate with enterprises from countries in the "Belt and Road" region. Under the guidance of the "Belt and Road" principles of reciprocity, cooperation, and mutual benefit, enterprises have increased communication and trust, which has promoted the transfer of knowledge. However, the construction of "Belt and Road" initiative faces many political, cultural and legal challenges, due to the differences between China and the other countries along the routes. Construction of the "Belt and Road" initiative requires multitudinous elements, including governments, enterprises, social organizations, and the public, all working to effectively promote knowledge transferring and sharing between "Belt and Road" enterprises. Knowledge transfer, as a crucial channel to obtain external knowledge resources, has received extensive attention from enterprises. An increasing number of enterprises have realized profits and knowledge accumulation by establishing cooperative relationships with other enterprises, but they also face the risk of divulging their confidential information and technological to their partners. Within the broader "Belt and Road" strategy, one of Chinese enterprises' key concerns lies in maximizing their knowledge advantage and market competitiveness among the "Belt and Road" countries, through the formulation and implementation of core knowledge protection

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[1] Corresponding Author: Inner Mongolia University of Finance and Economics, Hohhot, China, E-mail:zsd0710@163.com, Phone: +86 13704758659

strategies.

Due to economic, political and cultural differences between "Belt and Road" countries and the lack of adequate communication, brokers with rich experience and strong activity capabilities can positively influence, coordinate, and promote various types of "Belt and Road" policies. In the context of the "Belt and Road" initiative, Chinese enterprises and companies along the route need to understand the business processes, cultures, and norms of the other countries involved in the process of knowledge transfer. Therefore, knowledge brokers are particularly significant as they can understand the value of the mutual knowledge shared by both parties. Organizations lacking knowledge brokers may misunderstand or have an incomplete understanding of the knowledge shared by other enterprises. Therefore, knowledge brokers' role is to coordinate the transfer of knowledge between knowledge senders and receivers.

Knowledge brokers are generally independent third parties. However, the process of knowledge transfer is not always meaning the same thing, in some scenarios they may take on the slightly different role of knowledge mediators. With the enhancement of research literature on knowledge brokers, these brokers are knowledge intermediaries (Shin S K and Kook W, 2014) when they are used as an independent third-party who acts as a transmission medium between the sender and receiver of the information. For example, non-government organizations outside China play a bridging role in the development of the "Belt and Road" initiative by holding seminars, training sessions, and providing manpower and technology (Chen XC and Peng YH, 2018). In addition, knowledge brokers are positioned in the middle of intellectual potential, such as within industrial chain leading enterprises and scientific research institutions (Mi J and Lin RH, 2016). Therefore, from the perspective of knowledge broker, this study explores knowledge brokers' the mediation effect of knowledge transfer between enterprises in the process of "Belt and Road", and analyses the factors affecting their transfer behavior, furthermore, this study bounds multi-agent knowledge transfer game model of finite rationality under the "Belt and Road" initiative.

2. Literature Review

2.1 Knowledge Broker

After the Canadian Health Service Research Institute published the "gray book" of knowledge broker theory and practice in 2003, the concept of knowledge broker was widely adopted. The book analyzes the ability of knowledge brokers to promote communication, discover knowledge, and adapt knowledge to suit the needs of different groups in different situations. The broker's intermediary role is not a new concept in the societal structure (Hargadon, 2002; Lomas, 2007). The role of a intermediary emerged in Germany in the late 1800s, when knowledge brokers created information networks between universities and industry. Later, broker roles gradually became more diversified as they adapted to different scenarios. For example , link or connection officers, (Jones, 2006), agents of change, (Jones, 2006; Pratim, 2007); third community (CHSRF, 2004); intermediary (Cillo, 2005); knowledge brokers (Hargadon and Sutton, 1997); boundary-spanners (Huberman, 1994，Pawlowski and Robey,2004); gatekeepers (Cohen and Levinthal,1990；Jones, 2006); bridgers (Howells, 2006); innovative mediators (Cillo, 2005); information intermediaries (Cillo，2005) and so on. These titles emphasize how the actor's multiple networks allow them to act as an intermediary for information exchange. In recent years, the role of the broker has evolved beyond the scope of the intermediary to identify, absorb, and integrate useful knowledge for organizations or projects. Knowledge brokers can be called "boundary spanner" or "bridge builders". Knowledge brokers have a range of roles, such as "gatekeepers" and "boundary spanner", and participate in the management functions such as decision making. Additionally, the roles of knowledge brokers have been continuously expanding.

1.2 Knowledge brokerage and knowledge transfer

Scholars engaged in structural network and knowledge transfer research often use the term of knowledge broker（Burt, R., Hogarth, R. M.& Michaud, C. 2000）. Knowledge brokers are actors working within overlapping organizations or industries. Therefore knowledge brokers can be either individuals or organizations. Their role is to transfer knowledge and create connections between researchers and readers (audience groups) or promote knowledge flow between different areas of knowledge producers and users (Meyer M, 2010). In different contexts, knowledge brokers have different roles. For another, knowledge brokers are at the center of the tacit knowledge exchange system and provide a large amount of knowledge to the network, which can enhance companies contact with suppliers, customers, and strategic partners, giving it an important competitive advantage (Zook M A, 2010). Base on existing analysis and organizational literature, research of knowledge brokerage business can be divided into two branches: knowledge management and knowledge innovation. Knowledge brokers play two disparate roles in these two research branches.

In knowledge management literature, especially in the field of health care, knowledge brokers are valuable at both the individual and organizational level（Conklin & al, 2013, Russell & al, 2010）. Many scholars analyze the role of knowledge brokers with in the medical field to gain a better understanding of their role in knowledge transfer. Justin Waring (2013) studied knowledge brokers who promoted knowledge sharing and learning in the context of healthcare organization, and put forward four structural positions roles of knowledge brokers adopt around patient safety issues. James Conklin (2013) conducted a case study of knowledge brokers in the field of geriatric health and found that in the knowledge network, knowledge brokers' role developed over time and gradually adapted to society and technological barriers(burden) in various environments to create a relationship between learning and communication. In the study of health policies and practices, several types of actors are considered knowledge brokers, including science journalists, knowledge exchange platforms (Kasonde J M and Campbell S, 2012) and advocacy alliances (Weible C M, 2005). Most of these knowledge brokers are scholars who have the dual role of knowledge generation and integration. These scholars are called "hybrid" professionals (Celia Whitchurch, 2010). They are connected to both the "world" of knowledge generators and knowledge users and therefore occupy a "Double border"(Meyer M, 2010). Nasreen Jessani (2016) , who studied with the School of Public Health in Nepal (SPHS), identified existing knowledge brokers, supported the emergence of potential knowledge brokers, and recruited staff with knowledge brokers characteristics to enhance the collective human capital and impact public health practices. The above mainly studied knowledge brokers in the field of health care.

The five determinants of a successful knowledge brokerage business are (1) an understanding of the political, economic and social background of partners, (2) trust among partners, (3) the ability to mobilize, translate, transfer, manage and mediate knowledge, (4) co-build knowledge, (5) an established-knowledge process culture among knowledge partners(Phipps D J, Brien D, Echt L, et al, 2017). Therefore, knowledge brokers, as promoters of knowledge transfer, must not only engage in the exploration, transformation, and dissemination of knowledge, but also have the ability to establish connections between unrelated external groups, while also sharing knowledge within the organization. Determining an brokerage's performance requires assessment of how effectively they identify knowledge user needs, obtain credible knowledge, provide information to users, establish relationships between producers and users, accumulate knowledge, and promote an evidence-based culture (Karol, Estelle Etc., 2016).

However, knowledge innovation literature (Hargadon, 2002) and knowledge management literature have different views on knowledge brokers. Knowledge innovation literature considers knowledge brokers to be innovators. In knowledge innovation, knowledge broker is an actor of the organization. These actors gain knowledge through their networks and generate new solutions through reintegration of knowledge. In the social dimension of knowledge broker, this branch focuses on the cognitive process of the knowledge brokerage business.

These actors play an important role in innovation and are responsible for making decisions and transferring valuable knowledge. Knowledge brokers can promote innovation in two ways (Howells, 2006). First, knowledge brokers make it easier and faster for individuals, organizations, and industries to transfer knowledge. Second, knowledge brokers combine old and new ideas to propose new methods for innovation. Knowledge brokers' contribution to innovation has already been demonstrated across many fields. For example, in the field of industrial technology, the brokers are seen as a conversion agent, who promotes decision-making and the adoption of new technologies. They are described as an adviser, a real coordinator and a leader with excellent communication skills. In the service industry, brokerage business organizations are called "KIBS" (knowledge-intensive business services), which promotes innovation by acting as an agent between researchers and enterprises. Ma T et al. (2015) combined the characteristics of project organization knowledge transfer, and used a multi-group evolutionary game analysis method to construct a three-group evolutionary game model based on knowledge broker. The main factors influencing knowledge transfer stability strategy are: institutional factors, knowledge transfer capabilities, knowledge spillover effects, knowledge synergy effects, knowledge transfer costs, and knowledge transfer incentives and penalties. Among these six factors knowledge synergy effects, knowledge transfer costs, and knowledge transfer rewards and penalties determine the evolutionary trend of project-based organizations' knowledge transfer behavior. Boari C (2014) established a conceptual framework for the role and key functions of knowledge brokers, combining broker roles and functions, and conducted an exploratory study the Italian Small Manga Publishing House as an example. The discovery of knowledge brokers is a cyclical process. It is the use of external knowledge resources that create value through the mediation of business models obtained from internal and external environments. The concept and role of broker and knowledge broker are shown in Table 1.

Table 1. Concepts and roles of broker and knowledge brokers.

Type	Origin of concept	Definition	Role
Broker	The identification of intermediary behavior originated in the early 19th century, when the intermediary business appeared in the books of Simmel（1920s）and Merton (1960s)（brokerage）; Gould R V, Fernandez (1989) divided mediations into five types	• An intermediary between two unrelated actors or organizations • An actor who obtains information and resources from one actor and delivers information and resources to another	To facilitate businesses, resolve conflicts, and enhance personal rights or social capital
Knowledge Broker	The concept of a "knowledge broker" first emerged in the 1990s as a professional role in healthcare and education	• The definition of knowledge broker varies depending on the situation. • Maintain the coordination of two independent groups in a network with the aim to increase the flow of information within the network and prevent the division • Participate in multiple groups or organizations to promote knowledge transfer. • More refined classifications in education and health care.	Within the innovative literature: • Channel effect • Bridge interaction Within the knowledge management literature： •Knowledge acquisition •Knowledge integration •Knowledge adjustment •Knowledge diffusion •Create contact

3. Construction of the Evolutionary Game Model of Knowledge Transfer Based on Knowledge Brokers

(1) This study examines Chinese enterprises and enterprises from other countries in the "Belt and Road" region as they carry out knowledge transfer among three organizations: Chinese company C, "Belt and Road" route enterprise F, and knowledge broker B who are all bounded rational players.

Participants C, F, and B are from Chinese companies, Chinese or national knowledge intermediary organizations along the route, and national companies along the route respectively. As China and the countries along the route have different cultural and organizational characteristics, their knowledge stock and depth will vary. The knowledge transfer of enterprises along the route is an asymmetric evolutionary game.

(2) K_c, K_b and K_f indicate the existing knowledge stock of Chinese company C, knowledge broker B, and the "Belt and Road" route company F respectively.

(3) The TK_c, TK_b and TK_f represent the amount of knowledge transferred by the Chinese company C, the knowledge broker B, and the "Belt and Road" route F respectively.

(4) Knowledge transfer direct benefits are represented as $\rho_{CB}TK_B$. By collaborating with other "Belt and Road" countries, knowledge transfer members not only gain direct benefits from knowledge transfer, but also gain synergies. Direct income refers to the gains both parties make by absorbing the knowledge provided by the other and integrating it into their own capabilities. $\rho_{CB}TK_B$ is direct income and represents the amount of knowledge Chinese company C obtains from knowledge broker B ρ_{CB} is the knowledge transfer coefficient, which is related to the knowledge screening agent's ability to screen, compile, and integrate β_B, and Chinese company C's knowledge absorptivity α_C, so that $\rho_{CB} = \beta_B\alpha_C$.

(5) Synergies are represented as $\theta_{CB}TK_CTK_B$. Through knowledge transfer Chinese company C and knowledge broker B exchange information and provide feedback, allowing them to learn and carry out collaborative innovation of their own knowledge system. It is the driving force for the continuous development of corporate cooperation with countries along the "Belt and Road" route. θ_{CB} which reflects the cooperation and collaborative innovation capabilities of enterprises along the to the synergy coefficient "Belt and Road" route. Conversely, when the parties choose a protection strategy, there is no synergetic innovation effect on knowledge.

(6) The cost of knowledge transfer is represented by C_{CB}. Knowledge transfer can bring direct or synergistic benefits to both parties, as the political, economic, cultural and other differences of countries in "Belt and Road" region can lead to a greater diversity of knowledge, as well as diversification of knowledge subject (Chinese enterprise, "Belt and Road" route enterprise, knowledge broker). Chinese company and "Belt and Road" enterprises possess proprietary knowledge and special technology module, and differ greatly in their ability to create, understand, disseminate and absorb special knowledge. Due to the large distance of knowledge (cognitive distance, cultural distance, geographical distance, etc.) between Chinese enterprises and "Belt and Road" route enterprises, their ability to understand, transfer and absorb knowledge is also different. Therefore, it is necessary for parties on both sides to take the time to carefully implement an effective knowledge transfer process. For knowledge providers, the cost of knowledge transfer mainly includes delivery costs, communication costs, and opportunity costs (Shang SX and Zhang ZS, 2015).

(7) The core knowledge loss is represented by $\gamma_{CB}K_C$. This is the loss of core knowledge as a result of Chinese company C transferring knowledge to knowledge broker B. As it is difficult for Chinese companies and other "Belt and Road" enterprises to clearly define the knowledge boundary in the process of knowledge transfer, there is a risk of core technology spillover. γ_{CB} is the risk probability of knowledge spillover.

(8) The "Belt and Road" policy incentive effect is represented by $\tau_C TK_c$. The "Belt and Road" initiative has implemented fair, equal, and mutually beneficial policies for the enterprises along the route. This also provides incentives for all parties to engage in knowledge transfer, such as providing a strong platform for knowledge transfer, implicit cooperation opportunities, and the ability to adapt knowledge. Additionally, if enterprises or knowledge

brokers violate the "One Belt and One Road" policy, they will be subject to a penalty mechanism C_I. P is the probability of adopting some kind of knowledge transfer behavior.

(9) Knowledge brokers' transfer rules. If knowledge brokers adopt a "transfer" strategy, the "Belt and Road" enterprises can communicate with each other through knowledge brokers, which can have a multiplier effect. If the knowledge agency selects a "protection" strategy, "Belt and Road" enterprises must establish contact with each other for communication and exchange. Due to differences in the knowledge structure, recognition degree, culture, laws, and political systems between enterprises of China and countries along the "Belt and Road" route, the cost of knowledge transfer increased to $2C_{CB}$. As a result, the transfer effect of the knowledge mediation when it adopts the

protection strategy is reduced to $\dfrac{\theta_{CB}TK_CTK_B}{2}$.

Based on the above rules, this study proposes the following propositions:

Proposition 1: When Chinese companies and other "Belt and Road" enterprise carry out knowledge transfer, differences in their professional fields or technical characteristics, as well as the differences in the knowledge structure, degree of recognition, culture, laws, and political systems, will inevitably create obstacles in the effective flow of information. Therefore, knowledge brokers are needed as a bridge for effective communication.

Proposition 2: When the collaborative innovation capabilities of the Chinese companies and the other "Belt and Road" enterprises are lower than the cost of knowledge transfer, both sides will tend to choose a protection strategy to maximize their own self-interest, and the entire project-based organization system will lose its validity.

Proposition 3: The "One Belt and One Road" policy provides a platform for cooperation and mutual assistance between Chinese companies and enterprises along the route, enhancing mutual trust, mitigating the losses caused by giving up the benefits of exclusive knowledge, and generating knowledge synergy which help compensate for knowledge transfer costs. In addition, the "Belt and Road" policy strengthens the knowledge transfer incentive mechanism to ensure that the knowledge transfer costs, incentives, and penalties have a positive proportional relationship, and can fully motivate both parties.

Proposition 4: While simultaneously gaining additional revenues, both parties also face the risk of core technology and knowledge spillovers. Enterprises cannot guarantee their core technologies and knowledge will not spill out beyond the trusted network due to another party's opportunistic behavior in the process of knowledge transfer. Companies' core technologies and knowledge have also been known to leak out unconsciously or unintentionally. As knowledge-receptive companies are driven by self-interest, once they find that stealing behavior is profitable, the protection of core technology and knowledge will become unreliable.

We established a 2×2×2 trilateral asymmetric evolutionary game in which the players are the Chinese company C, "Belt and Road" enterprise F and the knowledge broker B. C's strategy set is {C1, C2}, F's strategy set is {F1, F2}, and B's strategy set is {B1, B2}. The profit matrix of the three-group 2×2×2 asymmetric evolutionary game is shown in Table 2 and Table 3.

Table 2. Revenue matrix of knowledge broker choosing B1 strategy.

C1 Transfer	（c1，f1，b1）（c2，f2，b2）
	National enterprise along the "Belt and Road" F
Chinese company C C2 Protect	（c3，f3，b3）（c4，f4，b4）
	Transfer Protect

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Table 3. Revenue matrix of knowledge of knowledge broker B2 strategy.

| Chinese company C | National enterprise along the "Belt and Road" F | |
	Transfer	Protect
C1 Transfer	（c5，f5，b5）	（c6，f6，b6）
C2 Protect	（c7，f7，b7）	（c8，f8，b8）

$$e1 = K_C + \rho_{CB}TK_B + \theta_{CB}TK_C TK_B + \varphi\varepsilon_C TK_C - \gamma_{CB}K_C - C_{CB}$$
$$f1 = K_F + \rho_{FB}TK_B + \theta_{FB}TK_F TK_B + \varphi\varepsilon_F TK_F - \gamma_{FB}K_F - C_{FB}$$
$$b1 = K_B + Y\rho_{CB}TK_B + \theta_{CB}TK_C TK_B + \varphi\varepsilon_C TK_C - \gamma_{CB}K_C - C_{CB}Y + Y\rho_{FB}TK_B + \theta_{FB}TK_F TK_B + \varphi\varepsilon_F TK_F - \gamma_{FB}K_F - C_{FB}Y$$

$$e1 - e2$$

$$f2 = K_F + \rho_{FB}TK_B - C_{FB} - \varphi\omega_F$$
$$b2 = K_B + \rho_{CB}TK_B + 2\varphi\varepsilon_B TK_B - \gamma_{CB}TK_B - C_{CB} - \gamma_{FB}K_B - C_{FB}$$
$$e3 = K_C + \rho_{CB}TK_B - C_{CB} - \varphi\omega_C$$

$$f3 - f1$$

$$b3 = K_B + \rho_{FB}TK_B + 2\varphi\varepsilon_B TK_B - \gamma_{FB}K_B - C_{FB} - \gamma_{CB}K_B - C_{CB}$$

$$e4 - e3$$

$$f4 - f2$$

$$b4 = K_B - \gamma_{FB}K_B - C_{FB} - \gamma_{CB}K_B - C_{CB} + 2\varphi\varepsilon_B TK_B$$
$$e5 = K_C + \rho_{CF}TK_F + \frac{\theta_{CF}TK_C TK_F}{2} + \varphi\varepsilon_C TK_C - 2C_{CF}$$
$$f5 = K_F + \rho_{FC}TK_C + \frac{\theta_{FC}TK_F TK_C}{2} + \varphi\varepsilon_F TK_F - 2C_{FC}$$
$$b5 = K_B - 2\varphi\omega_B$$
$$e6 = K_C + \varphi\varepsilon_C TK_C - 2C_{CF}$$
$$f6 = K_F + \rho_{FC}TK_C + \frac{\theta_{FC}TK_F TK_C}{2} - \varphi\omega_F$$

$$e7 = K_C + \rho_{CF}TK_F + \frac{\theta_{CF}TK_CTK_F}{2} - \varphi\omega_C$$

$$f7 = K_F + \varphi\varepsilon_F TK_F - 2C_{FC}$$

$$b5 = b6 = b7 = b8 = K_B - 2\varphi\omega_B$$

$$e8 - K_C - 2\varphi\omega_C$$

$$f8 - K_F - 2\varphi\omega_F$$

4. Knowledge transfer strategy game model based on knowledge broker

Chinese company C and probability of it adopting policy C1 and C2 are represented by x and 1-x respectively. y and $1 - y$ represent the knowledge broker and their probability of adopting policy B1 and B2 respectively. z and 1-z represent "Belt and Road" enterprise F and the probability of it adopting strategy F1 and F2 respectively. There are 8 possible game strategy combinations among the three knowledge transfer subjects, which are:

（C１，F１，B１），（C１，F１，B２），（C１、F２、B１），
（C１、F２、B２），（C２，F１，B１），（C２，F１，B２），
（C２，F２，B１），（C２，F２，B２）.

Let U_{C1} denote the expected return when Chinese firm C adopts strategy C1, and $\overline{U_C}$ denote the mean return of Chinese company adopting strategy C1 and C2. Then:

$$U_{C1} = yzc1 + y(1-z)c5 + (1-y)zc2 + (1-y)(1-z)c6$$

$$\overline{U_C} - xyzc1 + xy(1-z)c5 + x(1-y)zc2 + x(1-y)(1-z)c6 + (1-x)yzc3 + (1-x)y(1-z)c7 + (1-x)(1-y)zc4 + (1-x)$$

Let U_{F1} denote the expected return of "Belt and Road" enterprise F when it adopts strategy F1, and $\overline{U_F}$ denote the average income of "Belt and Road" enterprise F that adopts strategy F1 and F2 . Then,

$$U_{F1} = xzf1 + x(1-z)f5 + (1-x)zf3 + (1-x)(1-z)f7$$

$$\overline{U_F} - xyzf1 + xy(1-z)f5 + y(1-x)zf3 + y(1-x)(1-z)f7 + (1-y)xzf2 + (1-y)x(1-z)f6 + (1-y)(1-x)zf4 + (1-$$

Let U_{B1} denote the expected return when knowledge broker B adopts strategy B1, and let $\overline{U_B}$ denote the average yield when knowledge broker B adopts strategies B1 and B2. Then:

$$U_{B1} - xyb1 + x(1-y)b2 + (1-x)yb3 + (1-x)(1-y)b4$$

$$\overline{U_B} = xyzb1 + xz(1-y)b2 + y(1-x)zb3 + z(1-x)(1-y)b4 + (1-z)xyb5 + (1-y)x(1-z)b6 + (1-z)(1-x)yb7 + (1-$$

This paper introduces the dynamic model of a multi-group simulator in evolutionary game theory to analyze the stability of knowledge transfer based on knowledge brokers. In evolutionary game theory, the core concepts are the Evolutionary Stable Strategy (ESS) and Replicator Dynamics. ESS represents a stable state in the population that resists invading mutation strategies. Dynamics are actually dynamic differential equations that describe the frequency at which a particular strategy is employed by a population. Because the dynamic formula derived from multi-population imitators is so complicated, we have directly provided the finalized the standard recurrence dynamic equation (Gates J M. Weibull and Jorgen W, 1996). Chinese company C adopts the copy dynamic equation of strategy C1 ratio as:

$$H(x) = \frac{dx}{dt} = x\left(U_{C1} - \overline{U_{CB}}\right) =$$

$$x(1-x)\left(((c1-c3)-(c5-c7))yz + (c5-c7)y + z(1-y)((c2-c4)-(c6-c8)) + (1-y)(c6-c8)\right)$$

$$G(y) = \frac{dy}{dt} = y\left(U_{F1} - \overline{U_{FB}}\right) =$$

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$$y(1-y)\left(\big((f1-f2)-(f5-f6)\big)xz + (f5-f6)x + \big((f3-f4)-(f7-f8)\big)z(1-x) + (1-x)(f7-f8)\right)$$

$$T(z) = \frac{dz}{dt} = x\left(U_{c1} - \overline{U_{cz}}\right)$$

$$= z(1-z)\left(\big((b1-b5)-(b3-b7)\big)yx + (b3-b7)y + \big((b2-b6)-(b4-b8)\big)x(1-y) + (1-y)(b4-b8)\right)$$

When x=0,1, the Billy of Chinese company C adopts knowledge transfer strategy is balanced. When y= 0,1, the Billy of knowledge transfer strategy adopted by "Belt and Road" enterprise F is balanced. When z= 0,1, the Billy of knowledge transfer strategy adopted by knowledge broker B is balanced. Therefore, there are 8 local equilibrium points, which are: E1(0,0,0), E2(1,0,0), E3(0,1,0), E4(0,0,1), E5(1,1,0) , E6(1,0,1), E7(0,1,1) , E8(1,1,1).

For a differential equation of the "neighborhood" dynamic knowledge transfer between enterprises, the stability of the equilibrium point can be obtained by the replicated dynamic equation of Jacobian Matrix of local stability analysis (Friedman, 1991). The Jacobian matrix of the "One Belt and One Road" tripartite game system at the equilibrium point E1 (0,0,0) is as follows:

$$\begin{bmatrix} \dfrac{\partial H(x)}{\partial x} & \dfrac{\partial H(x)}{\partial y} & \dfrac{\partial H(x)}{\partial z} \\ \dfrac{\partial G(y)}{\partial x} & \dfrac{\partial G(y)}{\partial y} & \dfrac{\partial G(y)}{\partial z} \\ \dfrac{\partial T(z)}{\partial X} & \dfrac{\partial T(z)}{\partial y} & \dfrac{\partial T(z)}{\partial z} \end{bmatrix} = \begin{bmatrix} (e6-e8) & 0 & 0 \\ 0 & (f7-f8) & 0 \\ 0 & 0 & (b4-b8) \end{bmatrix}$$

When an equilibrium point makes all eigenvalues of the Jacobian matrix λ<0, the equilibrium point is asymptotically stable. When an equilibrium point makes all eigenvalues of the Jacobian matrix λ>0, the equilibrium point is unstable. When an equilibrium point makes all the eigenvalues of the Jacobian matrix positive or negative the equilibrium point, i.e. the saddle point, is unstable. The cooperation between Chinese enterprises and other enterprises in the "Belt and Road" region will be a long-term strategy. The game evolution system's stability strategy, (transfer, transfer), (protection, protection), will also co-exist in the long-term. The evolutionary stability and convergence trend of game evolution system is influenced by the parameters of the payment matrix and tends to converge to different equilibrium points.

We defined five polynomials (①②③④⑤) that are expressed as follows:

Polynomial ① $C_{Bc} - \varphi\varepsilon_c TK_c > 0$ indicates that the knowledge transfer cost is significant and larger than the incentive. Polynomial ② $\varphi\varepsilon_c TK_c - \varphi\omega_c > 0$ indicates that the incentive is greater than the penalty. Polynomial ③ $\theta_{cB} TK_c TK_B - C_{cB} > 0$ indicates the knowledge transfer synergy effect is the driving force for all parties to carry out knowledge transfer. In the long run, it seems that the synergy effect is greater than the cost of knowledge transfer. In terms of knowledge transfers one side, Polynomial ④ $\rho_{cB} TK_B - C_{cB} > 0$ means that the benefits of direct knowledge transfer are greater than the costs, which is the key to knowledge transfer. $⑤ = 5 + GB3①⑤②\gamma_{cB}K_B \approx 0$ is the risk of leakage of core technology assets. The balance point stability is shown in Table 4.

Table 4. Stability Analysis of Balance Points

Balance Point	λ1	λ2	λ3	Stability
E1(0,0,0)	$\varphi\varepsilon_C TK_C - 2C_{FC} - 2$	$\varphi\varepsilon_F TK_F - 2C_{FC} - 2$		ESS
E2(1,0,0)		$\varphi\varepsilon_F TK_F - 2C_{FC} + \varphi$	$\rho_{CB} TK_B + 2\varphi\varepsilon_B TK_B - \gamma_{CB} K_B - C_{CB} - \gamma_{FB} K_B - C_{FB}$	Saddle Point
E3(0,1,0)	$\varphi\varepsilon_C TK_C - 2C_{CF} + \varphi$		$\rho_{FB} TK_B + 2\varphi\varepsilon_B TK_B - \gamma_{FB} K_B - C_{FB} - \gamma_{CB} K_B - C_{CB}$ >0	Saddle Point
E4(0,0,1)	$\theta_{CB} TK_C TK_B + \varphi\varepsilon_C T$	$\theta_{FB} TK_F TK_B + \varphi\varepsilon_F T$	$\gamma_{FB} K_B + C_{FB} + \gamma_{CB} K_B + C_{CB} - 2\varphi\varepsilon_B TK_B - 2\varphi\omega_B$ >0	Unstable
E5(1,0,1)	$\gamma_{CB} K_C - \theta_{CB} TK_C TK_B$	$\theta_{FB} TK_F TK_B + \varphi\varepsilon_F T$	$\gamma_{CB} TK_B + C_{CB} + \gamma_{FB} K_B + C_{FB} - \rho_{CB} TK_B - 2\varphi\varepsilon_B TK_B$	Saddle Point
E6(1,1,0)			$\mathbf{Y}\rho_{CB} TK_B + \theta_{CB} TK_C TK_B + \varphi\varepsilon_C TK_C - \gamma_{CB} K_C - C_{CB}\mathbf{Y}$	Unstable
E7(0,1,1)	$\theta_{CB} TK_C TK_B + \varphi\varepsilon_C T$	$\gamma_{FB} K_F - \theta_{FB} TK_F TK_B$ <0	$\gamma_{FB} K_B + C_{FB} + \gamma_{CB} K_B + C_{CB} - \rho_{FB} TK_B - 2\varphi\varepsilon_B TK_B$	Saddle Point
E8(1,1,1)	$\gamma_{CB} K_C - \theta_{CB} TK_C TK_B$	$\gamma_{FB} K_F - \theta_{FB} TK_F TK_B$	$\mathbf{Y}\gamma_{CB} K_C + C_{CB} - \rho_{CB} TK_B - \theta_{CB} TK_C TK_B - \varphi\varepsilon_C TK_C\mathbf{Y}$	ESS

In order to more intuitively understand the game system evolution of Chinese company C, knowledge broker B, and "Belt and Road" enterprise F, a game phase diagram was drawn in conjunction with Table 4, as shown in Figure 1. Figure 1 is a plane composed of two unstable equilibrium points E4(0,0,1), E6(1,1,0) and saddle points E2(1,0,0), E3(0,1,0), E5(1,0,1), E7(0,1,1) to form the interface of different convergence states of the evolutionary system. When the system's initial state is located on the boundary surface E2, E3, E5, E7 the system will converge to either stable point E8 (1,1,1) or E0 (0,0,0), meaning the evolutionary game parties Chinese company C, knowledge broker B, and "Belt and Road" enterprise F will all either adopt a transfer strategy or a protection strategy. The

evolution of the system is a long-term process. The knowledge transfer system can present a situation where knowledge transfer and non-knowledge transfer (protection) co-exist. On the one hand, considering the costs of implementing a knowledge transfer strategy while also having to safeguard the company's intellectual property enterprises are often discourage from carrying out knowledge transfer strategies. On the other hand, the short-term benefits, incentives and penalties provided by the "One Belt and One Road" initiative ultimately motivate enterprises to engage in knowledge transfer strategies. This paper analyzes the evolutionary process of the three-party game system to obtain the evolutionary stability strategy (ESS). It is discussed that parties, depending on different influencing factors, will tend to choose knowledge transfer strategies. The above-mentioned determination of saddle points and stable points is based on the above assumptions. When the above hypothetical relationship changes, the stable point will also change.
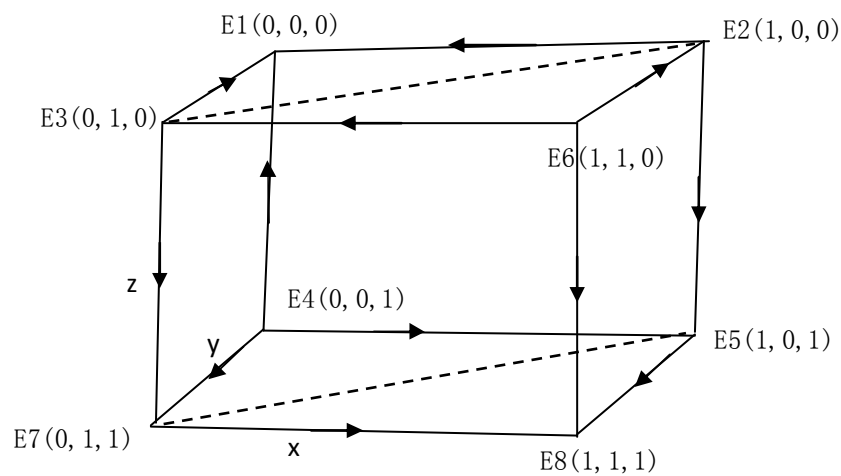
Figure 1. Game Phase Diagram

When the system satisfies different conditions, the stability state of local evolution will change. The stability state of local evolution is shown in table 5.

Table 5. Local stability strategies in different situations

Situation	Situation 1				Situation 2			
	①>0 ②>0 ③<0 ④>0 ⑤≈0				①<0 ②>0 ③<0 ④>0 ⑤≈0			
Equilibrium point	λ_1	λ_2	λ_3	Stability	λ_1	λ_2	λ_3	Stability
E1(0,0,0)	<0		<0	ESS	>0		>0	instability
E2(1,0,0)			>0	saddle point			>0	saddle point
E3(0,1,0)			>0	saddle point			>0	saddle point
E4(0,0,1)			>0	instability			<0	saddle point
E5(1,0,1)			Indeterminacy	saddle point			<0	saddle point
E6(1,1,0)				instability				instability
E7(0,1,1)			Indeterminacy	saddle point			>0	saddle point
E8(1,1,1)	<0		<0	ESS	<0		<0	ESS

Table 6. Local stability strategies in different situations

Situation	Situation 3				Situation 4			
	①>0 ②<0 ③<0 ④>0 ⑤≫0				①>0 ②>0 ③<0 ④>0 ⑤≫0			
equilibrium point	λ_1	λ_2	λ_3	stability	λ_1	λ_2	λ_3	stability
E1(0, 0, 0)	<0		>0	saddle point	<0		<0	ESS
E2(1, 0, 0)				instability			>0	saddle point
E3(0, 1, 0)	<0	>0	>0	saddle point			>0	saddle point
E4(0, 0, 1)	>0	>0	<0	saddle point			>0	saddle point
E5(1, 0, 1)	<0	>0	<0	saddle point			>0	saddle point
E6(1, 1, 0)	>0	>0	>0	saddle point	>0		<0	saddle point
E7(0, 1, 1)			<0	saddle point			>0	saddle point
E8(1, 1, 1)	<0		<0	ESS			>0	instability

* Due to the limited space, only part of the situation is discussed in this paper.

5. The Evolutionary Game Analysis between Chinese companies, other "Belt and Road" Enterprises and Knowledge Brokers

5.1 Analysis of the Mediating Effect of Knowledge brokers

Comparing balance point E6(1,1,0) and balance point E8(1,1,1) in Table 4, it can be seen intuitively, when the Chinese company and "Belt and Road" enterprise engages in knowledge transfer or absorbs external knowledge, its evolutionary stability strategy is to use knowledge brokers. This is mainly because knowledge brokers are knowledge transfer promoters (Pawlowski & Robey，2004). Knowledge brokers adjust and adapt the knowledge according to differences of the various knowledge users. The latest research on knowledge brokers mainly focuses on their role within organizations and between organizations and how knowledge mediation promotes the diffusion and transfer of knowledge through the interpretation, transformation and reengineering of knowledge(Pawlowski &

Robey，2004; Perrin，2013). Pawlowski and Robey (2004) believe that knowledge broker is the promoter of knowledge transfer. There are also scholars who use the concepts of boundary spanning (Ancona & Caldwell, 1988) and boundary objects (Brown & Duguid 1998) to explain the business process of knowledge brokers as promoters of knowledge transfer. Knowledge brokers promote the transfer of knowledge by acquiring information across borders and adapting that information to suit the characteristics of their target users to reduce the cognitive distance between two groups (Cillo, 2005). The role of knowledge brokers is to actively promote knowledge transfer between different groups; their core activities revolve around information management (collecting, sharing, and packaging information), networking (promoting communication between different groups), and developing capabilities (learning from the process of knowledge transfer to ensure sustainability) (Ward, John L, Medoza, et al, 2012).

5.2 Synergy analysis

In the process of knowledge transfer between Chinese companies, knowledge brokers and other enterprises along the "Belt and Road" route, knowledge can only be transferred in tripartite contexts if the revenues gained by the three parties outweigh the costs. This is the prerequisite for successful collaborative innovation. The benefits gained by these parties in the process of knowledge transfer are greater than the costs, which is the only precondition for the possibility of knowledge transfer. Currently, the system has two evolutionary equilibrium points (ESS) (0,0,0), (1,1,1), that is, knowledge transfer may end in failure, or it may succeed. In combination with situation 1 in Table 5 and situation 3 in Table 6, when the collaborative innovation capability is lower than the knowledge transfer cost, due to the enterprise's poor short-term knowledge transfer performance, or if no knowledge transfer occurs, the "Belt and Road" initiative enacts a very harsh punishment mechanism. The existence of penalty mechanism all parties to evolutionary stability strategy E8 (1,1,1). The punishment mechanism compels the enterprises to acquire new knowledge and strengthen cooperative behavior. Through knowledge transfer, collaborative innovation value between Chinese companies, knowledge brokers, and companies along the route are enhanced, so that the three parties always maintain a high level of collaborative innovation. If the "Belt and Road" policy only imposes soft penalties with incentive measures, the three parties will tend to choose a non-transfer strategy for the sake of maximum benefit and self-interest. The transfer of the three-party evolutionary stability strategy will be E1(0,0,0), so the entire transfer of the tripartite system loses its momentum .

5.3 The "One Belt and One Road" policy incentive effect

Combined with situation 2 in table 5, which the equilibrium point does the system ultimately evolve to, is related to the "Belt and Road" policy incentives for Chinese companies, knowledge brokers, and other "Belt and Road" enterprises to cooperate with each other. If the "Belt and Road" policy incentives can make up for the cost of knowledge transfer, the probability of successful knowledge transfer is high. If the "Belt and Road" incentives cannot make up for the cost of knowledge transfer, there is a greater probability of knowledge transfer failure. Therefore, reducing the knowledge transfer costs by improving technical means is the main determinant for increasing revenues. Secondly, strengthening cooperative relationships, enhancing mutual trust, and mitigating the losses caused by giving up the benefits of exclusive knowledge, then synergies are generated to compensate for the risks of knowledge transfer. In addition, strengthening knowledge transfer incentive mechanisms ensures that the knowledge transfer costs, incentives, and penalties are reasonably proportional to each other, and can fully motivate all knowledge transfer parties.

4.4 Core knowledge leakage

According to situation 4 in Table 6, it can be seen that the stability strategy, E1(0,0,0), is associated with a higher core technology leakage risk. When transferring knowledge between Chinese companies and other enterprises along the "Belt and Road" route, conflicts often occur due to difference in their national and corporate culture and management styles. Potential opportunistic behavior may result in the participating parties exploiting information asymmetry or other favorable bargaining position to cheat the other party. Selfish motivations are

strong and this kind of behavior is often complex. Its concrete manifestations include concealing and distorting information, failing to fulfill promises or obligations, stealing core technologies from cooperative enterprises and poaching key figures. Although the transfer costs have been reduced, differences in the background, goals, and expectations of the transferring parties mean that the security of core capabilities has not been guaranteed and may eventually lead to knowledge transfer failure.

6 Conclusions and management implications
6.1 Conclusion

This paper studied the knowledge transfer behavior among Chinese companies, knowledge brokers, and enterprises along the "Belt and Road" route. By replicating the dynamic equations and local stable state points using various factors, such as knowledge synergy effects, knowledge transfer costs, "Belt and Road" incentives and penalties, core technology leakage risks, and direct knowledge transfer effects, we attempted to understand how the parties' knowledge transfer behavior is affected. Among them, the direct effects of knowledge transfer, knowledge transfer costs, and the "Belt and Road" policy incentive and punishment mechanisms, and core technology leakage risks were the key determinants in the evolutionary trends of knowledge transfer behavior. Encouraged by the "Belt and Road" policy, the transfer parties establish links through the "Belt and Road" platform. Even with a low knowledge synergy, the stable state of knowledge transfer by all parties will be directed to equilibrium point E8 (1,1,1). The shift is due to the "Belt and Road" policy's severe punishment mechanism. The punishment mechanism, encourages companies to acquire and absorb new knowledge for transfer of all parties to produce opportunistic behavior, leading to stability of all parties gradually towards the E1 (0,0,0) state, but if the "Belt and Road" policy's severe punishment mechanism eventually forces the enterprises to cooperate in innovation, it is certain that the evolutionary system will develop. Therefore, reasonable rewards and punishments are a necessary foundation for the coordinated development for knowledge transfer under the "Belt and Road" initiative.

From the table of local stability status, it can be seen that the protection of the core technology by the enterprise inhibits the opportunistic behavior of the partner, as well as reduces the loss when the partner is subject to speculation. If the enterprise's ability to absorb and transform the other enterprises' knowledge is weak, successful knowledge transfer is often difficult to achieve. The risk that knowledge transfer may increase the chance of confidential knowledge theft will inhibit the knowledge transfer behavior, which prompts all parties to move towards opportunistic behavior.

6.2 Management inspiration

We have noticed that the participation of knowledge brokers creates change within evolutionary process of the knowledge transfer system. The role of the knowledge brokers plays an important part in the "Belt and Road" enterprises' knowledge transfer behavior. At this stage, there is a big gap of knowledge stock between the Chinese enterprises and the other "Belt and Road" countries, and the number of knowledge brokers is relatively small. If we want to promote the three-party knowledge cooperation, we must expand the scope of knowledge broker. In addition to focusing on supporting technology leading companies, some non-enterprise R&D organizations, such as research institutes can be employed as knowledge brokers, which also help eliminate knowledge transfer barriers caused by excessive knowledge gaps among enterprises. For the "Belt and Road" knowledge transfer enterprises, enhancing their own absorption capacity and increasing their emphasis on the protection of core technologies will not only strengthen other's' willingness to cooperate in knowledge transfer, but also curb the spread of short-sightedness and opportunistic behavior in the long run. This is not only beneficial to the knowledge synergy effect, but also enhance the company's own long-term benefits. At the same time, the reasonable ratio of incentives and punishments will help the evolution system to develop in a more constructive direction.

Acknowledgements

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IT-based supply chains on new product activities from the manufacturer's viewpoint

Tun-Chih KOU

Department of International Business, Ming Chuan University, 250 Zhong Shan N. Rd., Sec. 5, Taipei 111, Taiwan

Email: fredonef@hotmail.com, Tel:+886-2-2882-4564

Abstract

Some studies have suggested that a supply chain augmented with information technology (IT) has a positive effect on product performance in the marketplace. However, these studies have not explained how the IT-based supply chain achieves this superior performance. This study reveals some of the mediating influences at play: the new product development (NPD) activities of product launch, product innovativeness, and product development capability. The results supported the hypotheses that IT-based supply chain architecture affects new product performance through NPD activities.

