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A Study of Cultural Barriers in Multi Cultural Organization - Focusing on Thai's Small and Medium Enterprises

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DISSERTATION

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Title

A Study of Cultural Barriers in Multi Cultural Organizations

- Focusing on Thai's Small and Medium Enterprises

Abstract

Due to Globalization, companies are entering into new countries, at the same time, they bring with them their cultures and expectations that are sometimes incompatible with local cultures and expectations. This causes failures within overseas branches. In addition, cultural barriers have and will most likely continue to increase and pose new challenges and opportunities for business. Understanding the cultural differences of local branches is an important element for overseas organizations. Nowadays, many overseas firms are investing in Thailand in various forms. A lot of historical data shows that many overseas investors are facing unique challenges in coordinating with local Thai labor due to the cultural and/ or communication barriers. However, Thai SME can be considered as a good example of a multi cultural organization, because there are not only local Thai culture but also cultures of migrant laborers who come from Myanmar, Laos, and Cambodia in one organization. In order to overcome those cultural and/ or communication barriers inside multi cultural organization, a computational experiment models can be used as a platform for overseas investors and also for local investors to design or explore effective multi cultural team in Thai SMEs.

This research aims to compare the performance of various combinations of multi cultural team that are affected by communication barriers, which can be considered one type of cultural barrier. This research reveals the difficulties of communicating and coordinating among different nationality of laborers inside a multi cultural organization. It makes an initial attempt at developing a computational experiment to predict the impact of differing cultural elements on team performance in a multi cultural organization. The computational experiment in this research was developed into three types of models, based on the complexity of tasks, to simulate multi cultural labor team, in order to seek better organization designs when considering the dimension of labor hiring or the human resource. In every type of model, the effects of changes in actors or laborers were found to be significant and different.
This research found that the effects of changes of actors or laborers in three different types of computational experiment models show interesting correlations between task complexity and the variety of nationalities of actors, and offered initial evidence that the results had been encoded correctly, since the predictions of the experiment align with existing theory.

Moreover, globalization brings together participants from multiple national, organizational with different backgrounds of cultures and expectations. This research as well as its findings can exhibit the possible framework for designing the multi cultural team with less communication barriers among team members.

Key Words
Multi Cultural, Cultural Barriers, Communication Barriers, Cultural Differences, Thai SMEs

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

This introduction chapter consists of four main parts. First part is the background which will explains about the importance of SMEs to Thailand. It will explain about how Thai SMEs affects to the new job creation in neighbor countries' labor force in the same region. Also it will discuss about the relationship between overseas firms and Thai SMEs. Next, the current situation of Thai SMEs in global market as well as the typical structure of Thai SMEs at present will be explained in this part. Moreover, the detail about types of migrant labors in Thailand and their characteristics also will be discussed afterwards. Then, problem discussion, research question, will be defined in the second and third part of this chapter. Finally, the scope of study will be discussed in the end of this chapter.

1.1. Background

Nowadays, small and medium sized enterprises or SMEs are very important to economic growth in many developing countries. Thailand is also one of those developing countries. Not only in economic growth, but Thai SMEs is also very significant essential to generate employment in Thailand and neighbor countries such as Myanmar, Laos, and Cambodia. However, Thai SMEs are still facing some factors both external and internal that effect on their growth. In addition, there are still some challenges for local Thai SMEs to make a greater contribution to the overall economy.

Moreover, in globalization era, it is necessary for overseas investors who desire to invest in or become business partner with Thai SMEs to understand the characteristics and eliminate those barriers that will occurs during their investment.

1.1.1. SMEs in Thailand

SMEs, in general, is the short term of small and medium-sized enterprises. However, the definition of SMEs differs broadly in different regions. It is also depended on each country's social conditions, economic growth, and government policy. For example, Singapore, a small country in term of size but biggest trading country in South East Asia, distinguishes between local and overseas SMEs, while big country like China distinguishes township and village SMEs. Meanwhile, in Taiwan, an enterprise that still receives government assistance may be recognized as an SME (Panida et al, 2011).

Other indexes such as the amount of investment capital, total assets of the company, production capacity, and the number of employees are being used as well. In Thailand, the Ministry of Industry, Office of Small and Medium Enterprises Promotion or OSMEP, classifies an SME when that company has less than 200 employees with regards to employment and fixed capital less than THB 200 million, excluding properties and land (Sme ONLINE).

As in many developing countries, in Thailand, small and medium-sized enterprises or SMEs are very important to overall country economic growth and significantly fundamental to the employment both in Thailand and also Thailand's neighbor countries such as Laos, Myanmar, and Cambodia. Since, the proportion of SMEs in Thailand is more than 99% of the overall enterprises (Sme ONLINE), therefore it contributes to the overall employment account for around 76% of all jobs (Elin Grimsholm and Leon Poblete, 2010). This is conformed to Harvie and Lee (2005) argument, which is 70% of new jobs creation in Southeast Asia are claimed to be coming from SMEs. In addition, Harvie and Lee (2005) also state that SMEs contribute to more than half of the labor force within the private sector in the region. Particularly in Thailand their contribution to employment account for three quarters of all jobs and for that reason they also have an important role in the contribution of poverty alleviation in the country (Harvie and Lee, 2005). Therefore, basically, SME's are expected to play a dual role in Thailand economy – contribute to growth and in the process of creating jobs.

Snodgrass and Biggs (1996), states that the ideology behind the promotion of SMEs comes from the perceived failure of large enterprises in creating adequate productive jobs to absorb a significant share of the rapidly growing labor force in many developing countries. According to Ing-wei Huang (2003), the 1997-1998 Asian crisis is mainly caused by the Large Enterprises (LEs)' negligence and mismanagement. However, it turned out to be SMEs that suffered most because the Thai government was paying more attention to LEs. At that time, in order to recover the economy, researchers both Thai and foreign suggested to Thai government that Thailand needed to focus and accentuate on strengthening SMEs sector. Not only by Thai government themselves but also the international organization paid attention to promote SMEs both in Thailand and other developing countries in same region. Therefore, the 1997-1998 Asian crisis can be seen as the unofficial starting point of the encouragement of SMEs development and is therefore not a new topic of economic development in Thailand.

However, at present, globalization is an important role in renewing the attention to the role of SMEs in economic development sector. Thai SMEs in term of type of business can be categorized into 3 main segments. According to Table 1: The Proportion of Small and Medium Enterprises in Thailand (Sme ONLINE), the biggest proportion is the SMEs in wholesale and retailing segment, which is about 47.30 percent of over all enterprises both SMEs and LEs those existing in Thailand. Next, the second biggest proportion is the SMEs in the service segment that is around 33.63 percent. Then, the third one is the SMEs in manufacturing segment, which is around 18.64 percent, respectively.

Table 1: The Proportion of Small and Medium Enterprises in Thailand

Industry	SE	ME	LE	SMEs	not identify	Total
Wholesale and retailing	1,378,060	5,331	3,692	1,383,391	282	1,387,365
Service	976,503	7,107	2,615	983,610	111	986,336
Manufacturing	539,152	5,946	2,819	545,098	1,787	549,704
ETC	205	0	11	205	414	630
not identify	860	3	3	863	11	877
Total	2,894,780	18,387	9,140	2,913,167	2,605	2,924,912

From the table, we can see that SMEs in Thailand is more than 99 percent of overall enterprises. For that reason, the development of SMEs plays a critical role in the development of all Thailand's industrial sector. The number SMEs relative to LEs confirmed the importance of SME as a source of growth for the Thai economy in the future. Moreover, as SMEs are found to possess many desirable characteristics, including the high usage of abundant labor, the economic use of capital investment, and the more equitable distribution of income they generate, the relatively lower productivity of SMEs in some industries imply that overemphasis on the promotion of SMEs may, however, come at the cost of efficiency (Ing-wei Huang, 2003).

1.1.2. Overview of Thai SMEs' Situation in Global Market

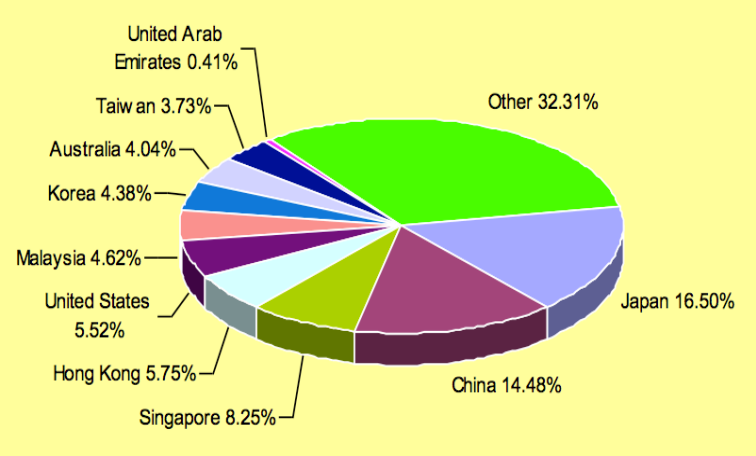

Figure 1: Thai SMEs' Import Role in Global Market

According to data of Office of Small and Medium Enterprises Promotion of Thailand (Sme ONLINE), Thai SMEs in global market majorly plays two roles, import and export. Import figure (Figure 1: Thai SMEs' Import Role in Global Market) shows that Asian countries are the biggest trade partner, Thai SMEs import from Japan, China, Singapore, Hong Kong, Malaysia, Taiwan, and Korea in total for more than 50 percents of overall import figure. Among those 50 percents, Japan is the biggest trade partner with 16.50 percents.

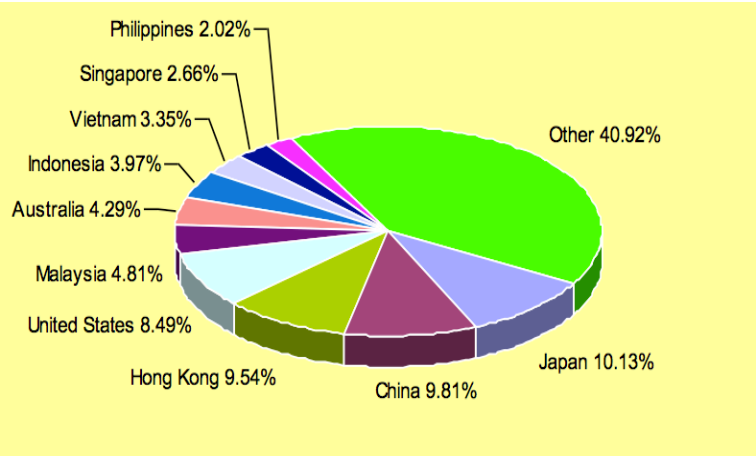

Figure 2: Thai SMEs' Export Role in Global Market

On the other hand, in export role, Thai SMEs still export to Asian countries about the half of overall export market. Still Japan is the biggest market for Thai SMEs to export with 10.13 percents, follows by China 9.81 percents, Hong Kong 9.54 percents , United States 8.49 percents, Malaysia 4.81 percents, Australia 4.29 percents, and others ASEAN country members about 12 percents, respectively. Finally, from data, we can see that Japan is the biggest trade partner in both import and export roles of Thai SMEs. Also, we can assume that Japanese investors are now investing a massive amount of money in Thailand.

1.1.3. Typical Structure of Thai SMEs at present

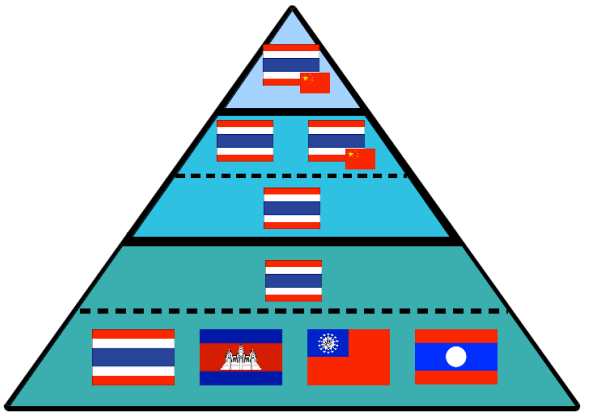

Figure 3: The Typical Structure of Thai SMEs

As in the above pyramid (Figure 3), most common structure of Thai SMEs has its own unique style, because of the combination of nationalities. Thai, Chinese-Thai, Laos, Cambodian and Myanmar are five stakeholders in Typical or common Thai SMEs. The top and middle level usually are Thai and or Chinese-Thai. Meanwhile, the lower level, in other words, the labor level is the combination of Local Thai labor and migrant labor from 3 neighbor countries, Myanmar, Laos, and Cambodia. Therefore, this research will also focus on five minor cultures in the micro-behavior level within Thai SMEs.

However, the types and useful facts about migrant labor force in Thailand will be explained in detail in the following section.

1.1.4. Migrant Labor Force in Thailand

Thailand's Office of Foreign Workers Administration classifies an alien or migrant workers who entered to Thailand on a temporary basis as Immigration law into 4 types.

1. General Type: which refers to an alien who is a skilled workforce and working in high positions, or may be sent by the mother company from its original country to invest in Thailand. Those labors may be sent to Thailand to work temporarily in jobs that require skills and high technology. To be more specific, this type of labors may have special talent, expertise, ability and or communication in language those Thai people are not capable or do not have the skills to work. Also, this type of migrant labor may work in his or her own company in Thailand or as business partner in joint venture enterprise. Moreover, this type of migrant labor may also work in his or her spouse's business in Thailand. This type of labor mainly works in the certain Foundation / Association / International Organization and enterprise with the investment more than 2 million baht.
2. Urgent Type: This urgent type refers to an alien who comes to work in Thailand and the task that must be done immediately. If it does not accelerated action may cause damage to the operation of the company or its customers or impact on society and the environment, etc., without the prior plan in advance. This urgent type's working period must not exceed 15 days.
3. Lifetime Type: the lifetime of an alien who has been granted a license by the National Executive Council Announcement No. 322, Article 10, which states that "Work permit or license that issued to an alien who has a residence in the Kingdom of Thailand under the law on immigration and working prior to December 13, 2515 shall be valid throughout the life of the aliens. Unless the alien has the new career "

(Doe ONLINE 1).

4. The labors under the employment agreements with partner countries: This is referred to migrant labor from Laos, Myanmar, and Cambodia who comes to work Thailand legally and illegally. However, next part will explain further detail about this type of migrant labor.

Before 1988, Thailand did not have a policy in place to deal with migrant workers from Myanmar, Laos, and Cambodia. There were however a lot of illegal migrant workers from those three aforementioned countries during that time. Therefore, in 1992, the Thai government decided to draft a policy to favor those illegal migrant workers from Myanmar, Laos, and Cambodia in order to let them work in Thailand legally with the temporary work permit. However, the registration of three countries' migrant workers officially started in 1996. Government at that time agreed to set up the resolution for this issue. Migrant workers from Myanmar, Laos, and Cambodia were allowed to work in Thailand for not more than one year, and then they all had to return to their home countries. However, in practice, this provisional permit was extended every year due to the shortage of unskilled labor. The fact was that these migrant laborers had been playing an important role in the strengthening of the economy of Thailand. Migrant labor from Myanmar, Laos, and Cambodia currently can be divided into four subgroups as follows.

1. Exemption Type: refers to an alien who came from Myanmar, Laos, and Cambodia illegally yet still working in Thailand. This type will be exempted and allowed to register for working in Thailand for a period of time. He or she will receive 3 temporary documents from Ministry of Interior that are resident permit, work permit, and health insurance. Then, after temporary permit expires, he or she will be sent back to his or her home country. As in November 2012, this type of migrant labor who came from three aforementioned countries was in total around 170,000 people.

2. Nationality Verification (NV) Type: This refers to migrant laborers who have proved their citizenship. Since 2006, the Thai government has laid down measure to upgrade the status of migrant laborers from illegal to legal by nationality verification process. Migrant laborers from Laos who pass this process will receive the temporary passport from Laos's Ministry of Foreign affair. Migrant laborers from Cambodia will receive the certification of identification issued by Ministry of Labor of Cambodia. For Myanmar migrant laborers, after passing nationality verification process, they will receive travel document and identity card issued by the government of Myanmar. As soon as migrant laborers from Myanmar, Laos, and Cambodia pass this process, they will become legal labor and have rights to work in Thailand. Thai officer cannot arrest and send them back to their countries. Also, they will be able to travel all over and Thailand and return to their countries. However, these workers must indentify themselves to the immigration office every 90 days and will be able to work in Thailand for not more than four years. Then, after they return to their countries, if they would like to be able to get back to and work in Thailand again, they must stay in their own countries for at least three years. As in November 2012, this type of migrant labor who came from three aforementioned countries was in total around 620,000 people.
3. Memorandum of Understanding (MOU), These laborers migrant from their home countries to Thailand for work under the agreement of Memorandum of Understanding between the government of Thailand and the government of those three aforementioned countries. In other words, these laborers are legally imported labor force. As in November 2012, this type of migrant labor who came from Myanmar, Laos, and Cambodia was in total around 120,000 people.