1. Introduction

According to the Global Supply Management Chain Forum (as mentioned in Lee and Whang, 2001), supply chain management is the integration of major business processes to provide products, services, and information from the original supplier to the end-user. A well-managed supply chain enables firms to meet market demands, and IT applications can improve supply chain management. Therefore, firms are increasingly phasing in procurement and logistics functions for supply chain management systems, and investing considerably in IT to manage the flow of information in supply chains (Kanakamedala et al., 2003). IT-based supply chain management systems can enhance financial performance by improving business processes in the manufacturing industry (Dehning et al., 2007). One previous study indicated how information technology (IT) can improve performance through the purchasing function and that IT investments have a positive effect on the purchasing function through purchasing practices (Rodríguez-Escobar and González-Benito, 2015). E-procurement was also recently discovered to have a positive influence on firm performance (Kim et al., 2015). Although some studies have considered the relationship between IT-based supply chains and performance, they have not stated that superior performance is the result of NPD activities.

Few studies have examined the combined moderating influence of product launch, product development capability, and innovativeness on IT-based supply chains and new product performance. If the logistics strategy creates greater efficiency in the facilities and number of suppliers, this may improve the success of a new product launch (Bowersox et al., 1999). Lean launch strategies use limited resources, increase the smoothness of manufacturing, and maintain low inventory during product rollout (Calantone et al., 2005). Bowersox et al. (1999) also suggest that a lean launch minimizes inventory and introduces products with lower costs and greater profit. Given that it is critical to reduce the risk for manufacturers and aim for minimal inventory, short lead times, flexible operations, and lower costs (Calantone et al., 2005), an efficient lean launch strategy could improve new product performance. Empirical analysis has indicated that an effective lean launch strategy and marketing orientation have a positive effect on performance (Calantone and Di Benedetto, 2012). Furthermore, suppliers can be a source of innovative ideas and important technologies for NPD (Bonaccorsi and Lipparini, 1994; Nishiguchi and Ikeda, 1996). Innovative products offer opportunities in their divergence from existing products, as well as technological product advantages (Kleinschmidt and Cooper, 1991) resulting in unique selling points and high customer satisfaction. It is also critical to leverage the supply chain for superior product development capabilities. Suppliers involved in product development contribute to short-term project schedules through product quality improvement and the reduction of development schedules and costs (Primo and

Amundson, 2002; Ragatz *et al*., 2002). Firms can leverage NPD activities to enhance profit and market share through solid supply chain architecture. Research on supply chain architecture has also addressed new ways that manufacturers can cooperate, communicate, and trade more efficiently with suppliers, such as business-to-business e-commerce. Moreover, IT advancement could upgrade channel management and capabilities for firms and in turn improve supply chain management and business operations (Wu *et al*., 2006). In general, manufacturers' IT-based supply chains should improve NPD activities, such as cost-driving and materials control for product launch and the exchange of product information and innovative ideas with suppliers for the planning of a competitive and sustainable new product. They should also develop a robust and quality product, and make improvements to the product development schedule that facilitate superior new product performance. As a result, lean launch, product innovativeness, and product development capability have been regarded as important moderators between the IT-based supply chain and new product performance, especially in the high-tech manufacturing industry. Many new products are released by high-tech manufacturers with well-managed supply chain systems; therefore, the high-tech manufacturing industry was chosen for this research.

2.   Theoretical background and hypothesis development
This study argues that IT-based supply chain management affects new product performance through the execution of NPD activities. We explain the detailed relationships of the hypotheses in the following section.

2.1. Manufacturers' IT-based supply chain
IT infrastructure is defined as the combination of related services that are shared by a firm—such as hardware, software applications, telecommunications technology, databases, Internet, and company intranet—coordinated centrally by the firm's IT department (Sambamurthy and Zmud, 1999; Sethi *et al*., 2003; Weill and Broadbent, 1998). As a consequence of IT advancements and globalization, IT has been adopted widely and firms must invest considerably in IT infrastructure for their business to be successful (Ngai and Wat, 2002). The decision for IT adoption is influenced by external business partners such as consultants, suppliers, and customers (Nguyen *et al*., 2015). For instance, an increasing number of firms use business-to-business systems to work with suppliers on related activities, including forecast planning and inventory checking (Kim *et al*., 2006). Firms recognize that using an IT-based supply chain could give them a competitive advantage in the market.

IT can also augment NPD activities. Computer-aided design (CAD), engineering (CAE), and manufacturing (CAM) tools can enhance product design and development processes and the manufactured results. Similar benefits can be achieved with the use of project management software, such as the program and review technique or the critical path method. (José Barbin Laurindo and de Carvalho, 2005). Kim *et al*. (2006) and Jean *et al*. (2010) consider IT advancement an efficient means for supply chain members to share information to improve forecast planning, cost and quality calibration, and conduct transactions, replenishment, and NPD. In the context of this study, we regard IT advancement as the extent to which high-tech manufacturers adopt more advanced IT for supply chain management and NPD activities to gain an edge over their competitors.

Supply chain architecture concerns the relationships between manufacturers and their suppliers. Firms share technology, market, and production information with major suppliers in the supply chain (Lee, 2000), because the key to a successful supply chain is to develop long-term relationships with partners (Heizer and Render, 2006). Kumar *et al*. (2016) revealed that relationship strength has a mediating effect between collaborative culture and supply chain performance, with collaborative culture demonstrated to enhance relationship strength and improve collaborative activities in the long term. Hicks (1999) highlighted that collaborative planning, information sharing, and synchronization with suppliers are crucial to supply chain improvement. We define supply chain architecture as involving cooperation and activity integration between manufacturers and suppliers.

2.2. IT-based supply chain architecture and NPD activities
Supply chains and NPD are highly related because the supply chain manufactures and distributes the product when it is in the final stage of the development process. Supply chain management is a method for designing products and organizing related activities from materials planning to channel distribution over a network including suppliers, manufacturers, and distributors (Vonderembse *et al*., 2006).

The corollary relationships with external partners and integrated operations enhance lean launch performance (Bowersox *et al*.,1999) The strategy for securing a competitive advantage is to share knowledge with suppliers, such as market trends, new materials available, or methods for reducing the product cycle

(Huang *et al*, 2003). Suppliers can prepare appropriate materials and other resources if they are involved in NPD decision making (Langner and Seidel, 2009). Aligning NPD with supply chain management mitigates problems such as failed product launches caused by insufficient production capacities (Van Hoek and Chapman, 2007). Past studies have also claimed that it is more efficient to announce new products if firms can obtain support from their suppliers (Petersen *et al*., 2005). For instance, if manufacturers receive support from their suppliers, the suppliers can customize key components to meet the product design, which facilitates the new product's announcement.

Firms can decrease non-value-added activities to reduce production costs because IT support can improve the information flow for the supply chain process (Gunasekaran and Ngai, 2003). Information about product types and their quantities in the warehouse and the product manufacturing process can be made available over the Internet (Lancioni *et al*., 2000). Suppliers can communicate directly with manufacturers about engineering changes via the supply chain system and suppliers can respond quickly to cut costs for lean launch execution. Thus, we hypothesize:

H1a: The level of a manufacturer's IT-based supply chain architecture is positively correlated with lean launch capability.

Some scholars have argued that IT improves the quality of information exchange between firms (Kim *et al*., 2006). Suppliers can provide innovative ideas and important technologies for NPD (Bonaccorsi and Lipparini, 1994; Nishiguchi and Ikeda, 1996). Supplier involvement is a key factor in improving knowledge transfer and the innovation process (Song and Di Benedetto, 2008) and the success of product development relies on partners' capability to manage, maintain, and create knowledge (Cohen and Levinthal, 1990). Past research indicated that knowledge-sharing routines have a significant positive influence on product innovation performance. Also, knowledge-sharing routines have a mediating effect between idiosyncratic investments and innovation performance (Charterina *et al*., 2016). One study discovered that suppliers' joint learning has a higher impact than absorptive learning on radical innovation (Jean *et al*., 2016). Therefore, IT-based supply chains support manufacturers because they can exchange product information and new ideas with suppliers to plan innovative products utilizing new technology and with new functions. Thus, we hypothesize:

H1b: The level of a manufacturer's IT-based supply chain architecture is positively correlated with product innovativeness.

In the early stages, suppliers involved in product development improve product development performance in areas such as quality, speed, and productivity (Gupta and Souder, 1998; Ragatz *et al*., 2002). Increasing knowledge sharing between buyers and suppliers can enhance collaborative problem solving by allowing partners to take advantage of each other's knowledge, resulting in product and process improvements (Takeishi, 2001).

Suppliers involved in product development contribute to short-term project schedules through product quality improvements, development schedule reduction, and development cost reduction (Primo and Amundson, 2002; Ragatz *et al*., 2002). IT-based communication and coordination between firms and their external suppliers can facilitate collaborations for overall project success, and for this reason IT has become central for NPD in many industries (Marion *et al*., 2012). Thus, we hypothesize:

H1c: The level of a manufacturer's IT-based supply chain architecture is positively correlated with product development capability.

2.3. New product performance of manufacturers

The literature suggests that lean launch strategies improve product marketplace performance by improving lead time, minimizing inventory and risk, reducing costs, and enhancing operation flexibility (Calantone *et al*, 2005). Especially in high-tech industries, lean launch substantially affects new product success. Thus, we hypothesize:

H2: The ability of a manufacturer to execute lean launch is positively related to new product performance.

Freeman (1983) also claimed that design is crucial to innovation, because creatively devised ideas and designs connect with technical possibilities to meet the market demand. Product innovativeness offers unique functions to customers, results in greater margins, and increases market share based on product advantage. Thus,

we hypothesize:

H3: The level of a manufacturer's product innovativeness is positively related to new product performance.

Cutting-edge product development could help firms communicate increased value to their customers, and product design could be cost-saving as advertising expenses decline for unique product designs (Karjalainen and Snelders, 2009). Thus, we hypothesize:

H4: The level of a manufacturer's product development capability is positively related to new product performance.

2.4. Theoretical model
The theoretical model and all hypotheses for this study are presented in Figure 1.
[Insert Figure 1 approximately here]

3. Methodology
We chose Taiwanese high-tech manufacturers for the empirical context of this study because they have become a critical part of the global supply chain for the high-tech industry, and are pioneers in developing IT systems for complex supply chain management. Furthermore, manufacturers such as the Foxconn Technology Group, Quanta Computer, and Pegatron have extensive IT experience to coordinate with suppliers efficiently. Foxconn Technology Group is a major contract manufacturer for the Apple iPhone series and the third largest IT company by revenue (US$132.54 billion in 2014) in the world. Quanta Computer is the largest manufacturer of notebooks in the world, with 2014 revenue reaching USD 27.8 billion and brand customers including Apple, Dell, and HP. Over the past two decades, high-tech manufacturers have been using more advanced IT for supply chain management, include just-in-time delivery, forecast planning, co-product development, engineering changes, inventory control, and outsourcing business. For instance, Quanta Computer developed the cloud application management platform for supply chain management. Because Quanta Computer cooperates with more than 1000 suppliers, it must implement numerous processes for orders and shipments in this platform, thereby facilitating solid supply chain architecture and improving supply chain performance through IT.

3.1. Measures
Previous studies were used to develop measurement instruments, and all of the constructs in this study were measured with multi-item five-point Likert-type scales.
The supply chain architecture measure was adopted from Hsu *et al.* (2008). This scale measured the supply chain management efforts of companies: whether they searched for new ways to integrate activities, such as establishing trust and procuring frequent contracts with supply chain members.
The product lean launch was measured using a multi-item scale developed by Calantone and Di Benedetto (2012). This scale measures firms' response time to customers, ability to maintain low inventory cost, and flexibility of techniques to launch new products in a timely manner. To measure product innovativeness, we used a multi-item scale drawn from Atuahene-Gima (1996) and Lee and O'Connor (2003) to measure the extent to which a new product's benefits and features offer a unique advantage over competitors. To measure the effectiveness and efficiency of NPD, we used a product development capability scale taken from Huang and Chu (2010). For new product performance, we used a multi-item scale drawn from Song and Parry (1999), which assessed whether the new product achieved the sales and profit goals as well as customer satisfaction. Appendix A presents all measurement instruments.

3.2. Sampling frame and data collection
A total of 667 questionnaires were distributed and a total of 235 usable responses were returned for analysis, representing a response rate of 35%. Of the manufacturers that responded to the survey, their major product lines break down as follows: laptop and desktop computers (30.6%), PC monitors (12.8%), industrial computers (14.9%), tablet PCs (9.3%), mobile phones (18.3%), and networking products (14.1%).

4. Model and hypothesis testing
AMOS 18 was used to estimate the parameters for the proposed conceptual model. Figure 2 shows the estimation results (GFI = 0.935, AGFI = 0.910, RMSEA = 0.017, p-value = 0.271, chi-squared = 177.706 (d.f. = 167)). Most of the hypothesized main effects are significant at the $\alpha = 0.05$ level.

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The path coefficient of IT-based supply chain architecture to product lean launch is 0.324 (t = 3.467, p < 0.01). We found a positive effect of IT-based supply chain architecture on product lean launch; therefore, H1a is supported. The path coefficient of IT-based supply chain architecture to product innovativeness is 0.275 (t = 3.984, p < 0.01). Therefore, H1b is supported, implying that IT-based supply chain architecture has positive effects on product innovativeness. In addition, the path coefficient of IT-based supply chain architecture to product development capability is 0.453 (t = 5.085, p < 0.01). Therefore, IT-based supply chain architecture has a positive effect on product development capability, and H1c is supported.

The path coefficient of product lean launch to new product performance is 0.507 (t = 4.488, p < 0.01). H2 is thus supported, implying that lean launch execution has positive effects on new product performance. The path coefficient of product innovativeness to new product performance is 0.704 (t = 3.481, p < 0.01). Product innovativeness has a strong direct effect on new product performance, supporting H3. The path coefficient of product development capability to product performance is 0.373 (t = 2.644, p < 0.05). We also found that new product capability has a positive effect on new product performance, supporting H4.

[Insert Figure 2 approximately here]

5. Discussion

This study found that IT-based supply chain architecture has a positive effect on lean launch execution. Manufacturers check the precise materials inventory or demand status for a new product with suppliers through MRP systems. A high level of IT-based supply chain architecture can prevent material shortages and help manufacturers minimize inventory costs during a new product launch. The results also reveal that a high level of IT-based supply chain architecture has a direct positive influence on product innovativeness. This result is consistent with the literature on innovativeness. Firms' supply bases not only offer products and services but also are a critical source for obtaining innovative ideas for products (Lawson *et al.*, 2009). Through supply chain systems, manufacturers ask key suppliers for their input on specific functions that might bestow a market advantage, and suppliers share new material specifications, product roadmaps, and technical and market knowledge with manufacturers. This study also found that product development capability is derived from IT-based supply chain architecture. IT enables supply chain management to overcome a lack of resources during the NPD stage. To reduce NPD costs, an IT-based supply chain could improve the flow of information to decrease non-value-added development activities and support quick changes of product design to meet customer requirements between manufacturers and suppliers.

NPD activities act as a mediating mechanism on new product performance. We found that lean launch has a direct positive impact on new product performance. This implies that the execution of the lean launch of a new product could keep inventory to a minimum at a lower cost, and enable quicker responses to customers and the timely availability of new products, both of which improve customer satisfaction. This study found that new product performance is derived from product innovativeness. Manufacturers build a trusting relationship with suppliers, learning from each other and innovating together on products. This innovativeness could result in new or unique functions that create a competitive advantage, leading to gains in market share and profit. The results reveal that product development capability has a positive effect on new product performance. For example, a high level of product development capability implies that manufacturers could facilitate a development schedule with more cost savings; ensure that product design is compatible with manufacturing processes, given production capability improvements; and design quality products that attract customers and can be delivered on time to meet market demand.

5.1. Limitations and suggestions for future research

One limitation of this study is that it only considers three moderating effects of new product activities on the relationship between IT-based supply chains and new product performance. Future research could adopt the theoretical model in this paper to investigate whether additional factors moderate this relationship. Furthermore, future research can investigate the effects of other types of supply chain architecture on new product performance, such as trust and risk.

5.2. Managerial implications

This paper provides some managerial implications for manufacturers in the technology industry. First, this study indicated to managers the specific characteristics of an IT-based supply chain. By relying on long-term relationships, manufacturers can use IT to efficiently execute critical processes with suppliers, such as demand forecast planning, order placement, materials shipping status updating, and product engineering changes. If they build a stable supply chain through IT, manufacturers can precisely plan their clear goals, shorten processes, and

reduce the risks in supply chain activities.

Second, this study provided empirical evidence that IT-based supply chains are critical for the improvement of NPD activities. Manufacturers cooperate with suppliers through IT systems, leading to higher levels of NPD activity execution in the high-tech industry. Manufacturers can communicate with suppliers in more detail and suppliers can respond quickly, incurring lower costs on the product lean launch stage. Additionally, manufacturers can improve product innovation using new technology and functions through the frequent exchange of technological information, market information, and creative ideas with suppliers. Suppliers can customize key components to improve quality during manufacturers' new product development.

Finally, an IT-based supply chain improves new product performance indirectly. Leveraging the capabilities of NPD activities toward new product performance is particularly crucial. Technology manufacturers can cooperate with suppliers to increase their flexibility, quality, and efficiency for NPD activities through IT to meet frequent changes in customer demand; regarding product diversification and quality, for example. Then, customers' satisfaction in the new product increases, achieving profit and sales targets.

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Appendix

Measurement scales of constructs

(Respondents were requested to answer the following questions, choosing the most appropriate option from a continuum of strongly agree to strongly disagree on a Likert 5-point scale.)

IT-based supply chain architecture (Hsu et al., 2008)

How important are the following issues in your firm's supply chain management efforts?

- Improving the integration of activities across your supply chain through IT

- Searching for new ways to integrate SCM activities through IT

- Establishing more frequent contact with supply chain members through IT

- Creating a greater level of trust among your firm's SC members through IT

- Involving SC members in your product/service/marketing plans through IT

Product lean launch (Calantone and Di Benedetto, 2012)

- Work-in-process inventories were well-controlled.

- QR (Quick Response) or ECR (Efficient Customer Response)

Programs were in force.

- Flexible manufacturing techniques were used on this project

Product innovativeness (Atuahene-Gima, 1996; Lee & O'Connor, 2003)

- The innovation addresses a wholly new customer benefit.

- The innovation offers customers unique advantages over competitor products.

- The innovation introduced completely new features to the market.

Product development capability (Huang & Chu, 2010)

- Development of products with high quality.

- Product development at high speed.

- Product development at low cost.

New product performance (Song and Parry, 1999)

- The product has achieved our sales goal

- The product has achieved our profit goal

- Customers are very satisfied with the product performance
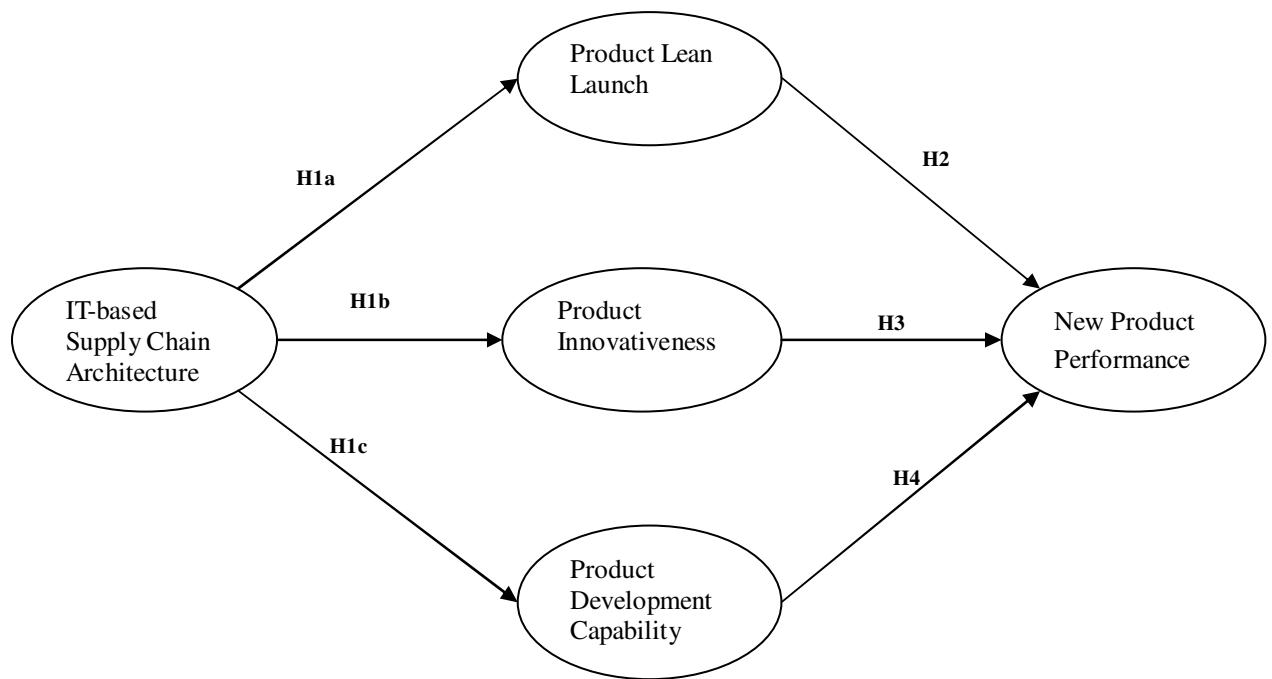
Figure 1. Theoretical model.
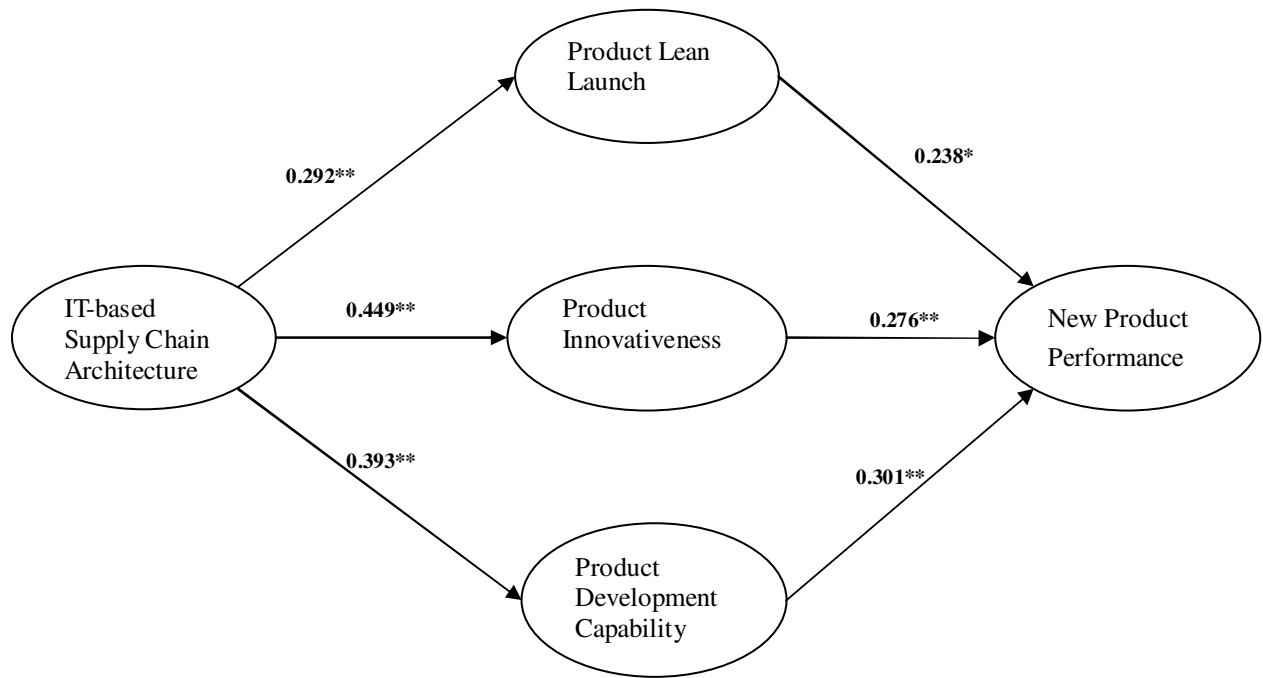
Figure 2. Analysis results of structural equation model (* p < 0.05, ** p < 0.01).

Notes: Dotted and solid arrows indicate nonsignificant and significant paths, respectively.

The Impact Of Psychological Occupational Strain Load On Engineering Managers Decision Making Behaviour

Dirk FÖRSTER-TRALLO[a], Thomas RACHFALL [b]

[a] *Hochschule für Technik und Wirtschaft Berlin, Fachbereich 4, Ostendstraße 1, 12459 Berlin, Germany,*
E-Mail: dirk.foerster-trallo@htw-berlin.de, Phone: 49 (0) 30 5019 3596
[b] *Hochschule Merseburg, Fachbereich Wirtschaftswissenschaften, Eberhard-Leibnitz-Str. 2 06217 Merseburg, Germany*
E-Mail: thomas.rachfall@hs-merseburg.de

Abstract

Executives, especially in the technical work environment, are influenced by different psychological strains at the workplace. The negative effects on health have been studied in recent years. Predominantly, the effects on physical well-being have been investigated and there are few studies on the effects of chronic psychological strains on information processing and decision-making behaviour. This paper presents the results of a study that examined the decision-making behaviour of 53 engineering managers. The participants can be divided into three groups according to their chronic psychological occupational strain load (high, medium, low). The decision-making behaviour of the participants was investigated using a quasi-experimental research design. It has been established that the decision-making behaviour at low or high loads is becoming increasingly extreme and unpredictable.

Keywords: stress, psychological strains, decision-making under stress, engineering manager

1. INTRODUCTION

The work environment is subject to constant change and the demands on organisations and their members are becoming increasingly complex [Schoeneberg 2014]. This increase in complexity is due to the development of modern production and information technologies, shorter product lifecycles and increased global competition [Rothe et al. 2017]. Furthermore, companies are reacting to crisis faster and more quickly than before with restructuring measures, thus increasing the pressure on organisations and their members [Schütte & Köper 2013]. The effects of increased pressure have been the focus of scientific work for about 20 years. It has been shown that stress occurs when individuals are no longer able to control the stress. As a result, negative health consequences arise which negatively influence the individual and their performance [Michie 2002, van Onciul 1996].

Along with the increasingly complex world of work, the cognitive demand for knowledge workers is also increasing, as more and more information is available and has to be processed [Bouwman 2005; Schoeneberg 2014; Rachfall 2017]. This is particularly important for decision-making [King 2014; Speier & Morris 2000] which is one of the main tasks of executives [Malik 2007]. Various scientific research disciplines have investigated the influence of strains and stress on decision- making [Starcke & Brand 2012; Pabst et al. 2013; Burns & Zurilla 1999; Staal 2004]. It has been found that cognitive abilities are influenced and thus have a negative impact on decision-making behavior. Starcke & Brand [2012].

Thus, an overall picture results that organisations and their members are influenced by psychological burdens in connection with work and the working environment. In addition, the negative health effects on employees and managers are also known. In connection with the characteristic tasks of knowledge workers and executives, it is also known that information processing and decision-making are negatively influenced. However, in the studies to date, the effects of acute strains on decision-making behaviour have mainly been investigated and it was experiment investigated, rather how "good" or "bad" a decision was examined. It was often analysed which financial value a decision led to. However, in order to analyse the decision-making behaviour of managers, realistic environmental

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conditions and examples under the influence of chronic strains should be used. In the contribution presented here, the decision-making behaviour of executives is examined on the basis of a personnel decision. Therefore, participants in the study were provided with one job description for a quality engineer position. In addition, they received the CVs of four fictional candidates for this position. Since, it has been ensured that each of these options has the same probability of being chosen, the decision behaviour could be analysed in relation to the psychological occupational strain load.

2. THE ROLE OF STRESS IN DECISION-MAKING

Every person reacts differently to cognitive stress. The validity of the statement made by Dodson and Yerkes in an animal experiment back in 1908 that performance depends on the degree of stress and decreases in the event of an overload or underload has been the subject of intense debate for decades. The validity for the human decision-making process has been proven several times and is shown in Figure 1 [Staal 2004; Hunter & Thatcher 2007; Szalma & Hancock 2008].
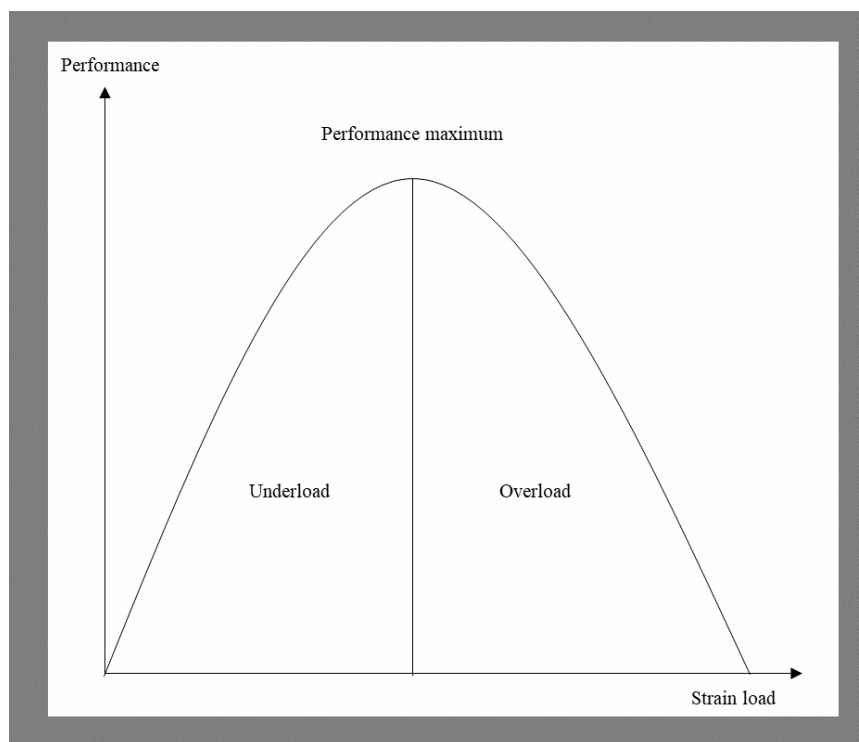
Figure 1: Performance curve by Dodson and Yerkes

[Source: von Nitzsch 2006, p. 70]

This law describes the cognitive performance depending on different general nervous excitation levels, which are also called activation levels: There is a reverse U-shaped connection between physiological activation and performance. It is also known as an activation model. The performance progression is very variable for every person. It depends on the level of emotional activation. In the event of underchallenge, people fall short of their capabilities - a performance leak occurs. A healthy degree of emotional activation can increase performance to a peak level. If the excitation level rises above the required level, the power decreases again. If the power curve is entered into a coordinate system as a function of the excitation level, the U-curve is reversed. This connection is called the Dodson- Yerkes Law [Zimbardo & Gerrick 2008; Dodson & Yerkes 1908; Staal 2004; Hunter & Thatcher 2007].

The validity of this model for individuals' decision-making has already been proven experimentally by Förster-Trallo & Rachfall [2012;2016]. They investigated how performance under stress, induced by time pressure, evolved over four different degrees of difficulty (according to Svenson [1990,1996]. The managers solved logic tasks of

varying difficulty and had 1 minute, 3 minutes or 5 minutes to solve the tasks. It has been found that in all difficulty levels, the managers with medium strain load solved most of the answers correctly.

The fact that stress influences information processing and decision-making behaviour has been proven several times [Starcke & Brand 2012; Szalma and Hancock [2008]; Pabst et al. 2013; Burns & Zurilla 1999; Staal 2004]. With reference to the publication of Starcke & Brand [2008], the effects can be summarised as follows and are illustrated in Figure 2:
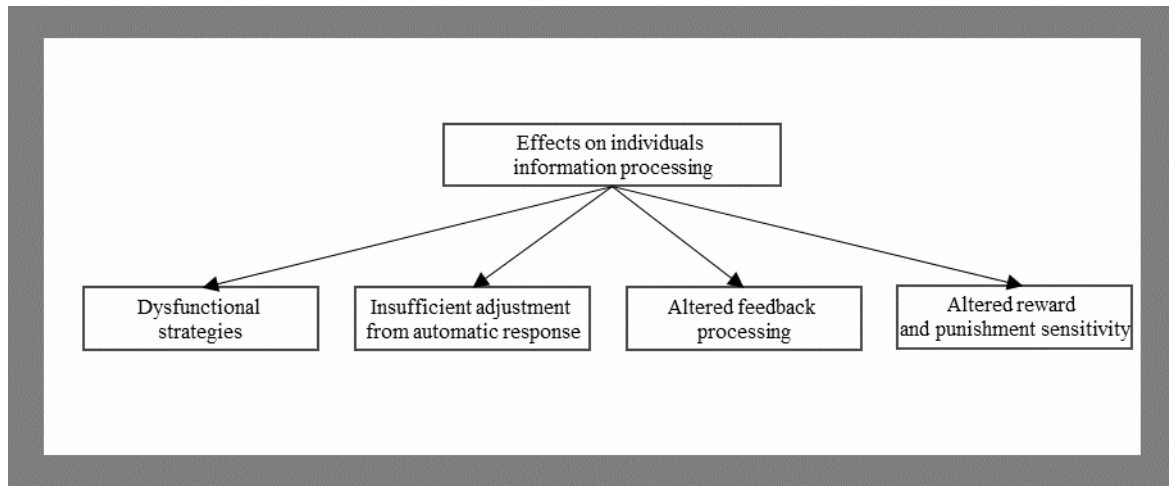
Figure 2: Effects on individuals' information processing

[source: Starke & Brand 2008]

- **Dysfunctional strategies:** Under stress, decision-makers make rash decisions without any possible alternatives to be assessed conclusively. This was found in experiments under real conditions and laboratory conditions. In addition, non-systematic scanning of alternative as well as temporal narrowing of information was found during the decision-making process [Starcke & Brand 2012]. In addition, Brand et al. [2006, 2008] noted that decision-makers made more risk and therefore disadvantageous decisions [Starcke & Brand 2012].

- **Insufficient adjustment from automatic response:** By analysing current peer-reviewed articles, Starcke & Brand [2008] determine that information is processed according to the context of the presentation. Adaptation to a situation was positively influenced if the participants of an experiment received positive rather than negative feedback. Subsequently, the subjects who have received positive feedback chose the better alternatives. In addition, Starcke & Brand [2008] summarise that under stress, decision preferences shift. Under stress, decision-makers make conservative decisions when there are only alternatives available where they can win. On the other hand, decisions that involve a loss are more risky decisions.

- **Altered feedback processing:** Decision makers choose alternatives under stress which are accompanied by high losses if higher profits are promised in the course of information processing. This misinterpretation of the information is associated with damage to the prefrontal cortex regions or the amygdala [Starcke & Brand 2008]. In addition, they note that the learning curve for repetitive tasks under stress is slower for stressed individuals [Starcke & Brand 2008]. In addition, a study by Gray [1999] shows that stress has a negative impact on decision-making, as participants in the study he conducted chose alternatives under high strain load that enabled lower profits than groups with less strain load.

- **Altered reward and punishment sensitivity:** Under stress, participants of a fictitious second person decided to allocate more money than themselves. So, they overreached another person by distributing an

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unequal amount of money in favour of the second person. The results were interpreted by Starcke & Brand [2008] in light of evolutionary theories that postulated that social evaluation triggers reputation formation tendencies. Moreover, Oliver et al. [2000] note that people who are stressed tend to eat unhealthy food rather than non-stressed people. This is justified by the assumption that individuals under stress tend to reward themselves. In this experiment by choosing unhealthy snacks.

However, it has not yet been demonstrated whether the decision-making behaviour of engineering managers has been influenced by the degree of chronic psychological occupational strains. Therefore, this contribution tries to close this gap in science. The methodology of the study used for this purpose is described below.

3. Methodology

A quasi-experimental research design was chosen to investigate the effects of chronic psychological stress on the decision-making behaviour of managers. Using this design, the following hypothesis - H1- - and the associated alternative hypothesis H0- are to be tested.

H1:	The degree of psychological occupational strain has no influence on the decision-making behaviour of engineering managers at a personnel selection decision making task.
H_1_0:	The degree of psychological occupational strain influences the decision-making behaviour of engineering managers at a personnel selection decision making task.

In order to verify the hypothesis, it is imperative to determine the psychological occupational strain load of the participants in detail. In order to measure not only the burdens resulting from the workplace design but also macroeconomic aspects for consideration, a questionnaire was developed. This questionnaire took into account the aspects and scales from Karaseks Job Demand Job Control Model [Karasek 1979; Karasek 1989; Karasek and Theorell 1999] as well as from the Effort reward Imbalance Model by Siegerist [Siegrist 1996; Siegrist 2008; Siegrist 2010; Siegrist et al. 2004; Siegrist et al. 2009].

The quasi-experiment was designed in such a way that each participant was provided with a job description for a quality engineer at the beginning. This job description regulated the requirements for the potential job holder and was developed on the basis of a qualitative analysis of 75 existing job advertisements. The requirements for a potential job holder can be divided into the following dimensions.

- General information (job title, workplace, etc)

- Task and field of activity section (description of the job)

- Required skills (kind of studies, detailed quality managements skills, required it-skills)

- Required individual skills

- Required language and readiness to travel

In addition, each participant received the CVs of four fictitious candidates for this position and the participants chose what they considered to be the most suitable candidate. These four CVs were developed with the collaboration of five experts with various scientific backgrounds and a business relation with quality management. These CVs' had been developed iteratively with the objective to process four equally suitable CVs'.

19 pieces of information of each candidate were provided by the CVs with the objective to describe candidates' suitability for the provided job. The information was provided in a three page CV. On the first page descriptive data were given, on the second page the six dimensions of the Bochum Inventory for Profession-related Personality description (BIP) test are explained and rated and on the third page a graphic evaluation in form of a target range is presented. The structure of the CVs and presentation form were developed with respect to the status quo of information processing and application praxis. The following information are included in the CV:

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- Age, university, course of studies, study focus, grade, information about internship, internal experience, if the applicant wrote an practical or theoretical oriented thesis, topic of the thesis, language skills, IT skills, individual strengths (self-perceived by the applicant), extracurricular activities, engagement according to the BIP 6F test, discipline according to the BIP 6F test, social competence according to the BIP 6F test, co-operation skills according to the BIP 6F test, dominance according to the BIP 6F test and stability according to the BIP 6F test.

To secure the equality of the provided CVs' it is necessary to evaluate the importance of each information of the decision as well as the respective characteristic values. By that a total utility value of each option can be calculated as presented in formula 1. The equality is given when the utility values are similar to each other. Perfect equality is attained when the utility values are exact equal [Jungermann et al. 2010]. Since four options are offered the totally equality is given when each option will be chosen with a probability of 25%.

$$(1) \quad MAUi = \Sigma Wj * Uj$$

Importance of provided information: With the help of the AHP process the importance of each information could be calculated [Saaty 1987; Saaty & Vargas. 2013]. Therefore, and after introducing interview, five experts with a background in HR and quality management received a predefined excel spreadsheet as well as a two-sided explanation document. Each expert evaluated the information by pair-to-pair comparisons. The AHP process was used to translate these comparisons of each expert into an eigenvector which can be used to calculate the importance of each information. The average assessment of the importance per information was evaluated by the mean assessment. Finally, the utility value of each CV was calculated by the added-up multiplication of the importance of each information and the respective characteristic values of each candidate. In the design phase of the quasi-experiment a deviation of 2% percent points was determined as acceptable. The authors of this contribution cannot control any variable during the decision-making experiment and is not able to exclude all individual impact factor for the decision. Therefore, a quasi-experiment instead of an experiment was chosen which allows the researcher to accept a not fully controlled decision-making situation [Bortz & Döring 2006; Saunders et al. 2012; Kubbe 2016; Baur & Blasius 2014].

However, to analyse the decision-making behavior of engineering manager it is necessary to secure the equality of each provided option during the experiment. This was secured by the here provided approach. After the influence of the respective information on the decision was determined, the CVs had to be designed in such a way that each candidate was elected with the same probability. For this purpose, 4 lab runs were prepared in detail and the suitability of the respective candidates was evaluated by the experts. Subsequently, the mean values were determined for each candidate. In this way, the probability with which each candidate was chosen could be determined. iteratively examined. The researcher consider the CVs as equally suitable when the respective calculated utility value for each option is between 23.0 % and 27.0 %. At the first iteration this requirement was not met and an adaption of the CVs was necessary. With respect to the evaluation result the CVs were adopted and re-evaluated by the experts. The second iteration step showed a better fit of the candidate. However, the results did not meet the requirements and a third iteration step was necessary. The results of each iteration are pictured in table 1.

Table 1: Calculation of suitability

Iteration step	Suitability Option 1	Suitability Option 2	Suitability Optione 3	Suitability Option 1
Age	18.39 %	21.14 %	29.67 %	30.80 %
Course of studies	22.12 %	22.78 %	29.11 %	25.99 %
University	24.17 %	25.59 %	23.73 %	26.51 %

Since the degree of psychological occupational stress was known to each participant on the basis of the previously conducted questionnaire survey, the decision behaviour of the participants could then be determined

depending on the psychological occupational strains. Since it has been ensured that each option is selected with the same probability, the decision-making behaviour can be analysed by comparing the frequency of the selected options per load level.

Sample of this are paper Engineering manager at the middle management level in Germany. Various sources suggest that approximately 285.000 of them are working in the automotive sector, the industrial or telecommunication sector [Thiel 2009; Ihsen 2008]. Finally, 1.566 engineering managers in Germany were invited and 153 of them participate on the questionnaire. 53 of them participate on the quasi-experiment to analyse the impact of psychological occupational strains on engineering managers' decision-making behavior. Most of the participants were between 30 and 39 years old (65.38 %), male (94.34 %), working an average of 44.01 hours per week.

4. Results

A total of 53 engineering managers have participated in an experiment to test whether executives choose different options under different loads. Based on the results of the quantitative data collection, the participating executives were divided into three different groups depending on their strain load, in managers with low, medium and high psychological occupational strain load. 14 participants were considered as engineering managers with low psychological strain load, 18 with medium load and 21 with high load.