4. Unregistered Type: means migrant laborers who are still working in Thailand illegally without any government certified identification document. This type has not exact amount in government record. Unfortunately, this type of laborers often live in Thailand with the paranoia of being arrested and always intimidated of being sent back to their countries.

Table 2: The Number of Legal Migrant Laborers from Myanmar, Laos, and Cambodia

unit: people

	General Type	NV Type	MOU Type	Exemption Type	Total
Myanmar	1,383	536,711	44,830	65,785	648,709
Laos	139	26,394	12,753	39,743	79,029
Cambodia	275	54,322	60,804	64,452	179,853
Total	1,797	617,427	118,387	169,980	

Based on data from Thailand's Office of Foreign Workers Administration (Doe ONLINE 2), the table above shows the number of legal migrant laborers from Myanmar, Laos, and Cambodia updated in November 2012. From table, the number of overall legal workers from three countries in four types of labor is 907,591 people. Nevertheless, there are some unofficial data states that the real total number of both legal and illegal migrant labors from three countries is about 2 million people. This means that one million people or 50 percents of migrant workers from these three countries are off the record. Moreover, in this 50 percents of the Thai government record, illegal Myanmar workers are in the highest rank with the number of around 800,000 people (Daily news ONLINE).

1.2. Problem Discussion

In the era of globalization, cultural barriers will most likely go up and pose new challenges and opportunities for business (House et at, 2004). Generally, culture can be defined as a set of shared experiences, understanding, and meaning among members of a group, organization, a community, or a nation (Davis, 1984; Hofstede, 1991; Schein, 1992). Understanding the cultural differences between mother firms and local branches is the basic important element for overseas organizations. At present, many overseas firms are investing in Thailand in various dimensions. Many historical data such as Overseas Vocational Training Association's document states that Japanese managers from the Japanese mother firms are facing unique challenges in coordinating with Local Thai labor due to the communication and cultural barriers. First example that OVTA had discussed in their document called タイの日系企業が直面した問題と対処事例 (OVTA ONLINE) is case 12-1, workers in Thailand ignored 5s program and safety policy of the company and this caused some accident in their manufacturing line. OVTA explained the Thai life style is too relaxed and loose. Most of workers think it is not necessary to follow the company's rules. Second example (case 12-3) is that OVTA claimed that Thai people are thinking that asking questions is a kind of embarrassing and humiliating themselves. Moreover, Thai people are too shy to express their feeling or comment in public or in front of their colleges and managers. Then, the result was the defects in their production line because Thai workers did not ask their managers even they did not understand the order clearly. Then the third example (case 12-8), which caused the bottleneck in their process, is that worker just left their duty for the Buddhist activity without any permission from Japanese manager. OVTA explains the reason of this case that Thai people strongly believe that every men should become a monk once in a life time even for short period like 7-14 days. Some Thai people strongly expect that this belief of becoming a monk is important enough for being pardon for leaving their duty or work without any permission.

Moreover, This cultural issue is getting more complex, when foreign investor wants to invest in Thai SMEs. Since, as mentioned in previous section, Thai SMEs structure is very unique. It is considered to be multi cultural organization and there will be two or more cultures in one organization those foreign investors have to encounter. Finally, In order to overcome those barriers, computational models can be used as a platform for overseas investor as well as local Thai investors to design or explore effective multi-cultural team in Thai SMEs. Moreover, understanding

1.3. Research Purpose and Question

The purpose of this research is to understand how cultural differences among each nationality of labor force inside Thai SMEs affect the team performance via computational experiment (simulation program). To be more specific, this research aims to answer two main questions. First, how do we handle factors that make Thai SMEs unique and different from other countries' SMEs? Second, what are the most significant differences in Thai SMEs characteristics among demographics of participants (in this case, communication skill)? Finally, This research's objective is to assist overseas investors to understand and take measures to counteract culture differences inside Thai SMEs.

1.4. Scope of Study

Due to globalization, companies are entering into new country, at the same time, they bring with them their cultures and expectations that are sometimes incompatible with local cultures and expectations. Things that make incompatible situation between oversea companies and their local branches are called barriers. These barriers usually cause failures within the overseas branches. There are so many kinds of barriers in the investment in this globalization era. The situation of economics, politics, government policies or even the climate of the invested or local countries can be considered as barriers (Figure 4).

Because of those barriers, the investments cannot achieve hundred percent of efficiency as mother firms expect. However, since cultural barriers, at present, will most likely go up and pose new challenges and opportunities for business, this research is focusing on cultural barriers of the local country.

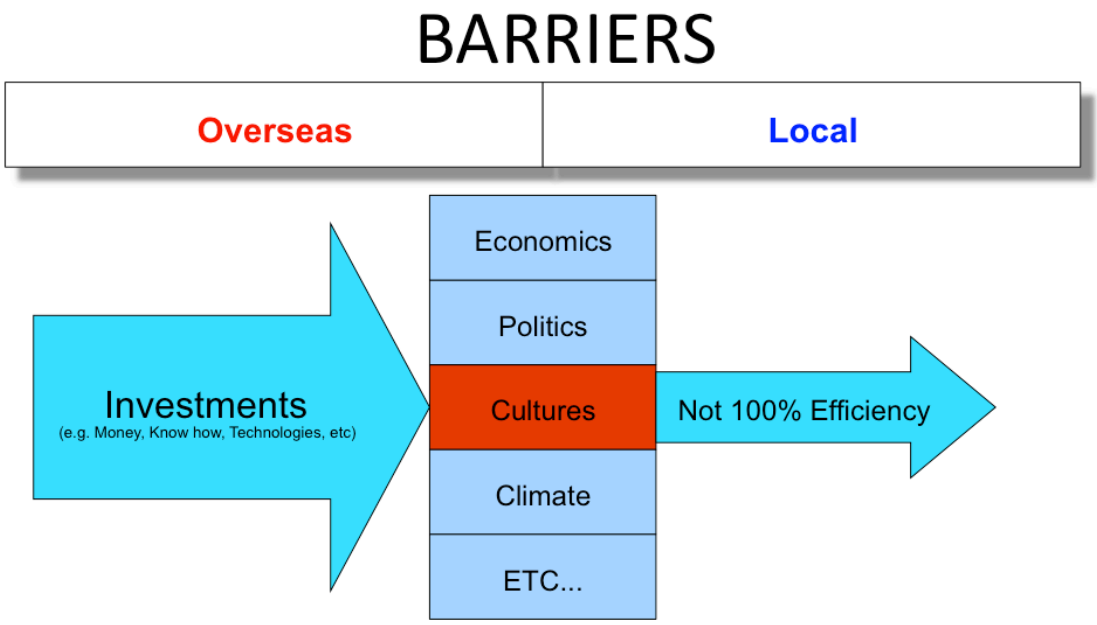

Figure 4: Barriers in Investment

In addition, the cultural barriers issue gets more complicated and complex when overseas or mother firms want to invest in local firm that consists of more than two nationalities of labors (multi cultural organization).

However, Thailand is one of those local countries that have multi cultural organization in both LEs as well as SMEs scale. As mentioned in previous sections, Thai SME is a good example of multi cultural organization in developing countries. Moreover, at present, many overseas firms are investing in various capacities in Thai SMEs. Yet, there are still some cultural barriers in those investments especially cultural barriers in communications between local Thai and those migrant laborers who come from Laos, Myanmar, and Cambodia. Therefore, in order to overcome this issue, this research will focus on the communication barriers among those four nationalities of laborer in lower level labor of

Thai SMEs. Thereafter, a computational experiment will be applied and used as platform to design and explore effective multi cultural team inside Thai SMEs. Finally, the simulated results after applying computational experiment will be used to analyze causes and effects of the communications barriers in Thai SMEs quantitatively.

CHAPTER 2

LITERATURE REVIEW

2. LITERATURE REVIEW

This literature review chapter begins with the explanation of the concept of culture as well as its definition that is commonly used in the field of study. Then, this chapter will discuss about Thai culture through the famous Hofstede's cultural dimension model with the explanation. In the next section of this chapter, the cross-cultural communication as well as the cultural barriers to effective communication will also be introduced and discussed. Then, in the next section "Overcoming Language Barriers in communication", an argument about the importance of language differences in communication will be discussed and a suggestion of how to overcome the difficulties in international communications according to linguistic differences will be provided.

2.1. Concept of Culture

In the study field of culture, there are so many ways in which researchers defined the concept of culture. Basically, culture defines the way of life, or the way people do things. Different sets of people may have different way of doing things. Culture is usually transferred from one generation to the next by learning. The word culture itself has many meaning and its concept is very complicated and varied by the field of study. The concept of culture is widely defined. For example, Kroeber et at (1952) gave the definition 60 years ago that culture consists of patterns, explicit and implicit, of and for behavior acquired and transmitted by symbols, constituting the distinctive achievements of human groups, including their embodiments in artifacts; the essential core of culture consists of traditional (i.e. historically derived and selected) ideas and especially their attached values; culture systems may, on the one hand, be considered as products of action, and on the other as conditioning elements of further action. Meanwhile, Hofstede, one of the most famous researchers in the field, defines culture shortly as the collective mental programming of the human mind, which distinguishes one group of people from another.

However, in order to summarize the concept of culture, Miriam (2001) stated that the general idea which, authors in the field of cross-cultural psychology now follow is that the conception that culture can be very broadly defined as the human-made part of the environment consisting of both objective elements, and subjective elements, or a group's characteristic way of perceiving its social environment. The subjective view includes a multidimensional array of shared beliefs, norms, and values of a particular group that are instantiated in everyday social practices and institutions, and that have been historically cultivated, transmitted, and deemed functional across time. Thus, cultures are seen as both products of past behavior and as shapers of future behavior and at the same time, humans are seen as producers of culture and are being influenced by it.

2.2. Cultural Dimensions

Understanding cultural dimension is one way to help answering the question of why individuals in different cultures interpret events and actions differently in his or her own style. When people belong to a team, different interpretations of across cultures can lead the misunderstandings among members. Hofstede (2001) provided his version of cultural dimension. His cultural dimension explains the necessary reason of why people who belonging to one culture have a unique manner and act distinct from another culture.

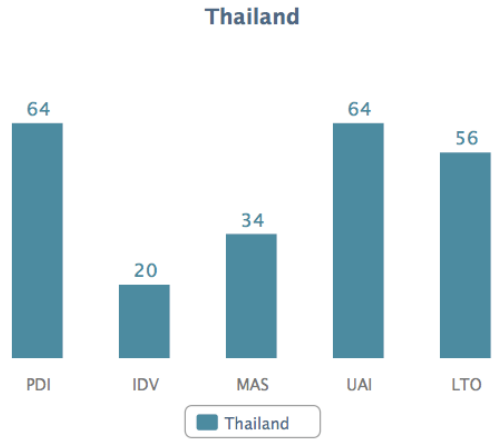

Figure 5: Hofstede's Five Dimensions of Thai Culture

Considering Thai culture through the Hofstede's lens of the 5-Dimension Model could provide a good overview of the deep drivers of Thai culture relative to other world cultures. The 5-Dimension model consists of power distance (PDI), individualism (IDV), masculinity/ femininity (MAS/FAM), uncertainty avoidance (UAI), and long-term orientation (LTO). According to Hofstede (Hofstede ONLINE), Thai culture could be summarized under the5-D model as below.

- Power distance

This dimension contends with the fact that all individuals in societies are not equal. It expresses the attitude of the culture towards these inequalities amongst people. Power

distance is defined as the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally. Thailand scores 64 on PDI index, slightly lower than the average Asian countries (71). It is a society in which inequalities are accepted; a strict chain of command and protocol are observed. Each rank has its privileges and employees show loyalty, respect and deference for their superiors in return for protection and guidance. This may lead to paternalistic management and, therefore, the attitude towards managers are more formal, the information flow is hierarchical and controlled.

- Individualism

The primary subject addressed by this dimension is the degree of interdependence a society maintains among its members. It has to do with whether people´s self-image is defined in terms of "I" or "We". In individualist societies, people are supposed to look after themselves and their direct family only. In collectivist societies, people belong to 'in groups' that take care of them in exchange for loyalty. Thailand scores 20 on IDV which indicates that Thailand is a highly collectivist country. This is manifest in a close long-term commitment to the member 'group' (a family, extended family, or extended relationships). Loyalty to the in-group in a collectivist culture is paramount, and over-rides most other societal rules and regulations. The society fosters strong relationships where everyone takes responsibility for fellow members of their group. In order to preserve the in-group, Thai are not confrontational and in there communication a "Yes" may not mean an acceptance or agreement. An offence leads to loss of face and Thai are very sensitive not to feel shamed in front of their group. Personal relationship is a key to conducting business and it takes time to build such relations thus patience is necessary as well as not openly discuss business on first occasions.

- Masculinity / Femininity

A high score (masculine) on this dimension indicates that the society will be driven by competition, achievement and success, with success being defined by the winner in field – a value system that starts in school and continues throughout organizational behavior. A low score (feminine) on the dimension means that the dominant values in society are caring for others and quality of life. A feminine society is one where quality of life is the sign of success and standing out from the crowd is not admirable. The fundamental issue here is what motivates people, wanting to be the best (masculine) or liking what you do (feminine). Thailand scores 34 on this dimension and considered a feminine society. Besides, Thailand has the lowest Masculinity ranking among the average Asian countries of 53 and the World average of 50. This lower level is indicative of a society with less assertiveness and competitiveness, as compared to one where these values are considered more important and significant. This situation also reinforces more traditional male and female roles within the population.

- Uncertainty avoidance

The uncertainty avoidance refers to the way that a society deals with the fact that the future can never be known- to control the future or just let it happen. This ambiguity brings with it anxiety and different cultures have learnt to deal with this anxiety in different ways. The extent to which the members of a culture feel threatened by ambiguous or unknown situations and have created beliefs and institutions that try to avoid these is reflected in the UAI score. Thailand scores 64 on UAI, indicating a preference for avoiding uncertainty. In order to minimize or reduce this level of uncertainty, strict rules, laws, policies, and regulations are adopted and implemented. The ultimate goal of this population is to control everything in order to eliminate or avoid the unexpected. As a result of this high uncertainty avoidance characteristic, the society does not readily accept change and is very risk adverse. Change has to be seen for the greater good of the in group.

- Long term orientation

The long term orientation dimension is closely related to the teachings of Confucius and can be interpreted as dealing with society's search for virtue, the extent to which a society shows a pragmatic future-oriented perspective rather than a conventional historical short-term point of view. Thailand is a Long Term Oriented culture with a score of 56, though not as much as for most Asian countries. LTO is manifest on their respect for tradition and inequality between people. Amongst the values that are praised, working hard and having a sense of moderation are dominant. The investment in personal relationships and network is paramount. Protecting one's face is the key and a protocol in their non confrontational behavior. Their concern is not to look for one truth which helps them be flexible and pragmatic in negotiations. Thai favor long term oriented perspective and thus Thailand deadlines and timescales are fluid.

2.3. Communication Across Cultural Barriers

2.3.1. Cross Cultural Communication

Communication is the exchange of meaning. It refers to any behavior that another human being perceives and interprets. Communication includes sending both verbal messages and nonverbal messages e.g., speaking tone, facial expression, as well as physical setting. Communication involves a complex, multilayered, dynamic process through which people exchange meaning and could take place even when the sender is totally unaware of sending.

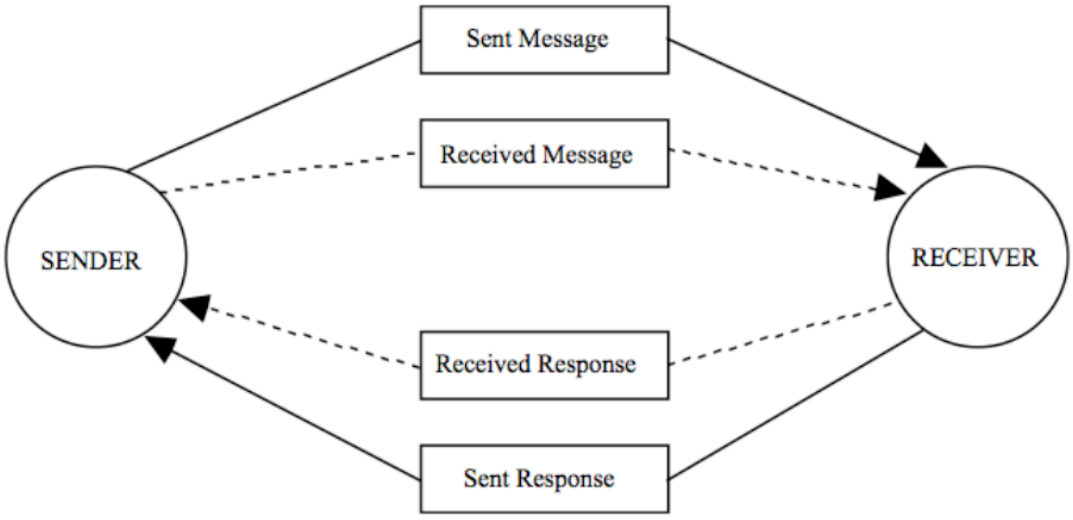

Figure 6: Adler's Communication Mode

As shown in Figure 6, Adler (1991) suggested that every communication has a message sender and a message receiver. However, the sent message is never identical to the received message. Communication is a symbolic behavior and indirect. Ideas, feelings, and pieces of information cannot be communicated directly but must be symbolized before being communicated. Encoding describes the producing of a symbol message whereas decoding describes the receiving of a message from a symbol. The message sender must encode his or her meaning into a form that the receiver will recognize i.e., into words and behavior. Receivers must then decode the words and behavior, namely the symbols, back into messages that have meaning for them.

Alder (1991) also states that translating the meanings into words and behaviors (symbols) and back again into meanings is based on a person's cultural background and is not the same for each person. For example, because the Cantonese word for *eight* sounds like *faat*, which means prosperity, a Hong Kong textile manufacturer Mr. Lau Ting-pong paid $5 million in 1988 for car registration number 8. In contrast, whereas number 7 has little significance in the Chinese calculation of fortune, a European millionaire paid $4.8 million at Hong Kong's Lunar New Year auction for vehicle registration for the lucky number 7. Similarly, the prestigious members of Hong Kong's Legislative Council avoided using numbers ending in 4 to identify their newly installed lockers. Some Chinese consider numbers ending with the digit 4 to be jinxed, because the sound of the Cantonese word *sei* is the same for four and death. The number 24, for instance, sounds like *yee sei*, or death-prone in Cantonese.

In addition, Alder (1991), explained that the greater the difference in background between senders and receivers, the greater the difference in meanings attached to particular words and behaviors, and it could deliver some conflicts. For example, a British boss asked a young new American employee whether he would like to have an early lunch at 11 A.M. each day. The employee answered, "Yeah! that would be great!" The boss decoded the 'Yeah' differently with the employee and assumed that the employee was rude, ill-mannered, and disrespectful. In the process of encoding agreement (the meaning) into a word symbol and decoding the word spoken by a new employee to the boss (a word, behavior, and context symbol), the boss received an entirely different message than the employee had meant to send. Just as in most miscommunication, neither the sender nor the receiver was fully aware of what had gone wrong and how it happened.

Adler (1991) also mentioned an interesting point regarding cross-cultural communication in his study of international dimensions of organizational behavior that the greater difference between the cultures could easily lead to a cross-cultural miscommunication. Cross-cultural communication occurs when a person from one culture sends a message to a person from another culture and the cross-cultural miscommunication occurs when the person from the

second culture does not receive the sender's intended message. Cross-cultural communication often involves misunderstanding caused by misperception, misinterpretation, and misevaluation. When the sender of a message comes from one culture and the receiver from another, the chances of accurately transmitting a message are low. For example, A Japanese businessman intends to tell his Norwegian client that he is uninterested in a particular sale. To be polite, the Japanese says, "That will be very difficult." The Norwegian responds by asking how his company can help solve the problems as he interprets the statement to mean that there are still unresolved problems, not that the deal is off.

Therefore, Adler (1991) emphasized that in approaching cross-cultural situations, one should therefore assume difference until similarity is proven and recognizes that all behavior makes sense through the eyes of the person behaving and that logic and rationale are culturally relative. In cross-cultural situations, labeling behavior as bizarre usually reflects culturally based misperception, misinterpretation, and misevaluation; rarely does it reflect intentional malice or pathologically motivated behavior.

2.3.2. Cultural Barriers to Effective Communication

Different cultures give people with the different ways of seeing, ways of thinking, ways of hearing, ways of interpreting, and so on. As a result, the same words can mean different things to people who come from different cultures, even they communicate in the same language. Moreover, this can be more difficult issue when the language they use to communicate is different. This also can lead to the increase of misunderstandings during communications.

In order to communicate with people from different culture effectively and obtain the same understandings, Stella Ting-Toomey (online4), suggested three constraints about culture that effect to the cross-cultural understanding. First is the constraint of behavior. Each individual culture has its own way of considering an appropriate behavior or rule. This can be verbal and nonverbal communication. One good example is the politeness. Politeness can be different in each culture. In western countries, greeting sometimes means not only by words but also touches likes hugging is considered polite. On the other hands, in eastern, hugging sometimes is not the polite way to greet.

Next constraint that Stella mentioned is the sentimental or emotional constraint. People cry when they sad, yell when they get angry because of their inside emotion. Yet, different cultures generate the display of emotion differently. Some cultures try to hide their emotion and try not to express their feeling or emotion. Other cultures, on the other hands, get very emotional when they debate or have argument.

Third is called cognitive constraints or cognition. This is referred to the perception or the frame of individual references that providing the experiences or background that all new upcoming information is entered into and or compared to. In addition, Figure 7, three constraints of culture, explains three constrains in clearer picture.

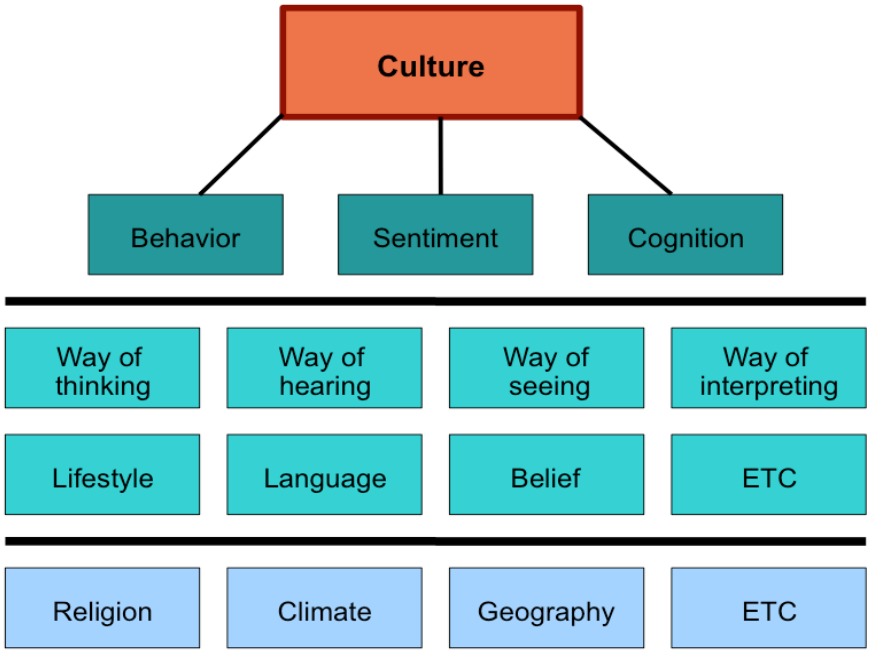

Figure 7: Three Constraints of Culture

The differences of behavior, sentiment, and cognition constraints between one culture and another, normally, come from the differences of one culture's way of thinking, hearing, seeing, and interpreting. Also, lifestyle, belief, and language that one culture has are also one of the reasons of the differences of behavior, sentiment and cognition in different cultures. Moreover, religion, climate, geography, and so on are important factors that make differences between cultures.

However, all of aforementioned differences tend to lead problems in communication across cultures. To decrease misunderstandings and communicate with people from different cultures effectively are challenging and difficult but worthwhile. In other words, eliminating communication barriers is very hard and troublesome to do. Nevertheless it is one of the important keys that help increasing the team performance, especially, when it is a multi cultural team or members of the team come from different cultures.

2.4. Overcoming language barriers in communication

Language differences seriously escalate communication problems. Language is not only ‘words’, but also involved a way of thinking and seeing and defining the specific culture. As a result, accurate translation, especially of abstract ideas, is very difficult. Without doubt, the chance for miscommunication is high.

As business becomes more global, communication takes place in a wider range of nationalities and people. Though English is normally used as Interlingua, communication between people of different cultural backgrounds involves much more than just overcoming the language barrier. Swallow (2009) mentioned that language differences are hugely significant. Language is not just how people speak; it also expresses who they are. Knowing the language thus provides an insight into the people. The English language, for instance, has sayings that reflect an efficient, activist driven society: "Actions speak louder than words" and "Time is money". The language itself is structured efficiently too: subject - verb - object. Japanese leaves the verb till the end to modify or do away with, depending on the reaction of the listener; the quest being for harmony. Thailand has 12 words for "you", denoting the importance of seniority. An East African tribe has numerous words for green, reflecting the importance to them of Nature's many shades. Nepal has different words for "uncle", according to whether he is the brother of your mother or father, and whether he is older or younger than your parent. French and Hindi both have "familiar" terms for you/thou, which are used either for intimates such as your family or when speaking down to someone. In French it's "tu/toi", in Hindi it's "toom". In both cases, the tone of voice makes the distinction. Arabs will tend to use the passive voice, e.g. "It was observed…"instead of "I observed..." because they are more fatalistic than active in approach to life. In each case, the national characteristics are revealed in the structure of their language. Those attitudes are carried over into the way they use English, even if they do not translate directly from their language into English. The significance, however, is not

just the linguistic differences, but also rather the attitudes that root behind them, and the cultural values that give rise to those attitudes.

To overcome the difficulties in international communications according to linguistic differences, it is necessary to first understand the partner clearly and objectively, and must have self-awareness of how you are being perceived by counterparts from other cultures. Additionally, it is important to developing skills in cross cultural communication such as communicating in English with non-native English speakers, using language, gestures and body language that is universally understandable across cultures.

CHAPTER 3

METHODOLOGY

3. METHODOLOGY

This research's methodology begins with data collection, which was obtained by interviewing managers from a number of Thai SMEs in several industries who are hiring both local Thai laborers and migrant laborers. Apart from Thai SMEs managers, there are some interesting points from the interviews of some Japanese investors who are investing in and want to invest in Thailand. The data obtained from the interviews will be the key for the inputs of this computational experiment. This chapter will explain the criteria of the computational experiment. Separated into 5 sub-chapters, first the data from the interviews will be discussed, followed by an explanation of the complexity of the tasks. Then, this chapter will discuss how the approach of this experiment was considered. Finally, the models of this computational experiment will be explained in the last two parts of this chapter.

3.1. Data Collection

The methodology of this research begins by identifying the characteristics of Thai SMEs team through interview, observation and literature review. Hofstede (1991), suggested two aspects of cultural factors, which are practices and values. Based on Horii et al (2005), this research extends the meaning of "practices" to include cultural norms of adopting or practicing specific management styles and organization structures. Horii has compared the management styles and organization structures of Japanese and American organization. However, instead of American organization, this research will compare management styles and organization structures of Japanese organization, which already observed by Horii (2005) to the Thai SMEs' management styles and organization structures. In addition, Horii (2005) proposed that the cultural practice factor in an organization is characterized by three attributes: level of centralization of authority, level of formalization of communication, and depth of organizational hierarchy.

Table 3: The Summary of Thai SMEs and Japanese Organization Style is summarizing the interviews as well as the observations data of Thai SMEs' organization style with the reference of Japanese organization style. Thai SMEs, based on the observation and interview, have flatter organization hierarchy and lower level of formalization than Japanese organization. However, Thai SMEs and Japanese organization are the same in centralized authority.

Table 3: The Summary of Thai SMEs and Japanese Organization Style

		Thai SMEs	Japanese
Organization Style	Centralization	Centralized Authority	Centralized Authority
	Formalization	Low Level of Formalization	High Level of Formalization
	Hierarchy	Flat Hierarchy	Multiple Hierarchy

Table 4: The Summary of Thai SMEs and Japanese Organization in Micro-Level Behavior

		Thai SMEs				Japanese
		Thai	Migrant Laborers			
			Laos	Myanmar	Cambodian	
Micro-Level (Actor) Behavior	Decision Making	Individual	Individual	Individual	Individual	Consensual
	Communication Style	Individual	Individual	Individual	Individual	Group Based
	Communication Skill (for Migrant Laborers in Thai SMEs only)		High	Medium	Low	

Similar to the cultural practices, this research extends the " cultural value" to refer to the preferences with which people make work-related and communication-related decisions (Horii et al, 2005). At the labor level, when team members or workers make decisions or coordinate with each other, their behavior is based on their cultural values. This is called "micro-level behavior" (Jin and Levitt, 1996). Horii (2005) explained that the micro- level behavior include the decision-making and coordination behaviors. On the other words, cultural values at the micro or labor level are defined by how participants or workers make work and coordination decisions. Based on Horii (2005), Japanese participants or workers tend to seek consensus before making decisions. Meanwhile, base on observations and interviews, laborers in Thai SMEs prefer to decide independently. Both Japanese and Thai SMEs's laborers have their own distinctly different patterns of micro-level behavior. In addition, since the language that is often used in both white-collar and blue-collar level in Thai SMEs is definitely Thai, this research is also focusing on the communication skill (in Thai language) of the laborers inside Thai SMEs. However, migrant laborers from Laos are most likely to understand and communicate easier and faster in Thai language than the migrant laborers who come from Myanmar and Cambodia (see Table 4: Summary of Thai SMEs and Japanese Organization in Micro-Level Behavior).

3.2. Computational Experimental Approach

The methodology this research will use is the computational experiment or simulation. Simulation is one of the most common methods and used widely for management or operation research sciences techniques. Law and Kelton (2000) suggest that the application areas for simulation are numerous and diverse. One of those numerous applications is designing and analyzing manufacturing system, which is used in this research. Law and Kelton, however, also state that there are two main categories of simulation system, discrete and continuous. Continuous system is one for which the state variables change continuously with respect to time. Meanwhile, this research is using the discrete type of simulation system, which refers to a system that is one for which the state variables change instantaneously at separated points in time. These points in time are the ones at which an event occurs. An event is defied as an instantaneous occurrence that may change the state of system. In short, discrete event simulation system is concerned about the model of a system as it evolves over time by a representation in which the variables change instantaneously at separate points of time.

However, this research is modeling the event and the state of variables based on the task complexity, and the combinations of nationality in Thai SMEs, which will be explained in the next section.

3.2.1. Task Complexity

Types of task, in common, can be varied. However, this research attempts to study the communication barriers among team members inside Thai SMEs based on three types of task complexity, which are parallel, sequential, and reciprocal type.

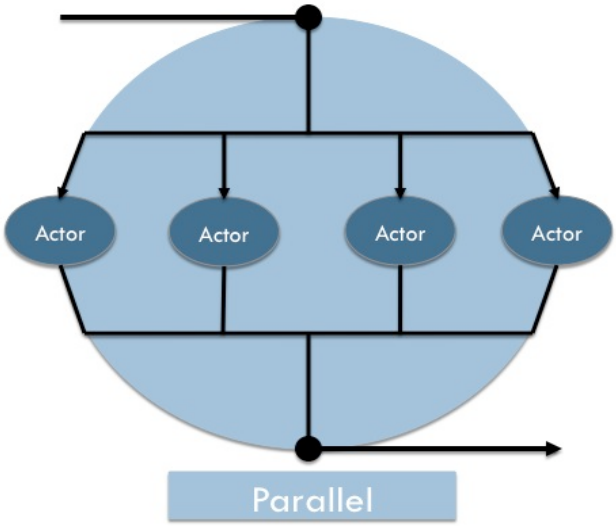

Figure 8: Task Complexity Type 1_Parallel

To explain more in detail, assumes that there are four workers or actors working as a team. Parallel task means that all four actors or workers are working in parallel. As shown in Figure 8 (Task Complexity Type 1_Parallel), beginning with order or job comes via the black line in one unit of time constantly into the big blue circle which representing the system. After order or job enters to the system, that job will be separated into four for each actor, which is representing in small circles. Finally, after actors complete their job, job will come out of the system then the actors will take care of the new job that just come into the system. Next type of task that will also be used as a simulation model in this research is the sequential type. Beginning with the same process as the parallel type, order will come into the system constantly in one unit of time.