As shown in Figure 3, different decision behaviour of the participants is visible, and a statistical analysis is carried out in Table 2. While the participants with a low strain load do not choose option 1 at all, the participants with a higher strain load will choose option 1 more often. Seven participants with a medium strain load and ten participants with high strain load consider Candidate 1 to be the most suitable candidate. Candidate 2 is considered the most suitable by four participants with low strain load, while six participants with medium and two participants with high strain load selected this option. Five participants with low strain loads and three participants with higher strain loads considered option 3 to be the most suitable candidate. Option 4 was chosen by eight participants with low strain loads, whereas only three, respectively two, participants with medium or high loads considered this candidate to be the most suitable.
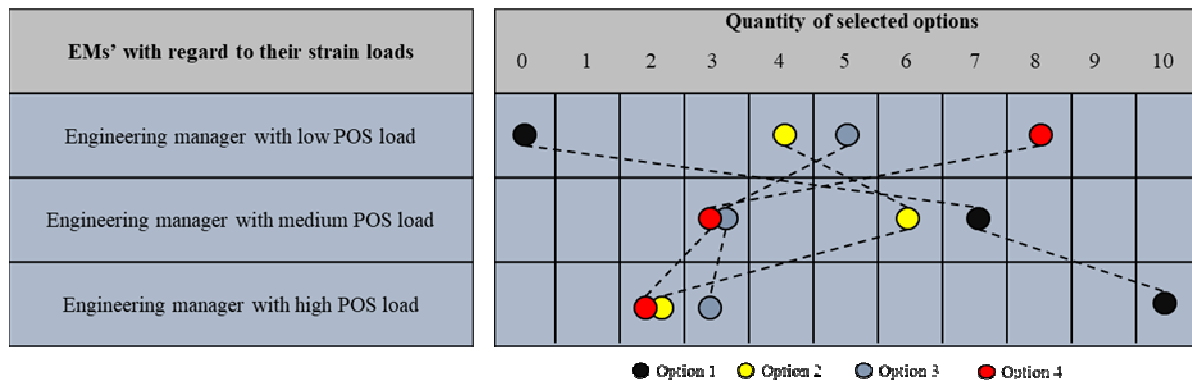
Figure 3: Decision-making behaviour with respect to psychological occupational strain load

Table 2 shows how often each option was chosen within the strain level, within the option and in total. Engineering manager with a low psychological occupational strain load chose option 4 most often, as eight out of 17 participants chose this candidate (47.1%). No participant in this group chose candidate 1 and candidates 2 respectively 3 were elected four times (Candidate 2:23.5%) respectively five times (Candidate 3: 29.4%). Seven out of 19 participants with a medium strain load chose candidate 1 (36.8%) and six participants chose candidate 2, while candidates 3 and 4 were elected three times (15.8% each). The majority of engineering managers with a high strain load preferred candidate 1, as ten out of 17 participants chose this candidate (58.3%). The remaining candidates were found to be less as the most suitable. Two participants each chose candidate 2 or candidate 4 and three participants chose candidate 3.

Table 2 also illustrates the decision-making behaviour of the options with regard to the psychological occupational strain load. It can be seen that 17 participants elected candidate 1. In total ten of them have a high strain load and seven have a medium one. No participant with low psychological occupational strain load chose candidate 1 as the most suitable candidate. Candidate 2 was predominantly chosen from engineering managers with medium strain load. Six out of twelve participants who preferred these candidates belonged to the strain group 2 which represents engineering managers with medium strain load. Four candidates with low strain load and two participants with high strain load considered candidate 2 to be the most suitable candidate for the advertised position. A total of 11 participants considered candidate 3 to be the most suitable candidate for the advertised position of quality engineer. Five of them have low psychological occupational strain load and three participants each have medium or high strain load. Candidate 4 was considered as the best suited option 13 times. Of these 13 participants, eight belonged to the strain group 1 which represents participants with low strain load and two respectively three participants have medium or high strain load.

Table 2: Cross table: Decision-making behaviour per strain group

Cross table: Decision making behaviour per strain group						
Strain level	Analysis dimension	Chosen option				Overall
		1	2	3	4	
Low	Quantity	9	2	1	2	14
	% within strain level	64.3%	14.3%	7.1%	14.3%	100.0%
	% within option	56.3%	15.4%	9.1%	15.4%	26.4%
	% of total	17.0%	3.8%	1.9%	3.8%	26.4%
Medium	Quantity	0	4	6	8	18
	% within strain level	0.0%	22.2%	33.3%	44.4%	100.0%
	% within option	0.0%	30.8%	54.5%	61.5%	34.0%
	% of total	0.0%	7.5%	11.3%	15.1%	34.0%
High	Quantity	7	7	4	3	21
	% within strain level	33.3%	33.3%	19.0%	14.3%	100.0%
	% within option	43.8%	53.8%	36.4%	23.1%	39.6%
	% of total	13.2%	13.2%	7.5%	5.7%	39.6%
Overall	Quantity	16	13	11	13	53
	% within strain level	30.2%	24.5%	20.8%	24.5%	100.0%
	% within option	100.0%	100.0%	100.0%	100.0%	100.0%

The distributions shown in the above paragraph show that engineering managers' with high psychological occupational strain load have a different decision-making behaviour than engineering manager with low or medium strain load. To check whether these deviations are random or not, the exact chi-square test was performed and is presented in Table 3. The results show a significance level of 0.2%. Since the significance is less than 5%, the null hypothesis of independence between the degree of strain load and decision-making behaviour is rejected and a significant correlation between the two variables studied is assumed. Thus, it has been proven that psychological occupational strain load influences the decision-making behaviour of engineering managers.

Table 3: Chi-Square Test for hypotheses 1

Chi-Square Test				
Tests	Value	Degree of freedom	Asymptotic significance two-sided	Exact significance two-sided
Pearsons' Chi Square	19,255[a]	6	0.004	0.003
Likelihood-Quotient	23.305	6	0.001	0.002
Fishers' exact test	19.635			0.002
Number of valid cases	53			

5. Discussion

The effects of stress on decision-making situations have been discussed more intensively in recent years. However, the study carried out here differs in its intension and structure from the previously known studies. On the one hand, the decision-making behaviour is investigated in relation to chronic strain load, in this case psychological occupational strain load. On the other hand, this research only investigates whether the decision-making behaviour of managers is influenced by psychological occupational strains. The quality of the answer is deliberately ignored. The participants were given four options to choose from, which promise an almost identical outcome in terms of the Multi Attribute Utility theory. The decision-making behaviour of the study participants was investigated to determine whether the decision-making behaviour changes depending on the chronic strain loads during the decision-making process. As far as the authors know, the findings obtained here are thus unique for the cohort studied and with regard to the type of data collection. It has been found that engineering managers with high or low psychological occupational strain load have a more extreme decision-making behaviour than engineering managers with a medium chronic strain load. At medium load, the results are significantly closer to the predicted 25% probability than at high or low load. This corresponds to results obtained under laboratory conditions. Like this research, Wise et al. [2015] found that more risky decisions are made under stress. Leder et al. [2015] also used a quasi-experiment to investigate decisions under stress. They show that simple decision heuristics can be applied under stress, but that more complex calculations are no longer possible. In addition, the likelihood of misinterpretation increases. Consequently, a more extreme result can be expected as in the personnel selection experiment carried out here. Furthermore, Simonovic et al. [2017] conclude that the degree of strain load influences information processing and that this can also have an influence on decision-making behaviour.

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An Evolutionary Game and Simulation Analysis of Frugal Innovation Behavior under Different Levels of Knowledge Potential

Zhang SHUDAN [a], Zhao YUNHUI [b*], Zhao CHUANLI [c], Li YAHUI [d]

(a. Inner Mongolia University of Finance and Economics，Hohhot, China, zsd0710@163.com)

(b. Inner Mongolia University of Finance and Economics，Hohhot, China, zhaoyunhui602@126.com)

(c. Inner Mongolia University of Finance and Economics，Hohhot, China,417242783@qq.com)

(d. Inner Mongolia University of Finance and Economics，Hohhot, China, gsxlyhgg@126.com)

Abstract

The Belt and Road strategy has provided a good opportunity for the development of the emerging market. Enterprises must choose between adopting traditional innovation with high investment in pursuing multi-functional products and adopting frugal innovation that saves resources. Given their different levels of knowledge potential, these enterprises are playing a game of choice between the two innovation models: both their income situations and game results are different. This study divides the enterprise into two knowledge potential: high and low, and randomly selects two companies from different knowledge potential groups. It is divided into nine different situations. The evolutionary game method is used to analyze their selection behavior of the innovation model and simulations are performed. The results show that in nine different situations, the evolutionary trend of enterprise innovation behavior choice is different, and that the enterprise can choose the most favorable innovation behavior according to its income situation.

Keywords: knowledge potential; frugal innovation; traditional innovation; evolutionary game

1. INTRODUCTION

With the development of the economy, innovation models have also developed. In addition to traditional innovation types such as imitation, integration, and original innovation, new models have recently emerged, such as open innovation, disruptive innovation, frugal innovation, and integration and innovation. Faced with limited global resources, environmental degradation, and the expense of classic innovation models, people and organizations began to seek more affordable and effective methods and technology. Specifically, the creation of frugal innovation, a destructive growth strategy, has provided new development ideas for solving these problems. Its goal is to create more business opportunities and social value by using fewer resources, less funding, and less time, resulting in sustainable, simple, high-quality, and affordable products or services (Navi, 2014).

Frugal innovation originated in emerging economies, such as China, India, and Brazil. It focuses on developing products for low- and middle-level consumers, in order to "do more with less" (Ganapathy, 2015). Given the documented advantages of frugal innovation, more developed countries have also developed interest in it. This new paradigm of innovation can help firms in developed countries survive economic crises and meet

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consumer needs for a simplified lifestyle (Rao, 2013). So, there is a question: whether companies need to change their innovation model to make frugal innovations or continue with traditional classic innovations. In order to answer this question, this paper studies the choice of companies' innovation behaviors in different knowledge potential positions by means of an evolutionary game, analyzes the choice between innovation behaviors by companies with different knowledge potential, and simulates the related evolutionary trends. By doing so, the paper provides a theoretical basis for choosing innovation behavior.

2 Theoretical Review

2.1 Knowledge Potential

The concept of knowledge potential draws on the theory of potential energy in physics to study the depth and breadth of knowledge. It is believed that each knowledge subject in the innovation network will result in a gap in knowledge potential, due to the breadth and depth of knowledge (Li, Dang, & Zhang, 2007). A company's knowledge potential is a function of the depth and breadth of its knowledge (Ryu & Kim, 2005; Turner & Bettis, 2002). The knowledge possessed by the company determines its knowledge potential, and knowledge is also the source of innovation. Therefore, the different knowledge potentials of a company will inevitably affect its innovation ability and innovation behavior. Liu and Dang (2013, 2015) showed that different knowledge breadths and depths influence different ways of acquiring knowledge for disruptive innovations. They recommended that companies acquire knowledge based on the breadth and depth of the knowledge acquired. In 2015, 252 high-tech companies were surveyed to empirically study the impact of different types of knowledge acquisition on technological innovation under different knowledge potentials. The results empirically verified the authors' 2013 conclusions. Guo and Yi (2012, 2013) defined knowledge potential in a two-dimensional space of knowledge breadth and knowledge depth. Based on this, a task-based team knowledge innovation model was constructed, and the authors analyzed the team cooperative innovation of high and low knowledge potential teams through a game. This provided guidance for the selection of partners for cooperative innovation. Under open innovation, enterprises form higher knowledge potential through vertical and horizontal knowledge acquisition and knowledge research, which is conducive to the development of corporate innovation behavior.

In the era of the knowledge economy where uncertainty is the only determinant, the rules of market competition are changing. Knowledge-based competition has gradually become the main method for enterprises to obtain competitive advantages. The acquisition, integration, and management of knowledge have become important strategic resources for enterprise innovation and an inevitable choice for the sustainable development of enterprises. In the development of innovative enterprises and innovative national policies, innovation is a necessary means for companies to obtain or maintain their competitive position in the market, and their knowledge potential determines enterprises' ability to innovate. The scales of companies' size, knowledge stock, knowledge depth, knowledge acquisition ability, and knowledge absorptive capacity are all different, which will inevitably affect their innovative behavior. Therefore, it is of great significance to study the choices in corporate innovation behavior under different knowledge potential.

2.2 Frugal Innovation

Innovation is the key to adapting to a fiercely competitive environment and gaining a sustainable competitive advantage. The more intense the competition, the more important innovation becomes. As global competition has been fierce, companies have sought various innovation models to gain a place in the market. As a result, various forms of innovation have emerged globally, such as the User Innovations model proposed (Von Hippel, 1986), Disruptive Innovation (Christensen, 1997), Open Innovation (Chesbrough, 2003), Design-driven Innovation (Verganti, 2009), Social Innovation (Nicholls & Murdock, 2012), Common Innovation (Swann, 2014), Jugaad Innovation (Radjuu et. al, 2012), Imitation (Kim, 2000), Indigenous Innovation (Chen, 1994),

Comprehensive Innovation (Qingrui Xu, 2006), and Holistic Innovation (Chen, 2017). Among the many innovative models, the frugal innovations model proposed by Indian scholars in 2012 has received extensive attention.

The concept of introducing frugality into innovation first appeared in emerging markets, as a resource-constrained innovation model created to meet the needs of consumers at the bottom of the pyramid. This model aimed at satisfying the needs of consumers, and optimized a supply network and value network by taking into consideration costs and quality to achieve multiple features such as functionality, robustness, and affordability of low-cost products or services (Chen, 2014; Mourtzis et. al, 2016; Navil, 2014; Prahalad, 2005). Generally, enterprises will have a set of structured procedures and spend a lot of R&D resources to innovate. However, due to the constraints of some legal systems, resources, and other factors, companies have obtained limited returns despite large amounts of R&D investment. At the same time, corporate innovation enters a bottleneck stage. Frugal innovation provides an effective way to solve these problems. Companies like 3M, GE, Pepsi, Renault-Nissan, Facebook, Google, and Siemens all use frugal innovation to achieve breakthrough innovation results. Since the creation of frugal innovation, it has been prevalent in India. The application of frugal innovation in India has provided valuable experience for other emerging countries to carry out such innovations.

Frugal innovation is also increasingly important in developed countries (EU Commission, 2016; Nesta, 2016; Tiwari et al., 2016). The EU (2014) proposed to deal with the global "Grant Challenges" policy by emphasizing that the use of frugal innovation should be applied to developed economies, especially those related to Key Enabling Technologies. The global economic crisis in 2008 has had an important impact on the economic development of many countries. Learning from the frugal style of developing countries helped developed countries redefine innovation and survive the economic crisis (Rao, 2014). For developed countries, the consequences of this crisis required a new paradigm of innovation to meet the needs of socio-economic development; developing countries, where there are a lot of low- and middle-income groups, need to reform the traditional innovation paradigm in order to meet the consumption needs of these groups and develop low-price, high-quality products. Therefore, frugal innovation was not only adapted to the development of emerging economies, but also brought new development opportunities for developed countries.

3 Basic assumptions of the model

The paper divides innovation models into two categories: the traditional classical innovation model and the frugal innovation model. Enterprises need to choose one according to which innovation behavior will be most profitable. In the game between low-knowledge-potential companies and high-knowledge-potential companies that choose an innovation model, each participating company's decision will have an impact on the decisions of the other participating companies. In order to maximize their own benefits, the players need to adjust their own innovation models based on the others' choices. In order to achieve "win-win," high- and low-knowledge-potential companies must consider their innovation strategy in the long-term, rather than focusing on short-term benefits. Assume that there are several high- and low-knowledge-potential companies that produce similar products in the market, and that each company with different knowledge potential has two innovative models to choose from. In the traditional innovation model, enterprises use high input and high cost to pursue multi-functional products; in the frugal innovation model, they seek to "do more with less, do best with less" by pursuing simple, high-quality, and affordable innovation that is conducive to sustainable development (Navi, 2014). Thus, we can chart a game strategy combination for the choice of innovative models for low- and high-knowledge-potential companies. It is shown in Figure 1.

Figure 1. Innovation behavior game strategy combination

For the sake of analysis, the following assumptions are made in the model without changing the nature of the problem:

Assumption 1: High- and low-knowledge-potential companies are the subjects of bounded rationality. In this paper, the game subjects are divided into low-knowledge-potential and high-knowledge-potential enterprise groups, and each of the two groups is randomly selected for the game.

Assumption 2: Both high- and low-knowledge-potential companies have two innovation models: traditional innovation and frugal innovation.

Assumption 3: The probability of the low-knowledge-potential companies choosing the traditional innovation model is x, the probability of their choosing the frugal innovation model is 1-x, the probability of the high-knowledge-potential companies choosing the traditional innovation model is y, and the probability of their choosing the frugal innovation model is 1-y. Both x and y are functions of time and change over time.

When companies with different knowledge potential choose different innovation models, the paper also makes assumptions about their benefits and costs. When high- and low-potential companies both choose to carry out traditional innovation models, the income of low-potential companies is R1. The cost is C1. The income of high-knowledge-potential enterprises is R2 and the cost is C2. When low-knowledge-potential companies choose traditional innovation and high-knowledge-potential companies choose frugal innovation, the profits and costs of the low-knowledge-potential companies remain unchanged. However, due to the adoption of low-cost, frugal innovations, the high-potential company's income is $R_2^{'}$ and the cost is C_2-a, where is the reduced cost for a high-knowledge-potential company adopting frugal innovation and a>0. When a high-knowledge-potential enterprise adopts the traditional innovation model and a low-knowledge-potential enterprise adopts frugal innovation, the profit and cost of the high-potential enterprise remain unchanged, while the return of the low-knowledge-potential enterprise is $R_1^{'}$ and the cost is C_1-b, where b is the reduced cost for low-knowledge-potential companies adopting frugal innovations and b>0. Finally, when high- and low-knowledge-potential enterprises both make frugal innovations, the income of low-knowledge-potential companies is $R_1^{''}$, the cost is C_1-b, the high-knowledge-potential companies benefits are $R_2^{''}$, with the cost C_2-a.

The main parameters and their meanings are shown in Table 1. The game's income matrix for both parties is shown in Figure 2.

Table 1. Main Parameters and Meanings

Parameter symbol	Meanings
R_1	income of low-knowledge-potential companies for Traditional Innovation
C_1	cost of low-knowledge-potential companies for Traditional Innovation
R_1'	income of a low-knowledge-potential enterprise making frugal innovations when high-knowledge-potential companies adopt traditional innovations
b	the reduced cost for low-knowledge-potential companies adopting frugal innovations, b>0
R_1''	income of a low-knowledge-potential enterprise making frugal innovations when high-knowledge-potential companies carry out frugal innovations
R_2	income of high-knowledge-potential enterprises for Traditional Innovation
C_2	cost of high-knowledge-potential companies for Traditional Innovation
R_2'	income of a high-knowledge-potential enterprise making frugal innovations when low-knowledge-potential companies adopt traditional innovations
a	the reduced cost for high-knowledge-potential companies adopting frugal innovations, a>0
R_2''	income of a high-knowledge-potential enterprise making frugal innovations when high- and low-knowledge-potential enterprises both make frugal innovations

Low-knowledge-potential companies

High-knowledge-potential companies

Traditional Innovation (T)   Frugal Innovation（F）

Low-knowledge-potential companies	Traditional Innovation (T)	$(R_1-C_1,\ R_2-C_2)$	$(R_1-C_1,\ R'_2-(C_2-a))$
	Frugal Innovation (F)	$(R'_1-(C_1-b),\ R_2-C_2)$	$(R''_1-(C_1-b),\ R''_2-(C_2-a))$

Figure 2. Income matrix

According to the income matrix, we can see that the high- and low-knowledge potential companies choose their different innovation behaviors, their expected income, and their average expected income.

The expected income of low-knowledge-potential companies choosing traditional innovation and frugal innovation is:

$$U_{LT} = R_1 - C_1$$

$$U_1(LF) = y(R_11^{T'} - (C_11-b)) + (1-y)(R_11^{T''} - (C_11-b)) = yR_11^{T'} + (1-y)R_11^{T''} - C_11 + b$$

The average expected income of low-knowledge-potential companies is:

$$\bar{U}_1L = xU_1LT + (1-x)U_1LF = xR_11 + (1-x)yR_11^{T'} + (1-x)(1-y)R_11^{T''} + (1-x)b - C_11$$

The expected income of high-knowledge-potential enterprises choosing traditional innovation and frugal innovation is:

$$U_{HT} = R_2 - C_2$$

$$U_1HF = x(R_12^{T'} - (C_12-a)) + (1-x)(R_12^{T''} - (C_12-a)) = xR_12^{T'} + (1-x)R_12^{T''} - C_12 + a$$

The average expected income of high-knowledge-potential companies is:

$$\bar{U}_1H = yU_1HT + (1-y)U_1HF = yR_12 + x(1-y)R_12^{T'} + (1-x)(1-y)R_12^{T''} + (1-y)a - C_12$$

The replication dynamic equations for low- and high-knowledge potential enterprises are:

$$dx/dt = x(U_1LT - U_1^-L) = x(1-x)(R_11 - R_11^{T^*} - y(R_11^{T'} - R_11^{*}) - b)$$
$$dy/(dt = y(U_1HT - U_1^-H) = y(1-y)(R_12 - R_12^{T^*} - x(R_12^{T'} - R_12^{T^*}) - a))$$

When the two sides of the game reach equilibrium, the two parties' strategic choices will tend to be stable and will not change over time, i.e., $dx/dt = 0, dy/dt = 0,$ so the equilibrium point of the game can be obtained:

（0，0），（0，1），（1，0），（1，1），$\left(\left(\left(R_2 - R_2^{-a)/((R\_2^{\wedge'}-R\_2^{\wedge})} \right) \right), \left(\left(R_1 - R_1^{-b)/((R\_1^{\wedge\wedge}-R\_1^{\wedge})} \right)\right) \right)$.

4 Evolutionary Stable Equilibrium of Frugal Innovation Behavior and Simulation Analysis

4.1 Equilibrium Point and Stability Analysis

According to Friedman's method, the Jacobian matrix (marked as J) can be obtained by solving the partial derivative of x and y for the above two replication dynamic equations, and the matrix determinant (detJ) and trace (trJ) of the Jacobian matrix can be obtained as shown in Table 2. According to the signs of the values of detJ and trJ, the stability of the equilibrium of the evolutionary system can be analyzed.

$$J = [\blacksquare((1-2x)(R_11 - R_11^{T^*} - y(R_11^{T'} - R_11^{*}) - b); \quad -x(1-x)(R_11^{T'} - R_11^{*})@ \quad -y(1-y)(R_12^{T'} - R_12^{T^*}); \quad (1-2y)(R_12 - R_12^{T^*} - x(R_12^{T'} - R_12^{T^*}) - a) \quad)]$$

Table 2. Values of detJ and trJ of Jacobian Matrix

Equilibrium point	detJ	trJ
（0，0）	$\left(R_1 - R_1^{-b)(R\_2-R\_2^{\wedge}} - a \right)$ $b(R_12 - R_12^{T^*} - a)$	$\left(R_1 - R_1^{-b)+(R\_2-R\_2^{\wedge}} - a \right)$
（0，1）		$b \quad (R_12 \quad R_12^{T^*} - a)$
（1，0）	$a(R_11 - R_11^{T^*} - b)$	$a \quad (R_11 \quad R_11^{T^*} - b)$
（1，1）	ab	a+b
$\left(\left(R_2 - R_2^{-a)/(R\_2^{\wedge\wedge}-R} \right), \left(R_1 - R_1^{-b)/(R\_1^{\wedge\wedge}-R} \right)\right)$	$\left(R_2 - R_2^{-a)(R\_1-R\_1^{\wedge}} - b \right)\left(\dfrac{R_2^{'} -}{R_2^{'} - R_2^{)}[(R\_1^{\wedge}} \right)$	0

When both the detJ>0 and trJ<0 conditions are satisfied, the equilibrium point of the system is the evolutionary stable strategy (ESS). According to Table 2, at the equilibrium point (1,1), trJ>0, and the equilibrium point($\left(\left(R_2 - R_2^{-a)/((R\_2^{\wedge\wedge}-R\_2^{\wedge})} \right)\right), \left(\left(R_1 - R_1^{-b)/((R\_1^{\wedge\wedge}-R\_1^{\wedge})} \right)\right)$), trJ=0, does not satisfy the condition of trJ<0, so these two points are definitely not ESS. Therefore, combining the different ranges of values of each parameter, the resulting nine scenarios will be analyzed to discuss the possibility of the three equilibrium points becoming ESS.

4.2 Results, Discussion, and Simulation Analysis

Based on the values of each parameter, the results of the evolution analysis of the nine scenarios are summarized in Table 3, Table 4 and Table 5.

Table 3. Local Stability Analysis Summary 1

Equilibrium point	Scenario Ⅰ			Scenario Ⅱ			Scenario Ⅲ		
	detJ	trJ	result	detJ	trJ	result	detJ	trJ	result
（0，0）	+	—	ESS	−	uncertain	Saddle Point	+	−	ESS
（0，1）	−	uncertain	Saddle Point	+	−	ESS	−	uncertain	Saddle Point
（1，0）	−	uncertain	Saddle Point	−	uncertain	Saddle Point	−	uncertain	Saddle Point

Table 4. Local Stability Analysis Summary 2

Equilibrium point	Scenario Ⅳ			Scenario Ⅴ			Scenario Ⅵ		
	detJ	trJ	result	detJ	trJ	result	detJ	trJ	result
（0，0）	−	uncertain	Saddle Point	+	−	ESS	+	+	uncertain
（0，1）	−	uncertain	Saddle Point	−	uncertain	Saddle Point	+	−	ESS
（1，0）	+	−	ESS	−	uncertain	Saddle Point	+	−	ESS

Table 5. Local Stability Analysis Summary 3

Equilibrium point	Scenario Ⅶ			Scenario Ⅷ			Scenario Ⅸ		
	detJ	trJ	result	detJ	trJ	result	detJ	trJ	result
（0，0）	−	uncertain	Saddle Point	+	−	ESS	−	uncertain	Saddle Point
（0，1）	+	−	ESS	−	uncertain	Saddle Point	−	uncertain	Saddle Point
（1，0）	−	uncertain	Saddle Point	−	uncertain	Saddle Point	+	−	ESS

Scenario I: When $R_1 < \overline{R_1^{"}}$, $R_2 < \overline{R_2^{"}}$, among the three equilibrium points, (0,0) satisfies the conditions of the evolutionary stability strategy, detJ>0 and trJ<0. So, the point (0,0) is ESS, and the evolution trend of the system is shown in Figure 3. Over time, high- and low-knowledge potential companies will choose frugal innovation, because the benefits of frugal innovation are higher than those of traditional innovation. This is obvious. At this time, the products on the market are all frugal innovative products. This is inconsistent with reality. There are different types of consumers in the market, and there are various types of products that meet the needs of different consumers. Therefore, this kind of situation is only a theoretical one.

Low: low-knowledge-potential company

High: high-knowledge-potential company
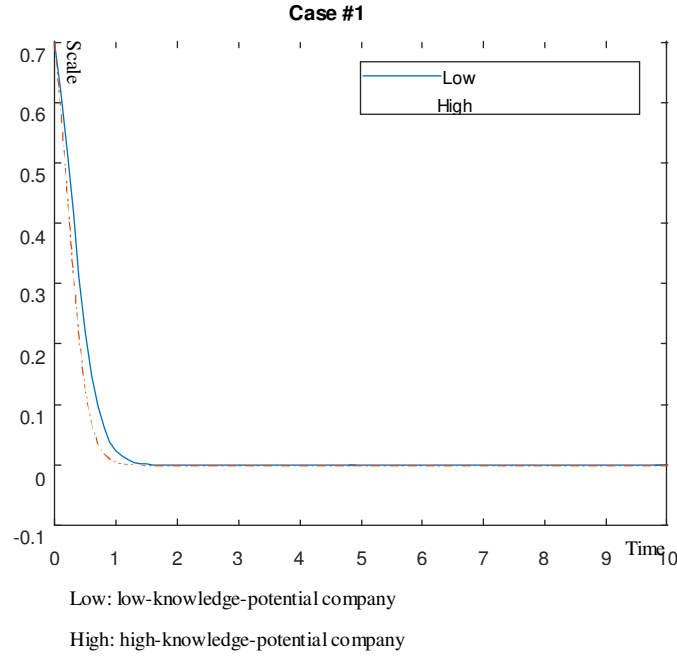
Figure 3.   Scenario I Evolution

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Scenario Ⅱ : When $R_1 < \bar{R_1}$, $R_2 > \bar{R_2}$, and $R_2 - \bar{R_2} > a$ 〖 〗 _^_D_Dd_____,Ď∂∂_____ _ 〖 〗 _()^_D_Dd_____Γĝ∂∂_____ _ 〖 〗 _^_D_Dd_____ ·Ď∂point(0,1) is ESS, and the evolution trend of the system is shown in Figure 4. Over time, high-knowledge-potential enterprises choose traditional innovation models, and the gains obtained at this time are higher than the gains of high- and low-knowledge-potential companies that choose frugal innovation. The gains difference between them is also higher than the reduced cost of high-knowledge-potential companies choosing frugal innovations. Obviously, high-knowledge-potential companies choose traditional innovations and use their acquired knowledge to develop high-end innovative products, to meet the needs of high-income consumers. Low-knowledge-potential companies without knowledge advantages can choose low-cost, frugal innovations to obtain satisfactory benefits from satisfying the needs of BOP (Bottom of Pyramid) consumers. This situation is more in line with the normal situation of the development of the actual market, and companies use their respective competitive advantages to obtain satisfactory income.
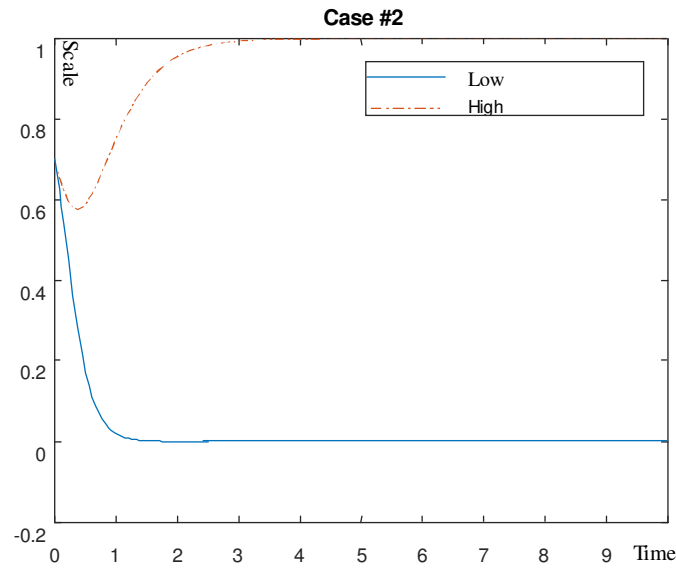
Figure 4.   Scenario Ⅱ Evolution
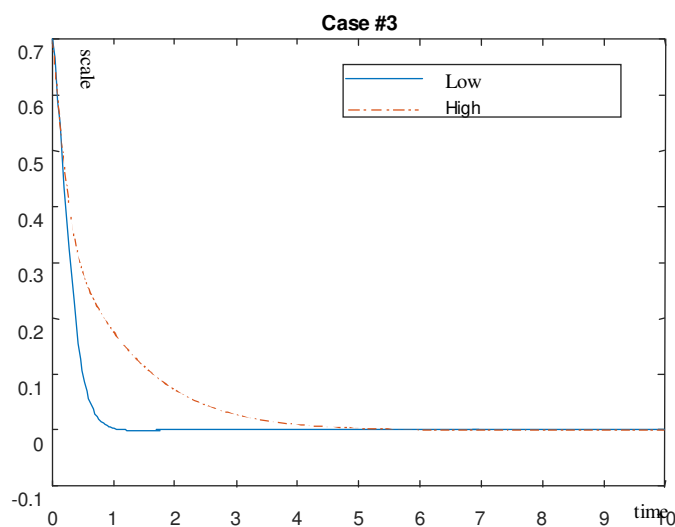
Figure 5. Scenario III Evolution

Scenario III: When $R_1 < \bar{R_1}$, $R_2 > \bar{R_2}$, and $R_2 - \bar{R_2} < a$ 〖 〗

ユア

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儀≈愀ꞁ ꟷ攭ꞓ Ꞌꞃ 6Ꞷꟿ・緗颲ꞃ 佖 Jsystem is shown in Figure 5. Over time, when a low-knowledge-potential company gains more income from frugal innovation than traditional innovation, it will naturally choose frugal innovation. For high-knowledge-potential companies, the gains from traditional innovations are higher than the gains of high- and low-knowledge- potential companies that choose frugal innovation. But the gains difference between them is lower than the reduced cost of high-knowledge-potential companies choosing frugal innovations. It is clear that high-knowledge-potential companies will also choose frugal innovation to achieve higher income. Therefore, in this situation, from the perspective of companies seeking higher returns, high- and low-knowledge-potential companies will choose frugal innovation.

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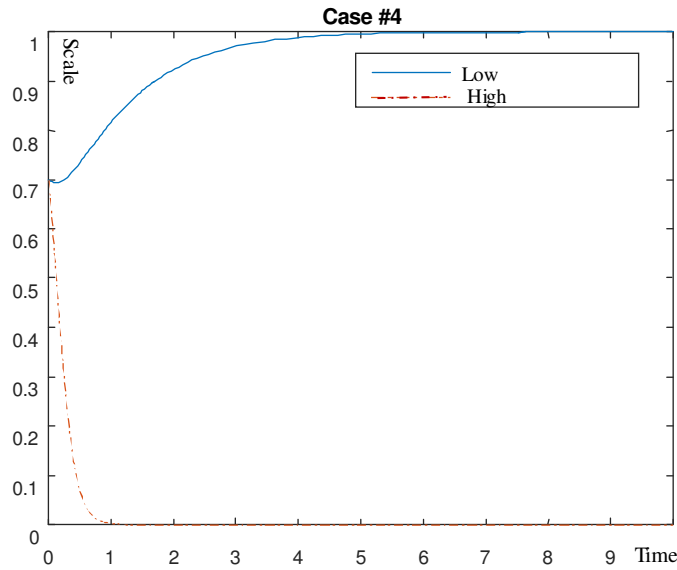
Figure 6.   Scenario IV Evolution

Scenario   IV: When $R_1 > R_1^{*}$, $R_2 < R_2^{*}$,   and $R_1 - R_1^{*} > b$ _ 〖 〗
_^_D_Dd_____,Ď22_____   _   〖   〗
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_ 次 _ 之 _ 窊 _ 突 _ 摁 _ 撖 _ 撨 _ 攒 _ 敨 _ 敯 trend of the system is shown in Figure 6. When the
low-knowledge-potential companies choose the traditional innovation model to obtain higher income, and
compared with the gains of high- and low-knowledge-potential companies when they both perform frugal
innovation, the gains difference is higher than the reduced cost of frugal innovation. Thus, the
low-knowledge-potential companies will choose traditional innovations, while the high-knowledge-potential
companies will have higher income from frugal innovations and will carry out frugal innovations. In this kind of
situation, low-knowledge-potential companies perform traditionally high-input and multi-functional innovations,
while high-knowledge-potential companies will choose frugal innovations. It seems a bit strange, but this
situation also exists. For example, the high-knowledge-potential is multinational. In order to seek development in
emerging markets, the company will carry out frugal innovation in response to local consumption conditions.
Compared with multinational companies, companies in emerging countries have a low knowledge potential, but
they will adopt traditional innovation models to enter the markets of developed countries or meet the demand of
high-income consumer groups in the local market.

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Figure 7.   Scenario V Evolution

Scenario V: When $R_1 > R_1^{\bullet}$, $R_2 < R_2^{\bullet}$, and $R_1 - R_1^{\bullet} < b$ _ 〖 〗

_^_D_Dd_____,Ď૪૪_____ _ 〖〗_^_D_Dd_____,Ď૪૪_____ _ 〖〗

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・・D_Dd_____ᏐĎ૪૪_____cost of frugal innovation. Low-knowledge-potential companies

choosing to adopt frugal innovation will get better returns, while high-knowledge-potential companies will gain higher returns from frugal innovation, so they will carry out frugal innovation. In this case, high- and low-knowledge-potential companies are making frugal innovations and gaining benefits by meeting the needs of BOP consumers. For example, high-knowledge-potential multinational companies and low-knowledge-potential local companies in emerging markets are both profitable through frugal innovation to win a share of emerging markets.

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Figure 8.   Scenario VI Evolution

Scenario VI: When $R_1 > R_1^-$, $R_2 > R_2^-$, and $R_1 - R_1^- > b$ ‧ $R_2 - R_2^- > a$ 〖 〗 _^_____the conditions of the evolutionary stability strategy. So, both points are ESS, and the evolution trend of the system is shown in Figure 8. This evolutionary trend diagram is similar to Figure 4. The gains of high- and low-knowledge-potential companies choosing the traditional innovation model are higher than the gains of both choosing frugal innovations, and the gains difference between the two different types of innovative behaviors for both types of companies is higher than their reduced cost from frugal innovation. The stable equilibrium of the two types of enterprises will be frugal innovation for one, and traditional innovation for the other. They use their respective advantages to meet the needs of different levels of consumers, and the company will also receive satisfactory returns.

Figure 9. Scenario VII Evolution
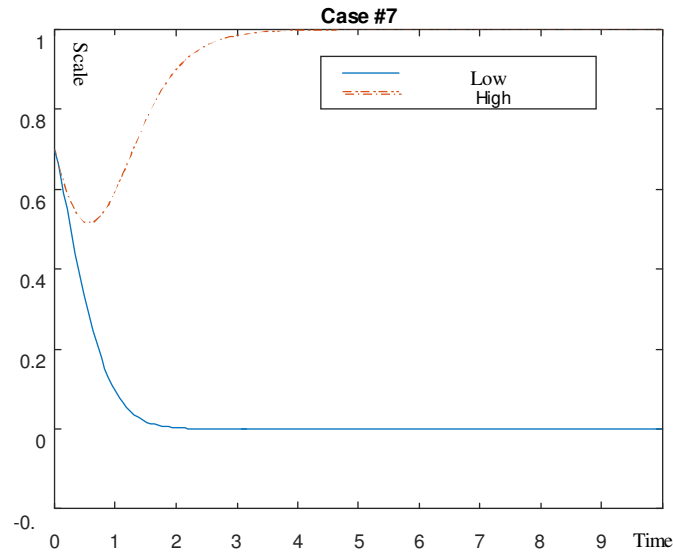
Scenario VII: When $R_1 > R_1^{\ast}$, $R_2 > R_2^{\ast}$, and $R_1 - R_1^{\ast} < b$, $R_2 - R_2^{\ast} > a$

income of high- and low-knowledge-potential companies choosing the traditional innovation model is higher than the gains when both choose frugal innovations. The low-knowledge-potential companies carry out two different innovations: the gains difference is lower than the reduced cost of carrying out frugal innovation, and the gains difference between high-knowledge-potential companies performing two different innovations is higher than the reduced cost of frugal innovation. At this time, the low-knowledge-potential companies choose frugal innovation, while the high-knowledge-potential companies choose traditional innovation. High-knowledge-potential companies use their knowledge advantage to carry out traditional innovations to meet the needs of high-level consumers. Low-knowledge-potential companies avoid knowledge disadvantage and carry out frugal innovations to meet the needs of low- and mid-level consumers. Both parties will receive their own satisfactory income.

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Case #8
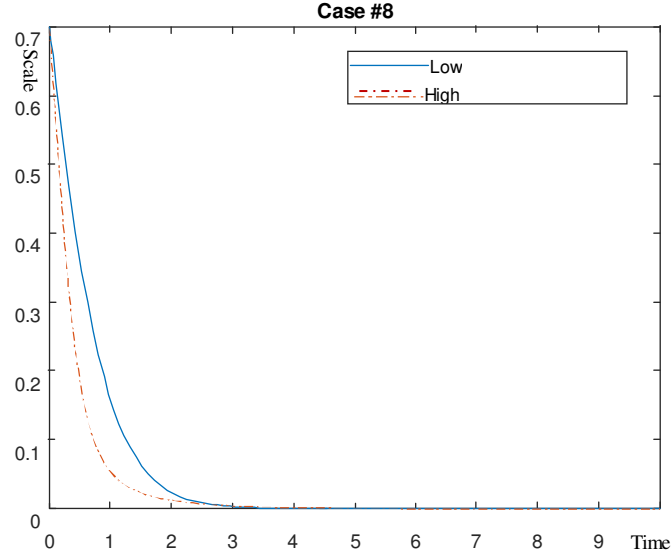
Figure 10.   Scenario VIII Evolution

Scenario VIII: When $R_1 > R_1^-$, $R_2 > R_2^-$, and $R_1 - R_1^- < b$, $R_2 - R_2^- < a$ _ 〖 〗
_^_D_Dd_____,Ď∂∂_____   _   〖   〗
_^_____point is ESS, and the evolution trend of the system is shown in Figure 10. Regardless, the benefits of high- and low-knowledge-potential companies choosing traditional innovation models are higher than the benefits of both choosing frugal innovations, and the gains difference between the two different types of innovative behaviors of both types of companies is lower than the reduced cost of frugal innovation. That is, the reduced cost of frugal innovation is higher than the gains difference between two different innovation behaviors. Therefore, both types of companies will choose frugal innovation. In the emerging markets, low- and middle-income groups account for a large proportion of consumers and the cost of frugal innovation is relatively low. Therefore, whether it is a high-knowledge-potential multinational corporation or a local low-knowledge-potential enterprise, it will benefit from frugal innovation. When frugal innovation develops to a certain extent, innovation knowledge will spread from low-knowledge-potential emerging markets to high- knowledge-potential developed countries, and achieve reverse innovation.

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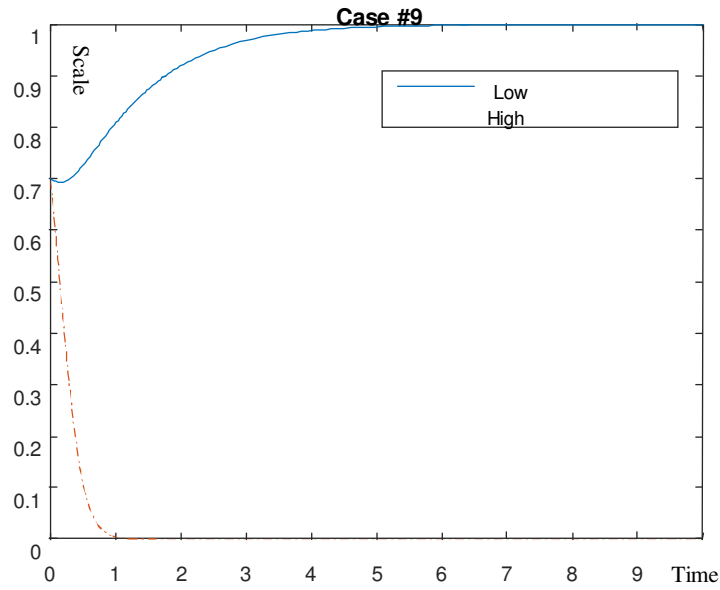
Figure 11. Scenario IX Evolution

Scenario IX: When $R_1 > R_1^-$, $R_2 > R_2^-$, and $R_1 - R_1^- > b$, $R_2 - R_2^- < a$ 195195195195195195195195195195195195195195195195195195195195 195195195195195195195195195195195195195195195 satisfies the conditions of the evolutionary stability strategy. So, this point is ESS, and the evolution trend of the system is shown in Figure 11. The income of high- and low-knowledge-potential companies choosing the traditional innovation model is higher than the gains of both choosing the frugal innovations, the gains difference between the high-knowledge-potential companies performing two different innovations is lower than the reduced cost of frugal innovation, and the gains difference between low-knowledge-potential companies performing two different types of innovation behaviors is higher than the reduced cost of frugal innovations. At this time, high-knowledge-potential companies choose frugal innovation, low-knowledge-potential companies choose traditional innovations, and both parties will gain their own satisfaction. This situation is similar to Scenario IV. High- and low-knowledge-potential companies have different target markets, face different consumer groups, and adopt different innovative behaviors.