However, the differences between parallel type and sequential type is that actors in sequential type have to work in sequence instead of parallel. Supposing that there are 4 actors A, B, C, and D standing in line inside the system as shown in Figure 9: Task

Complexity Type 2_Sequential. After order or job 1 comes into system, firstly actor A, who is at the beginning of the line, will take care of that job 1. After actor A finishes his job, actor A will send job 1 to actor B who is standing next to him. Then, actor B will take care of job 1, meanwhile, job 2 will come into the system with the constant rate of time. After actor B finishes job 1, he will send job 1 to actor C and receive job 2 from actor A. Again, job or order 3 comes into the system starting at actor A with the constant rate of time. At this point, there are three actors who are taking care of job, actor A with job 3, actor B with job 2, and actor C with job 1. However, actor D is still waiting for job 1 to be done by and sent from actor C. Finally, after actor D receives and finishes his job 1, he will send it out of the system that is to mean that order or job 1 is completely done. According to this type of task, all actors in the system have a systematic arrangement and will do jobs in sequence or order.

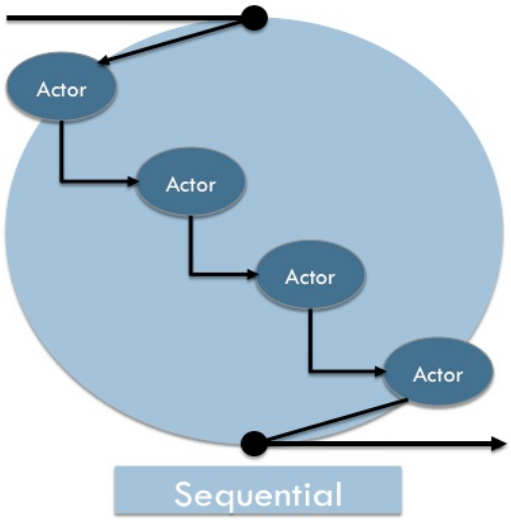

Figure 9: Task Complexity Type 2_Sequential

The last type of task that this research attempts to study the communication barriers among team members inside Thai SMEs is the reciprocal type. Same as both aforementioned types of task, there are four actors in the system A, B, C, and D. However, the flow of job or order in reciprocal type is almost the same as sequential type but differs in actors' coordination. Actors in both parallel as well as sequential types are working independently. But, actors in

the reciprocal type are working together as a pair.

As shown in Figure 10: Task Complexity Type 3_Reciprocal, all actors are working in pairs. Actor A and B have to corporate and take care of the job together. Then, actor B and C also have to do jobs together. Finally, the last pair of actors who are actor C and D will complete job or order together.

However, this reciprocal type of task is most likely to have the biggest barrier in communication compared to parallel and sequential type since all workers or actors have to rely on each other and work dependently. Moreover, this reciprocal type of task tends to have bigger problem in communication when the actors or workers speak in different language, which could normally happen in Thai SMEs according to the four nationalities of laborers.

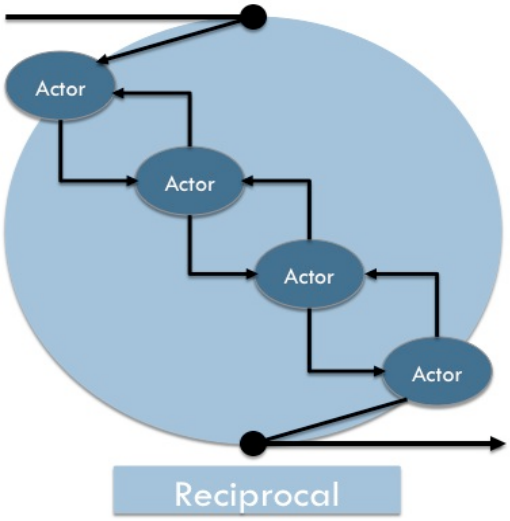

Figure 10: Task Complexity Type 3_Reciprocal

3.2.2. Case Scenarios

According to the four nationalities in labor level of Thai SMEs, which are Thai, Laos, Myanmar, and Cambodia, the actors in our computational experiment were set up with the unit of four. Each actor will represent their own characteristic based on their nationalities. Since there are four units of actors, this computational experiment will put these four actors as in one team. Then, the job or task will be assigned to the team in every one unit of time constantly, in order to find out the performance of the team. In this research, the approach of the computational experimental begins with listing up the combinations of team member's nationalities in each team. These combinations are considered based on parallel type of task complexity that is to mean that there is no order or sequence of team member effects (see 3.2.1. Task Complexity), since they all work together as a parallel line. All possible combinations of nationalities that could happen in one team is listed up and shown in Table 5: The Combinations of Nationalities in One Team. T represents Thai Laborers. Then, L, M, and C are representing the migrant laborers from Laos, Myanmar, and Cambodian, correspondingly (notes that small alphabets t, l, m, and c can also be mentioned in this research and those alphabets are also representing the laborers who are from Thai, Laos, Myanmar, and Cambodia, respectively). For example, in case 1, the combination consists of one Thai Laborer, one laborer from Laos, one Myanmar laborer, and one Cambodia laborer. On the other hands, case 17 consists of two laborers from Laos, one from Myanmar, and one from Cambodia. Meanwhile, case 25 refers to three Thai laborers and one laborer from Myanmar.

Table 5: The Combinations of Nationalities in One Team

CASE	Combination	CASE	Combination	CASE	Combination
1	TLMC	13	TTLC	25	TTTM
2	TTTT	14	TTMC	26	TTTC
3	LLLL	15	LLTM	27	LLLT
4	MMMM	16	LLTC	28	LLLM
5	CCCC	17	LLMC	29	LLLC
6	TTLL	18	MMTL	30	MMMT
7	TTMM	19	MMTC	31	MMML
8	TTCC	20	MMLC	32	MMMC
9	LLMM	21	CCTL	33	CCCT
10	LLCC	22	CCTM	34	CCCL
11	MMCC	23	CCLM	35	CCCM
12	TTLM	24	TTTL		

In order to find out that which combination of nationalities can give the best performance on each task complexity, above possible 35 combinations in table above will be used as the case scenarios in the computational experiment of this research. However, there are three types of task complexity, parallel, sequential, and reciprocal, and then each task complexity has 35 case scenarios. Therefore, in this experiment we will have 105 case scenarios in total.

3.3. Modeling Framework

This research computational experiment's modeling framework can be categorized into 2 main parts, the team description and project description (Figure 11: Modeling Framework). Then, each of the aforementioned parts can also be divided into two sub parts, organization style and actors in team description part, and task complexity and communication experience in project description part.

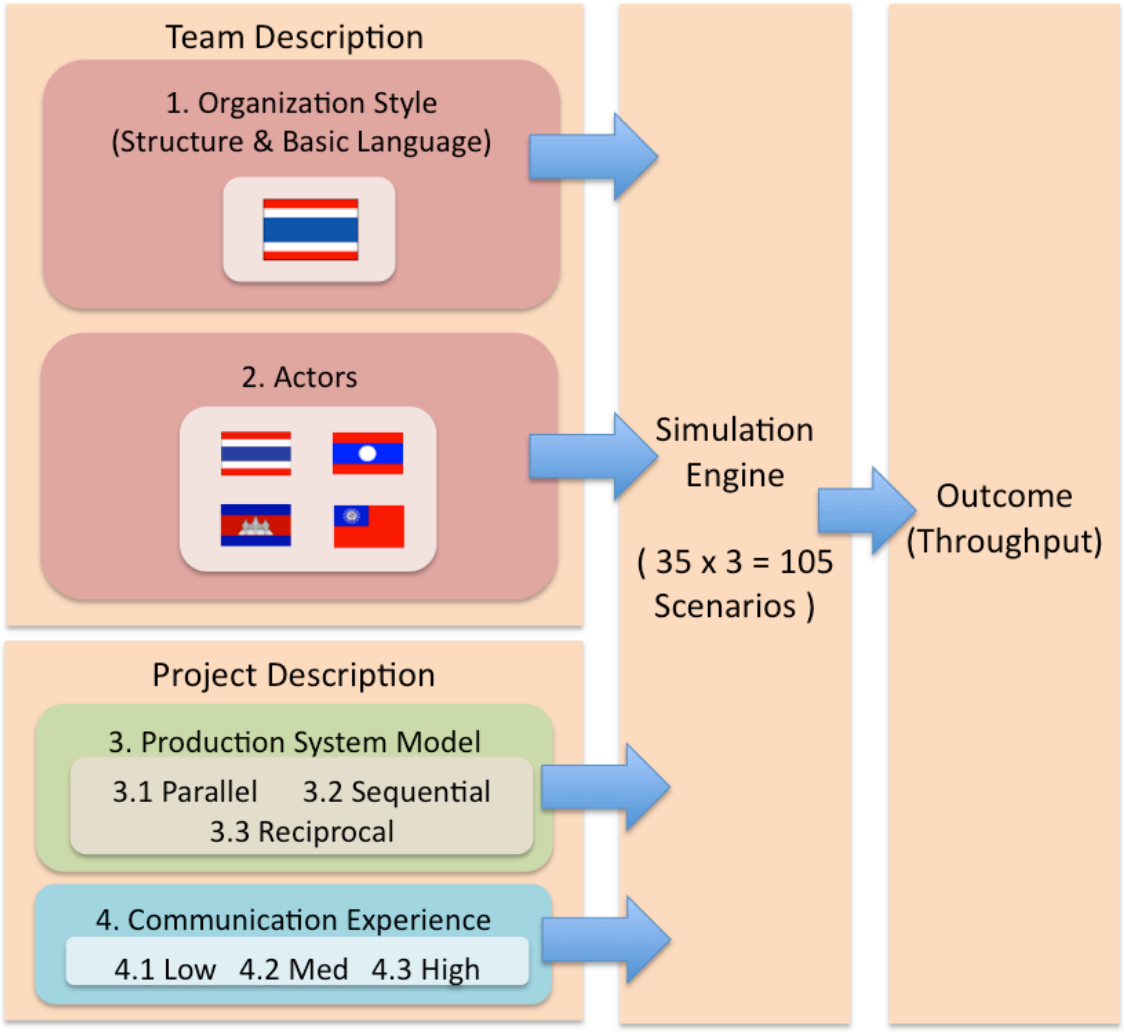

Figure 11: Modeling Framework

First, the team description, which consists of two sub parts that are the Thai SMEs organization style and the actors in the lower or labor level of Thai SMEs. Organization style (number one) refers to how that organization controls or manages the stakeholders inside. Based on the interview data (Table 3 and 4), most Thai SMEs have a flat hierarchy

that means that the management level and the labor level inside Thai SMEs is interacting to each other with not so many processes. Orders coming from customers can be planned and sent to labor level shortly. Next sub part in team description is the actors or the members of the team (number two). In this case, it refers to the four nationalities of laborers inside Thai SMEs. Local laborers from Thailand, as well as migrant laborers from Laos, Myanmar, and Cambodia, will be the four actors or members in the team during the computational experiment.

In project description part, it consists of another two sub-parts, which are task complexity and communication experience (number three and four). There are three types of tasks that will be applied in this research experiment: parallel, sequential, and reciprocal type. Since this computational experiment is about Thai SMEs, the communication experience refers to how well actors in the same team can communicate and understand the orders those usually come directly from the management level in Thai language.

However, after we obtain the inputs of those four sub-parts, the computational experiment will be done, or simulated. According to chapter 3.2.1 (Task Complexity) and 3.2.2 (Case Scenarios), the total number of case scenarios in this research will be based on the combination of four laborers' nationalities together with three types of task, which also based on its complexity. There are 35 set of combination of laborers' nationalities (Table 5: The Combinations of Nationalities in One Team). With three types of task, finally, we will have (35 x 3 =) 105 case scenarios in total. Then, the result or outcome of this experiment will be considered in term duration or the time consumed in each assigned order as well as the utilization of workers or actors.

3.4. Computational Experimental Model

Computational experimental model or the simulation model in this research can be explained in form of the process modeling which is the activity of representing processes inside the organization or enterprise, so that the current process may be analyzed and improved. Process modeling, in this experiment, was done based on a flowcharting technique, which is a type of technique that is using diagrams to represent processes or algorithms. Flowcharting technique is commonly used in various fields for analyzing, managing or even designing a process or program. This technique visualizes what is going on inside the process in order to help stakeholders to understand more about the process. It shows the process as various kinds of boxes in steps, and also shows the connection by arrows. Process operations are represented in various shapes of boxes, and arrows connecting them represent flow of process and its control.

However, Data flows are not in general represented in a flowchart. But, they are implied by the sequence of operations. The process diagram will become a process model of the experiment when it describes how each activity processes transactions and identifies data types such as the resources and time needed to process the transactions.

Finally this research will simulate the action of and interactions among, actors (departments) as processes of attention allocation, capacity allocation, and communication. In addition, there are three types of computational experimental Model based on three types of task complexity, which are model type 1: Parallel, type 2: Sequential, and type 3: Reciprocal.

3.4.1. Model Type 1: Parallel

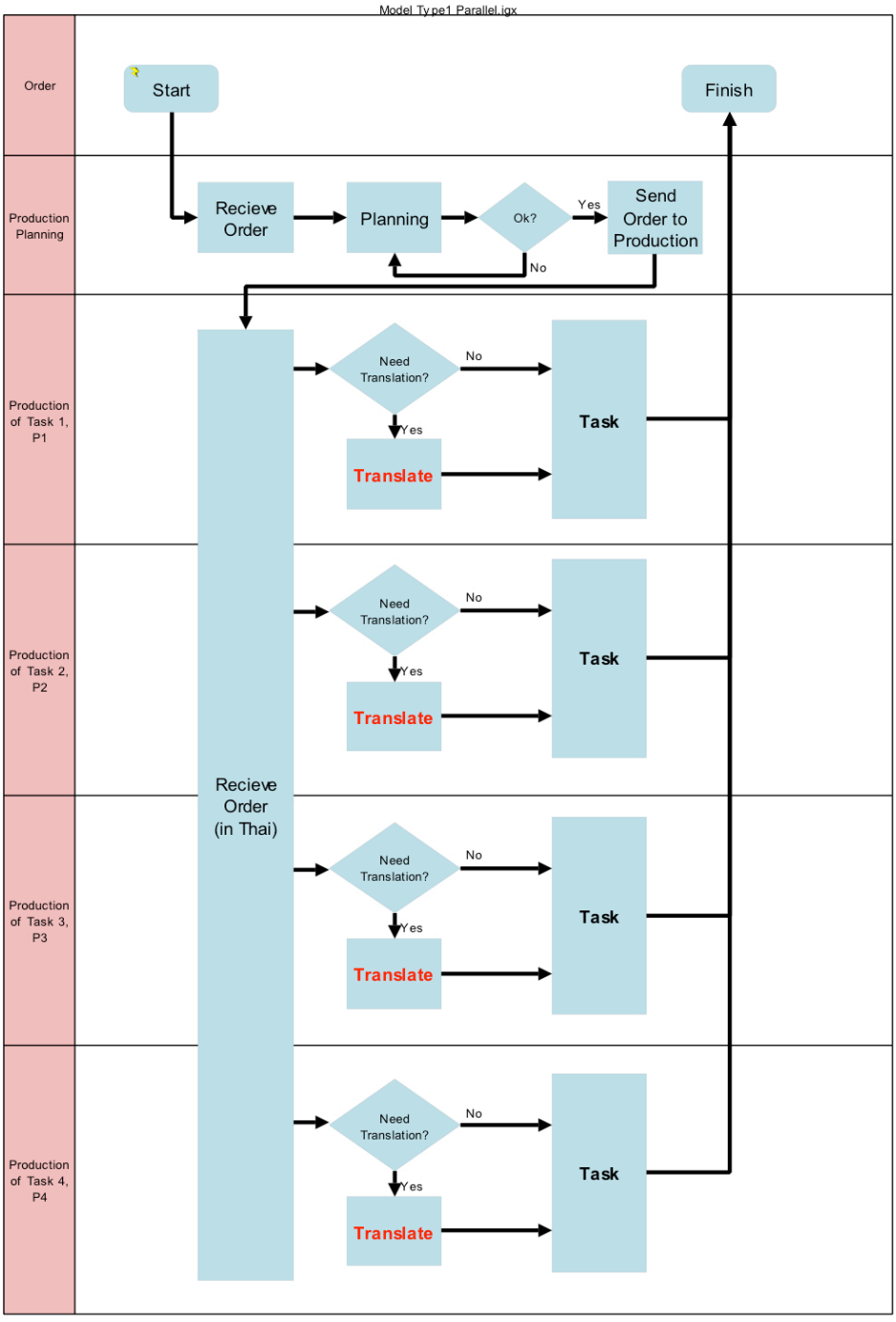

Figure 12: Model Type 1_Parallel

In model type 1: Parallel (Figure 12), there are six parts or departments in this process flow model. First is customer who places orders. Second is the production planning or the management level of Thai SMES. The rest (P1, 2, 3, and 4) represent the production department, or in the other words, the team or the workers inside Thai SMEs. Each worker P1 to P4 is changed according to the 35 case scenarios. In the beginning, an order will come in at a constant rate from customers. The production-planning department will then plan how to complete that order then send that order to workers or actors. Since it is a Thai SME, the order will come in Thai language. After each actor receives order, they will decide whether this order needs to be translated or not. If the actor is Thai laborer, of course, this order does not need to be translated. On the other hands, if the actors are migrant laborers who come from Laos, Myanmar, and Cambodia, this order will need to be translated into their languages in order to obtain the same understandings with others workers in that order. The time the migrant labors will consume for translation order into their own language will be different according to their communication experiences. After they all understand the order, the job or task will be done that is to mean that they finish that order completely. Then, all actors will take care of another waiting order right away.

However this Parallel type of process model was made based on the Thai SMEs organization style and the task parallel task complexity. After, order comes, each actor will take care of their own task separately without any communication among actors except the order translations. This parallel type of process model seems to have less communication barriers compared to other two process models.

3.4.2. Model Type 2: Sequential

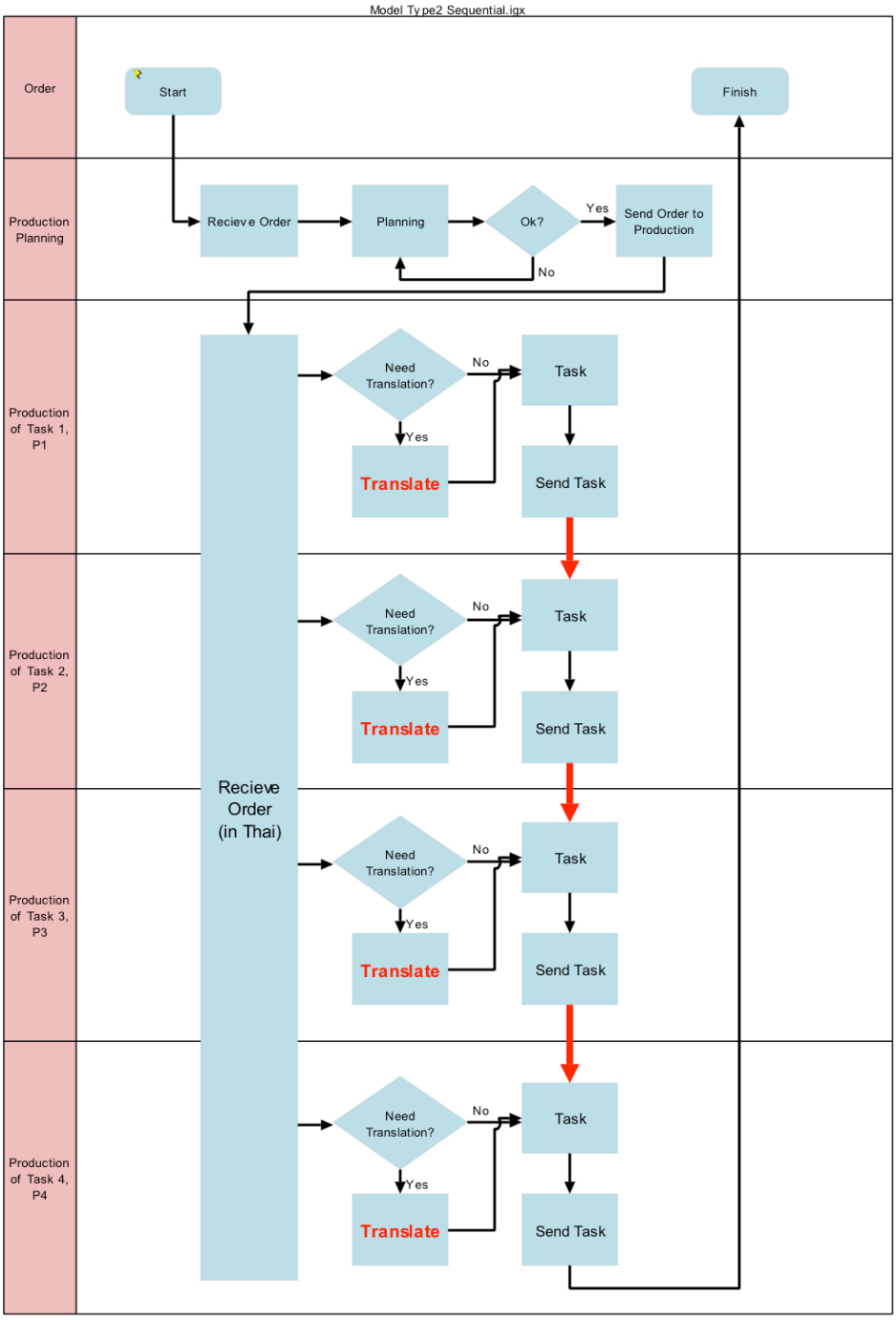

Figure 13: Model Type 2_Sequential

In model type 2: Sequential (Figure 13), there are also six parts or departments in this process flow model. The beginning is the same as in model type 1: Parallel, first part or stakeholder is the customer who places orders. Second is the production planning or the management level of Thai SMES who directly receive orders from the customer. The next stakeholders are the production departments that are represented by P1, P2, P3, and P4. These production departments are considered as the team or the workers inside Thai SMEs. The combinations of workers P1 to P4 is again changing based on the 35 case scenarios. In the beginning orders will come at a constant rate. After the planning process is completely done by the production-planning department, the order will be sent to workers or actors in Thai language. After each actor receives the order, they will decide whether this order needs to be translated or not. If the actors are migrant laborers who come from Laos, Myanmar, and Cambodia, this order will be need to be translated into their languages in order to obtain the same understandings with others workers in that order. The time the migrant labors will use to translation the order into their own language will be different according to their communication experiences.

However this sequential type of process model was made based on the Thai SMEs organization style and the task sequential task complexity. After receiving orders, actors in sequential type will have to work in sequence instead of in parallel.

3.4.3. Model Type 3: Reciprocal

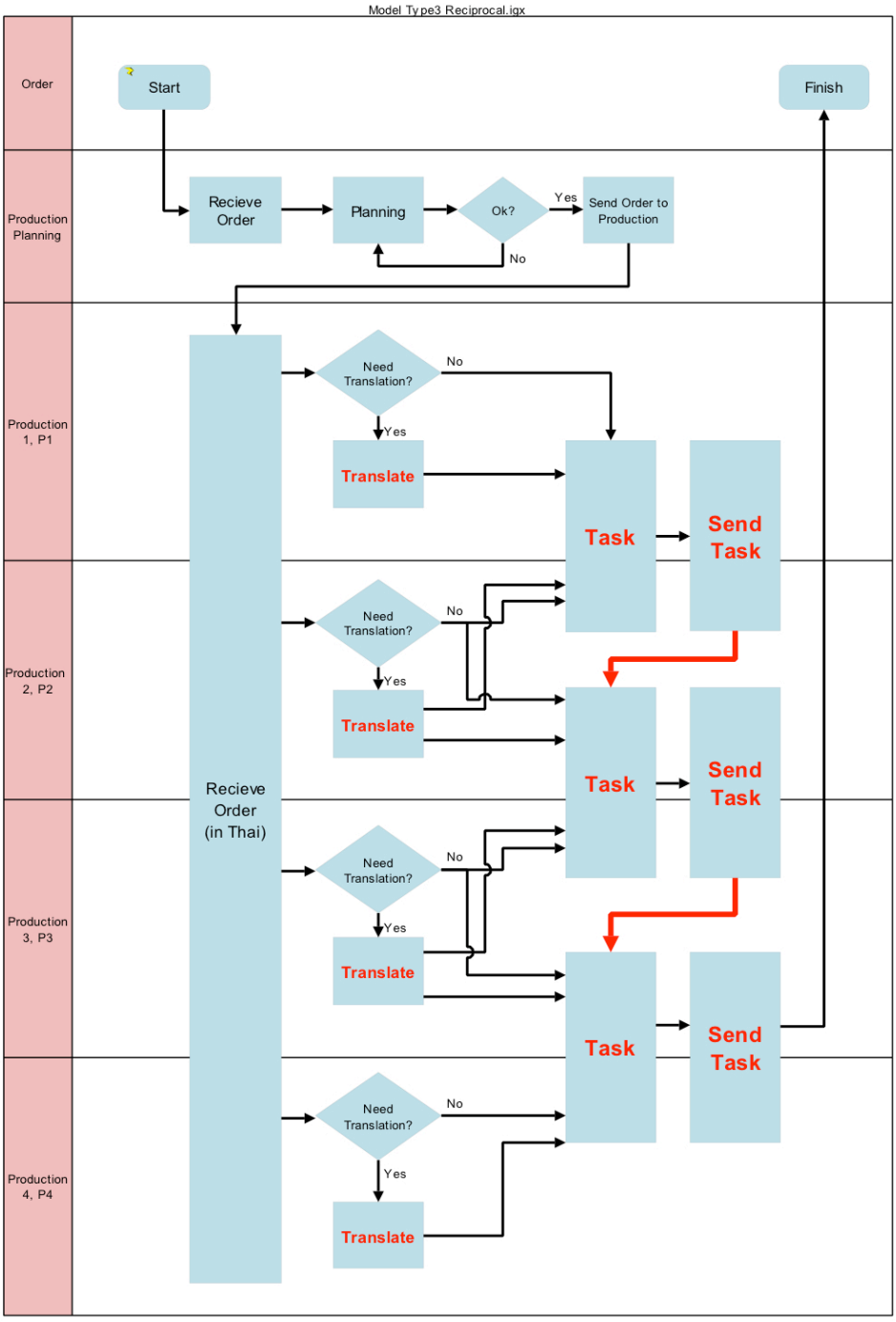

Figure 14: Model Type 3_Reciprocal

In last model type: Reciprocal (Figure 14), similar to the two aforementioned models, there are six parts or departments in this model. First is customer who makes orders. Second is the production planning department. Third are the four workers or actors in the production department, who is working together as one team. Again, Each worker P1 to P4 is changed according to the 35 case scenarios. At the starts, orders will be received at a constant rate from customers. Then, after planning, order will be sent to workers or actors in Thai language. Based on the language experiences, time consumptions that each actor will take to understand order will be different. However, the flow of job or order in reciprocal type is almost the same as sequential type but differs in actors' coordination. Actors in both parallel as well as sequential cases worked separately. But, actors in the reciprocal model work together as a pair. As shown in Figure 14: Model Type 3_Reciprocal, all actors work in pairs. Actor P1 and P2 have to co-operate and take care of the job together after the decision of order translation. Then, actor P2 and P3 also have to do jobs together. Finally, the last pair of actors who are actor P3 and P4 will complete job or order together. This reciprocal type of process model was made according to the Thai SMEs organization style and the reciprocal type of task complexity.

In addition, this reciprocal type of process model is assumed to have the most communication barriers compared to other two process models, since actors have to interact, share the same understandings, communicate to, and rely on each other.

CHAPTER 4

DATA ANALYSIS AND RESULTS

4. DATA ANALYSIS AND RESULTS

4.1. Data Analysis

The results in this computational experiment basically will be shown in form of the number of transactions or products produced during elapsed time or the simulated time and the overall time that all actors used. This section will explain the equations used in this research as well as their relationship to the results obtained in the computational experiment.

This research is focused on finding the performance of each combination in each specific case scenario. In short, the performance in this study will be considered using the productivity of each combination of actors, and the productivity index in this computational experiment is called “count” or complete transaction or work count. In addition, this completion count refers to the final products or works those each team can finish during the simulated or elapsed time. In other words, in this research “count” refers to number of transactions that passed through activities that done by all actors and successfully completed during the simulation.

Moreover, assuming that actors have to work 8 hours a day, this computational experiment will set up the criteria of working for 10 days or 80 hours, continuously. Also, this experiment attempts to study and find out the ideal performance of each team without any fatigue of workers or actors. That is to say that the every workers or actors will do their jobs after receiving orders in one unit of time stably until the end of simulation period.

For a given order or job, the time that transactions were in activities is called the cycle time Ct, then this research assumed that

$$\mathbf{Ct = St + It} \qquad \mathbf{(1)}$$

Where, St is service time, refers to the amount of time that all actors spent servicing on

transactions. Meanwhile, Inactive time means the amount of time items were waiting due to resources or activities not being available or not being active.

Moreover, service time (St) can be broadened and calculated as work time (Wkt), resource waiting time (Rwt), and blocked time (Bt).

$$\mathbf{St = Wkt + Rwt + Bt} \qquad \mathbf{(2)}$$

Working time or the time accumulated during actors work, refers to amount of time work was being performed actively on transactions, which is calculated from task duration times. Meanwhile, resource waiting time (Rwt) is the time accumulated transactions were waiting to obtain resources and blocked time refers to the amount of time transaction were blocked at any activities, including blocked time due to capacity limits at each activity's collection and delay. In addition, in this experiment, blocked time is considered no significant and closed to zero, since there is no collection at any activity, and delay during this experiment.

However, in this experiment we can also find the total waiting time (Wt) or the total amount of time transactions spent on waiting during the simulation. Waiting time can be calculated by the amount of inactive time (It), resource waiting time (Rwt), and blocked time (Bt).

$$\mathbf{Wt = \quad Rwt + It + Bt} \qquad \mathbf{(3)}$$

Then, based on equation (3), after the computational experiment, we can calculate the time accumulated waiting for a resource that is out of schedule or inactive time by

$$\mathbf{It = Wt - Rwt - Bt}$$

Finally, from equation (2) and (3), the cycle time or the amount of time that transactions were in activities can also be calculated by

$$\mathbf{Ct = Wkt + Wt} \qquad \mathbf{(4)}$$

Where, Wt is working time and Wt is waiting time.

However, according to those aforementioned equations and their relationships, the computational experiments were performed in this research. The results of the experiments will be shown in the following sections of this chapter and be separated into three main parts based on the three types of models, parallel, sequential, and reciprocal.

4.2. Results

The results from the simulation will be shown separately based on the task complexity or the types of models. The first result will be in form of the number of completed transactions or count, which refers to the final products or works those each team can finish during the simulated or elapsed time. The second result of each model will be shown in the total cycle time that refers to the amount of time that transactions were in activities.