5 Conclusions

To sum up, enterprises choose different innovation models under different circumstances. Different target markets and different target consumers have different innovation behaviors. In a borderless competitive world, information and products can flow freely into and out of the market. All types of enterprises must use their respective advantages. Different stages of the company's development can also use its different stages of development advantages to achieve satisfactory incomes. For example, high-knowledge-potential companies can use their acquired knowledge advantage to carry out traditional innovations, while low-knowledge-potential companies can carry out frugal innovations to meet the needs of niche consumers or low- and middle-level consumers. At the same time, high-knowledge-potential enterprises can also adopt frugal innovation based on targeted low- and medium-income target consumer groups, and low-knowledge-potential companies can also

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adopt traditional innovation based on their target markets. Traditional innovation and frugal innovation are different types of innovation, which do not compete but complement each other.

As an emerging innovation paradigm, frugal innovation is a beneficial supplement to the traditional innovation model. Under the situation of scarce resources, low consumption levels, and rapid changes in the market environment, frugal innovation is a wise choice. With a stable market environment, the traditional innovation model will bring the benefits of economies of scale. Therefore, in a fiercely competitive market environment, companies should adopt a combination of frugal innovation and traditional innovation to meet the needs of different markets and different consumer groups. General Electric Co., Ltd. is a typical example of successfully balancing frugal innovation and traditional innovation. It will bring development prospects through the application of frugal innovation in the fringe market, and maintain the development of its mainstream products through the standard innovation model in the developed market (Radjou, 2012). Successful companies must adjust their innovation strategies according to the competitive environment they face, turn constraints into opportunities, and turn challenges into the driving force for growth, so that they can continue to grow. The countries in the "One Belt and One Road" category are mostly developing countries, and they are in a low-knowledge-potential situation. Determining how to choose innovative behavior to achieve better development is a key issue. This study provides a theoretical basis for the innovative development for these developing countries and emerging economies.

Acknowledgements

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Plywood Market Analysis in Peninsular Malaysia

Noraida ABD WAHOB[a], Abdul Rahim ABDUL SAMAD[ib],
Mohd Shahwahid HAJI OTHMAN[c]

[a]Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400
Serdang, Selangor, Malaysia, aidawahob@gmail.com
[b]Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400
Serdang, Selangor, Malaysia, abrahimabsamad@gmail.com
[c]Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400
Serdang, Selangor, Malaysia, mohdshahwahid@gmail.com

Abstract

This paper attempted to investigate plywood market abides with the SFM Practices. This research goes two processes which Autoregressive Distributed Lagged ARDL Bound tests and forecasting. For the first stage, we employ ARDL Bound Approach test to investigate the determinant and become the elasticity of each market model. Secondly, the elasticity are used for second stage namely forecasting analysis. The scenario compromised of five scenarios; (i) reduced by 24% in harvested area, (ii) increased by 25% of the domestic price, (iii) increased 47% in input cost (iv) incorporated with scenarios (i), (ii) and (iii) and (v) increase 10% in Contribution of Forestry and Harvesting Activities to Total Gross Domestic Products (CGDP). Based on the finding, we found that plywood market was affected by SFM practices. Though, this finding can be a good indicator of the Malaysian Government to find a better solution and being a major supply of tropical plywood in the future.

Keywords: plywood, sustainable forest management practices, autoregressive distributed lagged (ardl) bounds test

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[i] Corresponding author's

Disaster Budgeting within Turkish Disaster Management

Fatma YAPICI [a1], Mustafa SAKAL [b]

a *Dokuz Eylül University, Faculty of Economics and Administrative Sciences, Public Finance Department, İzmir, Turkey,*
fatma.yapici@deu.edu.tr
b *Dokuz Eylül University, Faculty of Economics and Administrative Sciences, Public Finance Department, İzmir, Turkey,*
mustafa.sakal@deu.edu.tr

Abstract

Disaster is defined as sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses. Those losses exceed the community's or society's ability to cope using its own resources[1]. So, because of its unexpectable nature of disasters, communities' or society's in need of precautionary approaches towards disasters. Duties such as estimation, struggle against disasters related to minimize losses by reason of disasters are assigned to central and local governments. Also, civil society and disaster volunteers have important roles by the help of donations in disaster areas. Turkey is a country that can be faced with various risks, both located in the earthquake zone, as well as a country located in geopolitically critical region. After Marmara Earthquake happened in 1999, Turkey had faced many losses by death of 17.480 citizens, being injured of 23.781 citizens and 285.211 damaged building. Legislative regulations have been into force quickly thereafter. In this study our aim is to examine disaster management within Republic of Turkey's governmental financial system as of period after 1999 Marmara Earthquake.

Keywords: disaster management, earthquake, disaster budgeting, contingency appropriations.

1. INTRODUCTION

Disaster management is a collective term encompassing all aspects of planning for and responding to disaster. A collective term encompassing all aspects of planning for and responding to disaster of planning for and responding to disaster including both pre and post disaster including both pre and post disaster activities. Disaster management means management of both the risks and the consequences of a disaster [2].

The Sendai Framework for Disaster Risk Reduction 2015-2030 which was adopted at the Third UN World Conference on Disaster Risk Reduction in Sendai, Japan, on March 18, 2015 outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks[3]:

(i) Understanding disaster risk;
(ii) Strengthening disaster risk governance to manage disaster risk;
(iii) Investing in disaster reduction for resilience and;
(iv) Enhancing disaster preparedness for effective response,
(v) and to "Build Back Better" in recover,
(vi) Rehabilitation,
(vii) Reconstruction.

Disaster Management in Turkey

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[1] Corresponding author

2.2. After 1999 Marmara Earthquake

Decree Law No. 587 on "Compulsory Earthquake Insurance Law" prepared on the basis of Authority Law No. 4452 was published on 27.12.1999 it entered into force on the following date 27.09.2000. Then, The Natural Disaster Insurance Institution (DASK) (2000) has been established to make compulsory earthquake insurance for the residents in the scope of decree Law No. 587[4] .

The Naturel Disaster Insurance Institution (DASK) is a legal entity which is responsible for provision, implementation and management of Compulsory Earthquake Insurance in our country. With Compulsory Earthquake Insurance, insured house owners are provided with pecuniary assurance against earthquake and the risks of fire, explosion, landslide and tsunami following the earthquake and It mediates the normalization of life by indemnifying the building's damage immediately whether the building is inhabitable or partially damaged[5].
In the scope of 9th Development Plan of Turkey (2007-2013) followings were taken place among main objectives[6] :

- *Legal framework for ensuring information security will be established, a secure public network will be created and a disaster recovery center will be set up.*
- *Confusion about authority and duties among public institutions and organizations is still being encountered in some sectoral and thematic fields, especially in disaster management. Alongside the changing role of state, the Report on Reviewing the General Institutional Structure in the State was prepared in order to ensure that the duties, authorities and functions of all public institutions and organizations are reviewed and are provided with a structure where they can perform their principal duties.*

The 10th Development Plan (2014-2018) has a part for disaster management. To regenerate the districts that have disaster risk, infrastructure bottleneck and have lost their value and functions and has low spatial quality, by taking into account social, economic, environmental and aesthetical dimensions and to enhance urban welfare and quality of urban structure and life is one of the main goals of the 10th Development Plan. Also, to mainstream disaster risks in macroeconomic, sectoral and spatial planning processes; to raise awareness and resilience against disasters; to build disaster-resilient and safe settlements have been counted among main goals. Policies regarding disaster management situated in the 10th Development Plan are given below[7]:

- *Institutional authorization and responsibilities will be reorganized in order to determine, evaluate and supervise disaster risks and to improve the effectiveness.*
- *Microzoning practices will be completed primarily in high-risk areas and disaster risks will be taken into consideration in master plan processes. Risk mitigation practices, which vary depending on socio-economic and physical characteristics of regions and different disaster types, will be accelerated and post disaster recovery plans of high-risk areas will be prepared.*
- *Implementation mechanisms that will reduce disaster risks will be strengthened. Retrofitting of public places like hospitals, schools and dormitories that are important for disaster preparation and response processes, and critical infrastructures like energy, transportation, water and communication will be prioritized.*
- *In order to combat disasters more effectively, disaster information management system, that enables fast, safe and efficient information exchange among public institutions, will be established. Infrastructure will be reinforced to provide efficient and uninterrupted communication.*
- *Resilient buildings and infrastructure will be built and the supervision of construction activities will be strengthened via independent, capable and authorized individuals and institutions.*
- *The regeneration projects, that yield high benefit and value in public spaces and production areas, particularly in disaster risk areas, contribute to growth and development and widely improve life quality, will be given priority.*
- *The required basic information systems for e-government service delivery will be completed. The efforts of establishing shared infrastructure and setting common standards will continue; in the public sector, including local authorities, common applications will be expanded. In this context, the completion of MERSİS, TAKBİS, Spatial Address Registration System (MAKS), EKAP, the National Geographical Information System Infrastructure and Information Systems Disaster*

Management Centre projects will be prioritized. Institutional e-government projects will continue to be created within the framework of common action plans.

Table 1 shows developments and targets in disaster risk mitigation by years 2006-2018.

Table 1: Developments and Targets in Disaster Risk Mitigation

	2006	2012	2013	2018
Number of Provinces with Completed Integrated Disaster Hazard Map	...	3	6	81
Number of Houses and Workplaces with Compulsory Earthquake Insurance (Million	2.5	4.8	5.4	9.5

Source: The 10th Development Plan (2014-2018), p.140 ,
http://www.mod.gov.tr/Lists/RecentPublications/Attachments/75/The%20Tenth%20Development%20Plan%20(2014-2018).pdf

Turkey has 81 cities whose integrated disaster hazard maps have completed today. Number of houses and workplaces with compulsory earthquake insurance has reached to 9.5 millions. Since The Naturel Disaster Insurance Institution has been founded and Compulsory Earthquake Insurance came into force in 2000, number of houses and workplaces with compulsory earthquake insurance has raised by years.

The Disaster and Emergency Management Presidency (AFAD) and the Provincial Disaster and Emergency Departments under the special provincial administrations were established in order to improve disaster risk reduction and preparedness activities .AFAD identifies its vision as "Being a leading and coordinating organization which offers a model that can be taken at the international level as being, based on sustainable development, risk-centered, efficient, effective and performing reliable service in the studies related to disaster and emergencies." and AFAD's mission as "Building a disaster resilient society. " [8]

Disaster Budgeting in Turkish Budgetary System

Mainly sources of governmental institutions in Turkey are budget appropriations which are approved by the parliament every year before 31st of December according to constitution of the Republic of Turkey and Public Financial Management and Control Law No. 5018.

3.1. Budget Appropriations
3.1.1. Central Government

Public Financial Management and Control Law No 5018 was adopted on 10 December, 2003. New PIFC system started to be implementation on 1 January, 2006. The new PIFC system and Law No. 5018 has achieved budget's scope broadening, macroeconomic framework's identification and, brought   multi-year budgeting with strategic planning, performance-based budgeting to practice. Annual budgets of governmental institutions in Turkey prepare their budget drafts according to analytical budget classification since 2006 year. Structure of analytical budget classification is shown below: [9]

- Institutional Coding
- Functional Coding
- Financing Type Coding Financing Type Coding
- Economical Coding

Parliament is responsible to discuss and approve budget drafts of governmental institutions by the functional coding. Approved budget appropriations indicate the upper limit that public institutions can spend.
Disaster management in Turkey has been transformed into a unit and a single structure connected to the Prime Ministry. Disaster and Emergency Management Authority- AFAD and its provincial centers named as Provincial Disaster and Emergency Directorates established with the Law No. 5902.

AFAD's budget has been increased from about 1 billion to 3 billion Turkish lira as a result of the various disasters and emergencies that have affected Turkey. The biggest proportion of the budget (46 %) is devoted to response and recovery and only 20 % to planning and mitigation. In particular, the budget allocation for 12 DRR projects and 12 DM projects (TL 117 million overall) seems low, but DRR- and DRM-related funds are also managed by other ministries. The ready availability of funds in the event of an emergency is an example of good practice and

facilitated by the fact that AFAD reports directly to the Prime Minister's Office. While not having the information on the budget allocated for DRR and DRM in other ministries, it recommends that a sufficient proportion of overall funding should be devoted to planning and mitigation. Also, some expenditure capacity should be available to local (district, municipality) authorities [10] .

3.1.2. Local Authorities

Local authorities seem not to have significant autonomous budgets for DRR[11]. According to Law no. 5902,   some amount of allowances of the AFAD presidency budget may be transferred to the account of the public institutions and organizations and the local administrations in cases where it is deemed appropriate by the AFAD presidency. The amounts transferred in this way will be tracked on the private accounts without being recorded as income on the budgets of the relevant public institutions and organizations and local administrations ... " That source obtained by the way explained above is used on the strength of the Disaster and Emergency Expropriation Regulation [12].

In 1992, disaster, earthquake and civil defense funds were included in the general budget. Today Disaster and Emergency Management Authority- AFAD (Afet ve Acil Durum Yönetimi Başkanlığı), established with the Law No. 5902, meets the budget needed and the current budget for the investment program needed. Article 23 of Law No. 5902 provides a flexible, easy-to-implement system for financing. It is also a legal obligation for the special provincial administrations to allocate at least one percent of their budget for disasters. The governor has been authorized to prepare budgets for disasters. However, because the budget is not sufficient, the illicit cannot legally fulfill the duties assigned to it. The financial problems of the provinces regarding the preparation for disaster can be overcome by the legal arrangement which will enable the governor's budgets to transfer funds from AFAD or Ministry of Interior budget [13].

3.2. Carry-over of Appropriations

According to Law No. 5018, Article 21,   "*carry-over of appropriations among the budgets of the public administrations within the scope of central government shall be realized by law. However, public administrations within the scope of the central government are entitled to carry over appropriations in their budgets up to the amount of five percent of the appropriation in the allocation to be carried over, unless a different ratio is defined in the budget law of the relevant year. Such kind of carryovers shall be notified to the Ministry of Finance within the following seven days. No carryovers are allowed from the allocations for personnel expenditures, allocations including a previous a carryover and contingency appropriations to the other allocations*".
Ministry of Finance ratifies carryovers of appropriations within the following seven days. And as an important point of carry-over of appropriations is no allowances from the allocations for personnel expenditures, allocations including a previous a carryover and contingency appropriations.

3.3. Contingency *Appropriations*

Contingency appropriations are kind of carry-over appropriations from one to another. Contingency appropriations differ from other carry-over appropriations in terms of the unit having the limit and the authority to use it. Contingency appropriations have 09 code as first level of economic classification codes.

Table 2. First Level of Economic Classification Codes

Code	Kind of Expenditures
01	Personnel Expenditures
02	State Premium Payments to Social Security Institutions
03	Purchase of Goods and Services
04	Interest Payments
05	Current Transfers
06	Capital Expenditures
07	Capital Transfers
08	Lending
09	Contingency Appropriations

According to Law No. 5018, Article 21, "*In order to realize the services and objectives stated in the In order to realize the services and objectives stated in the Central Government Budget Law, to remedy any appropriation shortage or to perform services not foreseen in the budgets the contingency appropriation not to exceed two the budgets, the contingency appropriation, not to exceed two percent of the general budget appropriations, may be allocated to the budget of Ministry of Finance to be transferred to the budgets of administrations under chart I and transferred to the budgets of administrations under chart I and those which are to be shown in the central government budget law of the administrations included under chart II of this Law. The Minister of Finance is authorized for the transfers from this appropriation. Within fifteen days following the end of the year, The Ministry of Finance announces the distribution, in terms of type, amount and administrations, of the transfers from the contingency appropriation within the fiscal year*"..*

Limit of a contingency appropriation for a fiscal year is two percent of the general budget appropriations which may be allocated to the Ministry of Finance budget to transfer it to the budgets of the administrations under chart I and those which will be defined in the central government budget law among the administrations under chart II of this Law with an aim to provide the services and attain the objectives stated in the Central Government Budget Law, to remedy any appropriation shortage or to render services not envisaged in the budgets The Minister of Finance is authorized for making allocations from this appropriation. Information on the allocations made from the contingency appropriation in a fiscal year such as type, amount and distribution by administrations are announced by the Ministry of Finance within fifteen days following the end of the year [14] .

Table 3. Utilization of Carry-over Appropriations from Contingency Appropriations by Institutions, 2017 Central Governmental Budget

Code of Institution	Institutions / Economic Classification	03- Purchase of goods and services	05-Current transfers	06-Capital expenditures	07-Capital transfers	08-Lending	Total
07	Prime Ministry	605.000.000	0	0	0	0	605.000.000
07.77	Prime Ministry Directorate General of Press and Information	7.500.000	0	0	0	0	7.500.000
07.86	Presidency of Religious Affairs	50.000.000	0	0	0	0	50.000.000
07.96	Disaster and Emergency Management Authority- AFAD	0	0	19.081.400	0	0	19.081.400
08	Republic of Turkey Ministry of Justice	185.250.000	0	0	0	0	185.250.000
09	Republic of Turkey Ministry of National Defense	450.000.000	0	0	0	0	450.000.000
10	Republic of Turkey Ministry of Interior	98.000.000	77.000.000	52.411.000	35.043.000	0	262.454.000
10.81	Turkish General Command of Gendarmerie	96.000.000	0	0	0	0	96.000.000
10.82	Turkish National Police	87.464.000	0	13.925.000	0	0	101.389.000
10.85	Directorate of General of Migration Management	10.000.000	0	0	0	0	10.000.000
12	Republic of Turkey Ministry of Finance***	0	129.250.000	46.000.000	60.192.000	0	235.442.000

12.76	Revenue Administration	3.776.000	0	0	0	0	3.776.000
18.75	State Personnel Presidency	984.000	0	0	0	0	984.000
20	Republic of Turkey Ministry of Energy and National Resources	0	0	0	0	72.000.000	72.000.000
21	Republic of Turkey Ministry of Culture and Tourism	0	14.000.000	0	0	0	14.000.000
25	Republic of Turkey Ministry for EU Affairs*	0	283.868.000	0	0	0	283.868.000
28	Republic of Turkey Ministry of Economy*	5.000.000	0	0	0	0	5.000.000
34	Republic of Turkey Ministry of Transport and Infrastructure	0	132.768.000	0	0	0	0
39.13	İzmir Democracy University	2.790.000	210.000	0	0	0	3.000.000
40.14	Directorate of General of Sports Services	0	30.000.000	0	0	0	30.000.000
40.30	Presidency of KOSGEB **	0	600.000.000	0	0	0	600.000.000
40.52	General Directorate of Highways	0	334.888.000	160.440.600	0	0	495.328.600
	Total	1.366.514.000	1.837.234.000	272.776.600	114.316.400	72.000.000	3.662.841.000

Source: Republic of Turkey Ministry of Finance, http://www.maliye.gov.tr/.

* Those ministries have been abolished after the general election and presidency election which both had been held in 24th of June, 2018 in Turkey.

**Small and Medium Scale Enterprises Development and Support Administration.

*** The name of Ministry of Finance has been changed as Ministry of Treasury and Finance after the general election and presidency election which both had been held in 24th of June, 2018 in Turkey.

3.4. Donations

Earthquakes centered Van-Ercis occured in 23th October 2011 and centered Van-Erdemit in 9th November 2011; are very strongly felt in Van and its districts. Totally 644 citizens lost their lives, 1.966 citizens injured and 252 citizens were rescued from the debris alive [15]. According to AFAD's numbers, in Campaigns which have been launched by Prime Minister Recep Tayyip ERDOĞAN has raised 224 million TL fund in accounts of Prime Ministry. Table 4 indicates expenditures dispersion for Van Earthquake.

Table 4. Expenditure Dispersion for Van Earthquake

Type of expenditures	Amount
Total Immediate Support Subsidy Sent	502.175.666 TL
Prime Ministry	10.000.000 TL
Expensing From Humanitarian Aid Accounts	224.030.000 TL
Spending of Ministry and Public Institutions	1.210.552.445 TL
Turkish Red Crescent	121.740.373 TL
NGOs (can be debriefed ones)	27.112.540 TL
Governorships	21.345.000 TL
Private Sector	13.880.000 TL
The Total Amount of International Material Donations	76.849.000 TL
Transferred sum to Housing Development Administration of Turkey	2.362.000.000 TL
Transferred sum on the scope of Financial Aid for Reconstruction	254.500.000 TL
The Total Cost of Van Earthquake	4..824.185.024 TL

Source: AFAD, https://www.afad.gov.tr/en/2608/Appropriations-Expenditures-Campaigns.

CONCLUSION

Within Turkey's disaster management system , it may said that AFAD is an unique central governmental institution which established connected to Prime Ministry. AFAD also have its Provincial Disaster and Emergency Departments under the special provincial administrations. AFAD has its own budgetary appropriations to use for its disaster management activities yearly. Also extra-allowances may be allocated when its needed and ratified by Ministry of Finance (Ministry of Treasury and Finance) to AFAD and the ministries which are have function related to disaster management from contingency appropriations. Local authorities are also have an opportunity to get extra-allowances from central government.

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Credit risk assessment using Z Altman method - Case study: Manufacturing companies in Kosovo

Fisnik MORINA

University " Haxhi Zeka, Faculty of Business, Peja, Kosovo, fisnik.morina@unhz.eu

Abstract

The risk is the element that conveys every investment. Consequently, the more exposed to the risk that is an investment, the rate of its return differs. Each investor tries to predict and evaluate the risk of a potential investment, and based on his return, makes the decision to accept or not the investment. Various authors have dealt with the problem of risk, and many of them are categorized into different types and are trying to develop methods to measure it. In this paper, we will analyze the credit risk as one of these risk categories, a risk that is quite present in virtually every economic activity. The analysis of this risk will be developed through the author's method Edward Altman, otherwise called the Z-Altman method.

The purpose of this paper is to analyze the financial indicators of some local companies through the Z-Altman method. This analysis will be carried out in order to assess these companies through the Z-Altman model, with the tendency to assess the credit risk from the perspective of financial institutions that intend to link business relationships through loans with these companies. This paper will serve the broad audience and in particular financial institutions that reflect the ranking of these enterprises in terms of credit risk judged by the Z-Altman method.

Keywords: credit risk, bankruptcy, Kosovar companies, Z-Altman method, bankruptcy forecast.

1. INTRODUCTION

This paper aims to identify dilemmas related to the performance of enterprises judged by the prism of credit risk management. In addition, this study aims to carry out a detailed analysis using the Z-Altman method, in order to provide a fair view of the credit risk that these enterprises present to financial institutions in the event of a credit agreement.

The research questions that this paper aims to answer are:

1. How do Kosovar enterprises rank according to the Z-Altman model?

2. Would crediting institutions in Kosovo be exposed to a high credit risk if they were to give credit to these enterprises?

3. How stable are Kosovar companies in relation to the risk of bankruptcy?

4. How does the future of Kosovo companies stand in relation to the risk of bankruptcy judged by the Z-Altman model?

The realization of this paper and the opening of the overall potential of results that might have emerged from this paper prevented a host of factors, ranging from bureaucratic to privacy. It should be noted at the outset that company data is missing, especially those of manufacturing companies. In the absence of data for more companies, this paper assumed only twenty manufacturing companies. The Z-Altman model is heavily based on the performance of companies in financial markets, so another limitation that affected the results of this paper is the lack of a capital

market in Kosovo. And recently, the reluctance to adopt new accounting practices, or compliance with international accounting standards for reporting, has caused problems in collecting data from most of these companies.

2. LITERATURE REVIEW

The financial barriers of large businesses are typical and dramatic phenomena that affect the economic and social structure of a country. This phenomenon has been the object of numerous studies aimed at identifying the causes and predicting the level of credit risk. The financial cycle of a business is a concern for internal and external stakeholder. Internal stakeholder may be interested in the enterprise if its financial capabilities are transferable, while external stakeholder may be directly concerned with the investments or profits of this company (Mossman & Bell & Swartz & Turtle, 1998). According to the authors (Tam & Kian, 1992) bankruptcy forecasts and credit risk are some of the most important business decision-making problems as they affect the entire lifecycle of a business. If firms are financially unstable, then bad choice (advers selection) will be too high. Investors invest in companies that are financially healthy, as credit risk decreases (advers selection). In this way, the investor confidence to a firm will be reduced, resulting in corporate failure.

The Z-Altman model for credit risk assessment was developed by renowned finance professor Edward Altman. This model he accomplishes during his work at New York University. This model preaches or predicts the risk of bankruptcy as a result of the severe financial situation. The model was first published in 1968 with the aim of providing an alternative that would serve to evaluate the probability of credit failure of manufacturing companies as a result of their activity reflected in balance sheet items. So, the risk assessment that is carried out by this model comes through financial reports (Sanesh, 2016). The formula for the Z-Altman model for bankruptcy risk assessment in manufacturing companies is:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

Where:

$$X_1 - \frac{Working\ capital}{Total\ assets}$$

Working capital in relation to total assets is a measure of liquid assets in relation to the size of the firm. Working capital is simply defined as the difference between actual assets and current liabilities and can be a positive or negative ratio. The company is recommended to have positive working capital as it is an indicator of a firm's ability to pay its short-term liabilities.

$$X_2 - \frac{Retained\ earnings}{Total\ assets}$$

Retained earnings are the accumulated amount of reinvested earnings and losses of a company throughout its life. This is a measure of cumulative profit throughout the life cycle of a company. The higher growth of retained earnings to total assets means that undistributed profits have been applied more to finance total assets than debt (Niresh & Pratheepan, 2015).

$$X_3 = \frac{EBIT}{Total\ assets}$$

This indicator is a measure of firm productivity, which is essential to the long-term survival of a company (Al-Rawi & Kiani & Vedd, 2008). The report expresses the operating performance of the company and also shows the company's profit power. In addition, this is a measure of productivity of firm assets, regardless of the impact of any tax factor or financial leverage (Mohammed, 2017).

$$X_4 = \frac{\text{The value of capital in the market}}{\text{Accounting value of total liabilities}}$$

The report shows how much the firm's assets may fall in value before the liabilities exceed the assets and the firm becomes unable to pay. Sustainability of a company's financial position is reflected in market capitalization. So if a firm has significant market capitalization, then this indicator expresses a high degree of credibility with respect to the financial position of the company in the market (Cecilia, 2003).

$$X_5 = \frac{\text{Sale}}{\text{Total assets}}$$

This report measures the ability of generating sales of the firm's assets. It is a measure of a company's management ability in dealing with competitive conditions (Niresh & Pratheepan, 2015). The criteria for the decision to classify a firm are as follows:

1. Z > 2.99 - The overall index that is larger than 2.99 illustrates that a firm is less likely to go bankrupt. Therefore, if a firm has a Z value greater than 2.99, it can be concluded that a firm is in a safe area and the credit risk is low.

2. Z < 1.81 - The Z value less than 1.81 means that the firm is likely to go bankrupt in the near future. Therefore, if a firm has a value of less than 1.81, it is considered to be in the bankruptcy area and the credit risk is too high.

3. $1.81 \leq Z \leq 2.99$ - The Z value between 1.81 and 2.99 indicates that the firm is at risk of financial distress (gray area). So, firms that have the coefficient Z within this internally have a level of average (unspecified) credit risk.

The Z-Altman model was developed in order to combine traditional index analysis with rigorous statistical techniques. Most of the models used to identify credit risk (advers selection) of businesses are based on multivariate discriminatory analysis (Danovi & Quagli, 2012). Aziz dhe Dar (2006) illustrate that Multiple Discriminatory Analysis (MDA) and Logit models are very accurate with error rates of 15%. The MDA model uses a calculated result from a linear equation to determine the probability of bankruptcy, while the Logite model predicts the probability "as a dependent variable that is a function of a vector of explanatory variables" (Aziz & Humayon, 2006). The different authors (Dugan & Zavgren, 1989) (Chen & Shimerda, 1981) have presented seven financial factors that can help predict the financial difficulties: return on investment, financial leverage, capital turnover, short-term liquidity, cash flow, inventory turnover and receivables. Using financial ratios, the accuracy of bankruptcy forecasting of a firm is greater than 90%.

The forecast of corporate failure is crucial, as its consequences are countless. Any change that happens to an organization in the end will affect the claims of the interested parties. Bankruptcy brings many individual losses to stakeholders such as creditors, managers, investors, employees, etc (J. Sun & F. Hui, 2006). A survey conducted in 2014 by author Gunathilaka reviewed the financial difficulties of 82 companies listed on the Colombo Stock Exchange (CSE) by some industries, using the Z-Score Altman and Springate models. Samples were collected from 2008 to 2012 and analyzed including Multivariate Discrimination Analysis (MDA). The results were identical, though the coefficient Z - Altman showed a higher degree of accuracy in predicting financial difficulties for selected companies in Sri Lanka (Gunathilaka, 2014). A study conducted by Water Coopers (2002) on 1,200 public production companies (data from 1998 to 2001) concluded that score Z remains a stable indicator of financial distress. This indicator is used to predict sustainability in a number of sectors such as telecommunications (Permatasari, 2006), wood industry (Muhammad, 2008), pharmaceutical industry (Ambarsari, 2009) etc.

The Artificial Neural Networks (ANN) model is more favorable compared to the Logistic Regression model with regard to the accuracy of the credit risk projection. Coverage of interest is the most important signal of business

failure in the Korean hotel industry (Youn & Gu, 2010). Using financial reports, the accuracy of the preliminary forecast (usually 1 or 2 years) is greater than 90% (Chen, 1981). However, even different authors argue that as bankruptcy is preceded by uncontrolled and unforeseen events, it can not be predicted with precision. According to new studies by authors such as Stephen Ross and Randolph Westerfield, firms who experience difficult financial situations can be identified by looking at different forms of financial statements. One of the ways to achieve this goal is the Z-Altman model (Ross, 2016). This is also confirmed by the author, Altman, who during several researches in 2003 came to the conclusion that through this model, at least one year earlier, bankruptcy of firms can be predicted if accurate information is provided in their financial statements. There are also numerous studies that provide an independent overview about the accuracy of this model. Some of these researches have been carried out in different time periods and have resulted in impressive findings that send the accuracy of forecasting of this model at high rates up to 90%. Some of these studies are: Sanesh (2016), Mizan, Amin and Rahman (2011) and Gerantonis Vergos and Christopoulos (2009).

Sanesh (2016) tried to evaluate 50 NIFTY companies, excluding banks and financial institutions, and through this model tried to produce data about the bankruptcy potential of these companies, giving particular importance to the problem model financial. Although the author appreciates the Z-Altman model, he does not see it as the only determinant of the company's future. The author of this research suggests that a poor score Z can be upgraded with operational decisions so that the company's position improves (Sanesh C. , 2016). Mizan, Amin and Rahman (2011), conducted a study to anticipate the bankruptcy trends of the pharmaceutical industry in Bangladesh. They used the Z-Altman model, and using a representative sample of the 6 main companies in this industry they managed to produce very valuable results. They found that these companies are quite exposed to risk in future periods. Two of these firms do not show such a tendency. The study also gave an interesting result: the value of these companies in the securities market did not reflect their operational realities. So there was a discrepancy between performance in financial markets and factual performance (Mizan, 2011). Gerantonis & Vergos and Christopoulos (2009) jointly carried out a study aimed at predicting bankruptcy of Greek companies three years earlier. The paper was carried out with data from 2002-2008. The results showed that this model performs well in predicting failures. These results could also be used to manage these companies' financial decisions, regulatory authorities, and portfolio investment managers (Gerantonis, 2009).

It should be noted that since studies on the Z-Altman model offer relative results for companies in a particular market, there is no need to compare the results generated by this model to Kosovo companies with results from other researches of this type. Despite the many researches that have been made to predict the probability of desire, the original Z-Score model introduced by Altman (1968) has been the most dominant model applied worldwide. Thus, although the Z-Altman model has been applied 45 years ago, this model is still used as a main or supporting tool for forecasting or analyzing bankruptcy or credit risk, both in scientific and practice research.

3. METHODOLOGY OF SCIENTIFIC RESEARCH

As a method of collecting data, quantitative method was used, which is realized through secondary data. While their analysis is done through application programs Microsoft Office Excel and STATA. This study was based on the data of twenty manufacturing companies in Kosovo, and applied them to the Z-Altman model, drawing on the trends of these companies towards bankruptcy. The criteria for selection of these companies has been access to the records of their financial reports for at least three years.
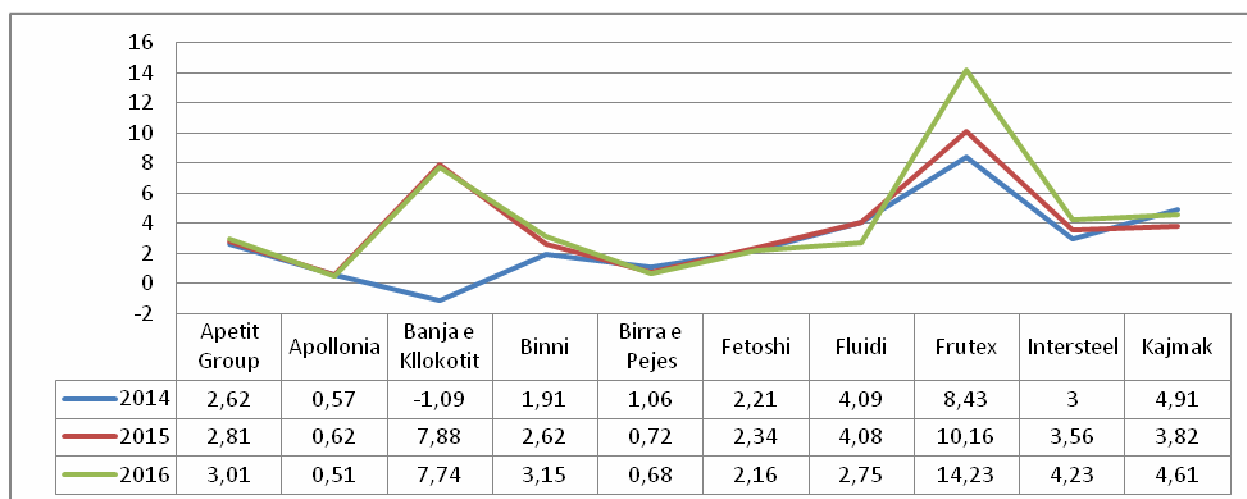
This research aims to test the Z-Altman model of risk assessment against bankruptcy by analyzing data from 20 Kosovar manufacturing companies and thus provide an overview that will serve commercial banks, state institutions, others to assess the credit risk to which they are exposed in case of cooperation and the conclusion of contractual-business relations with these companies. At the same time, it is intended that knowledge of the overall credit situation in the Kosovo market is gained through analyzing the credit standing of these companies. For the realization of the empirical analysis we will apply the linear trend analysis, and based on the Z-Altman equation for 20 manufacturing companies we will analyze the probability of failure and the level of credit risk for these

companies included in this study. Companies selected for credit risk assessment, based on Z-Altman's analysis are: Apetit Group, Apollonia, Banja e Kllokotit, Binni, Birra e Pejës, Fetoshi, Fluidi, Frutex, Intersteel, Kajmak, Kivo, Konsoni, Laberion, Teknika Asllani, Plastika, Sharri, Sole, Solid, Stone Castle and Tulltorja. The data for these companies are taken from their financial accounts for the years 2014, 2015 and 2016.

4. EMPIRICAL ANALYSIS OF THE STUDY

Empirical analysis will begin with the interpretation of results and calculations from the Z-Altman equation for each manufacturing company that is included in the sample. In 2014 the 20 surveyed manufacturing companies, based on the results of the Z-Altman model, only five manufacturing companies have Z-Score of less than 1.81 therefore it means that these companies have the highest probability of failure and the level of high credit risk. Company Apollonia, Banja e Kllokotit, Birra e Pejës, Kivo and Solid are companies that in 2014 have a higher level of credit risk, meaning that these companies will face financial difficulties in debt repayment towards creditors in the future. In the following chart, within these ten manufacturing companies, the highest value of Z-Altman for 2014 is owned by the Frutex company, while the lowest value of this coefficient has Banja e Kllokotit.

Figure 1: Z-score results for the first group of manufacturing companies in Kosovo (2014-2016)

	Apetit Group	Apollonia	Banja e Kllokotit	Binni	Birra e Pejes	Fetoshi	Fluidi	Frutex	Intersteel	Kajmak
2014	2,62	0,57	-1,09	1,91	1,06	2,21	4,09	8,43	3	4,91
2015	2,81	0,62	7,88	2,62	0,72	2,34	4,08	10,16	3,56	3,82
2016	3,01	0,51	7,74	3,15	0,68	2,16	2,75	14,23	4,23	4,61

Source: Author's calculations

Frutex Company during 2014 had a very low probability of failure because the working capital value in 2014 had an increase compared to the previous years and this year the working capital had a value of € 3,121,439 million €. Based on the following data, we can see that the Frutex company has consistently increased the Z-Altman coefficient, which means that its financial condition has continuously improved, with the value of this coefficient to 2016 to 14.23.

Table 1: The results of the Frutex manufacturing company analyzed using the Z-Altman model

Frutex	1.2*X1	1.4*X2	3.3*X3	0.6*X4	1*X5	Z-Score
Z − 2014	0.320824035	0.692222276	0.765884119	5.760637081	0.897374815	8.436942326
Z − 2015	0.44228417	0.821604022	0.649251617	7.406367342	0.844820239	10.16432739
Z − 2016	0.43385482	0.878794953	0.698112412	11.33584208	0.893213024	14.23981729

Source: Author's calculations

During 2015, two companies included in this study have a low level of Z-Altman coefficient. Apollonia Company has a Z-score coefficient of 0.62 in 2015, which means that this company faces a high credit risk and a high

probability of bankruptcy. During 2015, this company had an increase of short-term liabilities of 1.07%, the value of these liabilities amounted to 1,491,718 million €. While the company Birra e Pejës during this year reached the value of 0.72, which value identifies the difficult financial situation of this company during these three years. The net profit of this company in 2015 has decreased by 13.2%, ie from 3,154,000 € to 419,000 €. Even during 2016, within these ten companies, only two companies have low value of the Z-Altman coefficient (Apollonia and Birra e Pejës), while all other companies have an average level of credit risk

Table 2: The results of the manufacturing company (Birra e Pejës) analyzed using the Z-Altman model

Birra Peja	1.2*X1	1.4*X2	3.3*X3	0.6*X4	1*X5	Z-Score
Z – 2014	-0.216443488	-0.080193453	0.407022448	0.360252338	0.590254676	1.060892521
Z – 2015	-0.220267456	-0.057254686	0.154497328	0.317870576	0.5276363	0.722482063
Z – 2016	-0.213813714	-0.032425701	0.139349162	0.256621365	0.532541923	0.682273034

Source: Author's calculations

Based on the values of the table above, we can notice that the *Company Birra e Pejës* has a poor financial condition and during these three years faces a difficult financial situation. Based on this indicator, commercial banks in Kosovo identify that this company will face a high level of credit risk in the future and will be less willing to credit this company. The working capital value of this company is negative (-6,439,000 €) during 2016. Proportionally, this company has had a total increase in liabilities over the past few years and a drop in overall sales, which is one of the main causes for the company's difficult financial situation. Below we will graphically present the values of the Z-Altman coefficient and for the other ten production companies that are included in this empirical analysis, and through this data we will answer the research questions of this study.

Figure 2: Z-Score results for second group of manufacturing companies in Kosovo (2014-2016)

	Kivo	Konsoni	Laberion	Teknika Asllani	Plastika	Sharri	Sole	Solid	Stone Castle	Tulltorja
2016	0,96	2,4	3,98	1,93	2,53	5,64	3,25	1,22	5,17	14,3
2015	0,32	2,03	3,43	2,14	2,47	5,73	3,48	0,98	6,7	9,78
2014	-0,53	2,37	2,24	2,97	2,13	4,5	5,71	1,14	6,15	7,13
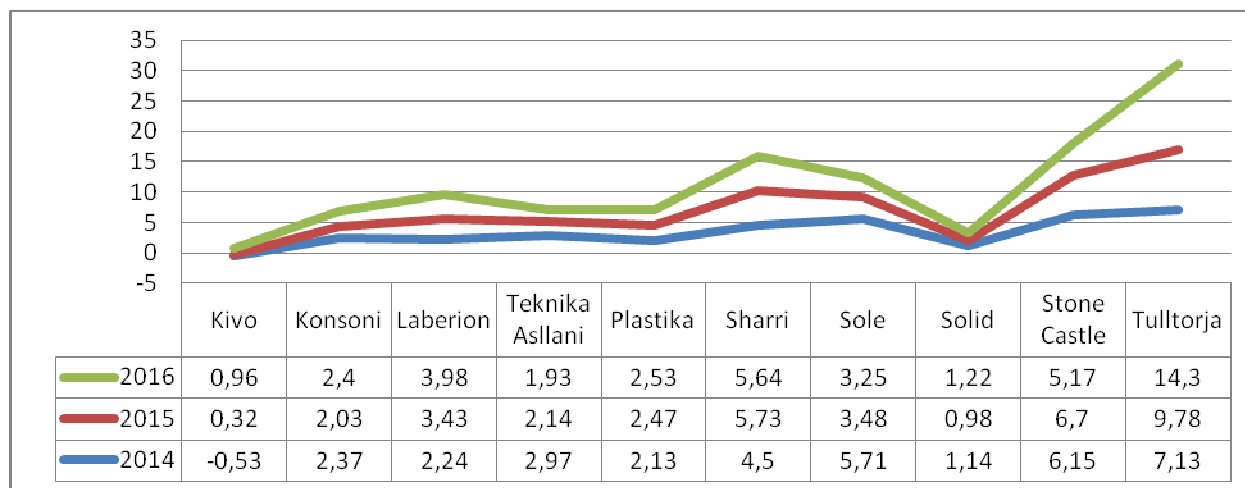
Source: Author's calculations

In the second group of 10 companies included in this study, the financial statements of these companies were analyzed and the above results for the three year period 2014-2016. For the past three years, only two companies have higher levels of credit risk and higher probability of bankruptcy and they are the company Kivo and Solid. These two companies are faced with great financial difficulties and negative working capital values. The profit retained for Kivo Company during these years included in the analysis was negative, only in the last year it had reached a positive value (€ 132,994).

Table 3: The results of the Kivo production company analyzed through the Z-Altman model

Kivo	1.2*X1	1.4*X2	3.3*X3	0.6*X4	1*X5	Z-Score
Z - 2014	-0.604030905	-0.030693156	-0.067326451	0.162875558	0	-0.539174954
Z - 2015	-0.492167185	-0.024421052	-0.021427409	0.087579528	0.77362166	0.323185541
Z - 2016	-0.116059348	0.020056166	0.09167191	0.085086418	0.884619706	0.965374852

Source: Author's calculations

Tulltorja Company during 2014 had the value of the Z-Score coefficient of 7.13, while in 2016 almost this value was doubled, 14.3. The indicators that have most affected this positive result are net profit, sales and working capital. The net profit of this company from 2014 to 2016 increased by 5.5%, while working capital increased by 4.9%. To analyze the impact of each indicator on the credit risk assessment and the probability of bankruptcy of manufacturing companies in Kosovo, we will also apply two econometric analyzes (the fixed effect and the random effect) that will validate the validity of the research questions submitted to this study.