4.2.1. Results of Model Type 1: Parallel

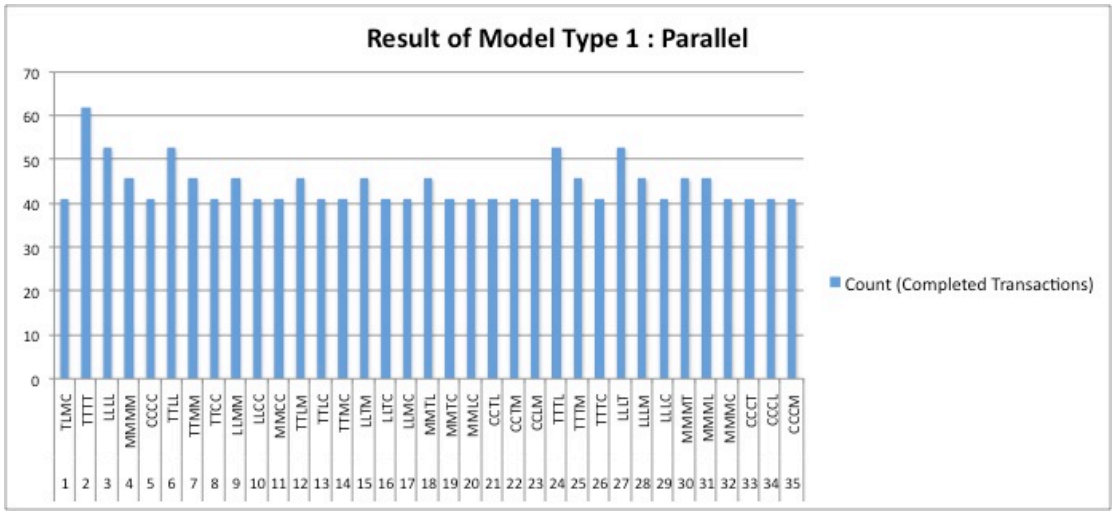

Figure 15: Result of Model Type 1_Parallel (Completed Transaction)

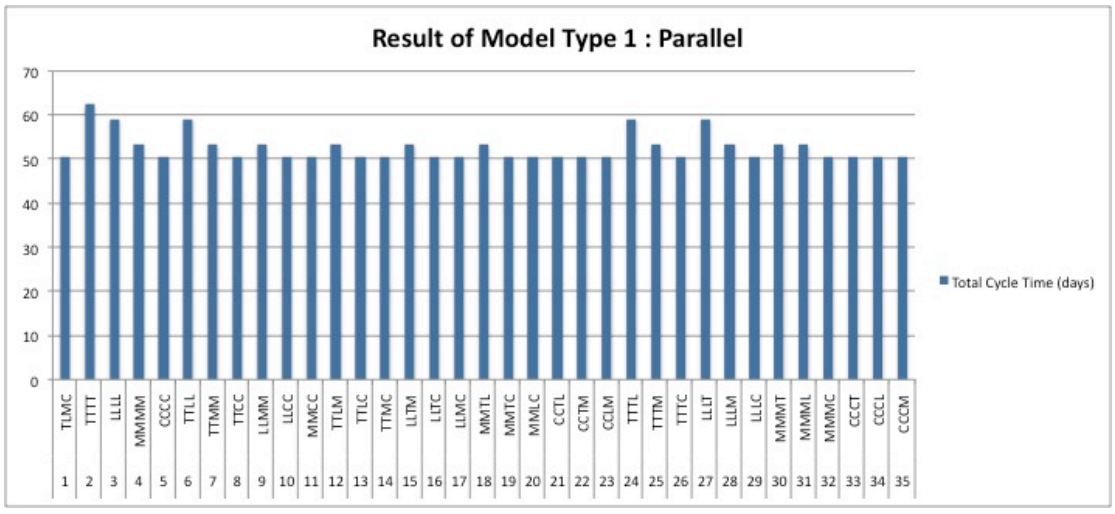

Figure 16: Result of Model Type 1_Parallel (Total Cycle Time)

4.2.2. Results of Model Type 2: Sequential

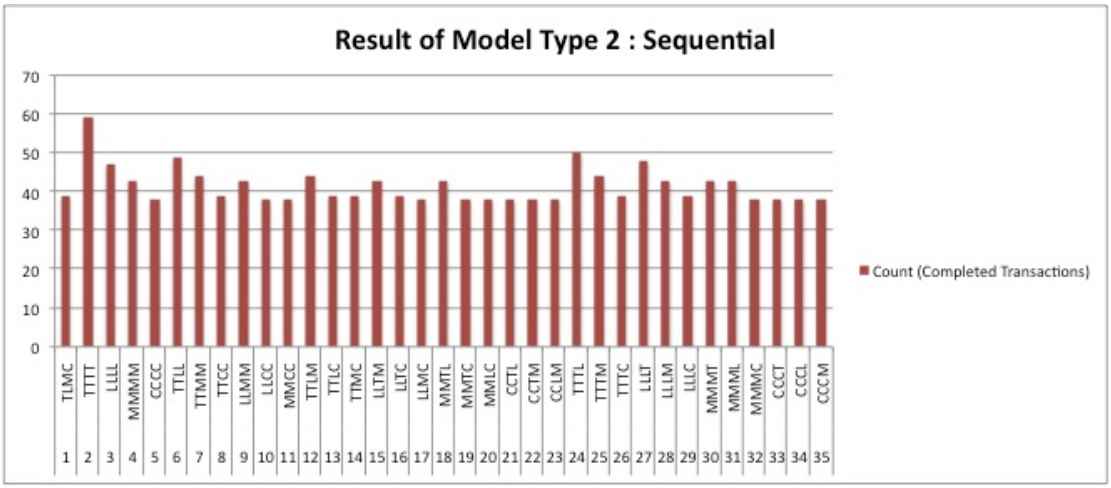

Figure 17: Result of Model Type 2_Sequential (Completed Transaction)

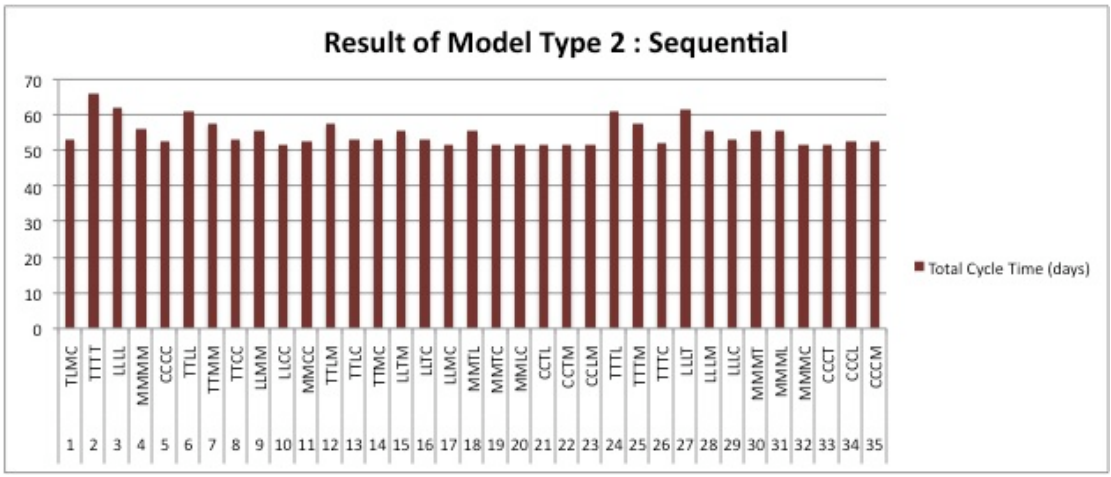

Figure 18: Result of Model Type 2_Sequential (Total Cycle Time)

4.2.3. Results of Model Type 3: Reciprocal

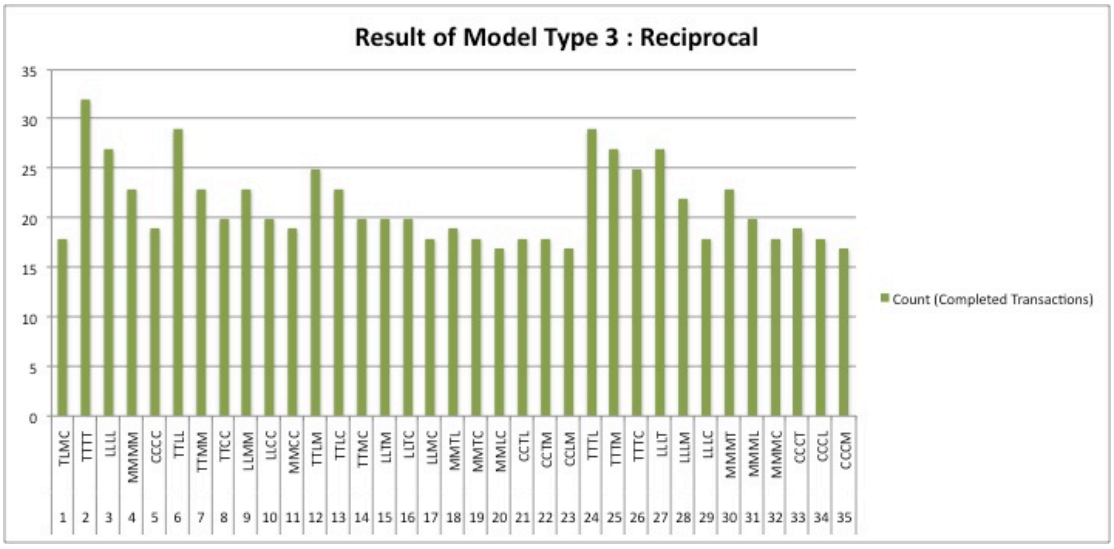

Figure 19: Result of Model Type 3_Reciprocal (Completed Transactions)

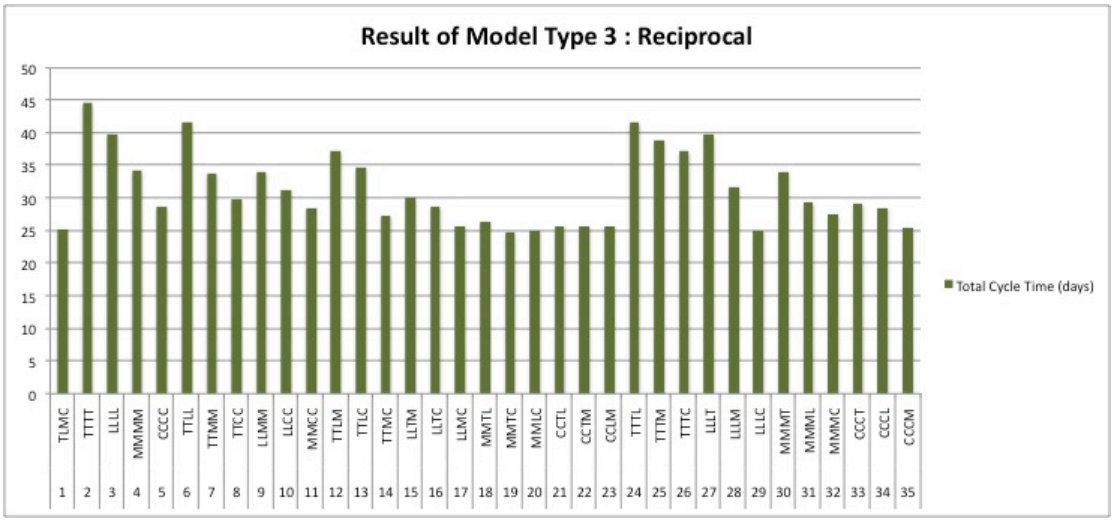

Figure 20: Result of Model Type 3_Recripocal (Total Cycle Time)

The previous results from the computational experiment will be shown in detail in appendix A, B, and C, respectively.

4.2.4. Summary of the Results

The results obtained from the computational experiments of all three types of models will be shown in the figure below. The results are the completion count or completed transactions from each combination.

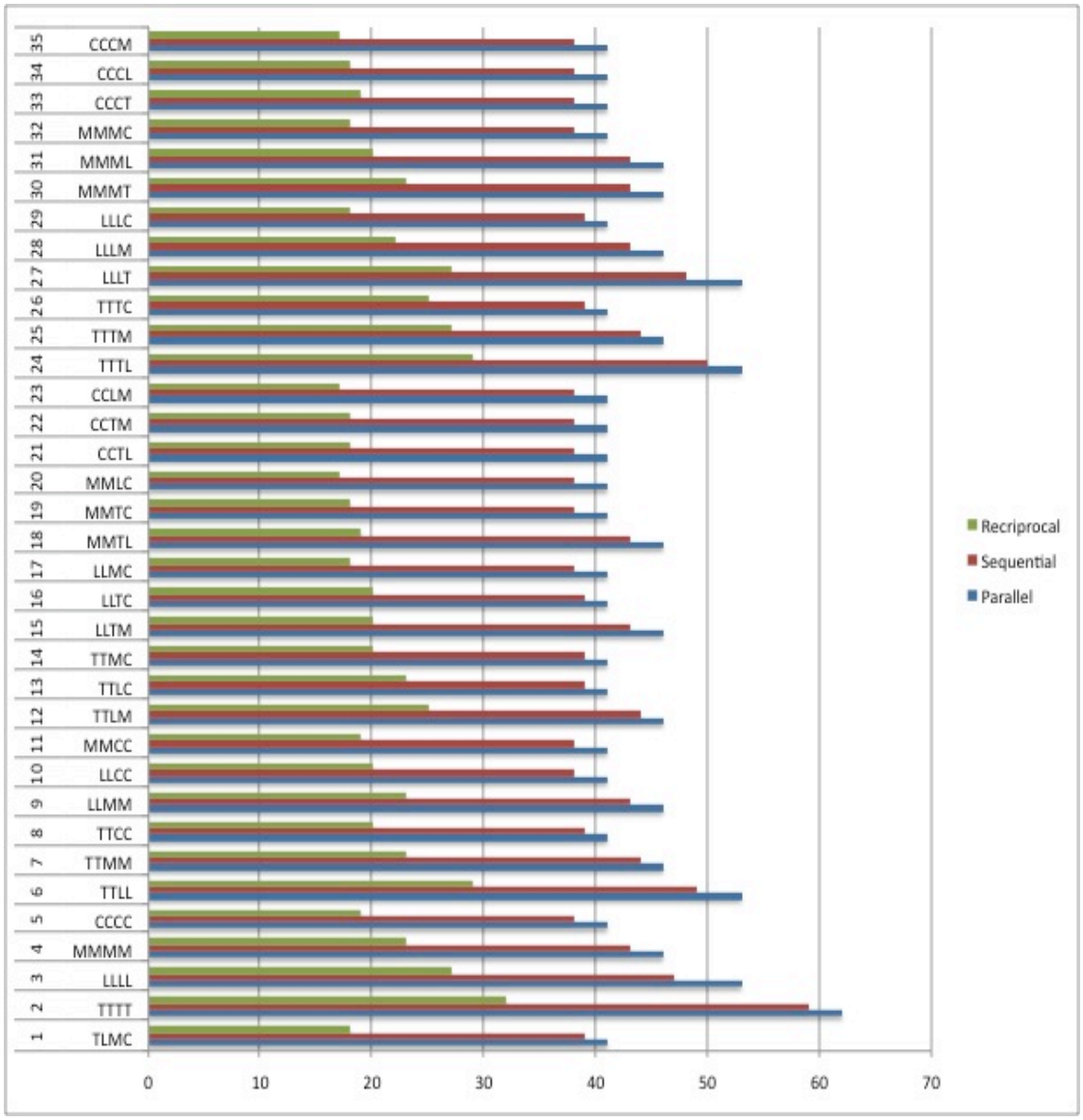

Figure 21: Summary of the Results (Completed Transactions)

To summarize all of results from the simulation, table below are showing the rank of each combination's productivity, which considered by the number of completed transactions during the simulation period.

Table 6: Ranking of the Results

Rank	Type of Task	Case	Combination	Count
1	Parallel	2	TTTT	62
2	Sequential	2	TTTT	59
3	Parallel	3	LLLL	53
4	Parallel	6	TTLL	53
5	Parallel	24	TTTL	53
6	Parallel	27	LLLT	53
7	Sequential	24	TTTL	50
8	Sequential	6	TTLL	49
9	Sequential	27	LLLT	48
10	Sequential	3	LLLL	47
11	Parallel	4	MMMM	46
12	Parallel	7	TTMM	46
13	Parallel	9	LLMM	46
14	Parallel	12	TTLM	46
15	Parallel	15	LLTM	46
16	Parallel	18	MMTL	46
17	Parallel	25	TTTM	46
18	Parallel	28	LLLM	46
19	Parallel	30	MMMT	46
20	Parallel	31	MMML	46
21	Sequential	7	TTMM	44
22	Sequential	12	TTLM	44
23	Sequential	25	TTTM	44
24	Sequential	4	MMMM	43
25	Sequential	9	LLMM	43
26	Sequential	15	LLTM	43
27	Sequential	18	MMTL	43
28	Sequential	28	LLLM	43
29	Sequential	30	MMMT	43
30	Sequential	31	MMML	43

Rank	Type of Task	Case	Combination	Count
31	Parallel	1	TLMC	41
32	Parallel	5	CCCC	41
33	Parallel	8	TTCC	41
34	Parallel	10	LLCC	41
35	Parallel	11	MMCC	41
36	Parallel	13	TTLC	41
37	Parallel	14	TTMC	41
38	Parallel	16	LLTC	41
39	Parallel	17	LLMC	41
40	Parallel	19	MMTC	41
41	Parallel	20	MMLC	41
42	Parallel	21	CCTL	41
43	Parallel	22	CCTM	41
44	Parallel	23	CCLM	41
45	Parallel	26	TTTC	41
46	Parallel	29	LLLC	41
47	Parallel	32	MMMC	41
48	Parallel	33	CCCT	41
49	Parallel	34	CCCL	41
50	Parallel	35	CCCM	41
51	Sequential	1	TLMC	39
52	Sequential	8	TTCC	39
53	Sequential	13	TTLC	39
54	Sequential	14	TTMC	39
55	Sequential	16	LLTC	39
56	Sequential	26	TTTC	39
57	Sequential	29	LLLC	39
58	Sequential	5	CCCC	38
59	Sequential	10	LLCC	38
60	Sequential	11	MMCC	38

Table 7: Ranking of the Results (cont'd)

Rank	Type of Task	Case	Combination	Count
61	Sequential	17	LLMC	38
62	Sequential	19	MMTC	38
63	Sequential	20	MMLC	38
64	Sequential	21	CCTL	38
65	Sequential	22	CCTM	38
66	Sequential	23	CCLM	38
67	Sequential	32	MMMC	38
68	Sequential	33	CCCT	38
69	Sequential	34	CCCL	38
70	Sequential	35	CCCM	38
71	Reciprocal	2	TTTT	32
72	Reciprocal	6	TTLL	29
73	Reciprocal	24	TTTL	29
74	Reciprocal	3	LLLL	27
75	Reciprocal	25	TTTM	27
76	Reciprocal	27	LLLT	27
77	Reciprocal	12	TTLM	25
78	Reciprocal	26	TTTC	25
79	Reciprocal	4	MMMM	23
80	Reciprocal	7	TTMM	23
81	Reciprocal	9	LLMM	23
82	Reciprocal	13	TTLC	23
83	Reciprocal	30	MMMT	23
84	Reciprocal	28	LLLM	22
85	Reciprocal	8	TTCC	20
86	Reciprocal	10	LLCC	20
87	Reciprocal	14	TTMC	20
88	Reciprocal	15	LLTM	20
89	Reciprocal	16	LLTC	20
90	Reciprocal	31	MMML	20

Rank	Type of Task	Case	Combination	Count
91	Reciprocal	5	CCCC	19
92	Reciprocal	11	MMCC	19
93	Reciprocal	18	MMTL	19
94	Reciprocal	33	CCCT	19
95	Reciprocal	1	TLMC	18
96	Reciprocal	17	LLMC	18
97	Reciprocal	19	MMTC	18
98	Reciprocal	21	CCTL	18
99	Reciprocal	22	CCTM	18
100	Reciprocal	29	LLLC	18
101	Reciprocal	32	MMMC	18
102	Reciprocal	34	CCCL	18
103	Reciprocal	20	MMLC	17
104	Reciprocal	23	CCLM	17
105	Reciprocal	35	CCCM	17

CHAPTER 5

DISCUSSION

5. DISCUSSION

5.1. Discussion of findings

According to the results of each model, we can put the results into various groups of ranking. In parallel type model, we can group the results based on the number the completed transactions.