Table 4: Random and Fixed Effects Results for Z-Altman Coefficient

```
     ZScore |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
------------+----------------------------------------------------------------
         X1 |   1.000451   .0004411   2267.84   0.000     .9995862    1.001315
         X2 |   1.000814   .0003607   2774.48   0.000     1.000107    1.001521
         X3 |    .999241   .0005559   1797.66   0.000     .9981515     1.00033
         X4 |   1.000009   .0000432   2.3e+04   0.000     .9999244    1.000094
         X5 |   .9997827   .0002137   4679.40   0.000     .9993639    1.000201
      _cons |   .0000498   .0002681      0.19   0.853    -.0004756    .0005752
------------+----------------------------------------------------------------
    sigma_u |  .00046938
    sigma_e |  .00057304
        rho |  .40153601   (fraction of variance due to u_i)
```

ZScore	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
X1	1.001045	.0009964	1004.62	0.000	.9990217	1.003067
X2	1.000852	.0006525	1533.89	0.000	.9995274	1.002177
X3	.9997774	.0008662	1154.24	0.000	.998019	1.001536
X4	1.000001	.000089	1.1e+04	0.000	.9998199	1.000181
X5	.9989971	.0005251	1902.47	0.000	.9979311	1.000063
_cons	.0006384	.0005116	1.25	0.220	-.0004001	.0016769
sigma_u	.00078449					
sigma_e	.00057304					
rho	.65207467	(fraction of variance due to u_i)				

F test that all u_i=0:   F(19, 35) =   2.44   Prob > F = 0.0109

Source: Author's calculations

Based on the results of the random effect and the fixed effect, we can conclude that all independent variables of this model are statistically significant at the significance level of 0.05. If we have a 1% increase in the ratio between working capital and total assets, then this will affect the increase of the Z-Altman coefficient for 1 unit, which means lowering the probability of bankruptcy of these companies.

All other independent variables have a positive impact on increasing the Z-Score coefficient, but the greatest impact is the ratio between retained earnings and total assets. Thus, the growth of this financial indicator has given a greater impetus to the increase in the value of Z-Altman for the manufacturing companies involved in this analysis. The Z-Altman credit risk assessment model has survived time as one of the most respected models for forecasting bankruptcy of companies through their financial results. Since estimating the accuracy of forecasting of this model depends on the future of the companies analyzed, making the conclusions on the efficiency of this model in forecasting bankruptcy is impossible. What we can say is that the companies analyzed in this research are characterized by different attributes judged by the prism of financial reporting, including the way of financing, the timely payment of timely payments, the efficiency of production and the return on assets. This makes these companies not easy to analyze as a whole or sector.

Nevertheless, we can say that most of the companies analyzed in this research have performed well with a Z-score above 2.99, while a significant part of the companies have been in the gray (gray) area as companies that are stable but may end up on both the polarizing sides of the evaluation of this model. What is worth noting is that companies: Birra Peja, Kivo, Solid and Apollonia performed badly according to this model. From the outcomes of these companies, it is judged that the future of these companies is not good, and that these companies are at risk of bankruptcy. As many other authors say: The Z-Altman model is a prediction of an event, it is not a final determination. Even companies that are bankrupt or have gone bankrupt, improving their performance, have managed to recover, so the poor rating of these companies is nothing more than a sign of care for individuals or institutions intending to enter into business relationships with these company.

5. CONCLUSIONS AND RECOMMENDATIONS

The data and information derived from this paper could be used by different categories of people and institutions to analyze the bankruptcy tendencies of the companies analyzed in this paper. This paper is thought to be a simple example of how companies are analyzed through the Z-Altman model. Also, by using the data extracted from this paper, lending financial institutions would have a clearer picture of the financial standing of these companies and thus could be protected from credit risk that is closely related to performance of these companies. As most of the giant manufacturing companies in Kosovo are involved in this paper, the overall analysis of these companies would

in some way be a general analysis of the production sector in Kosovo. Therefore, this paper can serve individuals who intend to recognize the state of play of the production sector and the state institutions in the use of policies in order to facilitate the realization of production activity in Kosovo.

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Financial Analysis Of Commercial Banks In Kosovo: Dupont Model

Valdrin MISIRI [a], Sami MAZREKU [b]

[a] *University of Peja " Haxhi Zeka", Faculty of Business, Peja, Kosovo, valdrin.misiri@unhz.eu*
[b] *Kosovo Insurance Association, Pristina, Kosovo, sami.mazreku@gmail.com*

Abstract

This paper tries as much as possible to analyze and measure the financial performance of commercial banks operating in Kosovo for the period 2007-2017 using the DuPont model of financial analysis based on the analysis of the return model capital. Return on equity consists of three main components: the net profit margin, the ratio of total asset turnover and the equity multiplier.

Kosovo's financial sector continues to be characterized by high sustainability. Key indicators of the financial sector's stability, such as liquidity and capitalization rates, as well as credit portfolio quality remain at a satisfactory level, while the level of expansion of this sector through credit activity has marked a slight slowdown. Foreign-owned banks continue to dominate the banking sector of Kosovo, out of ten licensed banks operating in the country, eight are foreign-owned. Risks to which the Kosovo banking sector is exposed remain at a low level especially in recent years. Furthermore, exposure to credit risk and solvency has decreased as a result of the decline in non-performing loans and accelerated credit growth as well as the growth of banking capital as a result of increased profit.

The purpose of this scientific paper is to measure the performance of commercial banks operating in Kosovo. For the realization of this paper, as a sample were taken the 7 largest banks in Kosovo for the period 2007-2017, based on the data published by these banks and the Central Bank of Kosovo. Empirical data testing is performed through 5 statistical analyzes such as: Linear Regression, Fix Effect, Random Effect, Hausman Taylor and GMM Model.

Keywords: DuPont, Return on equity, Net profit margin, Equity multiplier

1. INTRODUCTION

The purpose of corporate managers is to maximize the value of the firm, which is determined by investment decisions and financing made by the executives of the firm. (McGowan & Stambaugh, 2012).

In publishing of their financial statements, some authors argue that corporations fully discover issues related to their operations to assist investors in making investment decisions. (Blessing & Onoja, 2015).

Reports are used to establish the relationship between the two variables and how they affect each other, and this report analysis provides a tool that can efficiently diagnose the financial and operational problems of a business venture (Agala, Jadhav, & Borhade, 2014).

Various reports are used to measure different aspects of business in terms of performance, liquidity, riskiness and profitability. From the potential indicators, the literature shows that the most important measure of profitability and performance is to make calculations using DuPont analysis. The author (Demmer, 2015) notes that changes in the profit margin provide additional information for forecasting changes in the future return on assets, and (Soliman, 2008) cites the components of the DuPont model in providing important information about the operational characteristics of a firm.

2. REVIEW OF LITERATURE

The DuPont model was created in the early 1900's to assess the profitability of a business (Sheela & Karthikeyan, 2012). This model has been modified twice since its initial conception, the original method of DuPont

model analysis developed in 1918 by author F. Donaldson Brown, an engineer who used this model to better understand the finance flow of a company, who came to know a mathematical relationship between profitability and return on equity (ROE) that is determined by asset return (ROA).

For the financial analysis of any business in the private sector there are many different models that describe how well a business works. Within these various methods, the DuPont model was created in the early 1900s, but is still a valid model to be used for assessing profitability. Many authors in their research have not applied this model to the risk level yet, but if we as a researcher have good knowledge and are specialized in the field of risk management, then this model can be very valuable. The Du Pont model is also applied by F. Donaldson Brown, who through this method chooses many financial problems of General Motors and has since been considered an important model for financial analysis. Exceptionally, this model was not used in the security community for risk prioritization or impact analysis (Almazari, 2012).

As ROA affects both profitability and enterprise efficiency, a company's operational decision-making in planning and control will focus on ROA growth, but the first modification of the DuPont model shifted ROA's focus on ROE, including debt or "levens" in a third focus area of attention. This modification made the DuPont model a powerful tool for strategic decision-making within an organization to increase ROE (Collier, McGowan, & Muhammad, 2006).

According to the author (Rogova, 2014), DuPont analysis effectively revealed the efficiency factors which, in turn, had affected the attractiveness of Russian oil extraction companies' investments. It was also revealed that a strong ROE advantage was the possibility of dividing it into various profit ratios, so ROE shows profitability and efficiency from the shareholders' point of view.

Banks and other financial institutions are a unique set of business organizations, assets, liabilities, regulatory constraints, economic functions and their operation make these financial institutions an important subject for research, especially in the conditions of emerging financial sectors. Bank performance monitoring, analysis and control requires specific empirical analyzes related to their performance and performance results to be discussed from the perspective of different audiences, such as investors / owners, regulators, clients / clients and management. Romer (1986) argues that knowledge is easily distributed and transferred to the entire economy by realizing short-term asset return. Moreover, Romer (1986) concludes that capital gains are persistent due to large flows of capital movement within a particular economy (Romer, 1986). The modified DuPont model in the financial analysis process is used to identify financial success promoters according to alternative business strategies. Firms in the retail industry are categorized on the basis of their high / low relative net asset sales and asset turnover ratios (Little, 2009).

In his study, the author (Soliman, 2008) found that the highly functional components of the DuPont model provide more valuable estimates than the components of the economy around the world, suggesting that specific industry reports have increased validity. Standard Analysis DuPont breaks down the Return on Equity (ROE) Index into three multiplier ratios: profit margin, asset turnover and financial leverage (Ohlson, 1995). In different studies, return on equity, competitive pricing approach and CAPM model show that reasonable returns on equity are indispensable for the non-profit organization (Conrad, 2010). Despite the fact that the return on equity can be mechanically increased by the degree of financial leverage (assuming a positive spread), the increase in the discount rate results in the non-change in the value of equity (Panman, 2003).

The modified Du Pont model was a powerful tool to illustrate the link between a company's income statement and its balance sheet and to develop direct strategies for improving the firm's return on equity (Brigham, 2001). Credit analysts and bank directors should maintain a broader (if not higher) standard than their counterparts in less regulated financial institutions, as banks pose particular problems to corporate governance (Macay, 2003).

Today there are two variants of the DuPont model, the first with 3 steps and the second with 5 steps. We will discuss the first 3-step model for calculating ROE (Return on Equity).

Table 1: The coefficients that make up the DuPont model

Return on equity (ROE)	This coefficient measures the total profit of the commercial bank for each euro of the share capital (equity)
Return on assets (ROA)	This coefficient measures the profits generated in relation to commercial bank assets
Equity Multiplier (EM)	This coefficient measures the level of commercial bank financing support in debt financing or capital
Margin of profit (PM)	This coefficient measures the commercial bank's ability to pay the costs and generate profits from interest income and other revenues
Asset Utilization (AU)	This coefficient measures the amount of revenue from intersections and other revenues generated for each asset euro

Source:Author

3. PERFORMANCE OF THE BANKING SECTOR OF KOSOVO

In Kosovo today operate 10 (ten) commercial banks and represent 69.0 percent of the total assets of the financial sector. Their products and services include bank accounts, loans, domestic and international payments, bank cards, bank guarantees, credit cards, e-banking. Access to the services of these banks is currently facilitated by 263 branches and sub-branches, 540 ATMs and 9,493 POS and 196,656 e-banking accounts. Their activity is dominated by loans, whose maturity may be up to 15 years, depending on by type of loan. From the total of loans, 65.2 percent are loans to enterprises. Most of these loans are absorbed by trade sector enterprises (51.8 percent of corporate loans), while the industry sector (including mining, manufacturing, energy and construction) has 23.0 percent of total corporate loans. The agriculture sector currently accounts 4.0 percent of total loans to enterprises. The share of loans to households is 34.4 percent of total loans. The structure of banking sector liabilities is dominated by deposits, which represent 80.2 percent of total liabilities. Banking sector deposits grew 6.5 percent year-on-year, reaching 2.7 billion euros. Deposits of the banking sector in Kosovo consist of household deposits with a share of about 74.4 percent of total deposits, while deposits of private enterprises account 20.1 percent. Commercial banks in Kosovo have a different share structure. Eight of them are foreign-owned banks and two with local capital. The number of employees in commercial banks is about 3,337. The structure of the financial system at the end of 2016 is as follows: the number of banks operating in the Republic of Kosovo is 10, out of which 4 are subsidiaries of well-known banking groups of European Union origin, while 4 are branches of foreign banks and two are banks with local capital. Banks in Kosovo exercise their activity based on the legislation applied in the Republic of Kosovo and in the regulatory framework in force of the Central Bank of the Republic of Kosovo. The legal activity of the Central Bank of the Republic of Kosovo during 2016 is focused on the implementation, harmonization and advancement of the legal infrastructure of the financial sector in accordance with the legislation in force, the European Union legislation, and the best international standards and practices.

The role of banks today is expanding, they decompose into new markets and capture special market segments with a view to expanding the clientele and minimizing risk as a result of diversification of business areas (Zaho & Cani, 2008).

Table 2; Concentration of commercial banks in the five cities of Kosovo

Years	Region of Pristina		Region of Prizren		Region of Peja		Region of Gjilan		Region of Mitrovica		Total
	No.	%	No.	%	No.	%	No.	%	No.	%	
2004	60	24	37	15	60	24	59	24	30	12	246
2005	68	32	39	18	35	16	39	18	32	15	213
2006	68	33	37	18	37	18	41	20	26	12	209
2007	70	31	39	17	40	18	45	20	32	14	226
2008	97	34	44	15	51	18	59	21	36	13	287
2009	97	33	46	16	52	18	64	22	36	12	295
2010	100	32	49	16	57	18	66	21	39	13	311
2011	102	33	50	16	59	19	64	21	35	11	310
2012	101	33	50	16	59	19	67	22	33	11	310
2013	102	34	47	16	52	17	62	21	35	12	296
2014	97	35	45	16	46	17	55	20	34	12	277
2015	93	35	40	15	45	17	52	20	35	13	265
2016	95	36	38	15	42	16	52	20	35	13	262

Source: Kosovo Central Bank Annual Report for 2016

Kosovo's financial system during 2015 was characterized by further expansion of activity, although at a slower pace. The value of total system assets in June 2015 amounted to 4.73 billion euros, corresponding to an annual growth of 9.5. This growth is attributed to a significant extent to the expansion of the activity of commercial banks and pension funds. The structure of the financial system continues to be dominated by the banking and pension sectors, which in 2015 accounted for 69.1 percent and 25.0 percent of total system assets. Consequently, the slowdown in asset growth of the total financial system mainly reflects the slowdown in growth of these two sectors. During this period, the pension sector recorded the highest annual growth rate of 18.1 percent, followed by the banking sector, which was characterized by an annual growth of 6.9 percent. The third component in terms of asset size is the insurance sector which in June 2015 increased its participation in total financial system assets to 3.2 percent.

The structure of the financial system has also expanded with regard to the number of financial institutions operating in the country. By June 2015, two domestic insurance companies were added to the local market. Also, the number of financial aides was 43 out of 41 in June 2014. Meanwhile, the number of commercial banks, pension funds and microfinance institutions remained unchanged. Out of a total of 88 financial institutions licensed to operate in the country, most of them consist of microfinance institutions and financial aides, the number of which together amounted to 61 in June 2015.

Table 3; Number of financial institutions

Description	June 2010	June 2011	June 2012	June 2013	June 2014	June 2015
Bankat komerciale	8	8	8	9	10	10
Kompanitë e sigurimeve	11	11	13	13	13	15
Fondet pensionale	2	2	2	2	2	2
Ndihmësit financiar	29	32	39	40	41	43
Institucionet financiare	17	17	19	18	18	18
Gjithsejt:	**67**	**70**	**81**	**82**	**84**	**88**

Source: CBK (2015)

Kosovo's financial system is continuing to grow steadily. In June 2016, the value of total assets of the system amounted to 5.1 billion euros, an annual growth of 7.3 percent. The increase was mainly due to the expansion of banking sector activity and the positive performance of pension funds. The microfinance and insurance sectors contributed to the growth of total assets of the system, but at a lower rate. The financial aid sector continues to have a low share within the financial system in the country. The structure of Kosovo's financial system continues to be dominated by the banking sector. The second largest size sector are pension funds, which are continuing to increase participation in total assets of the system. The share of other financial sectors in the total assets of the system continues to be close to the previous years.

Diagram 1. The structure of the banking system
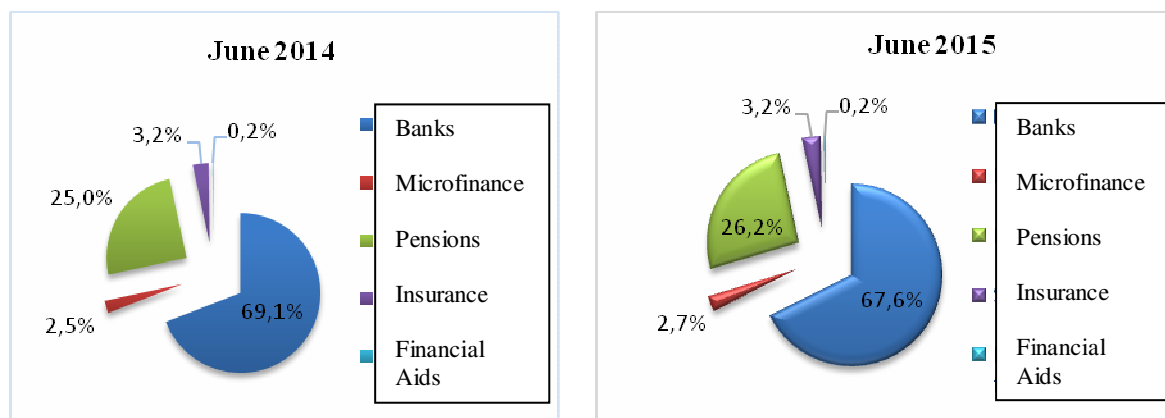
4. METHODOLOGY OF DATA AND SPECIFICATION OF ECONOMETRIC MODEL

For the realization of this study, secondary data were used which were obtained from the respective reports published by banks operating in Kosovo. These data have been processed with the data processing program STATA and through the five models that this program offers we will be able to determine the performance of the commercial banks in our country based on the DuPont model. Through econometric models we will test how they affect: asset utilization ratio, profit margin ratio, equity multiplier ratio as independent variables in the dependent variable, return on equity (ROE). At first we will make the specification of the econometric models then analyze the data, then we will calculate the econometric models and interpretation of the results.

Table 4; Description of model variables and source of data

Variable	Description	Source of data
ROE	Return to Equity is the dependent variable	Banks Annual Reports
AU	Asset Utilization	Banks Annual Reports
EM	Equity multiplier	Banks Annual Reports
PM	Profit Margin	Banks Annual Reports

Source: Author

The limitations of this paper are as follows:

- Lack of annual commercial banks' reports in Kosovo

- The analysis is focused solely on the Kosovo banking sector

- Not all Kosovo Banks are involved

The basic objective of regression is to calculate or predict the average value of a variable Y (dependent variables) based on the values of the other variable (independent variable) X;

The linear regression model specification is as follows:

$$Y = B_1 + B_2 X_2 + B_3 + u_i$$

- **Y** - represents the dependent variables (the variable being explained), in our case of research as a dependent variable is the return on equity.

- **X** - Y - represents the independent variable, in our case as independent variables are: asset utilization, equity multiplier, and profit margin ratio.

- **B1, B2** and **B3** are designated as parameters or coefficients of evaluation; where B1 is the constant parameter, while B2 and B3 are the parameters of the independent variable estimation.

- u_i – is the stochastic variable or error term, contains all the factors or variables that are not foreseen in the model and is a random and unobserved variable that captures positive and negative values. Stochastic error indicates that there are other factors that affect the dependent variance of the cost, except for income. This indicates that the fully-fledged variable is not clarified or does not give us information from independent variables. Otherwise, the stochastic component represents the unexplained part of the model.

- ✓ **Fixed effect model (FEM):** is supposed to be a different intercept and has no time effect.

- ✓ **Random Effect Model (REM):** is supposed to be a different intercept, and without time effect. REM is more suitable for use when crossing numbers are greater than the number of parameters.

- ✓ **Hausman Taylor Model:** this prior option suggests that the researcher should consider a model of Hausman-Taylor where some of the variables, but not all, can relate to individual effects.

- ✓ **GMM Model (GMM):** is a common valuation methodology that is widely used in empirical research.

Specification of Fixed Effect, Random Effect, Husman Taylor and GMM Model is as follows:

$$Y_{it} - \beta_1 X_{it} + \alpha_i + u_{it}$$

Where:

α_i **(i = 1 ... .n)** – is an unknown intercept for each entity (n-specific entity).

Y_{it} – is the dependent variable, where **i** = entity and **t** = time.

X_{it} – represents independent variables,

β_1 – is the coefficient for independent variables,

u_{it} – is the term of error

5. EMPIRICAL RESULTS OF RESEARCH AND CONCLUSIONS

Table 5 shows the result of the assessment from the above equation presented. The results show that all calculated dynamic panel models are well-modeled, since all ROE coefficients are statistically significant. For testing the hypothesis "Asset Utilization (AU), Profit Margin (PM) and Equity Multiplier (EM) have impact on Return on Equity (ROE)" we have used 5 empirical analyzes which are: Linear Regression, Effect Fixed, Random Effect, Haussman Taylor Regression and GMM Model.

Table 5; Empirical analysis of five models in STATA

Variabla e varur ROE	Linear regression (Model 1)	Fixed-effects (Model 2)	GLS-random effects (Model 3)	Hausman Taylor regression (Model 4)	GMM (Model 5)
ROEL1	---	---	---	---	-.0874** (0.321)
MEF	.7062** (0.000)	.6960** (0.000)	.7062** (0.000)	.7093** (0,000)	.7236** (0,000)
EM	1.583** (0,000)	1.738** (0,000)	1.583** (0,000)	1.585** (0,000)	1.144** (0,006)
AU	1.852** (0,001)	1.956** (0,003)	1.852** (0,000)	1.864** (0,000)	3.680** (0,000)
Corrected R²	0.7198				

Source: Calculations by the author

From the results of these five econometric models we can see that all variables are statistically significant at the 5% significance level. We will begin to interpret these empirical results based mainly on the statistical test and comparing them with the results from other econometric models.

The hypothesis presented in this study was that asset utilization, profit margin, and equity multiplier affect ROE. According to the results of all models we can conclude that these coefficients have a substantial ROE impact at the 5% level of significance. Therefore in this case the hypothesis is accepted. Based on the results obtained from the table above we will try to give an explanation for each model separately based on the hypothesis presented, where we can conclude that:

- ✓ **Model 1:** From the results of the linear regression analysis we find that the independent variables in this econometric model (AU, EM, PM) are significant at the 5% level with the dependent variables, ie return on equity (ROE), meaning for every 1% increase in AU, EM, PM, this will have a directly impact on ROE growth, ie if we have a 1% increase in "asset utilization" (AU), this increase will affect ROE growth for 1.852. Also 1% increase in the "equity multiplier (EM), return on equity (ROE)" variable will increase by 1,583 and 1% increase in "profit margin", return on equity will increase to 0.7062.
- ✓ **Model 2:** From the results of the fixed effect model we see that independent variables in this econometric model (AU, EM, PM) are significant at the 5% level with the dependent variables, ie return on equity (ROE). The "margin of profit" variable has (p-value) less than 5%, with 1% increase in profit margin, ROE increases by 0.6960, "equity multiplier" will affect 1.738 and 1% an increase in "asset utilization" would have an increase of 1,956 in the ROE "Return on Equity" variable.
- ✓ **Modeli 3:** In the Random effect model of the results achieved by this model, we see that the parameters are significant at the 5% level with the dependent variables and have a correlation with that, so if the "margin of profit" increases by 1% "return on equity" will increases by 0.7062, each 1% increase in "wealth utilization" addictive variables will increase to 1.852 and for 1% increase of independent variable "equity multiplier" will increase by 1.583 in ROE.
- ✓ **Modeli 4:** Results in the Hausman Taylor model for commercial banks that exercise the activity in Kosovo only confirm the results obtained from the preliminary models where all independent variables are significant at the 5% level with the dependent variables. So the p-value is less than 5%, which means with a confidence level of 95%. So from this model we can conclude that for every 1% increase in the independent variable "profit margin", return on equity will increase to 0. 7093. Also for each 1% increase of independent variables such as "asset utilization" and "equity multiplier ", ROE will rise to 1.864 and 1.585.
- ✓ **Modeli 5:** From the results of the GMM model for commercial banks operating in Kosovo, we see that the variables of "equity multiplier", "profit margin" and "asset utilization" have (p-value) less than 5%, where with 1% growth of the independent variable "equity multiplier" influences the growth of

dependent ROE variables for 1.144, 1% increase in independent variable "profit margin" affects 0.7236 in the dependent variables, as well as 1% increase in variables independent "asset utilization" the return on equity grew by 3,680..

On the basis of these results with a confidence level of over 95% we can conclude simply that asset utilization, profit margin and equity multiplier have a substantial impact on ROE. This paper only validates the work, contributions and studies of some authors in this field who have given positive opinions and have claimed that the main report on the performance of banks is ROE, where as authors can be mentioned: (Cole, 1972), (Liesz, 2002), (Nissim&Penman, 2001), (Piyush, 2015), (Georgios, 2013).

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Surface Investigation of the PMA polymer and Two Different Types of Copolymers of the PMA

Tayfun YARDIM [a], İbrahim YÜCEDAĞ [b]

[a] Düzce Üniversity, Scientific and Technological Research Center, Düzce, Turkey, tayf_yardim@hotmail.com
[b] Düzce University, Faculty of Technology, Computer Engineering, Düzce, Turkey, yucedagi@gmail.com

Abstract

Three different type of insulating polymers were solved in a 2-butanone solution and spin-coated on a pure glass in order to investigate them in a surface roughness and image perspectives. It is essential to use a dielectric polymer that has a smoother surface when it comes to manufacture high-quality organic field-effect transistors (OFETs). In this context, different kind of copolymers of poly(methyl acrylate) (PMA) were synthesized to reduce to roughness value of the PMA. Finally it was proven that roughness value of the copolymers of the PMA are lower than the actual roughness of the PMA polymer. Based on this fact, it can be said that by using copolymers, it is possible to reduce the surface roughness of the dielectric polymer which can be used in organic electronics applications.

Keywords: organic field-effect-transistor (OFET), PMA, dielectric polymer, surface roughness, spin coater

1. INTRODUCTION

Organic electronics have attracted great attention due to the usage of various kind of organic materials in electronics industry. In electronics, generally silicon is used for manufacturing active electronic components. However because of the need for high temperature when manufacturing and lack of elasticity properties, silicon as an inorganic material can be replaced with organic counterparts in some applications in which elasticity is an essential requirement [1]. It can be counted on flat-panel displays, integrated circuits, sensors, memories and radio frequency identification tags as among these applications [2-6].

Organic field-effect transistors (OFETs) are one of the electronic device in which organic materials are used. OFETs consist of three parts as a semiconductor, insulator, and conductor. Between them, insulators which can enormously affect the performance of the OFETs are a significant part of them [7]. Performance of the OFET can be affected by the insulators generally in two ways. One of them is an interface effect and the other one is electrical property of the insulator [8, 9]. These two factors affect the mobility, threshold voltage (V_{TH}), current on/off ratio (I_{on}/I_{off}) and subthreshold swing (SS) which are most important parameters of the OFET. Interface state between semiconductor and insulator in OFETs is highly important factor when the parameter enhancement is an issue [8]. In order to obtain a better interface, both of the semiconductor and insulator surface must be as smooth as possible to provide a proper adhesion between them. In this perspective, one of the criteria which supports to have a high performance OFET is to have an insulator material that is as smooth as possible [10]. Because smooth surface causes better carrier transport at the interface due to the less interface traps between the semiconductor-insulator interface.

In this context, polymer insulator named poly(methyl acrylate) (PMA) and copolymers of it named P29 and P30 were synthesized in order to investigate roughness of them. PMA was synthesized by free radical polymerization method from methyl acrylate. P29 and P30 contain different amount of soybean addition and they were synthesized

from methyl acrylate by a polymerization method. Firstly, it is estimated that their roughness values are differentiating via different level of addition. Afterwards, experiments were carried out to prove the estimates. Consequently it was shown by measurements that P29 has a lowest roughness value between the three polymers. This leads to consider that, addition level can be correlated with the roughness of the polymer insulator. Namely, when the addition level increases roughness decreases.

2. Material and Methods

Firstly, polymer insulator solutions are prepared for roughness measurement and 3D image acquisition process. In this stage, PMA, P29, P30 polymers are solved in 2- butanone at 30 mg/ml ratio respectively. Then all solutions were poured onto the glass substrates and spin-coated for 60 seconds at 2400 rpm. The formed films were annealed on a hot plate for 60 minutes at 150 ºC in order to remove the residual butanone.

Once the solution preparation process was finished, surface roughness measurement and 3D image acquisition of the thin film polymers were performed by Park Systems Atomic Force Microscope (AFM) device. Images of the formed thin films on glass substrates and AFM device can be seen in Fig 1. (a) and (b) respectively.

(a)   (b)
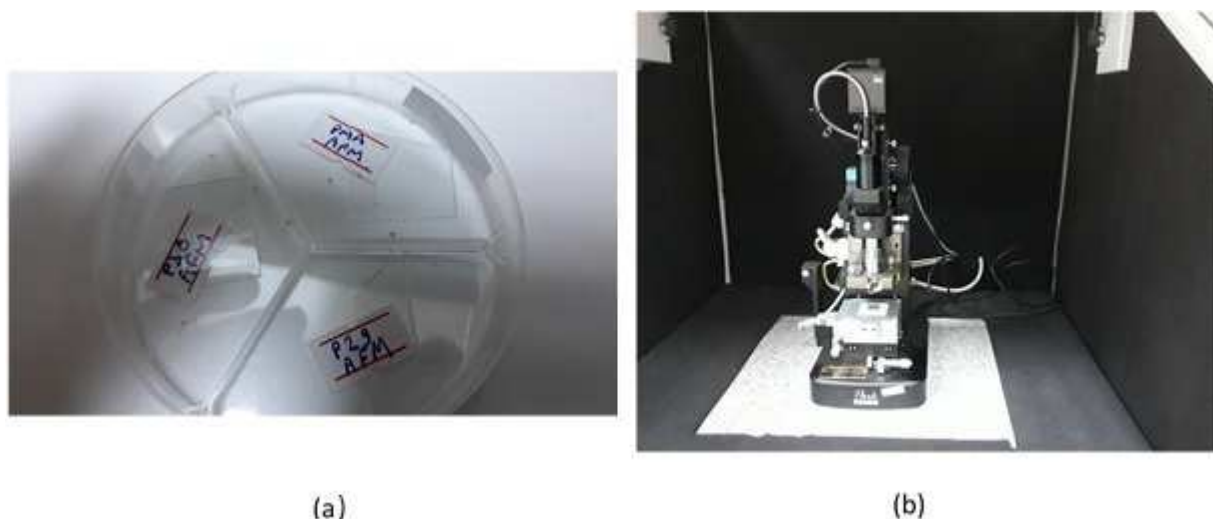
Fig 1. (a) PMA, P29, and P30 thin film polymer insulators on glass substrates (b) an image of the AFM device.

3. Result and Discussion

Fig 2. (a)-(b)-(c) shows the roughness measurement results of the thin film PMA, P29 and P30 polymer insulators and Table 1 shows the correlation between the soybean weights which are added to the methyl acrylate and the roughness value. From the results, it can be seen that root mean square (RMS) roughness of the polymers are increasing when the soybean addition are decreasing. In fact, PMA polymer surface which contains zero gram of soybean has the highest roughness value. This means that via addition of the soybean to methyl acrylate and creating copolymers of PMA homopolymer by this technique provides a smoother polymer insulator surface. Because of the reduced roughness of the polymer surface are desired in thin film OFET studies it can be said that this is useful for OFET designs. Namely those kind of polymers can be used in OFET designs as a gate insulator with a high performance especially in enhanced parameter perspective.

Apart from the roughness, kurtosis value of the PMA has the highest value among the three of them. It can be also seen that P29 has the lowest kurtosis value which is desired because if kurtosis value increases, carriers between the semiconductor-insulator interface run into more traps during the carrier transportation process and this leads to a less effective carrier transformation. As a result, carrier mobility decreases. In our study by decreasing the roughness and kurtosis for polymer insulator, mobility can be enhanced also it can be seen evidently good improvements in other parameters as V_{TH}, SS and I_{on}/I_{off}.
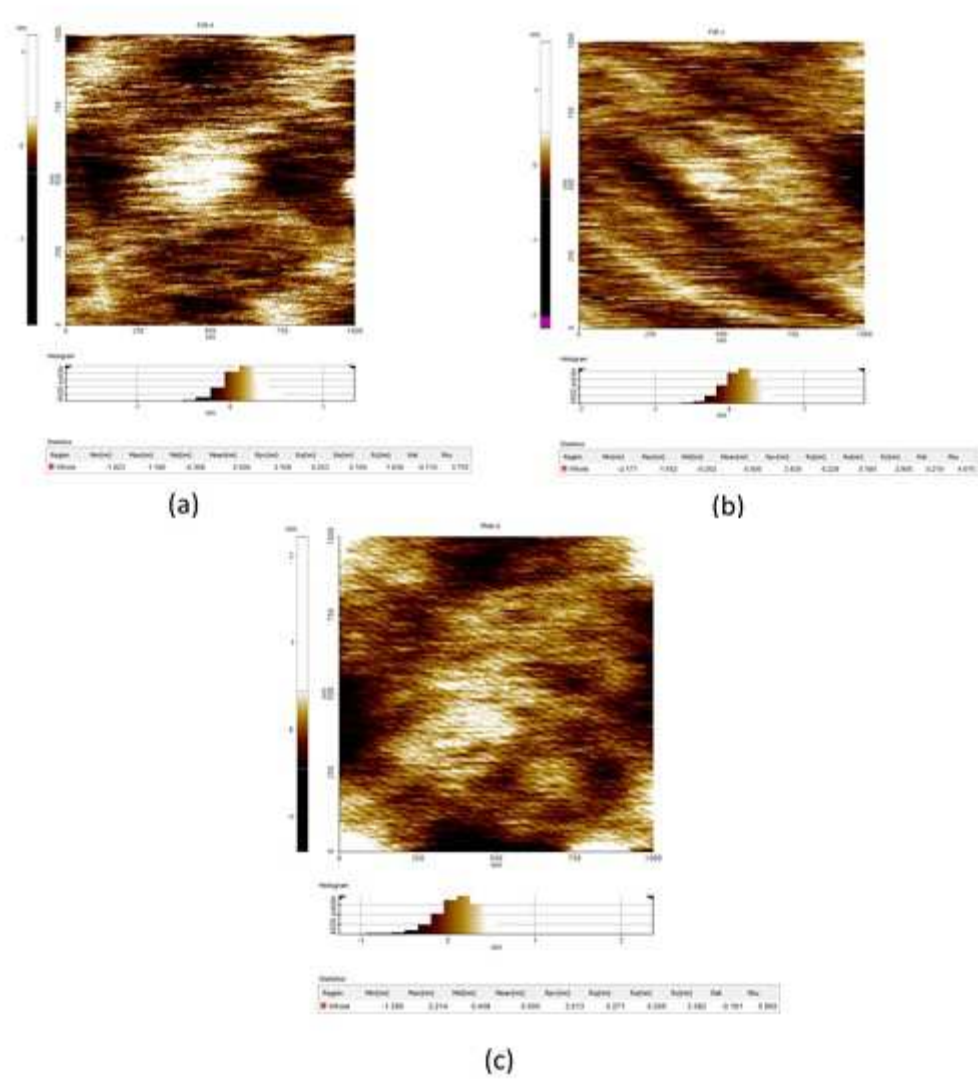
Fig 2. RMS roughness of the (a) P29 (b) P30 (c) PMA insulator surfaces.

Table 1. RMS roughness modulation relative to the soybean weight

Code	No	Soybean (PSy) (g)	Methyl Acrylate (MA) (g)	RMS roughness
P-29	Psy-MA-3	0.525	2	0.203 nm
P-30	Psy-MA-4	0.503	4	0.229 nm
P-31 Poly (methyl acrylate) (PMA)	MA-AIBN	0	2	0.271 nm

Besides the roughness measurement results, 3D images of the insulator surfaces are good indicators that shows whether the thin film is formed and presumably how much the roughness value for all of the three type insulators. Figure 3. (a)-(b)-(c) shows the 3D image of the P29, P30 and PMA polymer insulator surface. By just looking at the 3D images of the polymer surfaces one can judge that roughness is highest for PMA and lowest for the P29 polymer. This justifies the actual roughness measurement results.

(a)

(b)

(c)
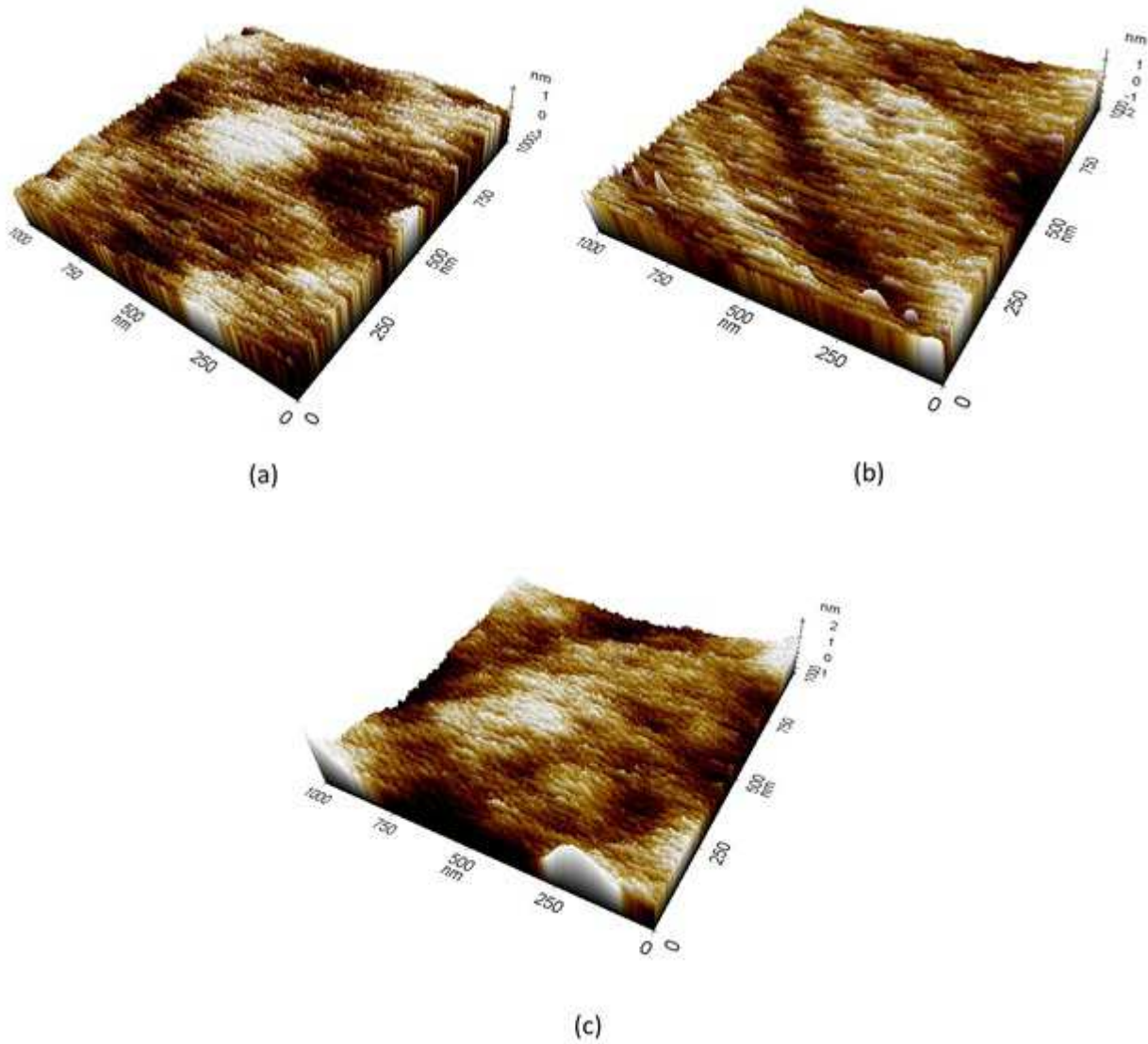
Fig 3. 3D surface profile of the (a) P29 (b) P30 (c) PMA polymer insulator surfaces.

4. Conclusion

Three different types of polymer insulator were formed as a thin film on a glass substrate in order to investigate them in roughness perspective. One of them was a homopolymer and the other ones were copolymers of this homopolymer. Homopolymer was synthesized using methyl acrylate without any addition by a polymerization method. On the other hand, copolymers were synthesized by adding a different amount of soybean to the methyl acrylate and then using a polymerization method. Results showed that adding soybean to create a copolymer make the polymer smoother than the actual homopolymer. This is useful for organic electronic studies. Namely, as carrier transport on the semiconductor-insulator interface is more effective and carriers run into less barriers and traps on

the interface, smoother thin-film surface are preferable in especially OFET designs. In this context, it can be said that creating a smoother surfaces for gate insulators by this above-mentioned technique can be used in order to fabricate more effective and high performance OFETs.

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Clustering OECD Cities for Transport Preferences of Traveling to Work Using K-Means Algorithm

Ayse Aycim SELAM[a]

[a] *Marmara University, Engineering Faculty, Industrial Engineering Department, Goztepe Campus,Istanbul, Turkey, aselam@marmara.edu.tr*

Abstract

Millions of people travel to work, especially in urbanized areas, by choosing from a variety transport solutions. It is important to provide sustainable and public solutions to citizens for a better quality of life. Citizens' preferences are also effective on transport investments. In this study, OECD citizens' preferences while traveling to work are analyzed using K-means algorithm. The indicators selected hereby are population density, registered private vehicles, total registered motor vehicles, share of trips to work by mode of transport (motor vehicles, environment friendly options, public transport and others), average trip length by car and average time of journey to work. The data is collected using the Urban Transport Data Analysis Tool of OECD where the indicators are provided for 93 cities. However, 35 cities are eliminated due to data availability. For clustering analysis first a hierarchical dendogram is drawn and an agglomerative hierarchical clustering is applied. The elbow point is found using the Ward's linkage method and 4 clusters are decided to form. K-means algorithm is applied on 58 cities (most of from OECD), using the 9 indicators selected with 4 clusters. Finally, findings and characteristics of clusters are discussed, and suggestions are proposed for sustainable transport and mobility.

Keywords: public transport, Clustering, K-means Algorithm, OECD

1. INTRODUCTION

Traveling to work is a daily activity of citizens and their preferences effect many decisions at municipal level. Sustainable alternatives also have significant influence on both citizens and investors (governments, municipalities, etc.). So called urban structure is one of the behavioral change policy areas, and appear to be an important enabler of carbon efficient travel in the form of public transport, walking and cycling and short distance trips [1]. In order to promote the use of renewable energy sources and build low-carbon eco-cities, comprehensive planning of transport systems, due to social, economic, environmental and cultural elements of the city should be done for quality of life and the environment [2].

With increasing traffic congestion and space limitations, the mobility requirements of cities increase and people tend to buy motorized vehicles when they get wealthier. Therefore, even the most transportation efficient cities in the world are facing escalating motorization and mobility demands [3]. Motorized mobility is known to increase transport related emissions in growing megacities where various methods have been employed to mitigate the environmental effects of motorized mobility [4]. This situation reveals the significance of sustainable transportation solutions not only for the technological performance of vehicles and fuels in terms of emissions but also for promoting public transportation in urban management.

The Centre for Sustainable Transportation, defined sustainable transportation systems which:
- Allow the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations.

- Are affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy.

- Limit emissions and waste within the planet's ability to absorb them, minimize consumption of non-renewable resources, limit consumption of renewable resources to the sustainable yield level, reuse and recycle its components, and minimize the use of land and the production of noise [5].

For the reasons above, an assessment of public transportation habits should be investigated and required solutions should be presented to citizens. In this study 58 cities are selected and evaluated for their public transport preferences using k-means clustering. The results and discussions are provided for the analyzed 4 clusters.

2. PUBLIC TRANSPORT PREFERENCES

Travel is increasing in virtually all regions of the world, usually at or faster than the rate of economic growth, and generally faster in the long run than the rate of reduction of energy and pollution intensity [3]. Public transport is a way of daily travel mostly middle and low income citizens prefer when going to work, school and other activities. It is a system designed generally for the traveling of citizen on pre-established routes and schedules with an affordable fee. In this study, bus, bus rapid transit and rail systems are in the context of public transport.

In literature, public transport preferences are researched for elderly people, their individual capacity and environmental stress [6], quality of service [7], the demand for public transport [8], choices of commuters assessed for priorities using multi-criteria decision making [9], and various policies [10]. Hence, these researches emphasized on for what reasons people choose to travel with public transport. On the other hand, some other studies from literature focus on the choice of public transport or private car [11, 12].

Apart from above, this study elaborates on 58 cities' transport preferences of traveling to work, taking into account 9 true measured variables including environmental and social ones. With this point of view, the study is different from the literature for containing a variety of indicators and analyzing public transport preferences on city basis.

3. DATA

Urban Transport Data Analysis Tool of OECD is used to collect the related data which is analyzed in this study. Transport indicators of 93 cities among the world are provided with this tool. However, due to missing values of some indicators 58 cities are selected for this study. Fig. 1 provides the regional distribution of the selected cities. The list of cities are tabulated with their countries and regions in Table 1.
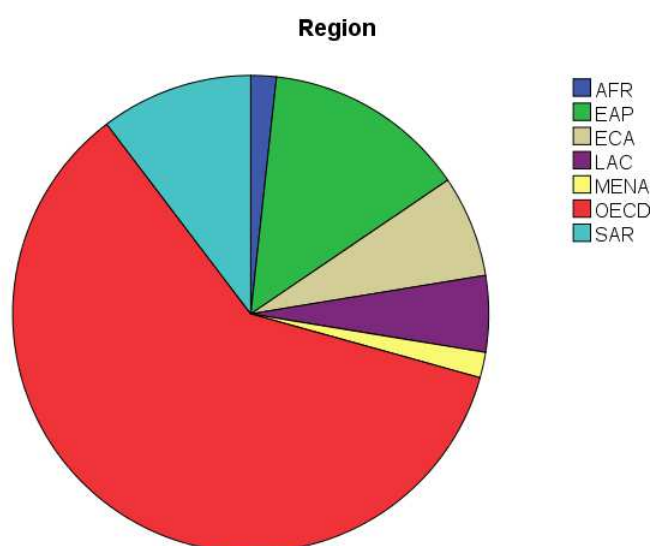
Fig. 1. Regional Distribution of 58 Selected Cities

The cities are selected from regions of Africa (AFR), East Asian Pacific (EAP), Europe and Central Asia (ECA), Latin America Countries (LAC), Middle East and North Africa (MENA), Organization for Economic Co-operation and Development (OECD), and South Asian Region (SAR). The number of cities from each region with respect to country is also provided in Figure 2.
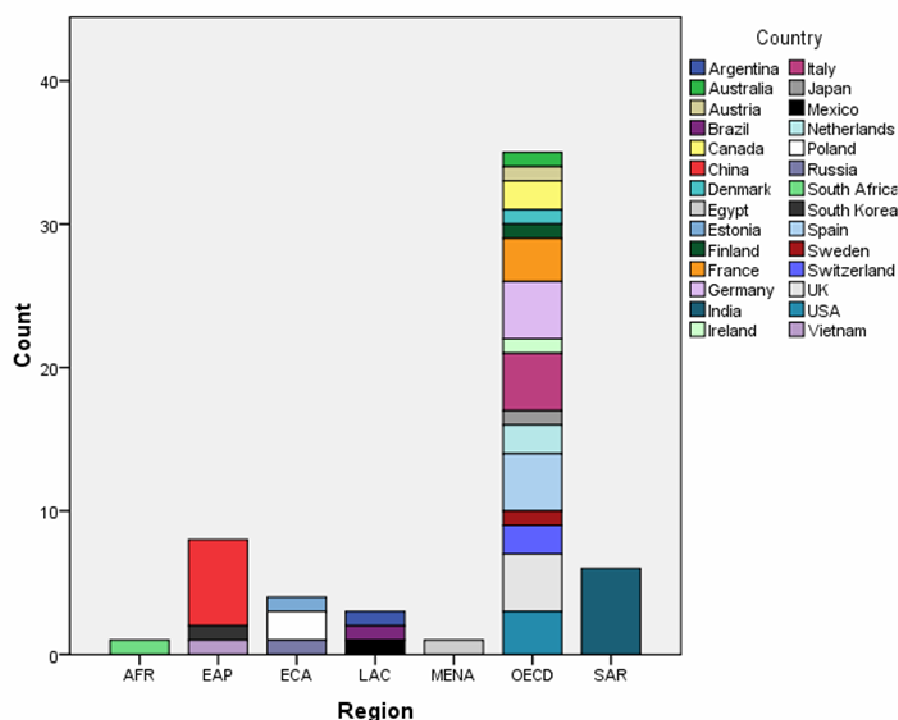
Figure 2. Reginal Distribution of Selected Cities

The total list of selected cities are tabulated in Table 1 with alphabetic order of the country.

Table 1. List of Selected Cities

City	Country	Region
1. Buenos Aires	Argentina	LAC
2. Melbourne	Australia	OECD
3. Vienna	Austria	OECD
4. Sao Paulo	Brazil	LAC
5. Toronto	Canada	OECD
6. Vancouver	Canada	OECD
7. Beijing	China	EAP
8. Guangzhou	China	EAP
9. Hong Kong	China	EAP
10. Kunming	China	EAP
11. Shanghai	China	EAP
12. Wuhan	China	EAP
13. Copenhagen	Denmark	OECD
14. Cairo	Egypt	MENA
15. Tallinn	Estonia	ECA
16. Helsinki	Finland	OECD
17. Marseilles	France	OECD
18. Nantes	France	OECD
19. Paris	France	OECD
20. Berlin	Germany	OECD
21. Hamburg	Germany	OECD
22. Munich	Germany	OECD
23. Stuttgart	Germany	OECD
24. Ahmedabad	India	SAR

Table 1. List of Selected Cities (continued)

City	Country	Region
25. Bangalore	India	SAR
26. Delhi	India	SAR
27. Jaipur	India	SAR
28. Mumbai	India	SAR
29. Pune	India	SAR
30. Dublin	Ireland	OECD
31. Bologna	Italy	OECD
32. Milan	Italy	OECD
33. Rome	Italy	OECD
34. Turin	Italy	OECD
35. Tokyo	Japan	OECD
36. Mexico city	Mexico	LAC
37. Amsterdam	Netherlands	OECD
38. Rotterdam	Netherlands	OECD
39. Krakow	Poland	ECA
40. Warsaw	Poland	ECA
41. Moscow	Russia	ECA
42. Johannesburg	South Africa	AFR
43. Seoul	South Korea	EAP
44. Barcelona	Spain	OECD
45. Madrid	Spain	OECD
46. Seville	Spain	OECD
47. Valencia	Spain	OECD
48. Stockholm	Sweden	OECD
49. Geneva	Switzerland	OECD
50. Zurich	Switzerland	OECD
51. Glasgow	UK	OECD
52. London	UK	OECD
53. Manchester	UK	OECD
54. Newcastle upon Tyne	UK	OECD
55. Chicago	USA	OECD
56. New York	USA	OECD
57. Washington DC	USA	OECD
58. Ho Chi Minh City	Vietnam	EAP

In order to evaluate public transport habits of the cities in Table 1 a list of indicators are selected from Urban Transport Data Analysis Tool (UTDAT) of OECD. This tool has a matrix design in excel and a researcher can report graphs and plots for 93 cities and 192 indicators. However, data is not available for every indicator and city. So that, in this study 58 cities are analyzed using 9 indicators which are from demand and demographics category. The indicator information is provided in Table 2.

Table 2. Evaluation Indicators

Indicator	Explanation	Unit
Population Density	City population /City municipal area	$1/km^2$
Registered Private Vehicles	Including 2 wheelers and 4 wheelers	#
Total Registered Motor Vehicles	Including public and private vehicles	#
Share of Trips to Work by Motor Vehicles	Car, motorcycle, taxi and 3 wheeler (India)	%
Share of Trips to Work by Environment Friendly Options	By bicycle and on foot	%
Share of Trips to Work by Public Transport	Bus, Bus rapid transit and rail	%
Share of Trips to Work by Others	Others except above	%
Average trip length by car	Trip length per day	km
Average time of journey to work	Trip time per day	minutes

The selected 58 cities were the ones having values for most of the indicators above, hence, there are some shortcomings for the data availability. For cities, Delhi, Bologna, Italy, Madrid, Seville, Valencia, Geneva, Zurich and Glasgow; total share of the trip to work by mode of transport did not add up to 100 or was more than 100. In this situation some corrections are applied for the data. The detailed information about this is provided in Appendix A. the second set of corrections are applied for missing data of average trip length by car and average time of journey to work. Average trip length by car was missing for Buenos Aires, Kunming and Wuhan for which the average

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value (12.82 km) is used. Similarly, average time of journey to work was missing for Kunming and Wuhan for which the average value (30.13 minutes) is used.

4. METHODOLOGY

In clustering algorithms, points are grouped by some notion of "closeness" or "similarity" where in k-means, the default measure of closeness is the Euclidean distance. K-means algorithm minimizes the total squared Euclidean distance between each data point and its closest cluster representative [13]. The variables that can be used in k-means clustering fall into four classes, listed here in increasing order of suitability for the geometric model; categorical variables, ranks, intervals, and true measures [14].

In this study true measures are used as the variables in the data set, and a two-step clustering is applied for selecting the appropriate value of k. Before applying k-means algorithm on the data, a hierarchical dendogram is drawn and seen that between 3 and 6 clusters are appropriate. In the second step Agglomeration Schedule is drawn using Ward's linkage method and tabulated in Figure 3. At point 54 the elbow point of the graphic is obtained, with this value 58-54=4 clusters can be selected.
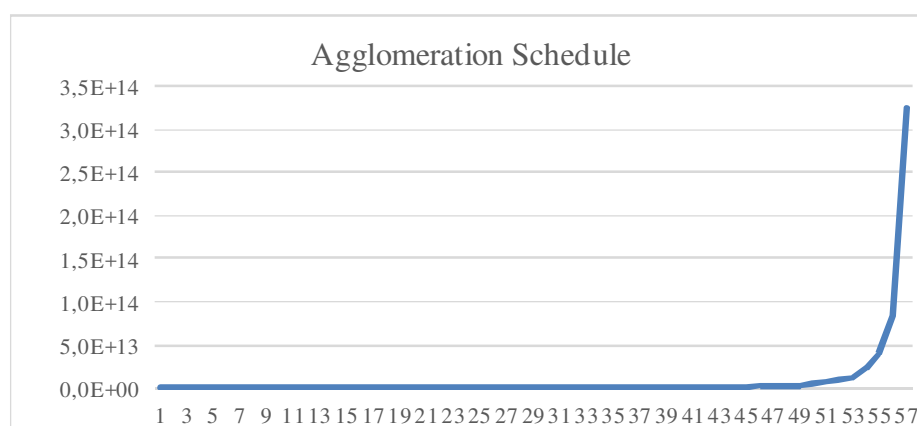
Figure 3. Agglomeration Schedule of the data

5. FINDINGS ON CLUSTERS AND CLUSTER CHARACTERISTICS

With k-means algorithm with 4 clusters and their members are analyzed. The first cluster contains 7 crowded cities which of 4 are out of OECD. Washington DC and New York are in this cluster which have similar characteristics with remaining capitals. The list of cities are provided in Table 3.

Table 3. List of Cities in Cluster 1

City	Country	Region
Buenos Aires	Argentina	LAC
Beijing	China	EAP
Bangalore	India	SAR
Tokyo	Japan	OECD
Moscow	Russia	ECA
New York	USA	OECD
Washington DC	USA	OECD

The second cluster is the one with highest number of members. There are 32 cities most of which are from OECD members. The other cities are European or Europe-influenced (Hong Kong, Wuhan, Pune, Johannesburg) cities. The list of Cluster 2 is given in Table 4.

Table 4. List of Cities in Cluster 2

City	Country	Region
Melbourne	Australia	OECD
Vienna	Austria	OECD
Vancouver	Canada	OECD
Hong Kong	China	EAP
Wuhan	China	EAP
Copenhagen	Denmark	OECD
Tallinn	Estonia	ECA
Helsinki	Finland	OECD
Marseilles	France	OECD
Nantes	France	OECD
Paris	France	OECD
Berlin	Germany	OECD
Hamburg	Germany	OECD
Munich	Germany	OECD
Stuttgart	Germany	OECD
Pune	India	SAR
Dublin	Ireland	OECD
Bologna	Italy	OECD
Milan	Italy	OECD
Turin	Italy	OECD
Amsterdam	Netherlands	OECD
Rotterdam	Netherlands	OECD
Krakow	Poland	ECA
Warsaw	Poland	ECA
Johannesburg	South Africa	AFR
Barcelona	Spain	OECD
Seville	Spain	OECD
Valencia	Spain	OECD
Stockholm	Sweden	OECD
Glasgow	UK	OECD
Manchester	UK	OECD
Newcastle upon Tyne	UK	OECD

The 15 members of Cluster 3 have a wide range of population density. The cities in this cluster have either very high metropolitan population or really low. Table 5 tabulates the cities in Cluster 5.

Table 5. List of Cities in Cluster 3

City	Country	Region
Toronto	Canada	OECD
Guangzhou	China	EAP
Kunming	China	EAP
Shanghai	China	EAP
Cairo	Egypt	MENA
Ahmedabad	India	SAR
Jaipur	India	SAR
Mumbai	India	SAR
Rome	Italy	OECD
Seoul	South Korea	EAP
Madrid	Spain	OECD
Geneva	Switzerland	OECD
Zurich	Switzerland	OECD
London	UK	OECD
Chicago	USA	OECD

The last cluster consists of 4 non-OECD member cities with highest metropolitan population and low population density range. The list of cities in Cluster 4 are in Table 6.

Table 6. List of Cities in Cluster 4

City	Country	Region
Sao Paulo	Brazil	LAC
Delhi	India	SAR
Mexico City	Mexico	LAC
Ho Chi Minh City	Vietnam	EAP

6. DISCUSSIONS

In this section, the clusters are tabulated available variables and findings are summarized. The first two variables are city population and metropolitan population. It is apparent in Figure 4 that the least city population distribution is from Cluster 2 which consists of OECD and European cities. Hence, the mild outliers of Cluster 2 are Berlin and Johannesburg, whereas the extreme outlier is Wuhan. This result is coherent with metropolitan population distribution which is in Figure 5. The outliers for metropolitan population is Paris in Cluster 2, New York and Washington in Cluster 1. Anyway, the widest metropolitan population is of Cluster 3 which is a mixture of highest and lowest crowded cities.
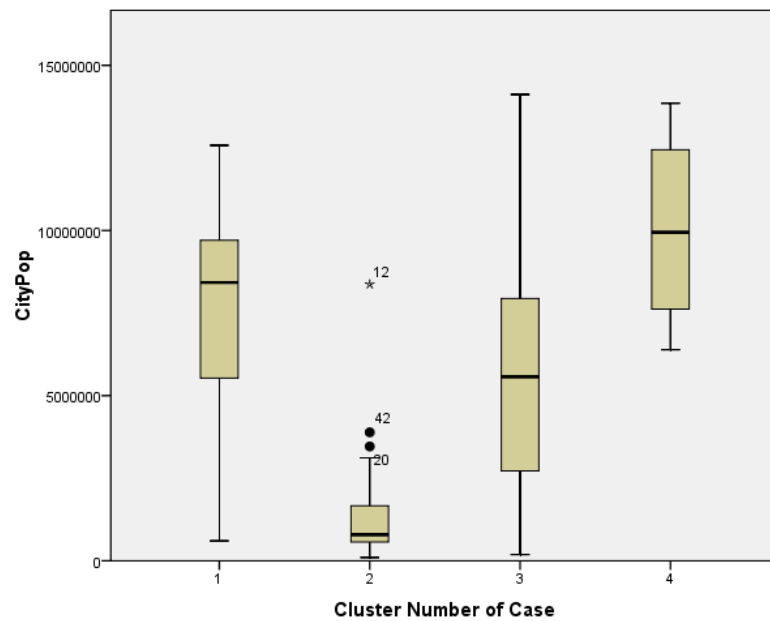
Figure 4. City population distribution of Clusters
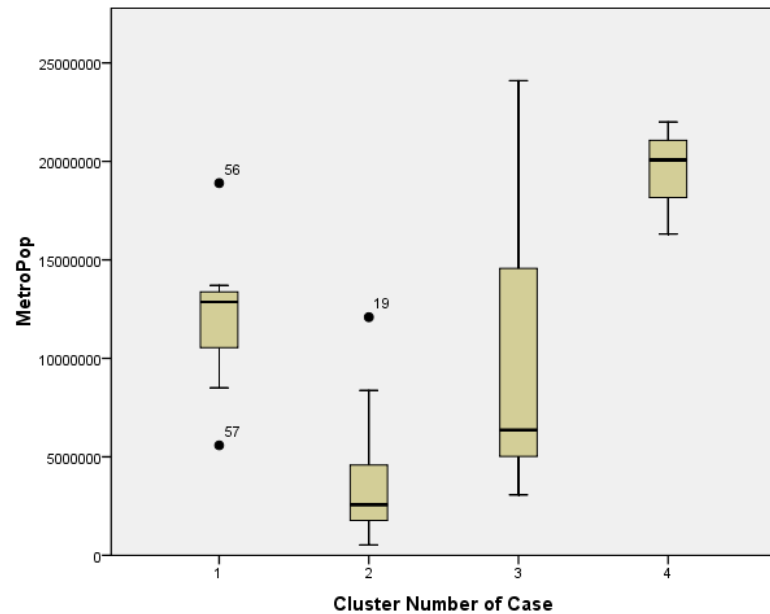
Figure 5. Metropolitan population distribution of Clusters

When population density of clusters are viewed in Figure 6, Cluster 2 similarly, distinct from the rest with its low values. However, in average population densities are approximately close to each other because this variable a more objective value than the populations above. Besides, there are outliers in Cluster 2 in order Pune, Hong Kong, Barcelona and, Paris. In Cluster 3 which has the widest distribution of population density, there is a single outlier, Cairo the only Middle East city in data.
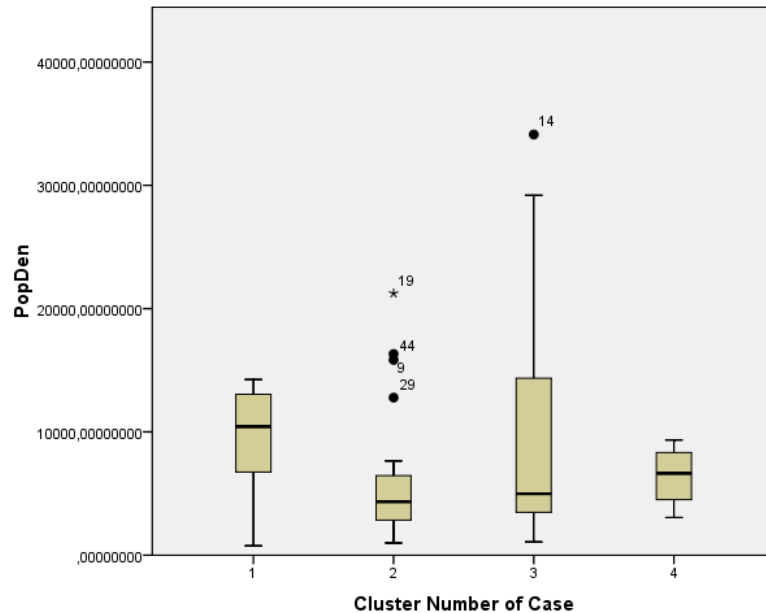
Figure 6. Population density distribution of Clusters

The preferences of selected 58 cities are grouped in by motor vehicles, by environment friendly options, by public transport and others. The cities Krakow (Poland) Warsaw (Poland) and Moscow (Russia) provided only others percentage 100 %. These cities are not excluded from the study because the other indicators was properly available. In addition, for Guangzhou (China), Cairo (Egypt), and Seoul (South Korea) environment friendly options share was 0 % and is not excluded from the clustering application with the same reason above. That why it is normal to see some values equal to 0% in boxplots.

Motor vehicles include cars, motorcycles, taxi and 3 wheelers (in India). For motor vehicle usage each cluster has a wide range of usage with a highest median of Cluster 2 and lowest median of Cluster 1. It is surprising to see Cluster 2 which consists of mostly sustainable cities with a high average of preference. The motor vehicle distribution is provided in Figure 7.

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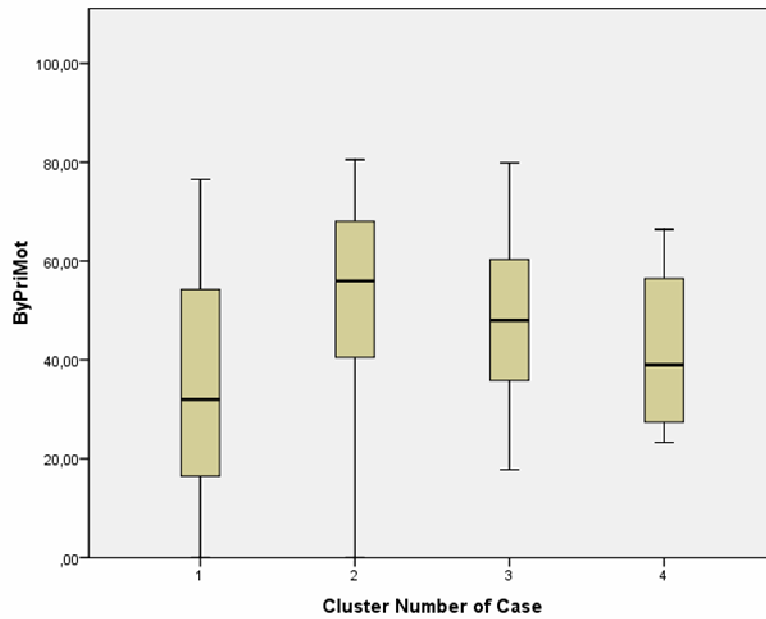
Figure 7. Motor Vehicle Usage of Clusters

Environment friendly options are going to work by bicycle and on foot. These options have zero Carbon emissions which makes them environment friendly. This option is preferred for example in Nordic countries where going to work by bicycle is a common alternative or going to work on foot is preferred economically. Figure 8 shows the widest range in Cluster 3 and the lowest median in Cluster 1. Wuhan is again an outlier in Cluster 2.
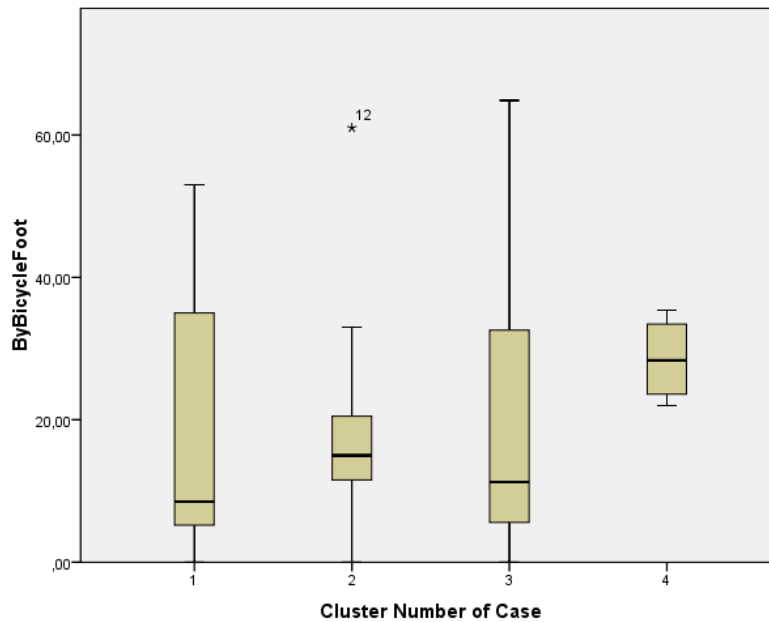
Figure 8. Environment Friendly Options Usage of Clusters

Public transport which is thought to be widely used when going to work has in average around 30 % share. In this study bus, bus rapid transit and rail are among this share. Having a wide distribution in each cluster, only Hong Kong is a mild outlier with 75.1 % in Cluster 2. Hong Kong has also the highest share of public transport among 58 cities. The distribution of public transport is tabulated in Figure 9.
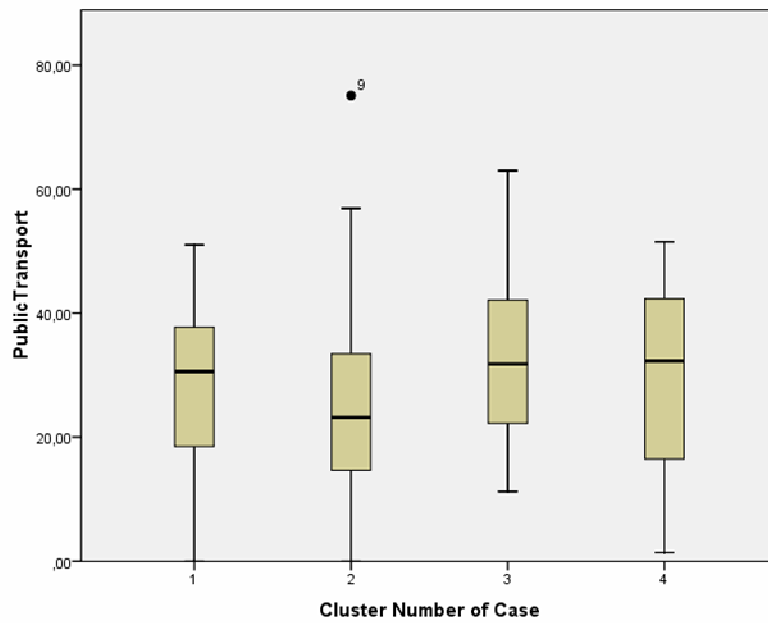
Figure 9. Public Transport Usage of Clusters

The two related indicators are "average minutes to work" and "average trip length by car". In each cluster average minutes to work median are around 30 minutes and above. The two outlies are Beijing (52 min) in Cluster 1 and Johannesburg (51 min) in Cluster 2 can be seen Figure 10. Average trip length by car in average varies from 10 to 15 km, however each cluster have values between ±10kms which can be seen in Figure 11.
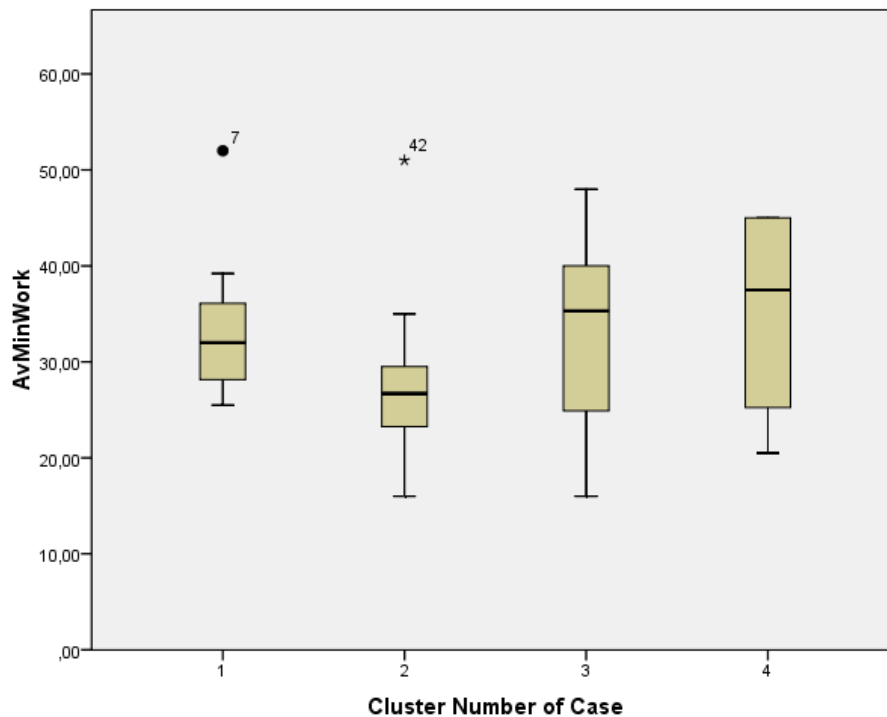
Figure 10. Average minutes to work distribution of Clusters
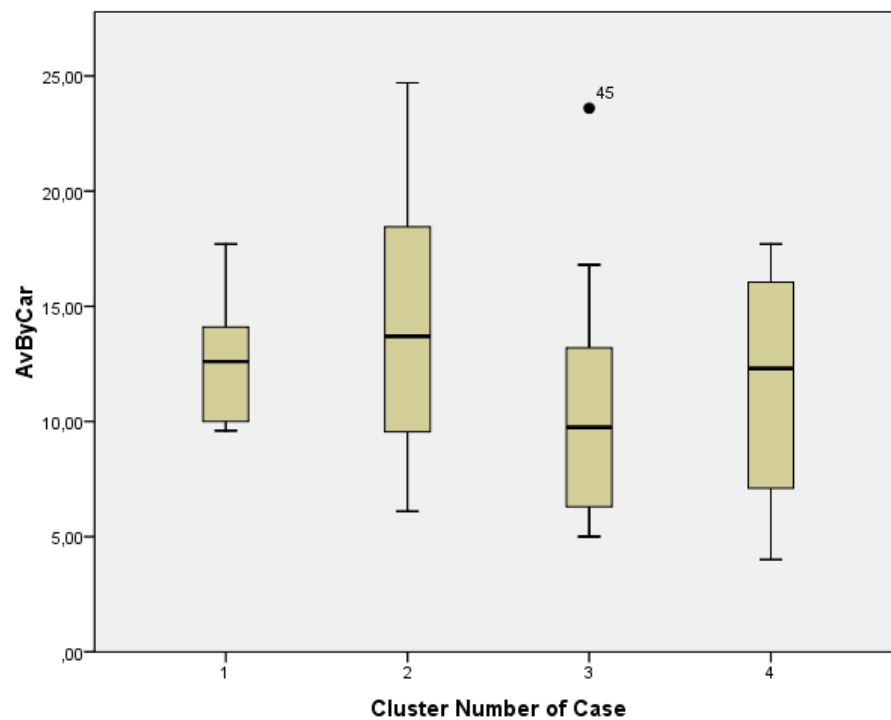
Figure 11. Average trip length by car distribution of Clusters

In order to see if there are any relations between public transport share and private motor usage, a comparative graph of 3 preferences is tabulated in Figure 12. It is obvious that there is a negative linear relationship between public transport and by private motors especially for Clusters 2 and 3.
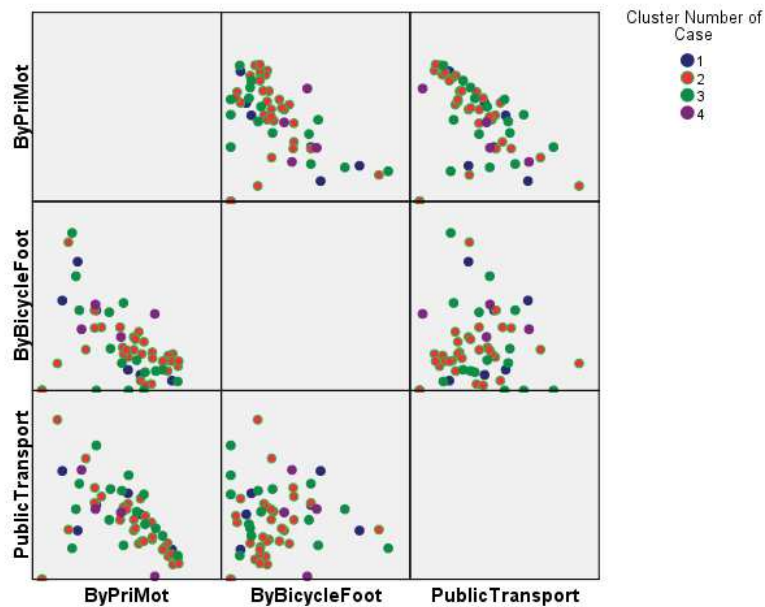
Figure 12. Relations between going to work preferences

Daily public transport boarding numbers are not analyzed for the clustering application but in Figure 13 they are tabulated for clusters. It is seen that the lowest range and values are obtained for Cluster 2. This is because Cluster 2 contains low population OECD cities and the public transport requirements of these cities are less than the remaining cities. The outliers of Cluster 2 are in order Wuhan, Hong Kong, Paris and Johannesburg, can be seen in Figure 13.
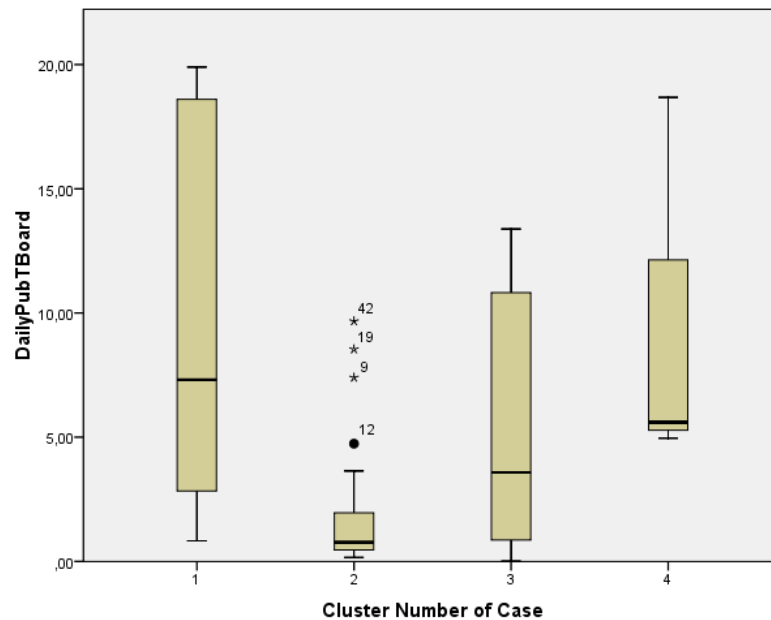
Figure 13. Daily Public Transport Boarding of Clusters

Figure 14 provides the relation between public transport and daily boarding, showing that even if the public transport shares of Cluster 2 is low, daily the boarding numbers has a narrow width of range. However, for Clusters 1, 3 and 4 a more spread out distribution is obvious.
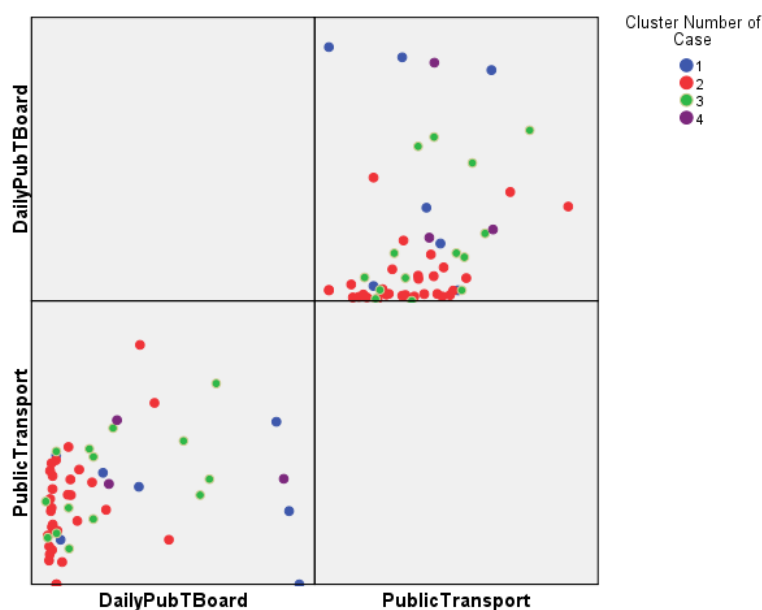
Figure 14. Relation between public transport and daily boarding

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7. CONCLUSIONS AND IMPLICATIONS

A significant area of sustainable development is the transport of human and goods. It effects the 3 pillars of sustainability; economic, environmental, and social. Transport alternatives should be affordable, environment friendly and provide quality choices for its users. One frequently used domain is the public transport which transfers millions from one place to another as a daily activity. In most of the cities, this is provided by either governments or municipalities. Providers attempt to present sustainable solutions and promote public transport usage by presenting fast, comfortable and greener alternatives.

In this study, the preferences of cities are evaluated using indicators collected from OECD Urban Transport Data Analysis Tool. K-means clustering is used for the grouping of similar cities. K-value is selected using agglomeration schedule and seen that 4 is the suitable value for the number of clusters. Starting from 93, the cities are eliminated to 58 due to data availability. The 4 clusters are formed and each indicator is interpreted separately. A comparative boxplot is also formed for related indicators.

As a result it is seen that Cluster 2 containing most of the OECD Cities (25 out of 32) have the least median for public transport and highest median for private motors. And this cluster also has the least number of daily public transport boarding values, however this may be caused by the low population of European cities which requires less number of boarding. Cluster 3 comes next which contains 15 cities nearly half of from OECD containing London, Chicago, and Madrid. This cluster has a wide distribution for both public transport and environment friendly options. For city population and metropolitan population Cluster 3 has the widest distribution because either very crowded or seldom cities are grouped here. Cluster 1 consists of crowded capitals and New York. The final Cluster 4 has 4 non-OECD members which are less congested than average and has close shares of public and private transport.

It is clear that OECD cities are dominated with private transport but for promoting sustainable transport, public transport should be promoted. And in order to see the effects of motorized vehicles, emissions and energy usage for transport should be investigated. It is known that OECD countries support clean fuels and green transport. So that, the cities can be evaluated with more environmental indicators and their policies influences can be viewed.

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Appendix A. Corrections for Share of Trips to Work by Mode of Transport

City	Original Value	Corrected Value
Delhi	Other (-1 %)	0.5 % is subtracted from by motor vehicles and 0.5 % is subtracted from by public transport so that other is (**0**%)
Bologna	By Motor Vehicles (76.06 %)	By Motor Vehicles (**76.05** %)
Rome	By Motor Vehicles (71.15 %)	By Motor Vehicles (**71.0** %)
	By Environmental Friendly Options (8.83 %)	By Environmental Friendly Options (**8.5** %)
	By Public Transport (20.6 %)	By Public Transport (**20.5** %)
Madrid	By Motor Vehicles (40.5 %)	By Motor Vehicles (**40.3** %)
	By Environmental Friendly Options (17.3 %)	By Environmental Friendly Options (**17.2** %)
	By Public Transport (42.7 %)	By Public Transport (**42.5** %)
Seville	By Motor Vehicles (80.64 %)	By Motor Vehicles (**80.5** %)
	By Environmental Friendly Options (12.03 %)	By Environmental Friendly Options (**12.0** %)
	By Public Transport (7.7 %)	By Public Transport (**7.5** %)
Valencia	By Motor Vehicles (55.1 %)	By Motor Vehicles (**55.0** %)
	By Environmental Friendly Options (21.1 %)	By Environmental Friendly Options (**21.0** %)
Geneva	By Motor Vehicles (55.77 %)	By Motor Vehicles (**55.74** %)
Zurich	By Motor Vehicles (47.07 %)	By Motor Vehicles (**47.04** %)
Glasgow	By Motor Vehicles (59.0 %)	By Motor Vehicles (**58.0** %)

Appling Information Technology in Gene Expression Reproducibility Bioinformatics Analysis

Chia-Yang LK[a], Ian C. HUW[b]

[a] Department of Genome Medicine, College of Medicine, Kaohsiung Medical University, Kaohsiung, Taiwan
chiayangli@gmail.com
[b] Department of Biomedical Engineering and Environmental Sciences, National Tsing Hua University,
Hsinchu, Taiwan ichsu@mx.nthu.edu.tw

Abstract

The gene expression reproducibility of microarray experiments has long been criticized. Many studies have been undergoing to address this issue. In this study we investigate the reproducibility problem when not only technical variance but also complex biological variances are involved by introducing the treatment of two different batches of Cordyceps sinensis (CS) to immature dendritic cells (DCs) which were isolated from blood samples of different individuals. Cordyceps sinensis, a complex compound, has been commonly used as herbal medicine and a health supplement in China for over two thousand years. In this study, we adopted duplicate sets of loop-design microarray experiments to examine two different batches of CS and analyze the effects of CS on DCs. Immature DCs were treated with CS, lipopolysaccharide (LPS), or LPS/CS for two days, and the gene expression profile were examined using microarrays. The results of two loop-design microarray experiments showed good intersection rates. The expression level of common genes found in both loop-design microarray experiments was consistent, and the R2 was higher than 0.93.