Table 8: Ranking of Model Type 1_Parallel

Ranking of Model Type 1 : Parallel

Rank	Case	Combination	Count (Completed Transactions)
A	2	TTTT	62
	3	LLLL	53
	6	TTLL	53
	24	TTTL	53
	27	LLLT	53
B	4	MMMM	46
	7	TTMM	46
	9	LLMM	46
	12	TTLM	46
	15	LLTM	46
	18	MMTL	46
	25	TTTM	46
	28	LLLM	46
	30	MMMT	46
	31	MMML	46
C	1	TLMC	41
	5	CCCC	41
	8	TTCC	41
	10	LLCC	41
	11	MMCC	41
	13	TTLC	41
	14	TTMC	41
	16	LLTC	41
	17	LLMC	41
	19	MMTC	41
	20	MMLC	41
	21	CCTL	41
	22	CCTM	41
	23	CCLM	41
	26	TTTC	41
	29	LLLC	41
	32	MMMC	41
	33	CCCT	41
	34	CCCL	41
	35	CCCM	41

According to Table 8, there are three groups of ranking in the results of model type 1: parallel. A group is consisting of the combinations that can complete more than 50 transactions during the simulation period. Then, B group is consisting of the combination those completed 46 transactions. Finally, C group is those who completed 41 transactions.

Table 9: Ranking of Model Type 2_Sequential

Ranking of Model Type 2 : Sequential

Rank	Case	Combination	Count (Completed Transactions)
A	2	TTTT	59
	24	TTTL	50
	6	TTLL	49
	27	LLLT	48
	3	LLLL	47
B	7	TTMM	44
	12	TTLM	44
	25	TTTM	44
	4	MMMM	43
	9	LLMM	43
	15	LLTM	43
	18	MMTL	43
	28	LLLM	43
	30	MMMT	43
	31	MMML	43
C	1	TLMC	39
	8	TTCC	39
	13	TTLC	39
	14	TTMC	39
	16	LLTC	39
	26	TTTC	39
	29	LLLC	39
D	5	CCCC	38
	10	LLCC	38
	11	MMCC	38
	17	LLMC	38
	19	MMTC	38
	20	MMLC	38
	21	CCTL	38
	22	CCTM	38
	23	CCLM	38
	32	MMMC	38
	33	CCCT	38
	34	CCCL	38
	35	CCCM	38

Table 9 is also showing the ranking group of the results we obtain from model type 2: reciprocal. There are group A to D. A refers to those who can complete jobs or transactions more than 45. B is the group of those who completed jobs between 41-45. C and D are the

group who completed 39 and 38 jobs.

Table 10: Ranking of Model Type 3_Reciprocal

Ranking of Model Type 3 : Reciprocal

Rank	Case	Combination	Count (Completed Transactions)
A	2	TTTT	32
	24	TTTL	29
	6	TTLL	29
	25	TTTM	27
	27	LLLT	27
	3	LLLL	27
B	12	TTLM	25
	26	TTTC	25
	4	MMMM	23
	7	TTMM	23
	9	LLMM	23
	13	TTLC	23
	30	MMMT	23
	28	LLLM	22
C	8	TTCC	20
	10	LLCC	20
	14	TTMC	20
	15	LLTM	20
	16	LLTC	20
	31	MMML	20
D	5	CCCC	19
	11	MMCC	19
	18	MMTL	19
	33	CCCT	19
E	1	TLMC	18
	17	LLMC	18
	19	MMTC	18
	21	CCTL	18
	22	CCTM	18
	29	LLLC	18
	32	MMMC	18
	34	CCCL	18
F	20	MMLC	17
	23	CCLM	17
	35	CCCM	17

However, the ranking of the results of model type 3: reciprocal is the most complex. The range of results is not so wide, yet it is frequent. There are 6 groups of ranking as shown in the Table10.

5.2. Implications and Strategic Recommendations

This research's computational experiments produce several outputs, including the amount of time spent servicing transactions, amount of time transactions were waiting for resources, or even the amount of time transaction were waiting because resources or activities were out of schedule. Nevertheless, above all of those, the performance on each team can be judged by one index, which is the productivity. In this research's computational experiment, productivity can be, basically defied by the count, or the number of transactions that pass through all activities or process and were successfully completed by all actors during the elapsed time or simulation time.

Nevertheless, there are still some suggestive implications due to the judgment by productivity only. The combinations those are in the same rank (Table 8, 9, and 10) are having the same performance in productivity but it is still very hard to judge which combinations are better than those who are in the same rank.

However, based on the queuing theory, the performance of a system that gives services can be seen from two different viewpoints. First is the user viewpoints, refers to the time to obtain a service or the waiting time before getting a service. Second is the system viewpoint, which is the number of users served in the unit time or the resources utilization level. In order to solve that problem, this research recommends the system viewpoint, which is to apply the "utilization" as another performance measure besides the productivity that obtained by from the simulation results. The utilization (ρ) can be calculated by

$$\rho = \lambda / \mu$$

Where, λ is the mean arriving rate that customers or orders come into system, and μ is the mean service rate that servers or actors in the system can serve those customers, which obtained from the average work time in the results (see appendix). We can calculate the Average work time by Tot Work (in hours) divided by the completion count. Then, after applying utilization into the results, the performance of combinations that have the same

level in productivity will be identified and classified as shown in the following 3 tables (Table 11, 12, and 13).

Table 11: Utilization of Model Type 1_Parallel

Utilization of Model Type 1 : Parallel

Rank	Case	Combination	Count (Completed Transactions)	Tot Work	Utilization
A	2	TTTT	62	1.29	1.001
	6	TTLL	53	1.28	0.863
	24	TTTL	53	1.28	0.863
	27	LLLT	53	1.28	0.863
	3	LLLL	53	1.29	0.856
B	4	MMMM	46	1.28	0.749
	7	TTMM	46	1.28	0.749
	9	LLMM	46	1.28	0.749
	12	TTLM	46	1.28	0.749
	15	LLTM	46	1.28	0.749
	18	MMTL	46	1.28	0.749
	25	TTTM	46	1.28	0.749
	28	LLLM	46	1.28	0.749
	30	MMMT	46	1.28	0.749
	31	MMML	46	1.28	0.749
C	1	TLMC	41	1.26	0.678
	8	TTCC	41	1.26	0.678
	14	TTMC	41	1.26	0.678
	19	MMTC	41	1.26	0.678
	21	CCTL	41	1.26	0.678
	22	CCTM	41	1.26	0.678
	26	TTTC	41	1.26	0.678
	33	CCCT	41	1.26	0.678
	13	TTLC	41	1.27	0.673
	16	LLTC	41	1.27	0.673
	17	LLMC	41	1.27	0.673
	29	LLLC	41	1.27	0.673
	5	CCCC	41	1.28	0.667
	10	LLCC	41	1.28	0.667
	11	MMCC	41	1.28	0.667
	20	MMLC	41	1.28	0.667
	23	CCLM	41	1.28	0.667
	32	MMMC	41	1.28	0.667
	34	CCCL	41	1.28	0.667
	35	CCCM	41	1.28	0.667

In parallel type model, it is considered to be multiple server system utilization (four servers inside the system), since there are four or actors working together in parallel. Therefore, service rate of the parallel type model has to be divided by four.

However, other types, sequential and reciprocal are considered as the single server system and the utilization of both types are showing in Table 12 and 13.

Table 12: Utilization of Model Type 2_Sequential

Utilization of Model Type 2 : Sequential

Rank	Case	Combination	Count (Completed Transactions)	Tot Work	Utilization
A	2	TTTT	59	4.92	0.999
	24	TTTL	50	4.34	0.960
	6	TTLL	49	4.42	0.924
	27	LLLT	48	4.5	0.889
	3	LLLL	47	4.57	0.857
B	25	TTTM	44	3.97	0.924
	12	TTLM	44	4.13	0.888
	7	TTMM	44	4.28	0.857
	15	LLTM	43	4.18	0.857
	18	MMTL	43	4.33	0.828
	28	LLLM	43	4.33	0.828
	9	LLMM	43	4.48	0.800
	30	MMMT	43	4.48	0.800
	31	MMML	43	4.63	0.774
	4	MMMM	43	4.78	0.750
C	26	TTTC	39	3.66	0.888
	13	TTLC	39	3.79	0.858
	14	TTMC	39	3.93	0.827
	16	LLTC	39	3.93	0.827
	1	TLMC	39	4.06	0.800
	8	TTCC	39	4.06	0.800
	29	LLLC	39	4.06	0.800
D	17	LLMC	38	4.09	0.774
	19	MMTC	38	4.09	0.774
	21	CCTL	38	4.09	0.774
	10	LLCC	38	4.22	0.750
	20	MMLC	38	4.22	0.750
	22	CCTM	38	4.22	0.750
	23	CCLM	38	4.35	0.728
	32	MMMC	38	4.35	0.728
	33	CCCT	38	4.35	0.728
	34	CCCL	38	4.49	0.705
	11	MMCC	38	4.49	0.705
	35	CCCM	38	4.62	0.685
	5	CCCC	38	4.75	0.667

Table 13: Utilization of Model Type 3_Reciprocal

Utilization of Model Type 3 : Reciprocal

Rank	Case	Combination	Count (Completed Transactions)	Tot Work	Utilization
A	2	TTTT	32	2.67	0.999
	24	TTTL	29	2.52	0.959
	6	TTLL	29	2.62	0.922
	25	TTTM	27	2.44	0.922
	3	LLLL	27	2.63	0.856
	27	LLLT	27	2.63	0.856
B	12	TTLM	25	2.34	0.890
	26	TTTC	25	2.34	0.890
	7	TTMM	23	2.24	0.856
	13	TTLC	23	2.24	0.856
	9	LLMM	23	2.4	0.799
	30	MMMT	23	2.4	0.799
	4	MMMM	23	2.56	0.749
	28	LLLM	22	2.22	0.826
C	15	LLTM	20	1.94	0.859
	14	TTMC	20	2.01	0.829
	16	LLTC	20	2.01	0.829
	8	TTCC	20	2.08	0.801
	31	MMML	20	2.15	0.775
	10	LLCC	20	2.22	0.751
D	18	MMTL	19	1.91	0.829
	33	CCCT	19	2.18	0.726
	11	MMCC	19	2.24	0.707
	5	CCCC	19	2.38	0.665
E	1	TLMC	18	1.88	0.798
	29	LLLC	18	1.88	0.798
	17	LLMC	18	1.94	0.773
	19	MMTC	18	1.94	0.773
	21	CCTL	18	1.94	0.773
	22	CCTM	18	2	0.750
	32	MMMC	18	2.06	0.728
	34	CCCL	18	2.13	0.704
F	20	MMLC	17	1.89	0.750
	23	CCLM	17	1.95	0.726
	35	CCCM	17	2.07	0.684

5.3. Extension to Supply Chain Management

This research can be broadened and extended to the supply chain management field of study by the extending and changing some parameters inside existing three types of simulation models. The concept of these three types of models, parallel, sequential, and reciprocal, can be modified, developed, and then applied into the various concepts of supply chain management.

A supply chain is the global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical goods and cash (Apics, 2004). In addition, supply chain management deals with the planning and control of operations in trans corporate networks as well as the design and management of productive systems. The three models in this research can be used as one tool to measure the performance of logistics or the flow of goods and operations processes, the parameters in the models can be change and users must select appropriate performance indicators that relate to their business objects and objectives.

In model type 1: Parallel (Figure: 12), considering each actor in the model as the suppliers in the same tier or the same level of the supply chain, then the existing model consists of four alternative supplier. Each supplier or actor has different processing time and has limited production capacity. The fastest supplier sometimes is not the best choice due to the cost. Therefore, there are few more parameters need to be considered and developed into the model according to the business objects and objectives. However, the application of model type 1: Parallel in supply chain management field, principally, is to help customer choosing the right priority of supplier in order to get the orders as fast and low cost as possible. Moreover, assuming that there is more than one tier or level in the supply chain and in each tier is consisting of various numbers of alternative suppliers, so this parallel type model can also be extended into sequential-parallel type.

In model type two, sequential type (Figure: 13), which is the basic structure of supply chain, the four actors can represent four suppliers in four different tiers or levels of the supply chain. Since they are all working in sequence and each supplier or actor has different processing time and has limited production capacity, and also the cost from each supplier is different. The extension of this model into supply chain field can help users to create the business and production strategies. This model will help actors or suppliers in production or manufacturing environment, which refers to whether that supplier is organized to fulfill orders downstream to specific customer. It involves methods and techniques of control and planning of procurement, production, and delivery. This sequential type model's application can allow suppliers to choose the most suitable techniques of their production such as make-to-stock, assemble-to-order, package-to-order, and make-to-order in order to go well with the downstream.

Next, the application after the extensions of model type three, reciprocal, is quite similar to model type two, sequential, in helping supplier to choose their production technique. However, the reciprocal type model can be developed into more realistic situation. Since all actors in the model are working together as a pair in sequence (Figure: 14), this reciprocal model can be used for the consideration of out-sourcing technique. The existing model shows that suppliers are working as dual sourcing, which is the out sourcing plan that two suppliers are working together for the same item or item family. This strategy can help reducing the risk of disruption in production due to the difficulties in delivery. This model can be expanded to the multiple sourcing, which refers to the search for the greatest number of sources. Multiple sourcing helps reducing the risk of too great a dependency upon single company. Also, local sourcing, which is the search for local sources of a certain service, can be considered after extend this reciprocal type of model.

In sum, the extension of this research to the field of supply chain management is fundamentally helps users in three main points, which are supplier evaluation and supplier selection, and supplier scheduling.

CHAPTER 6

CONCLUSION

6. CONCLUSION

This research aims to compare the performance of various combinations of multi cultural team that are affected by communication barriers, which can be considered one type of cultural barrier. Using Thai SME as an example of multi cultural organization, there were the mix of local Thai laborers and others three nationalities of migrant laborers in this study. This research reveals the difficulties of communicating and coordinating among different nationality of laborers inside a multi cultural organization. It makes an initial attempt at developing a computational experiment to predict the impact of differing cultural elements on team performance in a multi cultural organization.

In addition, the computational experiment in this research was developed into three types of models, based on the complexity of tasks, to simulate multi cultural labor team, in order to seek better organization designs when considering the dimension of labor hiring or the human resource. In every type of model, the effects of changes in actors or laborers were found to be significant and different.

This study found that the effects of changes of actors or laborers in three different types of computational experiment models show interesting correlations between task complexity and the variety of nationalities of actors, and offered initial evidence that the results had been encoded correctly, since the predictions of the experiment align with existing theory.