Keywords: IT, Bioinformatics, cDNA microarray, Gene Chip, Biochip, gene expression, Cordyceps sinensis, reproducibility

1. INTRODUCTION

Microarray technology is being applied widely to address increasingly complex scientific questions [1]. Microarray experiments yield lists of tens or hundreds of differentially regulated genes in sets of experiments. However, the presence of dissimilar regulatory patterns among functionally related genes makes it difficult for the biological interpretation of microarray data [2]. This is not surprising, because systematic biases and random variations are inherent in microarray data [1]. A careful experimental design and rigorous statistical analysis can increase the precision of microarray measurements [3], [4]. Moreover, statistical assessment is not only important in data analysis, but also plays a critical role in every stage of the microarray investigative process, including design of the experiment, data preprocessing, evaluation of systematic errors, identification of differentially expressed genes, functional classification, and biological interpretation [3], [4]. Kerr and Churchill first established the loop design for microarray experiments [5]. Previous studies demonstrated that loop design is more efficient than reference design because a range of statistical methods can be employed to increase the statistical power and robustness of microarray data analysis [6], [7]. Additionally, the loop-designed approach has a high hybridizations/nodes ratio that markedly increases the empirical power of microarray measurement [8]. The gene expression reproducibility of microarray experiments has long been criticized. In this study we investigate the reproducibility problem when not only technical variance but also complex biological variances are involved by introducing the treatment of Cordyceps sinensis (CS) to immature dendritic cells (DCs) isolated from blood samples of different individuals. Two kinds of replication are employed for the estimation of variance at different levels: technical and biological replicates. Technical replication is used to estimate system variance such as sample preparation and other effects of artifacts. Biological replication is used to evaluate variance in biological specimens and experimental procedures. Biological variance includes the

heterogeneous distribution of cell types of both treating sample, in this study i.e. CS, and the treated sample, in this study i.e. immature DCs.

Cordyceps sinensis (CS) is a species of parasitic fungus on the larvae of the Lepidoptera, and has been commonly used as herbal medicine and a health supplement in China for approximately two thousand years [9], [10]. Numerous pharmacological effects of CS have been reported such as anti-tumor [11], [12], immunomodulatory [13]–[15], anti-inflammatory [16]–[18], and anti-oxidant properties [19], [20].

The aim of this study was to examine the gene expression profiles of CS on DCs treated with CS, LPS, and LPS/CS using microarray technology. In each set of microarray experiments, technical replication, performed by identical RNA sampling, in the design of the experiment was employed to estimate systematic variance. For biological replicate, we adopted duplicate sets of loop-design microarray experiments to examine two different batches of CS. We analyzed the common genes found in the two loop-design experiments, which could be used to reduce the variance between different batches of CS. We incorporated technical and biological replication in the design of the experiments to estimate the systematic and biological variance. This was done to ensure more reliable results.

2. MATERIALS AND METHODS

2.1. Reagents

The culture medium was RPMI 1640 (Gibco-BRL, Life Technologies, Paisley, UK) supplemented with 2 mM L-glutamine, 25 mM HEPES, 100 U/ml penicillin, 0.1 mg/ml streptomycin (Gibco-BRL, Life Technologies, Paisley, UK), and 10% heat-inactivated FCS (Hyclone, Logan, UT, USA). Recombinant human GM-CSF and recombinant human IL-4 were purchased from PeproTech (Rocky Hill, NJ, USA). LPS (Escherichia coli serotype O55: B5) was purchased from Sigma (St. Louis, MO, USA). Corning UltraGAPS slides were purchased from Corning Incorporated (Acton, MA, USA). The 3DNA array 900 labeling kit was purchased from Genisphere (Hatfield, PA, USA). The RNeasy mini kit was purchased from Qiagen (Valencia, CA, USA). Human cDNA microarray probe was purchased from Incyte Genomics (Palo Alto, CA, USA) The SuperScript® II was purchased from Gibco-Invitrogen (Carlsbad, CA, USA). The SpotReport™ cDNA Array Validation System was purchased from Stratagene (La Jolla, CA, USA). The Agilent 2100 bioanalyzer and RNA 6000 Nano LabChip kit were purchased from Agilent Technologies (PaloAlto, CA, USA).

2.2. Preparation of hot-water extracts of CS

Different sample batches of Chinese herbal medicine may have different levels of active ingredients. To reduce the variance of different CS batches, we used two batches of CS in this study. To guarantee the quality of the CS, the genetic variation was analyzed by the DNA sequencing as previously described [21], [22]. The CS extracted with hot water was obtained as previously described [23]. Briefly, CS samples were dried at 45℃ in the dark to a constant weight and pulverized. Two grams of the CS sample was dissolved in 40 ml water and hot-water extraction was performed at 90℃ for 2 h. After centrifugation at 3,000 g for 20 min, the supernatant was harvested and sterilized by filtration through a 0.22 μm filter and stored at -20℃ until used. To examine potential endotoxin contamination, CS extracts were measured by LAL assay. Results indicated the two batches of CS had undetectable levels (<0.05 endotoxin units/ml) of LPS (data not shown).

2.3. Generation of human monocyte-derived DCs

Fresh whole blood was obtained from normal volunteers at the Taiwan Blood Center by an Institutional Review Board (IRB) approved procedure issued by National Tsing Hua University, Hsinchu, Taiwan. Human peripheral blood mononuclear cells (PBMCs) were isolated by Ficoll-Hypaque density gradient centrifugation. Monocytes were purified following the plastic adherence method [24]. A total of 107 cells/well in 6-well flat-bottom plates were incubated in RPMI 1640 culture medium. After 2 h incubation at 37℃ in humidified air containing 5 % CO_2, nonadherent cells were removed by gentle washing and plastic-adherent cells were used as monocytes. This monocyte population exhibited >90% CD14 positive staining, as revealed by flow cytometric analysis (data not shown). DCs were generated from monocytes that were cultured at 37℃ in an incubator with 5% humidified CO_2 in RPMI 1640 culture medium that was supplemented with recombinant human GM-CSF 500 U/ml and recombinant human IL-4 1000 U/ml for 6 days. On days 2 and 4, half of the medium was replaced with fresh medium containing recombinant human GM-CSF and recombinant human IL-4. On day 6, immature DCs were reseeded into a 6-well culture plate at a total of 106 cells/well and treated with various concentrations of CS extracts (0 and 1 μg/ml) in the absence or presence of LPS (1 μg/ml) in a culture for 2 days. The viability of the cells under these treatments exceeded 90% (data

not shown), based on results of MTT assay that were performed following the manufacturer's instructions (Sigma, St. Louis, MO, USA).

2.4. Microarray fabrication

A total of 7,334 sequence-verified human cDNA clones, ten Arabidopsis cDNAs (SpotReport™ cDNA Array Validation System) to serve as spike-in controls, and one housekeeping gene (β-actin) to serve as a positive control, were arrayed on Corning UltraGAPS slides. Quadruplicate spotting of 7,334 human cDNA and the 96 spottings of Arabidopsis cDNA and housekeeping genes were performed on every array, to enhance the statistical confidence in the gene expression data. Each array had 32,448 spots. The arrays were post-processed, based on the Corning Instruction Manual for UltraGAPS Coated Slides.

2.5. RNA extraction and microarray hybridization

DCs were harvested at scheduled sampling times to extract total RNA using an RNeasy mini kit following manufacturer's protocol (Qiagen, Valencia, CA, USA). In addition, we mixed the RNA of three different donors' in each loop-design microarray experiment. The quality of total RNA was evaluated using the Agilent 2100 bioanalyzer with the RNA 6000 Nano LabChip kit. Before reverse transcription, each sample RNA was spiked with a mixture of Arabidopsis mRNAs. Fluorescence-labeled cDNA was conducted using 3DNA Array 900 labeling kit, following the manufacturer's protocols (Genisphere, Hatfield, PA, USA). Reverse transcription was performed using SuperScript II. Hybridization was performed at 65℃ in a water bath for 16 to 18 hours, and arrays were washed following the manufacturer's protocol (Corning Life Sciences, New York, NY, USA). The arrays were scanned using the GenePix 4000B scanner (Axon Instruments, Foster City, CA, USA).

2.6. Microarray data analysis and statistical analysis

Microarray data preprocessing, normalization, and statistical analysis was performed using a bioinformatics software suite called Tsing Hua Engine for Microarray Experiment (THEME) [25]. Spot-screening rules were applied to screen out invalid spots on arrays. The spot-screening rules were as follows. (i) Exclude spots defined as "flag bad" or "absent" in all GPR files; (ii) exclude spots with a diameters of less than 75 μm; (iii) exclude spots with a coefficient of variation (CV) of pixel intensity of over 100% in both channels; (iv) exclude spots whose signal to noise ratios (SNRs) in both channels was less than 2 in loop-1 experiments and less than 3 in loop-2 experiments. The signal to noise ratio is defined as (S-B)/B ("S": mean of pixel intensities of "signal"; "B": median pixel intensity of "background").

The logarithm of the ratios for all valid spots on each array was normalized by pin-wise normalization [26]. After data preprocessing, the normalized log ratios of the cDNAs were processed using a log linear model, which was described in our previous study [2]. 5550 and 5843 genes satisfied the selection criteria in the two biological replication loop experiments. F test was used to identify differentially expressed genes. Differentially regulated cDNA clones were identified by applying Bonferroni-adjusted $P < 0.05$ for each null hypothesis in combination with at least a 1.5-fold change [2]. According to the technical replication experiments, a 1.5-fold change, reached 1% false discover rate, and was adopted as another selection criterion. The microarray data is available at GEO (GSE24191).

3. RESULTS

3.1. Duplicate sets of loop-design microarray experiments

Two types of replication were used in the study: (1) technical replication: identical RNA samples were performed on multiple microarrays as shown in Fig. 1; (2) biological replication: each loop-design microarray experiment was used to assay different batches of CS (Fig. 1). In addition, we mixed the RNA of three different donors in each loop-design microarray experiment, to reduce individual variations. In the present study, we adopted duplicate sets of loop-design microarray experiments to examine the two batches of CS. Each loop-design microarray experiment contained ten hybridizations and five experimental conditions, two controls and three treatments (Fig. 1).
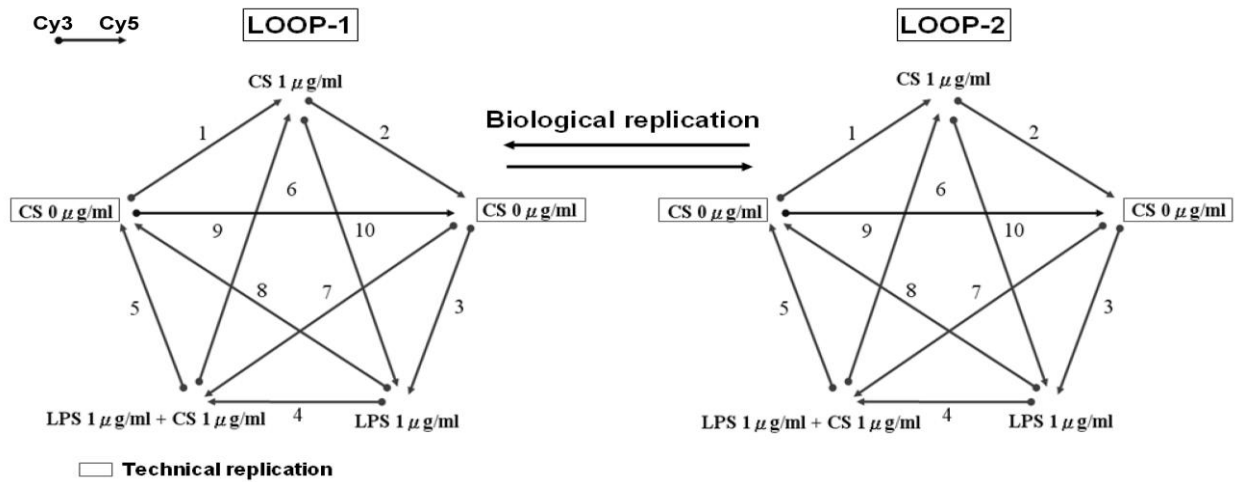
Fig. 1. Design of microarray experiment adopting duplicate sets of loop-design microarray experiments. Each experiment contained ten hybridizations and five experimental conditions, two controls and three treatments. Each mRNA sample was a combination of the mRNA of three donors, performed for biological replication in the loop-design microarray experiment. In addition, we utilized duplicate samples in each experiment for technical replication as well as internal control, estimate technological error and enhance the reliability of data.

3.2. Good intersection rate in two loop-design microarray experiments

Table I shows the number of genes differentially expressed in two biological replication experiments treated with CS, LPS, and LPS/CS. In experiment loop-1, we found 605, 776, and 725 differentially regulated genes treated with CS, LPS, and LPS/CS, respectively (Table I). In addition, we found 688, 754, and 748 differentially regulated genes treated with CS, LPS, and LPS/CS in experiment loop-2, respectively (Table I). The number of common genes between two loop microarray experiments treated with CS, LPS, and LPS/CS was 406, 490, and 453, respectively (Table I). The results indicated that the intersectional rate in two loop-design microarray experiments was higher than 60% treated with CS, LPS, and LPS/CS (Table I). The expression level of common genes between two loop-design microarray experiments was consistent and the R^2 was higher than 0.93 (Fig. 2). To avoid variances from different batches of CS, different donors, and experimental manipulations, we used common genes between two loop experiments following treatment with CS, LPS, and LPS/CS for analysis.

TABLE I

NUMBERS OF GENES DIFFERENTIALLY EXPRESSED IN TWO BIOLOGICAL REPLICATION EXPERIMENTS TREATED WITH CS, LPS, AND LPS/CS

Treatment	CS	LPS	LPS/CS
Genes identified from Loop1 experiment	605	776	725
Genes identified from Loop2 experiment	688	754	748
Common genes	406	490	453
Intersection rate	62.7%	64.0%	61.5%

Intersection rate was calculated by the following equation: common genes/((Loop1 genes+Loop2 genes)/2).

4. CONCLUSION

The loop-design microarray experiments in this study involved technical and biological replication. The technical replication helped us to define the threshold of a 1.5 fold change, which enabled us to attain accuracy of 99% in identifying differentially expressed genes. To reduce the individual variations, each mRNA sample was derived from a combination the mRNA of three donors. The biological replication in this study involved two sets of microarray experiments performed by different individuals using different batches of CS. Through such conscientious controls, our microarray results showed a good intersection rate in two loop-design microarray experiments, with good consistency among the expression of common genes. These results indicate that the data derived from this microarray arrangement is highly accurate and reliable.
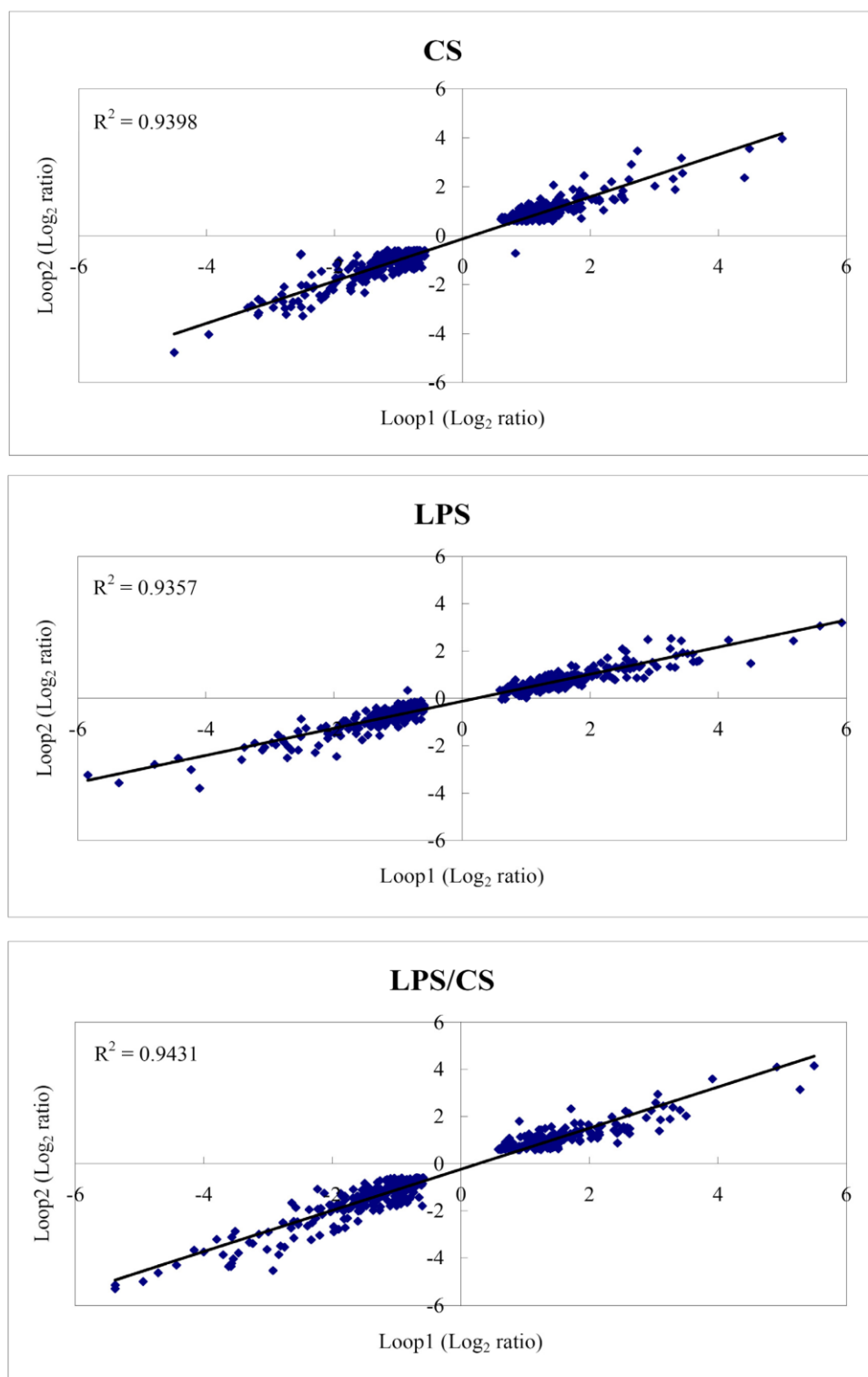
Fig. 2. Linear regression of the expression level of common genes found in both sets of loop microarray experiments. The Number of common genes found in both loop microarray experiments under CS, LPS, and LPS/CS treatment are 406, 490, and 453 respectively. Loop1 and loop2 log2 ratio denotes the expression ratio between control and treatments (CS, LPS, and LPS/CS) regarding duplicate sets of loop microarray experiments. R2, square of the Pearson correlation coefficient, in the three lists of common genes are 0.9398, 0.9357, and 0.9431, respectively

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Traffic Sign Detection using a modified Deep Q Neural Network

Niraj SINGH [a], Sweta KUMARI [b], Srinivasa CHAKRAVARTHY [c], Jitendra KUMAR [d]

[a] Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, Indian Institute of Technology Madras, Chennai, India, neerajajaysingh17@gmail.com
[b] Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, Indian Institute of Technology Madras, Chennai, India, swetaiitm17@gmail.com
[c] Department of Biotechnology, Bhupat and Jyoti Mehta School of Biosciences, Indian Institute of Technology Madras, Chennai, India, srinivasa.chakravarthy@gmail.com
[d] Continental Automotive Components (India) Pvt. Ltd. Technical Center India, Gold Hill Supreme Software Park, Electronic City Phase II, Bangalore, India, jitendra.kumar@continental-corporation.com

Abstract

Traffic sign detection is an important component of Advanced Driver Assistance Systems (ADAS). Deep learning has contributed immensely in progress of research in this field. The current state-of-the-art methods for traffic sign detection like Faster RCNN and YOLO use convolutional neural networks (CNNs) and were developed to detect objects in an image. A more naturalistic approach to detect traffic signs is to use road video data to harness temporal information of traffic sign movement. We propose a *Deep Q Neural Network* for predicting the location of traffic signs in the next frame, using the current frame. The proposed network has two parts: feature extraction and "value" estimation using reinforcement learning. First, a pretrained Alexnet network is used to extract the features of the input frames. Secondly, a convolutional layer was added, that outputs a feature map of dimension 29 x 63, which computes the value estimation of the input frame. A reward of 1 at the location where next frame contains traffic signs is defined for each frame and is resized to 29 x 63. The weights of the network are fine-tuned for grayscale frames of road video data by back propagating the temporal difference error. The network was trained on 12,224 frames and tested on 715 frames. The model outputs an activity map, and after contour detection, the coordinates where the traffic sign might appear in the next frame are obtained. Our model achieved mean average precision (MAP) of 56.001% which beats both Faster RCNN and YOLO v2 with MAP of 53.85% and 48.5008% respectively. Our model took 9 hours for training on GPU compared to 36 and 83 hours for Faster RCNN and YOLO v2 respectively. Thus our model not only outperforms both the state-of-the-art models in accuracy but also takes lesser time to train and generate predictions.

Keywords: Traffic Sign Prediction, Temporal Difference Learning, Deep Learning, Convolutional Neural Network

Analysis Of Resting Time Of Expressway Users At Parking Areas With Etc 2.0 Probe Data

Shoichi HIRAI [a], Jian XING [b1], Shin-ichiro KAI [c],
Ryota HORIGUCHI [c] , Nobuhiro UNO [d]

[a] *Central Nippon Expressway Company Limited,*
[b] *Nippon Expressway Research Institute Company Limited, xing@ri-nexco.co.jp*
[c] *i Transport Lab Inc.*
[d] *Kyoto University*

Abstract

In order to assess measures associated with rest areas, such as making rest areas more attractive by improving commercial facilities and parking lots or providing information on congestion of rest areas, it is necessary to analyse the resting behavioural changes of expressway users, which have not been studied very much so far. This paper reports on the analysis of the resting behaviours of expressway users using the ETC2.0 probe data and the identification of resting time model. The results show that approximately 20~30% of cars take a long rest late night & early morning (0~5) while the ratio reduces to only less than 5% in other time period. The rest time tends to be longer at rest areas with dining facility compared to those without dining facility.

1. Introduction

Three inter-urban expressway operators in Japan have carried out various measures concerning expressway rest areas (service area (SA) and parking area (PA)) to provide better services: making rest areas more attractive by rearranging parking spaces; renovating restrooms, shops, restaurants and other facilities; and providing real-time traffic information on mainline and at rest areas to ease congestion at rest areas. It may also be possible to control traffic to ease congestion on mainline by prompting users to stay at upstream rest areas longer to avoid the congestion.

To evaluate the rest area related measures, it is needed to predict how the trip behaviours (the sequence from entry of the expressway network to exit) of users change with the application of the measures.

Of the trip behaviours, only a limited number of studies have been carried out on resting behaviour, which comprises rest area selection behaviour and stay time behaviour: e.g. the study on short stays at rest areas by Shiino et al. (2011) and the study on how drivers select rest areas by Matsushita et al. (2011). Since 2015, Seya et al. (2015), Mouri et al. (2015), Yamada et al. (2015) have conducted the studies on rest area selection behaviour of expressway users. But the behaviour of users has not been analysed systematically.

Currently, we are developing an Expressway Network Simulator (ENS) to evaluate various traffic measures taken on expressway network (2015). The ENS is designed to reproduce the trip behaviour of each vehicle and is equipped with a route choice behaviour model, for selecting routes depending on the traffic condition on each route, but it does not include a resting behaviour model. By incorporating a resting behaviour model into the ENS, it will be possible to evaluate the effectiveness of rest area related measures for each rest area and a single route, and for

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[1] Corresponding author.

the entire network. In addition, we expect to improve the accuracy of the ENS by making it possible to reproduce trip behaviour which is closer to the actual behaviours of users.

In the study, we aim to build a resting behaviour model of inter-urban expressway users, based on the analysis of resting behaviour using various traffic data. We also aim to apply the model in the traffic flow simulator and use it to evaluate traffic flow improvement measures related to rest areas for each route and for the entire expressway network. In a previous paper (Hirai et al., 2016), the authors did a macroscopic analysis of trip behaviour focusing on the stay time at rest areas by combining data from ETC (electronic toll collection), used by 90 percent of expressway users, and vehicle detector data. A macroscopic resting behaviour model (Hirai et al., 2015, 2016, 2017) was formulated from the findings. Because ETC data provides only expressway entry and exit data and does not give the number and location of breaks the users took, details of resting behaviour are not yet analysed.

To analyse rest area selection behaviour and stay time behaviour, data on each vehicle that includes route data is necessary. So, the authors used trip history data included in the probe data of the newly introduced ETC2.0 system to analyse the actual resting behaviour. This paper reports on the analysis of the resting behaviours of expressway users and the identification of resting time model.

2. Outline of ETC2.0 Probe Data

The so-called ETC2.0 probe data is used in the study, which is output from an ETC2.0 service becoming increasingly popular in Japan (Saji et al., 2014). It includes vehicle type, time, latitude and longitude. Data is recorded every time a vehicle moves 200 m or 45 degrees, from the point where the previous data was recorded. But data within approximately 500 m from where the engine was turned on or off is not recorded from the viewpoint of personal information protection. Table 1 shows items included in the ETC2.0 probe data.

Table 1. Typical trip history data items of the ETC2.0 probe data

Trip history data	Operation ID 1
	Vehicle type & use
	GPS time
	Trip no.
	Serial no.
	Road type code
Added data after map matching	Matching flag
	Matched latitude, longitude
	Entry/Exit node
	Inbound, outbound code
	Road operator code

It should be noted that, to protect personal information data, identification number allocated to each ETC2.0 on-board equipment is shuffled every day from the viewpoint of personal information protection, and each equipment is given a separate consecutive number, or Operation ID 1" (hereinafter ID). By gathering data for each ID, the movement of a particular vehicle for one day can be collected. Since the ID changes when the date changes and the engine is turned off, data on trips of overnight or multiple days for a vehicle is basically difficult to grasp from the ETC2.0 probe data.

When using the ETC2.0 data, if there is a continuity of a trajectory data in space-time diagram collected from the same ID arranged in chronological order, the collection of the data is referred to as a "trip" (the meaning is different from the earlier mentioned "trip behavior"). When it is judged that, for some reason, the data discontinues, in other words if there is a big difference in the time or distance between one recorded datum and the next, the consecutive number is changed, and this number is called a "trip number." In addition, a serial number is given to the data in each trip.

The added data after map matching include "matching flag" which indicates whether map matching was successful or not, "matched latitude and longitude" which are the latitudes and longitudes of vehicle location after map matching, and links (entry/exit nodes) of the digital road map (DRM) and their attributions (inbound/outbound code and road operator code).

3. Analysis of Resting Time

The ETC 2.0 probe data collected between 1 and 2 August 2015 for the entire expressway network in Japan was used in this study to analyse the resting behaviour of expressway users. Since the ETC2.0 probe data at the time of analysis mainly covered small cars with almost no trucks, the target vehicle type of this paper is therefore focused on small cars.

3.1. Trip travel time, number of rests and resting time per break

The number of trip behaviour data extracted was 105,504. As for the type of vehicles, there were 104,415 small vehicles (99%), and 1,088 large vehicles (1%). According to traffic statistics (EHRF, 2015), average daily number of vehicles using expressways in August 2015 was 5.4 million, and average penetration rate of equipped ETC2.0 on-board units was approximately between 1% and 2%.

Fig. 1 shows trip travel time distribution from entries to exits estimated from ETC2.0 probe data and ETC trip data. The latter was obtained from electronic toll collection trip data comprising a pair of entry and exit for each vehicle and covered almost 90% of total vehicles using expressways in Japan. Trip travel time estimated ETC2.0 probe data is a bit smaller than that from ETC trip data because vehicle ID changed after midnight once engine was turned off and overnight long trips were omitted in ETC2.0 probe data. Nevertheless, the two travel time distributions are more or less the same. The 85-percentile trip travel time was 70 min. 90% travelled 90 min or under, and 772 min was the longest trip time. It should be noted that the trip time distribution includes resting time.
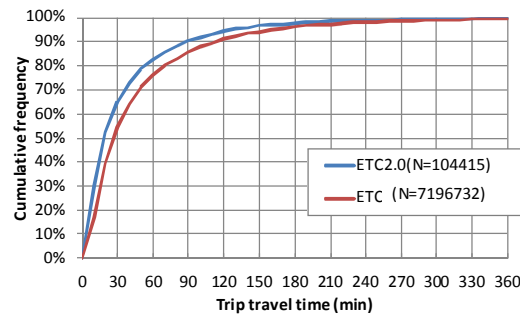
Fig. 1. Trip travel time distribution of trip behaviour (small cars)

The trip distance was 100 km or under for about 90% of the trips, and 99% were 200 km or under. The maximum trip distance was 714 km. On the other hand, from an early study conducted by the authors (Hirai et al., 2016), the cumulative ratio of the number of trips per trip distance taken from ETC data of November 2012 shows that 81.3% of small cars travelled less than 100 km on holidays, and 94.6% travelled less than 200 km. As can be seen, short trips were observed more in this study from ETC2.0 probe data.

Fig. 2(a) shows the distribution of the number of breaks during a trip. Of the 104,415 trips of small cars, 84.1% did not take any breaks; 12.9% took only one break, and only about 3% of the trips took multiple breaks during their trips. As for the resting time distribution shown in Fig. 2(b), the average resting time per break was 25.2 min and 85% of the trips took a break of less than 37 min.
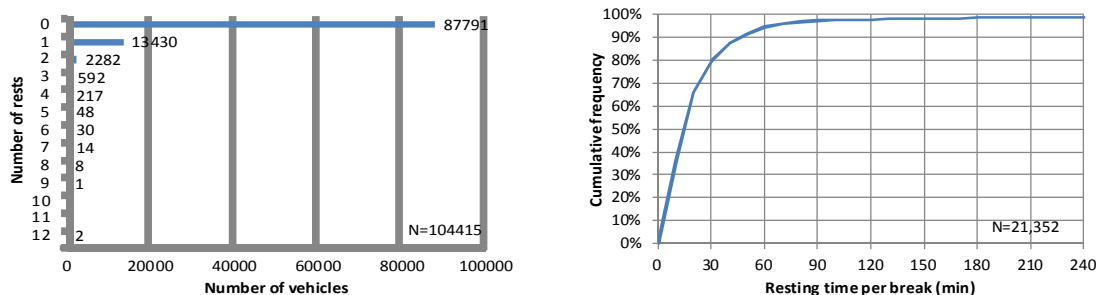
| (a) | (b) |

Fig. 2. Distribution of (a) number of breaks and (b) resting time (small cars)

3.2. Relations between trip distance and number of breaks and total resting time

Next, we analyse the relations between trip distance and number of breaks and total resting time. Fig. 3(a) shows the relation between number of breaks and trip distance. Typically, the number of breaks increases as trip distance increases. On the other hand, a fraction of vehicles have no breaks for trip distance over 200 km, and about 6% do not even have a break for trip distance over 300 km. Therefore, it is necessary to take measures against these long trip users driving with no break as it is well known that it is better to have a break every one and a half to two hours. Fig. 3(b) shows the relation between total resting time and trip distance. The total resting time is proportional to trip distance. When the trip distance is under 300 km, more than 80% of the total resting time is 1 hour or under.

(a)   (b)
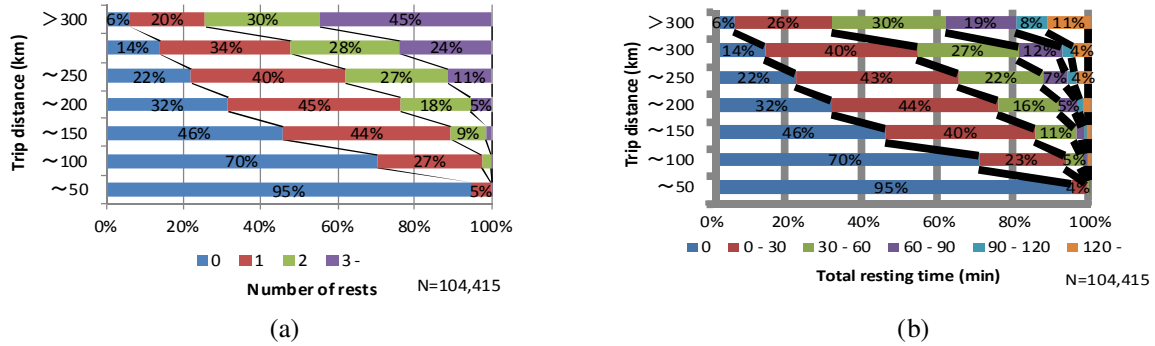
Fig. 3. Relation between trip distance and (a) number of rests; (b) total resting time (small cars)

3.3. Difference between 1st break and 2nd break

Fig. 4(a) shows the cumulative frequency distribution of resting time of the 1st and 2nd break in trip behaviours where the users took more than 2 breaks. As can be seen from the figure, the lengths of the two breaks are about the same. Fig. 4(b) compares the drive time from entry to 1st break and from 1st to 2nd break. We can see that the percentage of vehicles running longer between the 1st and 2nd break is higher. On the other hand, the percentage of vehicles running shorter between the 1st and 2nd break is smaller compared to the drive from entry to the 1st break. This is because the drive distance to the 1st break does not include the distance before entry to expressway. In both cases, the drive time is, for the most part, within 2 hours as usually advised for expressway users.

(a)   (b)
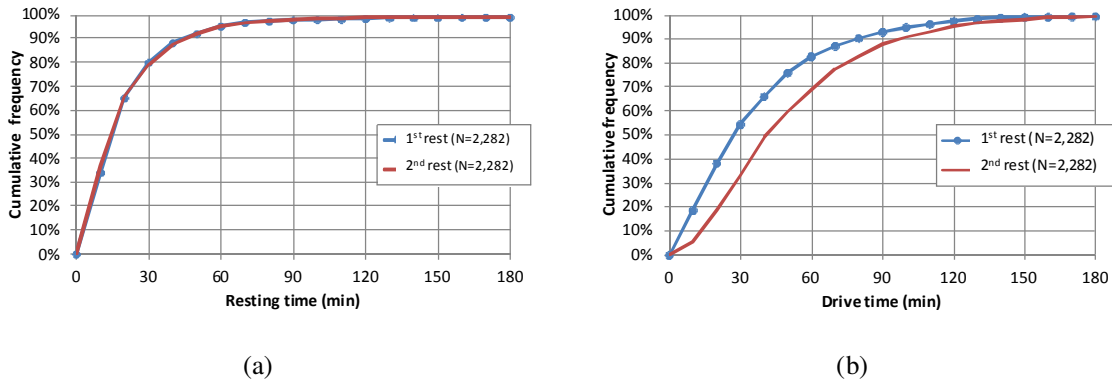
Fig. 4. Distribution of (a) resting time and (b) continuous running time (small cars)

3.4. Difference in resting behaviour per time of day and type of rest areas (SA/PA)

Next, we calculate the total number of vehicles stopping at a rest area to take a break and total resting time per time of day. To include the differences in size and available facilities at SAs and PAs in the calculation, those for the two types of rest areas were calculated separately. The results are shown in Fig. 5 (mean and standard deviation σ of resting time).
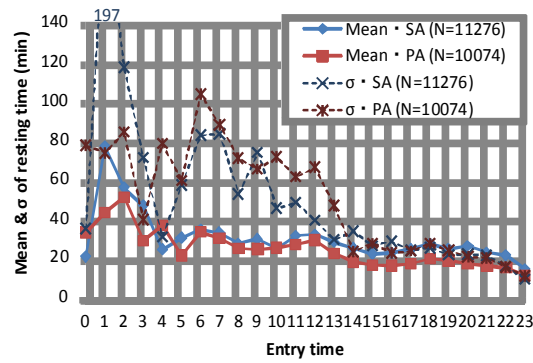
Fig. 5. Mean and standard deviation of resting time per time of day and type of rest area (small cars)

The total number of vehicles taking breaks at SAs and PAs had their peaks between 3 pm and 4 pm. In the morning, that at PAs reached its peak between 10 am and 11 am. As for SAs, the peak was observed between 11 am and noon. The difference in the two types of rest areas is assumed to be caused by the availability of restaurants and other commercial facilities at SAs. In the afternoon, the peak for both SAs and PAs was observed between 3 pm and 4 pm.

On the other hand, the peak of total resting time was observed between 11 am and noon at SAs and between noon and 1 pm at PAs, which shows that irrespective of the difference of availability of restaurants and other commercial facilities at SAs and PAs, expressway users took a longer break for lunch than any other time of day. However, there was no much difference in the mean resting time between SAs and PAs. They decreased from early midnight through to late night. The standard deviation of resting time was much larger from midnight to noon than from noon to midnight. It also varied largely from midnight to noon.

3.5. Distribution of resting time with availability of dining facility and time period

Based on the authors' prior study results, resting time of expressway users may depend on time period such as lunch time and midnight, availability of dining facility, type of rest area (SA/PA), etc. Fig. 6 depicts the distribution of resting time with the availability of dining facility and time period. Here in the study, the time period is basically categorized into late night & early morning (0~5), lunch time (11~14) and other time period. It can be seen that the resting time distribution differs with the availability of dining facility and time period. The resting time at rest areas with dining facility tends to be longer than at those without dining facility. In the case of no dining facility, since no difference exists between lunch time and other time period (morning & from afternoon to midnight), it can simply be divided into two time periods, i.e. late night & early morning (0~5) and other normal time period (5~24).
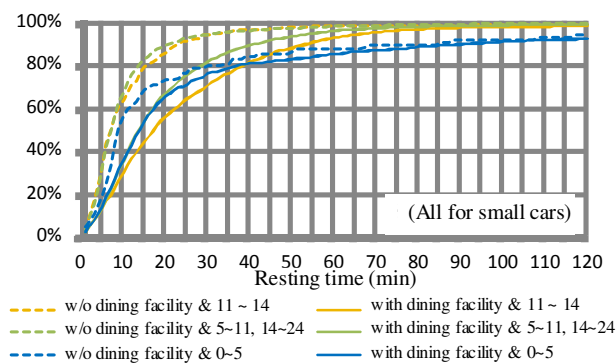
Fig. 6. Resting time distributions by availability of dining facility and time period

4. Resting Time Modelling

4.1. Resting time modelling

In order to model the resting time as shown in Fig. 6, an assumption arises that resting time will follow the compound distribution consisting of two components which have different motivations for resting. One may take, let's say 'normal resting', a relatively shorter resting time, to have a meal or to make a purchase, while another may take a longer resting time to adjust the arrival time to their business opening hours.

Now, let us introduce the following combination function $R_{d,t}(x)$ of two cumulative distributions to explain the appearance of resting time x.

$$R_{d,t}(x) = \alpha_{d,t} F_1(x; k_1, \theta_1, o_1) + \beta_{d,t} F_2(x; k_2, \theta_2, o_2) \tag{1}$$

where,

$R_{d,t}$: compound cumulative distribution of resting time,

d, t: availability of dining facility, time period of entry into a rest area,

$F_1(x; k_1, \theta_1, o_1)$: cumulative distribution of normal resting,

$F_2(x; k_2, \theta_2, o_2)$: cumulative distribution of long resting,

$\alpha_{d,t} \in [0,1]$: component ratio of normal resting,

$\beta_{d,t} \in [0,1]$: component ratio of long resting.

（$\alpha_{d,t} + \beta_{d,t} = 1$）

The cumulative distributions of normal resting and long resting are assumed to take gamma distribution with shape parameter k and scale parameter θ, offset parameter o.

$$F_i(x; k_i, \theta, o_i) = \frac{\gamma(k_i, (x - o_i)/\theta_i)}{\Gamma(k_i)} \qquad i = 1, 2 \tag{2}$$

4.2. Characteristics of normal and long resting time

The parameters of the compound cumulative distribution of resting time are estimated by maximum likelihood method. The numerical search using Microsoft Excel's Solver (GRG non-linear search) was conducted to find the best parameters giving the maximum likelihood. Fig.7 shows an example of the estimated cumulative probability distribution function of resting time for ETC2.0-equipped cars that (A) enter rest areas without dining facility from 5 am to midnight; and that (B) enter rest areas with dining facility from 5 am to 11 am and from 2 pm to midnight. The estimated compound distribution seems to well fit the observed cumulative relative frequency of the resting times of ETC2.0 cars.
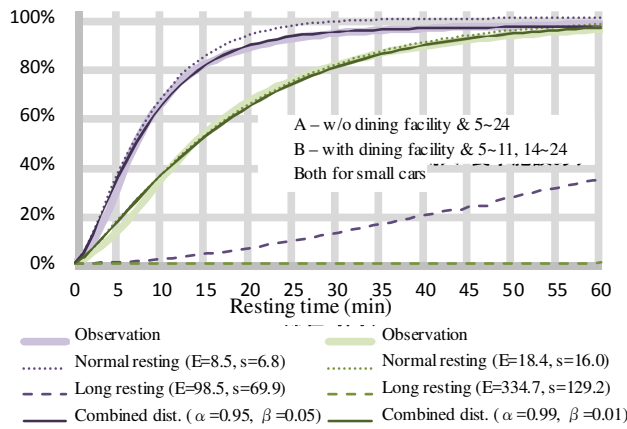

Fig. 7. An example of the estimated cumulative distribution function of resting time

Table 2 shows the results of the mean E and standard deviation σ of normal and long resting distributions as well as the percentage of estimated long resting, all of these values calculated from the estimated distributions. Although ETC 2.0 probe data do not contain the complete overnight trip information because randomly generated operation ID changes once a car is turned off at rest area after midnight, it is found that approximately 20~30% of cars took a long rest late night & early morning (0~5) while the ratio reduced to only less than 5% in other time period. The rest time tends to be longer at rest areas with dining facility compared to those without dining facility.

Table 2. Characteristics of combined distributions of resting time

Time period	Availability of dining facility	% of long resting β	Normal resting		Long resting	
			E	σ	E	σ
0 ~ 4	No	0.27	8.9	5.7	77.5	62.2
5 ~ 23	No	0.05	85	6.8	98.5	69.9
0 ~ 4	Yes	0.18	14.7	10.7	148.3	86.1
11 ~ 13	Yes	0.02	22.9	21.1	321.8	126.7
5~10, 14~23	Yes	0.01	18.4	16.0	334.7	129.2

5. Conclusion and Future Issues

This study used a two-day trip history data of the ETC2.0 probe data to analyse the resting behaviours of expressway users. It also identified a resting time model that is composed of normal resting behaviour and long resting behaviour. The results found that approximately 20~30% of cars took a long rest late night & early morning (0~5) while the ratio reduced to only less than 5% in other time period. The rest time tends to be longer at rest areas with dining facility compared to those without dining facility.

At the time of data analysis, the penetration rate of ETC 2.0-equipped cars was only less than 5% and few commercial vehicles were equipped with ETC 2.0 on-board unit. It is expected that the penetration rate increases in the near future for both cars and commercial vehicles, and their probe data are used to thoroughly analyse resting behaviours of expressway users.

Our future tasks are to further improve the accuracy in determining resting behaviours and conduct analysis on data taken for a longer time. In addition, we plan to develop a resting behaviour model applying the findings of this study, which will be incorporated into an expressway network traffic simulator developed by the authors. Thus the integrated traffic simulator is able to evaluate effectiveness of traffic operation schemes of traffic congestion mitigation related with mainline and rest areas.