Moreover, globalization, at present, brings together participants from multiple national, organizational with different backgrounds of cultures and expectations. This research as well as its findings can exhibit the possible framework for designing the multi cultural team with less communication barriers among team members.

However, in the smaller level, the fluctuation of labor needs that is happening Thai's labor market makes investors seek the way to improve their productivity conditions. Furthermore, the changes in labor markets will be more visible in the coming years. Thus, overseas as well as local investors can be proactive and start evaluating the potential of investment in

Thai SMEs market.

Being proactive means also the ability to choose an adequate human resource or the suitable combination of laborers in order to get as much performance as possible. This research can be adapted and used as a guidance to help making that decision.

Finally, above all, the most important thing to help overcoming the difficulties in multi cultural communication barriers according to linguistic differences, it is necessary to first understand all of your stakeholders clearly and objectively, and must have self-awareness of how you are being perceived by counterparts from other cultures as well. Additionally, it is important to developing skills in cross cultural communication such as communicating in English with non-native English speakers, using language, gestures and body language that is universally understandable across cultures.

With regards to limits and future work, since there are not only communication issues when considering the cultural barriers in multi cultural organizations, but also several other kinds of cultural barriers exist, this research did not include analyzing and modeling other cultural differences besides the communication barriers.

Rather than computational experiment or the simulations, understanding cultural issue in every dimension is a good way to help answer the question of why individuals in different cultures interpret events and actions differently in his or her own style.

However, in the near future, like the European Union, the Association of Southeast Asian Nation (ASEAN), that is consisting of ten countries; Indonesia, Malaysia, the Philippines, Singapore, Thailand, Brunei, Myanmar, Cambodia, Laos, and Vietnam, has plans to move to a free regional labor market. The first phase will be started in 2015, by freeing up some selected professions and allowing them to move and work between member's countries. Therefore, when labor markets in ASEAN countries are liberalized, this will make higher competition in the market. As the result of the free movement of labors, this may create the more migrant labor usage in Thailand.

However, freeing up lower paid labor's market can be one of the causes of the problem of migrant labor exploitation as well as utilization. For that reason, this research can be adapted and applied for more than four nationalities in the future.

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REFERENCES

Adler, N.J., (1991), International Dimensions of Organizational Behavior, 2nd edition, PWS-KENT Publishing Company, Boaston, MA, pp. 63-91

Apics, (2004), Dictionary 11th edition, APICS-The Association for Operations Management, Alexandria, VA

Davis, S.M., (1984), Managing Corporate Culture. Ballinger, Cambridge, MA., ch. 1

Elin Grimsholm, Leon Poblete, (2010), Internal and External factors hampering SME growth, A qualitative case study of SMEs in Thailand, Gotland University, pp. 9

Harvie C., Lee, B-C, (2005). Introduction: The role of small and medium-sized enterprises in achieving and sustaining growth and performance, Sustaining growth and performance in East Asia, Cheltenham: Edward Elgar, pp. 3-27, 301-325

Hiorii T., Jin Y., R.E. Levitt, (2004), Modeling and Analyzing Cultural Influences on Project Team Performance, Computational and mathematical Organization Theory, pp. 10, 305-321

Hiorii T., Jin Y., R.E. Levitt, (2005), Cross- Cultural Virtual Design Teams: Cultural Influences on Team Performance in Global Projects, Construction Research Congress, American Society of Civil Engineering, San Diego, California, pp. 2-5

Hofstede, G., (1991), Cultures and Organizations: Software of the Mind, Intercultural Cooperation and its importance for Survival. McGraw-Hill, NY.

House, R.J., Hanges, P.J., Javidan M., and Gupta V., (2004), Culture, Leadership, and Organizations, The GLOBE Study of 62 Societies, Thousand Oaks, Sage Publications Inc., CA

Ing Wei Huang, (2003), Importance of SMEs Development in Thailand, Forum of International Development Studies, pp. 159, 161

Jin Y., R.E. Levitt, (1996), The Virtual Design Team: A computational model of project organaizations, Computational and Mathematical Organization Theory, 2(3), pp. 171-196

Kritaya A., (2012), Classification of Migrant Labors from Myanmar, Laos, and Cambodia, Population and Development Newsletter, Vol.33, No.1, Mahidol University, Thailand, pp. 6-7

Kroeber, A.L., &Kluckhohn, C. (1952), Culture: A critical review of concepts and definitions, Harvard University, Peabody Museum of American Archeology and Ethnology, pp. 47

Law Averill M., Kelton W. David, (2000), Simulation Modeling and Analysis, 3rd edition, McGraw-Hill Companies, Inc., pp. 2-6

Miriam Spering, (2001), Current issues in cross-cultural psychology, Research topics, applications, and perspectives, Institute of Psychology, University of Heidelberg, GermanyHofstede, pp. 5

Panida Rujirawanich, Ramzi Addison, Clive Smallman, (2011), The effects of cultural factors on innovation in a Thai SME, Management Research Review, Vol. 34 Iss: 12, pp. 1266

Robertazzi Thomas G., (2000), Computer Networks and Systems, Queueing Theory and Performance Evaluation, 3rd edition, Springer, New York, Ch.1

Schein, E., (1992), Organizational Culture and Leadership, 2nd edition, Jossey-Bay, 1985, San Francisco, CA.

Snodgrass, Donald R. and Tyler Biggs, (1996), Industrialization and the Small Firm: Patterns and Policies, Co-publication of the International Center for Economic Growth and the Harvard Institute for International Development, San Francisco, California, pp. 11

Vollmann Thomas E., Operation Management, A System Model-Building Approach, Addison-Wesley Publishing Company, Inc., California, Ch. 1

HOMEPAGES

Colorado ONLINE, http://www.colorado.edu/conflict/peace/problem/cultrbar.htm
Access: January 12, 2013

Daily News ONLINE, www.dailynews.co.th/article/5832/173009
Access: January 6, 2013

Doe ONLINE 1, http://wp.doe.go.th/practice
Access: December 20, 2012

Doe ONLINE 2, http://wp.doe.go.th/node/263
Access: December 20, 2012

Hofstede ONLINE, http://geert-hofstede.com/countries,html
Access: January 20, 2013

OVTA ONLINE, www.ovta.or.jp
Access: September 2012

Sme ONLINE, www.sme.go.th
Access: November, 2012, December, 2012, January, 2013

Swallow ONLINE, Swallow D., (2009), http://www.diversitytrainingtoday.com
Access: December 13, 2012

APPENDIX A

The Simulation Results of Model Type 1: Parallel

parallel_case1_tlmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.26	49.39	15.12	0.69	33.58	17.07

parallel_case2_tttt.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
62	62.54	1.29	61.25	20.19	0.00	41.06	21.48

parallel_case3_llll.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
53	59.18	1.29	57.89	18.81	0.00	39.08	20.10

parallel_case4_mmmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case5_cccc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.28	49.38	15.13	0.00	34.25	16.41

parallel_case6_ttll.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
53	59.18	1.28	57.90	18.78	0.07	39.04	20.14

parallel_case7_ttmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case8_ttcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.26	49.40	15.13	0.69	33.58	17.07

parallel_case9_llmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case10_llcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.69	1.28	49.41	15.13	0.03	34.25	16.44

parallel_case11_mmcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.28	49.38	15.13	0.00	34.25	16.41

parallel_case12_ttlm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case13_ttlc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.27	49.39	15.12	0.69	33.58	17.07

parallel_case14_ttmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.26	49.40	15.12	0.69	33.58	17.07

parallel_case15_lltm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case16_lltc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.27	49.39	15.12	0.69	33.58	17.07

parallel_case17_llmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.67	1.27	49.40	15.12	0.07	34.21	16.47

parallel_case18_mmtl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case19_mmtc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.26	49.40	15.13	0.69	33.58	17.07

parallel_case20_mmlc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.28	49.38	15.13	0.00	34.25	16.41

parallel_case21_cctl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.26	49.40	15.13	0.69	33.58	17.07

parallel_case22_cctm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.26	49.40	15.13	0.69	33.58	17.07

parallel_case23_cclm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.28	49.38	15.13	0.00	34.25	16.41

parallel_case24_tttl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
53	59.17	1.28	57.89	18.78	0.69	38.42	20.75

parallel_case25_tttm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case26_tttc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.26	49.40	15.12	0.69	33.58	17.07

parallel_case27_llll.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
53	59.18	1.28	57.90	18.78	0.07	39.04	20.14

parallel_case28_llll.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case29_lllc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.27	49.39	15.12	0.69	33.58	17.07

parallel_case30_mmmt.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case31_mmml.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
46	53.38	1.28	52.10	16.58	0.00	35.52	17.86

parallel_case32_mmmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.28	49.38	15.13	0.00	34.25	16.41

parallel_case33_ccct.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.26	49.40	15.13	0.69	33.58	17.07

parallel_case34_cccl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.28	49.38	15.13	0.00	34.25	16.41

parallel_case35_cccm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
41	50.66	1.28	49.38	15.13	0.00	34.25	16.41

APPENDIX B

The Simulation Results of Model Type 2: Sequential

sequential_case1_tlmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
39	53.28	4.06	49.22	13.32	0.00	35.90	17.39

sequential_case2_tttt.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
59	66.17	4.92	61.25	18.06	0.00	43.19	22.98

sequential_case3_llll.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
47	62.26	4.57	57.69	16.05	0.00	41.65	20.61

sequential_case4_mmmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
43	55.97	4.78	51.19	13.92	0.00	37.27	18.69

sequential_case5_cccc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	52.91	4.75	48.16	12.47	0.00	35.69	17.22

sequential_case6_ttll.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
49	60.88	4.42	56.46	16.08	0.00	40.38	20.51

sequential_case7_ttmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
44	57.81	4.28	53.53	14.78	0.00	38.75	19.06

sequential_case8_ttcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
39	53.28	4.06	49.22	13.32	0.00	35.90	17.39

sequential_case9_llmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
43	55.78	4.48	51.30	14.03	0.00	37.27	18.51

sequential_case10_llcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.71	4.22	47.49	12.47	0.00	35.02	16.69

sequential_case11_mmcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	52.64	4.49	48.16	12.47	0.00	35.69	16.95

sequential_case12_ttlm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
44	57.65	4.13	53.53	14.78	0.00	38.75	18.90

sequential_case13_ttlc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
39	53.41	3.79	49.62	13.68	0.00	35.94	17.48

sequential_case14_ttmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
39	53.15	3.93	49.22	13.32	0.00	35.90	17.25

sequential_case15_lltm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
43	55.48	4.18	51.30	14.03	0.00	37.27	18.21

sequential_case16_lltc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
39	53.15	3.93	49.22	13.32	0.00	35.90	17.25

sequential_case17_llmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.72	4.09	47.63	12.69	0.00	34.94	16.78

sequential_case18_mmtl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
43	55.52	4.33	51.19	13.92	0.00	37.27	18.25

sequential_case19_mmtc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.72	4.09	47.63	12.69	0.00	34.94	16.78

sequential_case20_mmlc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.71	4.22	47.49	12.47	0.00	35.02	16.69

sequential_case21_cctl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.58	4.09	47.49	12.47	0.00	35.02	16.56

sequential_case22_cctm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.71	4.22	47.49	12.47	0.00	35.02	16.69

sequential_case23_cclm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.84	4.35	47.49	12.47	0.00	35.02	16.82

sequential_case24_tttl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
50	61.05	4.34	56.71	16.34	0.00	40.38	20.68

sequential_case25_tttm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
44	57.50	3.97	53.53	14.78	0.00	38.75	18.75

sequential_case26_tttc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
39	52.21	3.66	48.55	13.32	0.00	35.23	16.98

sequential_case27_lllt.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
48	61.80	4.50	57.30	16.30	0.00	41.00	20.80

sequential_case28_lllm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
43	55.72	4.33	51.39	14.12	0.00	37.27	18.45

sequential_case29_lllc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
39	53.28	4.06	49.22	13.32	0.00	35.90	17.39

sequential_case30_mmmt.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
43	55.67	4.48	51.19	13.92	0.00	37.27	18.40

sequential_case31_mmml.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
43	55.82	4.63	51.19	13.92	0.00	37.27	18.55

sequential_case32_mmmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.84	4.35	47.49	12.47	0.00	35.02	16.82

sequential_case33_ccct.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	51.84	4.35	47.49	12.47	0.00	35.02	16.82

sequential_case34_cccl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	52.64	4.49	48.16	12.47	0.00	35.69	16.95

sequential_case35_cccm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
38	52.77	4.62	48.16	12.47	0.00	35.69	17.09

APPENDIX C

The Simulation Results of Model Type 3: Reciprocal

reciprocal_case1_tlmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
18	25.26	1.88	23.38	6.59	0.00	16.79	8.47

reciprocal_case2_tttt.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
32	44.60	2.67	41.93	11.68	0.00	30.25	14.35

reciprocal_case3_llll.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
27	39.74	2.63	37.11	10.20	0.00	26.92	12.82

reciprocal_case4_mmmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
23	34.30	2.56	31.74	8.68	0.00	23.06	11.23

reciprocal_case5_cccc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
19	28.75	2.38	26.38	7.13	0.00	19.25	9.50

reciprocal_case6_ttll.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
29	41.70	2.62	39.08	10.42	0.00	28.67	13.03

reciprocal_case7_ttmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
23	33.93	2.24	31.70	8.68	0.00	23.02	10.91

reciprocal_case8_ttcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
20	29.48	2.08	27.40	8.02	0.00	19.38	10.11

reciprocal_case9_llmm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
23	34.09	2.40	31.70	8.68	0.00	23.02	11.07

reciprocal_case10_llcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
20	31.38	2.22	29.16	7.97	0.00	21.19	10.19

reciprocal_case11_mmcc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
19	28.62	2.24	26.38	7.13	0.00	19.25	9.37

reciprocal_case12_ttlm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
25	37.21	2.34	34.87	9.56	0.00	25.31	11.90

reciprocal_case13_ttlc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
23	34.67	2.24	32.43	8.97	0.00	23.46	11.21

reciprocal_case14_ttmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
20	27.43	2.01	25.42	7.46	0.00	17.96	9.48

reciprocal_case15_lltm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
20	30.19	1.94	28.24	8.14	0.00	20.10	10.08

reciprocal_case16_lltc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
20	28.85	2.01	26.84	7.86	0.00	18.98	9.88

reciprocal_case17_llmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
18	25.87	1.94	23.93	6.76	0.00	17.17	8.70

reciprocal_case18_mmtl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
19	26.51	1.91	24.59	7.03	0.00	17.56	8.94

reciprocal_case19_mmtc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
18	24.88	1.94	22.94	6.52	0.00	16.42	8.46

reciprocal_case20_mmlc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
17	25.09	1.89	23.20	6.78	0.00	16.42	8.67

reciprocal_case21_cctl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
18	25.72	1.94	23.78	6.66	0.00	17.13	8.60

reciprocal_case22_cctm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
18	25.78	2.00	23.78	6.66	0.00	17.13	8.66

reciprocal_case23_cclm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
17	25.73	1.95	23.78	6.68	0.00	17.10	8.63

reciprocal_case24_tttl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
29	41.60	2.52	39.08	10.42	0.00	28.67	12.93

reciprocal_case25_tttm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
27	38.89	2.44	36.45	10.01	0.00	26.44	12.45

reciprocal_case26_tttc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
25	37.21	2.34	34.87	9.56	0.00	25.31	11.90

reciprocal_case27_lllt.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
27	39.74	2.63	37.11	10.20	0.00	26.92	12.82

reciprocal_case28_lllm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
22	31.72	2.22	29.50	8.25	0.00	21.25	10.47

reciprocal_case29_lllc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
18	25.18	1.88	23.31	6.76	0.00	16.54	8.64

reciprocal_case30_mmmt.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
23	34.09	2.40	31.70	8.68	0.00	23.02	11.07

reciprocal_case31_mmml.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
20	29.43	2.15	27.28	7.55	0.00	19.73	9.70

reciprocal_case32_mmmc.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
18	27.54	2.06	25.48	6.83	0.00	18.65	8.89

reciprocal_case33_ccct.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
19	29.18	2.18	27.00	7.65	0.00	19.35	9.83

reciprocal_case34_cccl.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
18	28.61	2.13	26.48	7.17	0.00	19.31	9.30

reciprocal_case35_cccm.igx

Elapsed Time (Hours)

80.00

Transaction Statistics (Days)

Count	Tot Cycle	Tot Work	Tot Wait	Tot Res Wait	Tot Block	Tot Inact	Tot Serv
17	25.50	2.07	23.44	6.46	0.00	16.98	8.52