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Quantitative Estimation of the Precipitation utilizing the Radar's Common Observation Region

Jeongho CHOI [a]1, Myoungsun HAN [b]

[a] *Chosun College of Science & Technology, Department of Mechatronics Engineering, Gwangju, KOREA,*
jcspatium@gmail.com
[b] *Korea Institute of Construction Technology, Water Resources Research Division, Gyeonggi-do, KOREA,*
mshan@kict.re.kr

Abstract

This study suggests the way to estimate quantitative precipitation utilizing overlapped observation area of radars. We used the overlapped observation range of ground hyetometer observation network and radar observation network which are dense in our country. We chose the southern coast where precipitation entered from seaside is quite frequent and used Sungsan radar installed in Jeju island and Gudoksan radar installed in the southern coast area. We used the rainy season data generated in 2010 as the precipitation data. As a result, we found a reflectivity bias between two radar located in different area and developed the new quantitative precipitation estimation method using the bias. Estimated radar rainfall from this method showed the apt radar rainfall estimate than the other results from conventional method at overall rainfall field.

1. INTRODUCTION

Domestic meteorological observation network is more favorable than the observation density of USA or Japan when it comes to collecting and utilizing weather data as it is relatively dense. Precipitation observation facility has particularly high importance among other weather forecast equipment. Precipitation gauge observation facility has the measuring density (territory/precipitation gauge = 99,720 Km^2/642) of 155.3 Km^2 (based on a single ground rain gauge observation station) even when we only consider AWS (Auto Weather System) which is operated by the national weather service and the observation density reaches 78.7 Km^2 (based on a single ground rain gauge observation station) if we sum up every ground precipitation gauge operated by the Ministry of Land (456 pcs) and the Water Resource Corporation (169 pcs) (Kim et al., 2015).

According to precipitation observation network, 70% of annual precipitation is usually concentrated in from the month of June to September which is a rainy season and this is caused by the geographical characteristics of our country in which typhoon enters from sea side to inland every year. However, dense ground hyetometer observation facility is not enough to deal with heavy rain that got into inland from the sea side due to increase in frequency of local concentrated heavy rain occurrence caused by climate change and extreme spatio-temporal variability in occurrence of precipitation. It is even more severe in the area where precipitation data is hardly collected at the initial state like a seaside.

Various studies are conducted to improve algorithm and method to estimate radar precipitations quantitatively in America and Japan, where radar is operated for the purpose of weather forecast, while radar equipment go through

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* Corresponding author.

upgrade of radar equipment hardware. CASA(Collaborative Adaptive Sensing of the Atmosphere) project in America and TOMACS(Tokyo Metropolitan Area Convection Study for Extreme Weather Resilient Cities) in Japan are typical examples. First of all, CASA project proved applicability of new paradigm(DCAS) for detection of precipitation with overlapped observation range of low cost X-band polarized radar by installation of test observation net which are composed of small X-band polarized radars in Oklahoma (Wang and Chandraseka, 2010). A project to improve observation range of regular C-band radar observation net of the National Weather Service is conducted in Japan by installing three X-band polarized radars by NIED(National Research Institute for Earth Science and Disaster Prevention) as a part of TOMACS. These studies considered geographical and climate characteristics of local area and conducted to improve quantitative radar precipitation assumption by utilizing radar observation net, which are actually installed, as much as possible.

Geographical characteristics should be thoroughly considered in order to develop QPE algorithm appropriate for circumstance in our country (Km et al., 2015). Geographical characteristics should be thoroughly considered in order to develop QPE algorithm appropriate for circumstance in our country (Km et al., 2015). QPE is a Z-R relational equation to estimate the strength of precipitation with a relational equation ($Z=AR^b$), a parameter A is constant and b is quotient in the equation) which expressed the relation of reflectivity toward precipitation particles, Z, and ground rain rate, R, as series of power function. Generally, Z=200, R=1.6 by Marshall and Palmer (1948) is used but deduction of various - relational equation is available according to the precipitation type and space-time (Kim, 2014). With regard to Kim et al. (2015), most of precipitation comes through sea side and get into inland which is quite difficult to get ground hyetometer as our country is a peninsula in which three sides are covered with sea. Therefore, mean-field bias correction is difficult while assumption of parameter in Z-R relational equation is impossible as it is extremely hard to collect ground hyetometer data before precipitation gets into the inland and in the initial period of precipitation generation. Preset single Z-R relational equation is solely available in this period after all.

This study suggests the way to estimate quantitative precipitation utilizing overlapped observation area of radars. We used the overlapped observation range of ground hyetometer observation network and radar observation network which are dense in our country. We chose the southern coast where precipitation entered from seaside is quite frequent and used Sungsan radar installed in Jeju island and Gudoksan radar installed in the southern coast area. We used the rainy season data generated in 2010 as the precipitation data.

1.1. Common Observation Region

If there is an area in which two or more radar observation radius are overlapped, we call the area as an overlapped observation area. The overlapped observation area could be quite wide depending on the radar observation radius and it could also occur either inland or sea. The overlapped observation area in which two or more radar observation areas are overlapped allows collecting radar observation data twice. Therefore, the utilization of overlapped observation area is crucial in order to increase the practical use of the radar observation system and to complement shortcomings.
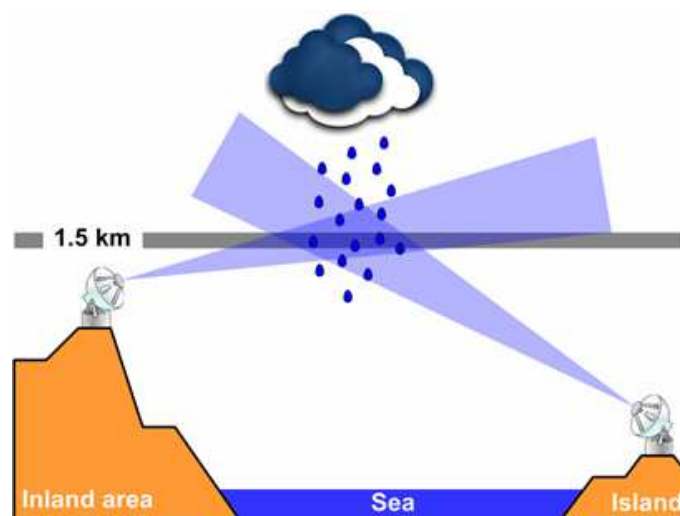

Figure 1. Diagram of a common observation region

Fig. 1 shows a schematic view of the common observation region reflecting the installation environment of the radars located in Jeju and South coast. Like Fig. 1, it is almost impossible to install the radar at the same altitude in the mountainous region that occupies most of the country. Therefore, most radars are installed at different altitudes. If the observations characteristics of two radars are different from each other, mutual bias will occur in the reflectivity data between the two radar, observed in the common observation region. The reflectivity bias between two radars is usually caused by radar observation direction, radar elevation, heavy rain direction, abnormal propagation, correction factors and parameters of radar equipment. In addition, due to the cause of these bias, the bias of the reflectivity between two radars in the common region may differ depending on the region and the storm events. In case the common observation region such as Jeju Island and South Coast region exists in the sea, it is not possible to verify the data on the ground because of the inability to use the terrestrial rainfall data. The rainfall estimation for the common observation region is not much different from the existing quantitative rainfall estimation process. The rainfall field is generated by quantitative rainfall estimation for each radar point, and the rainfall for the common observation region is simply determined by the arithmetic average calculation. The application of this arithmetic average method is also a cause of secondary radar rainfall estimation error because it does not consider the bias of reflectivity between radar points at all. Moreover, it is very likely that underestimation and overestimation of radar rainfall will occur at a time when the parameters of the relationship are difficult to estimate, such as at the initial stage of heavy rainfall.

2. Methodology

2.1. Quantitative precipitation estimation(QPE) using common observation region

Estimation of quantitative precipitation in Korea is a limited method using relational expressions, and it has it limitation in special areas such as coastal areas. In order to compensate for the limitation due to such geographical influences, we developed the algorithm of CRQPE (Common Region Quantitative Precipitation Estimation) method. For reference, a general quantitative precipitation estimation method applied in Korea is described by Kim et al. (2015). Fig. 2 shows the mimetic diagram for typical rainfall observations of radar and surface rain gauges in the southern sea and southern coastal regions according to heavy rainfall movement for describing the CRQPE method. 2, and Table 1 summarizes the observations and estimates of rainfall in the Jeju and South coast regions of each stage according to the movement of heavy rainfall.

For convenience of explanation, the radar that observes the heavy rain ahead is defined as 'Radar A' and the next radar is defined as 'Radar B'

Considering the currently installed radar model, the algorithm is constructed for the purpose of the application of single polarized radar.
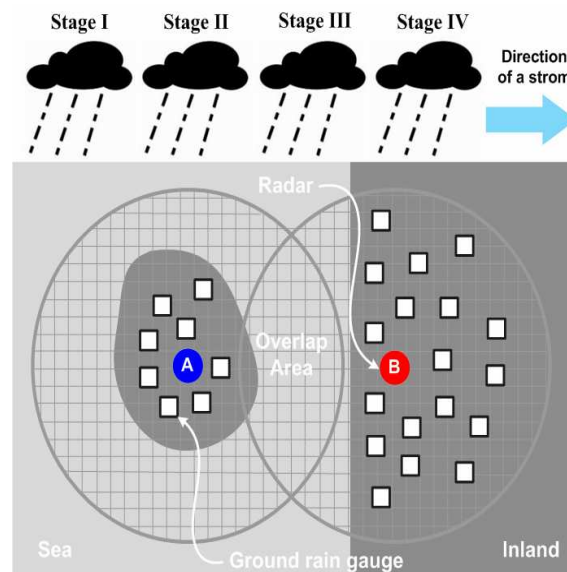

Figure 2. Conceptual diagram of radar observation according to storm movement in a coastal area

However, since it is time prior to collecting the ground level rain gauge data that can be used for the rainfall estimation of Radar A, quantitative rainfall estimation is performed using the existing Z-R single relational equation only. The reflectivity observed in Radar A is transformed into rainfall intensity, using $Z=200R^{1.6}$ or $Z=300R^{1.4}$ which is typically used. Of course, this method is one of the causes of poor quantitative quality of radar estimated rainfall, but it is the best in the present situation where there is no data of groundwater gauge.

Table 1. Availability of observation facilities (gauge and weather radar) and Z-R relationship in real-time depending on the stages

| Stage | Storm Location | Availability of gauge, radar and Z-R relationship in real-time | | | | | |
| | | Radar A | | | Radar B | | |
		Gauge	Radar	Z-R	Gauge	Radar	Z-R
I	Below the Island	No	Yes	No	No	No	No
II	On the Island	Yes	Yes	Yes	No	No	No
III	In overlapped area	No/Yes	Yes	No/Yes	No	Yes	No
IV	On the Inland	No/Yes	No/Yes	No/Yes	Yes	Yes	Yes

Stage II is also a step that can be observed in the rain gauge installed in observation radius of the radar A. At this stage, Quantitative Precipitation Estimate (QPE) using the reflectivity of Radar A is possible. Therefore, it is possible to estimate the coefficient of mean-field bias correction of radar rainfall as well as real-time determination of the Z-R relational parameters. On the other hand, it is impossible to observe rainfall with Radar B.

In this study, the least squares method was applied as a real-time quantitative precipitation estimation method for the cases where the ground rain gauge data were sufficient. The least squares method is easy to apply, and it is possible to calculate the parameters of the appropriate relational equation when the surface rain gauge has sufficient data.

The procedure for deriving the parameters of the equation using the least squares method is the same as one described in Kim et al. (2015).

The Stage III is the point at which the common observation region of both radars occurs. In other words, rainfall can be observed jointly for the same storm. Only at this stage, it is possible to confirm the difference in reflectivity between two radars. In addition, the relative error between two radar reflectivity data is checked and estimated. Fig. 3 shows various types of error between two radar reflectivity. The shape of the error is shown in Fig. 3. As shown in Fig. 3, the error type can be determined by mutual comparison (scatter plot) through the two radar's reflectivity.

If the error type appears as bias like Fig. 3 (a), it can be estimated relatively easily.

(a) System error   (b) Non-linear error   (c) Complex error
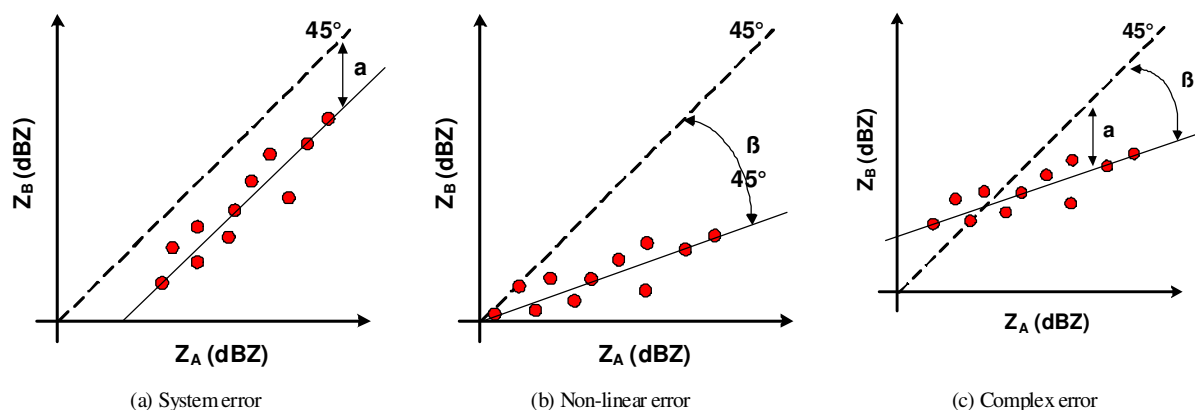
Figure 3. Type of the relative radar error

However, since it is the initial point of the occurrence of the heavy rainfall, it is difficult to obtain the data of the ground rainfall system enough to accurately estimate the parameters of the relational expression. Therefore, it is possible to estimate the radar rainfall using the existing single relational expression. From the time when the ground rain gauge can be sufficiently secured, more accurate radar rainfall estimation becomes possible by updating the real-time relational expression.

2.2. Calculation Method of Correction Coefficient between Radar

When relays calibration is made for the parameters of the two radar sites, consideration should be given to the equations described above.

First, defining the site's radar to transmit the parameters of the relational expression as 'A Radar' and the radar to be transmitted as 'B Radar', the correction factor can be calculated as follows. Such a correction factor is applicable when there is only a bias between two radars.

$$\alpha = \frac{\sum_{i=1}^{n} Z_A}{\sum_{i=1}^{n} Z_B} \qquad (1)$$

Where α is a bias correction factor for the two radar reflectivity, Z_A is the reflectivity of the radar observing the rainfall, and Z_B is the reflectivity of the radar observing the rainfall for the second time. The linear regression process using the existing least squares method considering this correction factor α is as follows. Eq. (2) is the parameter b, eq. (3) is a summary of the intercept.

$$b = \frac{n \cdot \sum_{i=1}^{n} y \cdot x - \sum_{i=1}^{n} y \cdot \sum_{i=1}^{n} x}{n \cdot \sum_{i=1}^{n} x^2 - \left(\sum_{i=1}^{n} x\right)^2} = \frac{n \cdot \sum_{i=1}^{n} (y + \log \alpha) \cdot x - \sum_{i=1}^{n} (y + \log \alpha) \cdot \sum_{i=1}^{n} x}{n \cdot \sum_{i=1}^{n} x^2 - \left(\sum_{i=1}^{n} x\right)^2} \qquad (2)$$

$$a' = \bar{y}' - b \cdot \bar{x} = (\bar{y} + \log \alpha) - b \cdot \bar{x} \qquad (3)$$

As a result, if there is only bias between the two radars, the parameters b are the same. On the other hand, the parameters A should be calibrated sequentially considering the bias as in Eq. (10) below.

$$A = 10^{[(\bar{y} + \log \alpha) - b \cdot \bar{x}]} = 10^{[\bar{y} - b \cdot \bar{x}]} \cdot 10^{\log \alpha} \qquad (4)$$

3. Application Data

3.1. Target area

The observation radius, common region, and surface rain gauge applied to Sungsan and Gudoksan radar points are shown in Fig 4. The radar parameters are summarized in Table 2. The distance between Seongsan radar and Gudeosan radar is about 274 km. Therefore, the observation radius with at least 137 km should be used to establish the joint observation area of these two radars. The number of the ground level gauges (only for AWS in the Meteorological Agency) within the 180 km observation radius of Seongsan radar is 83 (Gosan Center, Jeju Airport, Jeju, Gosan, Seongsan, Seogwipo, Jungmoon, Ara, Hawon, Chooja Island, Woo Island, Mara Island, Yoosooam, Seonheul, Seogwang, Erymook, Hanlim, Namwon, Kujwa, Seongpanak, Pyoseonmyeon, Moseulpo, Gapa Island, Azalea field, witsaeoreum, typhoon center, Jigwi Island and 56 others).
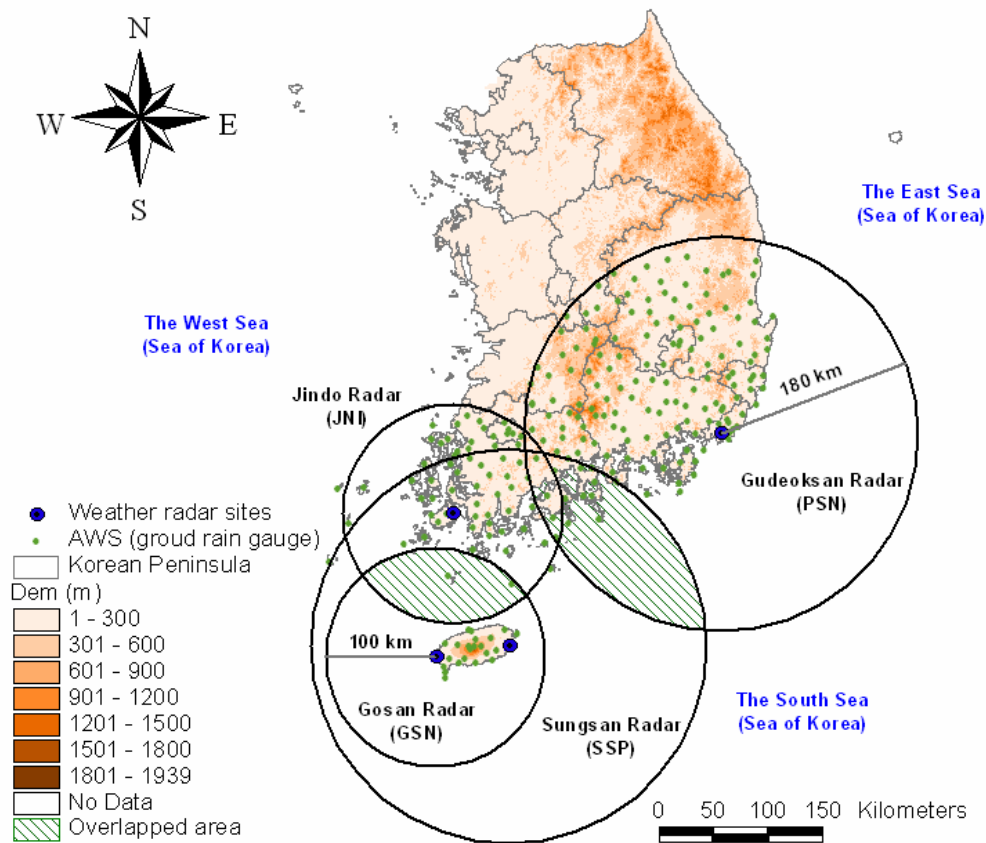
Figure 4. Weather radar sites applied and ground rain gauges in radar observation area

Table 2. Characteristics of weather radars applied

Radar station / Contents	Located in Jeju Island	Located in the coastal area
	SSP	PSN
Starting year	2006	2005
Company (nation)	Genmatronik (Germany)	EEC (USA)
Transmission frequency (MHz)	2,825	2,718
Band	S	S
Transmitting tube	Klystron	Klystron
Peak Power (kW)	750	850
Pulse recurrence frequency (Hz)	250 ~ 1200	250 ~ 1200
Beam width(°)	1.0	1.0
Antenna diameter (m)	8.5	8.5
Pulse width (μs)	1.0/4.5	1.0/4.5
Dynamic range (dB)	95	100
Altitude (m)	549	72

In Korea, CAPPI is used for the purpose of quantitative precipitation estimation, and usually 1.5 km is used due to mountainous terrain and high-rise buildings. However, in this study, when using CAPPI (Constant Altitude Plan Position Indicator) data, it is physically difficult to select appropriate radar Bin between two radars, so we used radar data which has the shape of the Plan Position Indicator (PPI). Fig. 5 is a schematic diagram of beams overlapped on the common observation region using the position, height, distance, beam width, and elevation angle between two

radars. In this study, we selected Bin necessary for the calculation of radar reflectivity considering radar angle and radar distance.
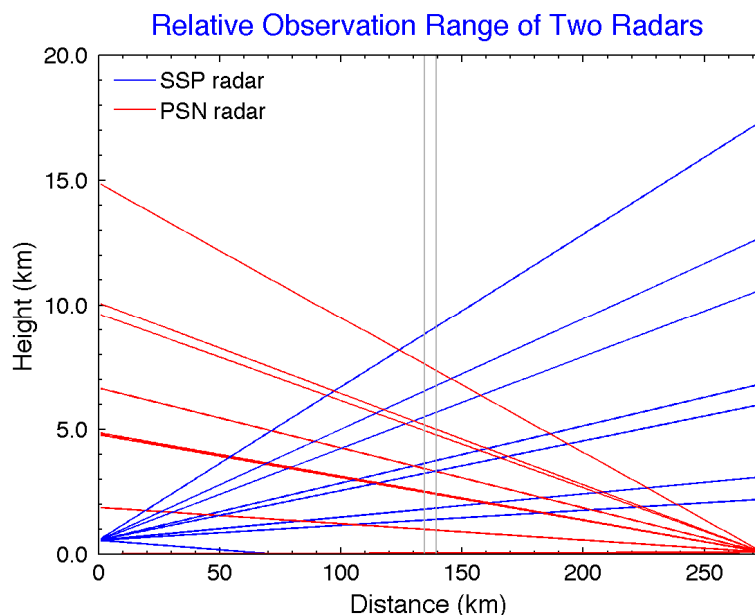
Figure 5. Radar beam diagram of the radar pairs

3.2. Applied storm event

In this study, a total of two storm events were selected for the application of the CRQPE method. Table 3 summarizes the duration of storm event, storm surveillance radar points, and application scenarios. The selected storm events are typhoon cases that penetrated the southern coast region. The period covered storm events which occurred during the year 2010, and the radar point which was actually influenced by the storm events can be confirmed through Table 3.

Table 3. Application storm events and its scenario to apply QPE in coastal area

# Event	Storm		Scenario
	Period (mm/dd/yy hh:nn)	Type	
1	06/11/10 06:00 - 06/12/10 23:00	Monsoon	SSP->PSN
2	07/10/10 10:00 - 07/12/10 04:00		SSP->PSN

The rainfall field of the storm event is shown in Fig. 6 to ascertain the route of the storm and the type of storm in the storm event. The storm event 1 and 2 applied in this study are types of storm event which occurs frequently in the rainy season, and storm event which moves from the southern coast to the inland.
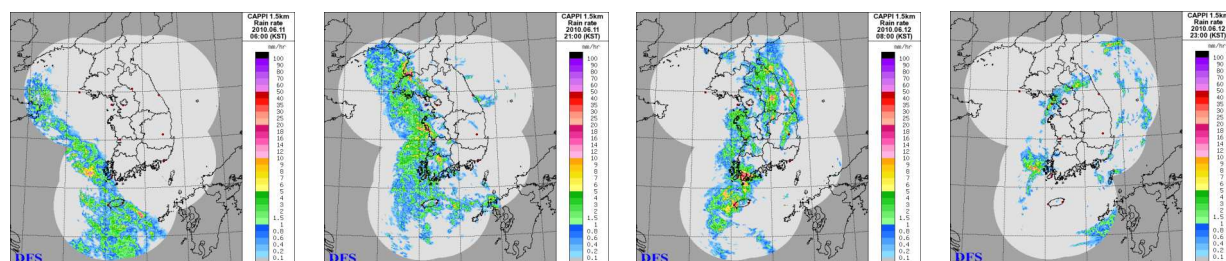
(a) Event 1
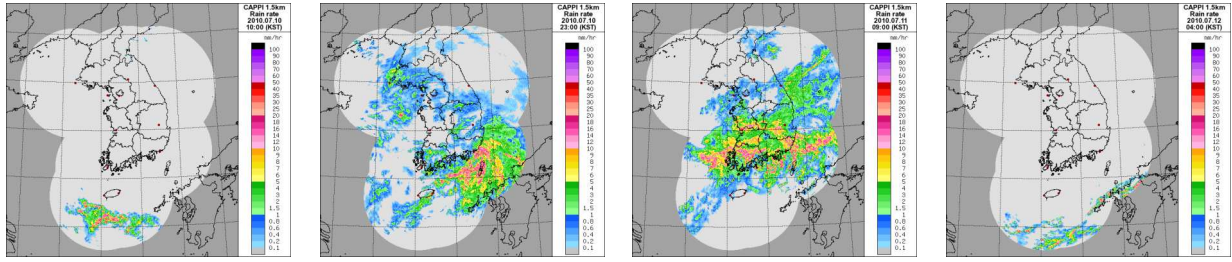
(b) Event 2

Figure 6. Radar rainfall field for each storm event

4. Application Result

4.1. Reflectivity bias and correction factor between radars

The two types of radar reflectivity data were compared with each other to find error type. Fig. 7 is a scatter plot for the reflectivity of the Sungsan radar and the Gudoksan radar. First, Fig. 7 (a) shows the scatter diagram to confirm the bias of radar reflectivity between two radar points.

As a result, the two radar reflectivity data were compared with each other, and it was confirmed that the difference in reflectivity data appeared as bias which is systematic error. In the case of Fig. 7 (a), the reflectivity (Z_{SSP}) of the Seongsan radar is less than the reflectivity (Z_{PSN}) of Gudoksan radar, which is 2.10 dBZ.

(a) Non-corrected

(b) Corrected
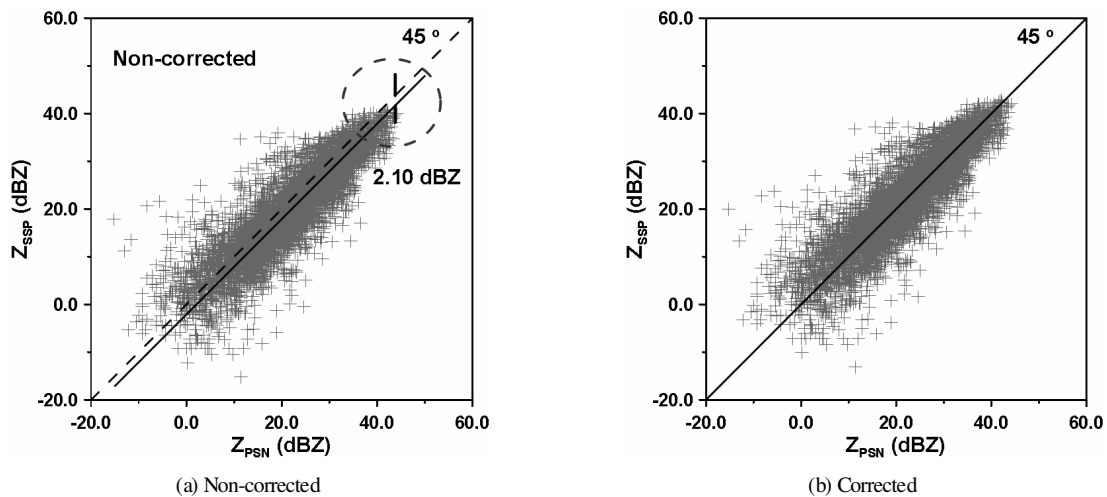
Figure 7. Correction of radar-radar bias (SSP and PSN radars)

Fig. 7 (b) shows the results obtained by correcting the bias between radar points by the simple correction method. Here, the simple correction method is to set the specific radar point data as a reference value and to correct as much as the bias which occurred in the other radar point data.

In the case of Seongsan and Gudoksan radars, most of the heavy rain moved to the Gudoksan radar through the Seongsan radar, and the Seongsan radar data was set as the reference value. The calibration result shows that the average deviation between the two radar reflectivity is eliminated by correcting the bias of 2.10 dBZ before correction.

In order to examine the bias between the radars according to the change of time, the bias was calculated every hour. Fig. 8 is the result of estimating the bias of the reflectivity of Sungsan and Gudoksan radar every hour. The results show that the bias between radars occurs in the range of -1.0 to 6.0 dBZ. The mean is 1.50 dBZ and the standard deviation is 1.44 dBZ. Particularly, this variability can be divided into Part A (0-400 minute) and Part B (400-1500 minute) time points of the storm events observed in the common observation region. The average of Part A is 2.48 and the average of Part B is 1.13, whose bias average difference between the two segments is more than 2 times. As a result, it is deemed appropriate to perform the correction using the real time data every hour rather than applying the constant value when performing the compensation of bias between the radars. In this study, the correction factor was calculated in real time to correct the inter-radar bias.
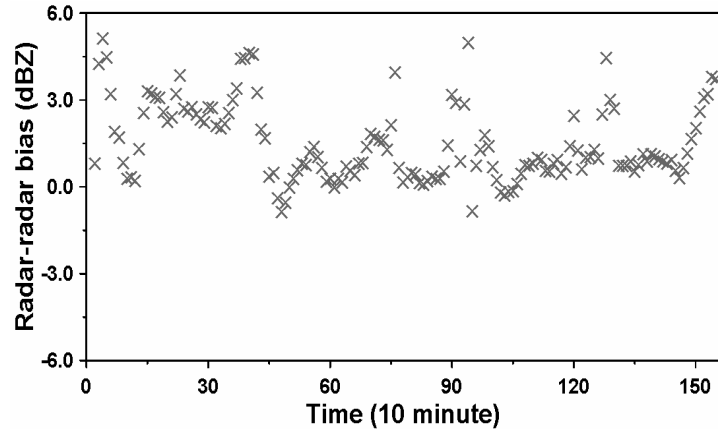
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Figure 8. Radar relative-reflectivity bias in real-time

4.2. Application example of overlapped observation area

In Fig.9, the box means the number of ground level rain gauge points available for the parameter estimation of the Z-R relational equation at the point, A_{SSP} and A_{PSN} are the parameter A estimated by the existing method with respect to Sungsan and Gudoksan radar points, and A_{CRQPE} is the parameter of Z-R relational equation, which is estimated in existing way by CRQPE method ZR relation.
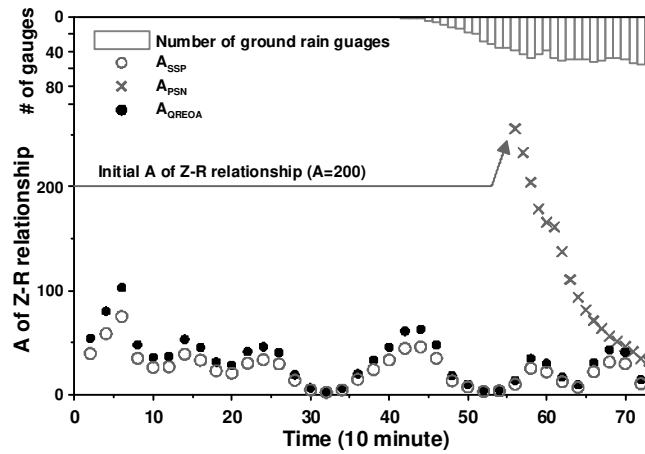
(a) Parameter A
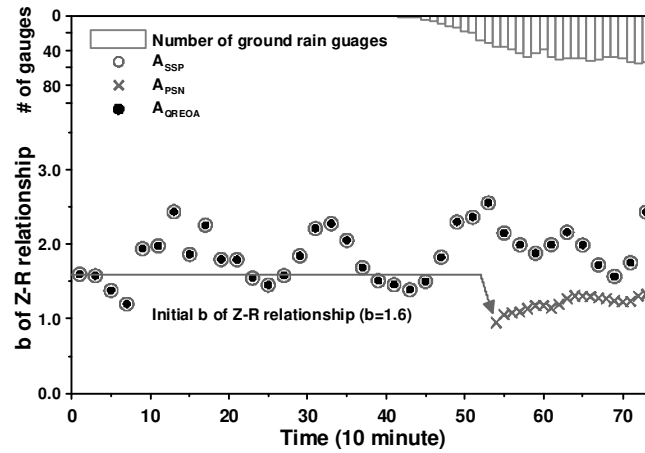
(b) Parameter b

Figure 9. Comparison results of Z-R relationship parameters resulted from the original and the proposed method

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When there is not available ground level rainfall gauge and there is not sufficient data to estimate the parameters of the Z-R relational equation, the parameters of the Z-R relationship are constantly applied with a specific relational equation (A = 200, b = 1.6). Therefore, the parameter A of 200 is constantly applied until the time point of 55. Then, when the ground water gauge data become sufficient, it becomes possible to estimate the parameters as shown in Fig. 9 (a). However, the estimated parameter is decreasing to a certain value at the initial stage of the heavy rainfall, so it is considered that the uncertainty is large.

On the other hand, the CRQPE method is able to estimate the parameters of the Z-R relational equation from the point at which the calculation and correction of the bias between two radars is possible. Therefore, it has an advantage that the parameter can be estimated before the heavy rain enters inland. In addition, it can be seen that the parameters are estimated more reliably than the existing method regardless of the quantity of the terrestrial rain gauge data at the initial stage of the influx of inland. In addition, we can confirm that the estimated parameters of both methods converge to similar values from the point of time of 67 when the surface rain gauge data are sufficient. Fig. 9 (b) is the result for parameter b.

As shown in Fig. 9 (b), the existing method applies a parameter of 1.6 to the point at which the groundwater gauge data are acquired.

In the case of the CRQPE method, the bias correction between the actual radar only affects parameter A of the Z-R relational equation as in Eq. (10), so the parameter b can use the previously estimated parameters as is. In the case of Seongsan and Gudoksan radar, the parameter b applied to the Gudoksan radar point is an estimated value with sufficient ground water gauge data at the Gudoksan radar point.
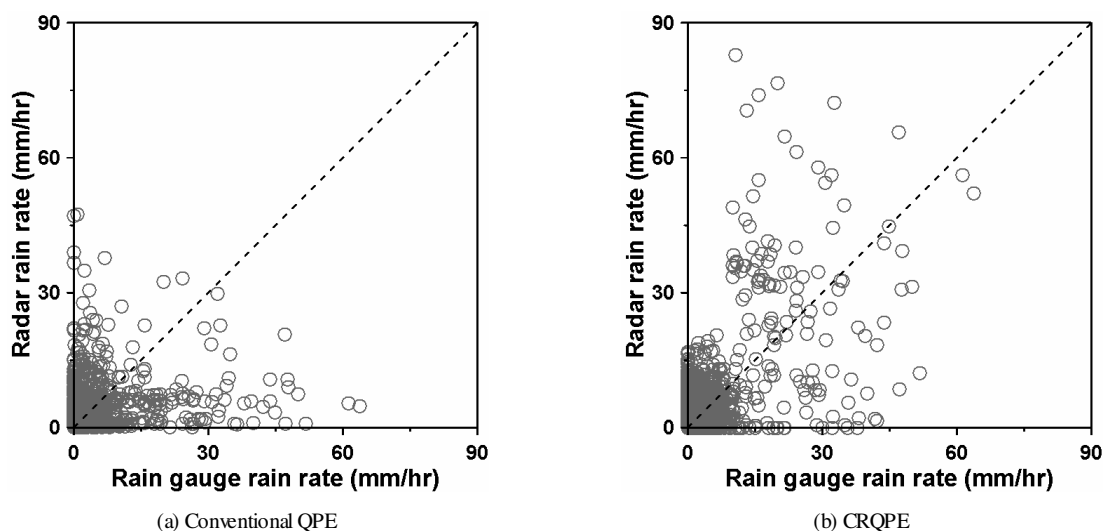

(a) Conventional QPE   (b) CRQPE

Figure 10. Comparison of the result from conventional QPE method and CRQPE method

Fig. 10 is a comparison of radar rainfall intensity estimated from the time of heavy rainfall's arrival inland for 6 hours with the rainfall intensity of ground rainfall system in order to examine the radar rainfall estimated by two methods. Fig. 10 (a) shows the existing method, and (b) shows the CRQPE method. First, in case of radar rainfall estimated by existing methods, rainfall less than 15.0 mm/hr based on the rainfall intensity of the ground rain gauge is not greatly underestimated or overestimated. However, when it exceeds 15 mm/hr, radar rainfall is generally underestimated.

A typical cause for such a result is the constant Z-R relational equation used at the beginning of the storm.

In general, the Z-R relationship, like Marshall-Palmer's equation, is one of the underestimated result of radar rainfall. In addition, even though the groundwater gauge data, which can estimate the parameters of the Z-R relational equation, have been obtained, the number is only the minimum number that can be used to estimate the parameters of the Z-R relational equation. In conclusion, when real-time parameters are estimated, uncertainties due to insufficient number of groundwater gauge data are very likely to be implied. Also, it can be considered as a problem that can be seen in estimating the quantitative precipitation by a single polarized radar. The results of applying the CRQPE method of Fig. 10(b) showed better results than the radar estimated rainfall by the conventional method. Under 15 mm/hr, radar rainfall was estimated based on the rainfall intensity of the ground rainfall gauge, and radar rainfall was estimated appropriately at 15 mm/hr or more.

This is because the appropriate parameters of the Z-R relational equation can be estimated and applied from the initial point of time when the heavy rain enters the inland. Furthermore, in the CRQPE method, the better result is expected to be produced since the bias between the radar rainfall and the rainfall by the ground rainfall system is also considered in real time in the quantitative rainfall estimation process.
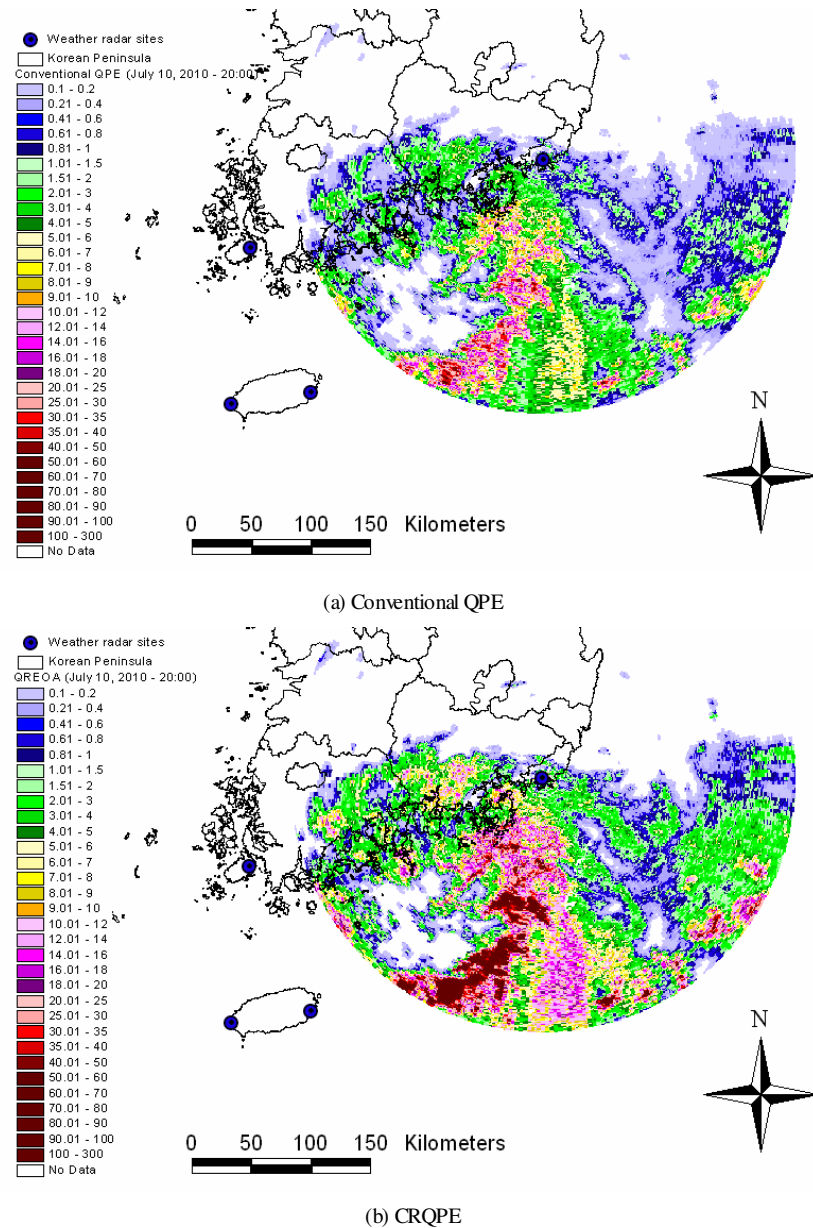

(a) Conventional QPE

(b) CRQPE

Figure 11. Comparison results of QPE field for Southern Coast Area

Fig. 11 shows the radar rainfall field at the time when the heavy rain enters inland. Fig. 11 (a) is the estimation result by the existing method, and (b) is the estimation result by CRQPE. If the existing method and the CRQPE method are examined together, it can be confirmed that the existing method underestimates rainfall compared with the CRQPE method. In particular, for rainfall above 20 mm/hr, the difference in the quantitative estimation results of the two estimation methods becomes clear. Based on these results, it can be concluded that the difference is larger when the same heavy rainfall occurs in urban and natural river basins in coastal areas and these differences are expected to have a significant effect on the outflow.

5. Conclusions

In this study, CRQPE is proposed to estimate the quantitative rainfall in the coastal area using geographical and climatic characteristics and radar observation network in Korea. For this purpose, we use the common observation region of the domestic dense groundwater gauge network and the radar observation network, and selected the southern coast region as the target area. We used Seongsan radar installed in Cheju Island and Gudoksan radar installed in the southern coast region. As heavy rainfall data, the rainy season data in 2010 was used. The results are summarized as follows.

(1) Two radar reflectivity data in the common observation region were used to confirm the existence or absence of bias which is the systematic error between the radar. At both application radar points, it was identified, and the degree of bias varied from site to site. In addition, it was confirmed that the bias varied over time. Based on these results, the correction factor of the inter-radar bias was calculated. There are various reasons for the occurrence of bias between radars, but the radar observation equipment model, installation characteristics, and observation environment seems to be the most important factors.

(2) It was found that when the parameters of the real-time Z-R relational equation are estimated by the CRQPE method proposed in this study. The CRQPE method can compensate the weakness of the existing method. The first is that the parameters of the Z-R relational equation can be estimated before the inland inflow of heavy rainfall. The second is that it is possible to estimate the parameters of the Z-R relational equation irrespective of the number of terrestrial rainfall data at the initial time after the inland inflow of heavy rainfall. The strength of this CRQPE method is to improve the accuracy of quantitative estimated rainfall in areas sensitive to heavy rainfall like coastal areas.

(3) As a result of estimating the quantitative rainfall by two methods, the radar rainfall estimated by the conventional method is underestimated than the rainfall intensity of the ground rain gauge over 15 mm / hr. This result is produced since a single Z-R relational equation is applied due to the lack of data on the groundwater system at the beginning of the storm. On the other hand, the rainfall intensity estimated by the CRQPE method was found to be a reasonable estimate of the quantitative rainfall over the entire rainfall intensity range.

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