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ABSTRACT

The purpose of this study was to prioritize/rank 12 existing software developer competencies and to find the pattern correlation among these competencies. A survey was designed to elicit responses from a target group (N=350) of software developers, system analysts, lecturers in Information and Communication Technology (ICT), ICT managers and others related to software industry (e.g. information technologist, software architect, computer technicians) in 14 organizations in Thailand. The return rate was 80.57% or 282 out of 350. Data was analyzed using descriptive statistics. Factor analysis was used to identify correlations among the 12 competencies. The 12 competencies were previously identified in a study of competencies for software developers in Thailand. The ranking was as follows: expertise; teamwork; logical thinking; system thinking; relation and communication; creative thinking; achievement; future thinking; emotion and ethic; flexibility; service mind; leadership and influence. In terms of correlations Future Thinking; System Thinking Relation & Communication; Teamwork are correlated. The second set of correlated factors are as follows: Leadership & Influence; Expertise; Emotion & Ethic; Flexibility. This research was limited to an investigation of competencies for software developers in Thailand only.

Keywords: Competencies / Software industry / Software Developer / Thailand / Factor Analysis

INTRODUCTION

Software developers are important keys to success of the software industry. In fact, as Turley and Bieman (1995) argue "Much effort has been placed in the development of engineering approaches to software development such as software tools, coding practices, and test technology. But the overwhelming determiner of software productivity and quality is still personnel and team capability" (p.19). Turley and Bieman further argue that software developers possess unique skills or competencies to solve problems related to software engineering. Boyatzis (1982, p.21) defined competency as "an underlying characteristic of a person which results in superior and/or effective performance in a job." The study of competencies can improve job descriptions, employee selection, staff development, performance evaluation and promotion (Lucia & Lepsinger, 1999; Spencer & Spencer, 1993).

A study by Booneka and Kiattikomol (2008) formulated a model of competencies for software developers specifically for the unique cultural, social and economic context of Thailand. The model identifies 12 competencies as follows: Expertise; Teamwork; Relationship and Communication; Service mind; Achievement; Flexibility; Leadership and influence; Emotion and ethic; Logical thinking; System thinking; Future thinking and Creative thinking. **Expertise** involves knowledge,

skill, knowledge application, continuous learning, follow-up technology trends, standards for software development, transfer knowledge, understanding of client's requirements, understanding of the business process, and prioritizing of tasks. **Teamwork** involves individual work as well as team work; cooperation, collaboration, coordination with each other, follow-up policy-making and acceptance of other's idea. **Relationship and communication** involve communication with others: communication in teams, good relationships, and respect for older people. **Service mind** involves appreciation and understanding of client's/user's needs. **Achievement** involves motivation, enthusiasm, diligence, patience, circumspection, responsibility and time management. **Flexibility** involves compromise and flexibility. **Leadership and influence** involve leadership, influence of others, and control of situations. **Emotion and ethic** involves emotional intelligence, sympathy, empathy, kindness, playfulness, calmness, consideration, willingness to help and honesty. **Logical thinking** involves an ability to design algorithms. **System thinking** involves being able to design for the whole system. **Future thinking** involves planning for the future. **Creative thinking** involves an ability to solve problems in different ways.

Booneka and Kiattikomol's (2008) study did not rank or prioritize these 12 competencies. Nor did their study identify any correlations among the 12 competencies. The purpose of the study reported on in this paper therefore was 1) to prioritize/rank competencies and 2) to identify the correlation among competencies in their model. Result of this study will be useful to Thai students and software developers to prepare and develop themselves to meet the requirements of companies and organizations. The results can also be used for companies and organizations for purposes of recruitment, placement, retention and promotion. Finally, the results will be of use to institutions to develop curriculum to train students.

METHODOLOGY

Participants

The target group consisted of 350 software developers, system analysts, lecturers in ICT, ICT managers and the others (related to software industry) who work in 4 public (government) and 10 private organizations (software houses, financial company, ICT service company) in Bangkok, Thailand.

We first contacted by telephone the heads of the organizations to tell them about the study and to informally invite their participation. The heads then identified individuals within each organization to help with recruitment. These individuals were contacted by telephone or in person. They chose the people. Potential respondents were offered a small gift for participating. Next, letters of cooperation from the coordinating institution of the researchers (King Mongkut's University of Technology Thonburi, Faculty of Industrial Education and Technology) were sent to the organizations to outline the purpose of the study and to request their participation.

Instruments

Included with the letter was a survey. The survey was designed by the authors of this paper specifically for the study. It consisted of one page and two parts. The first part focused on demographic information such as gender, age, position and years of experience. The second part listed the 12 competencies and invited respondents to rank all competencies from lowest to highest with the number 12 being the highest. The survey listed the competencies in this order: expertise; teamwork; relation and communication; service mind; achievement; flexibility; leadership and influence; emotion and ethic; logical thinking; system thinking; future thinking; creative thinking. The survey included a brief (one or two lines) description of each competency. We estimated the completion time for each survey at 10-15 minutes approximately.

We present a section of the survey here. The survey was presented to participants in Thai language with, in addition, labels in English for each competency.

Instruction: here is the list of Competencies for Software developers in Thailand; Please rank the competency from highest to lowest (12=highest, 1=lowest)

Competency	Rank
Expertise; Expertise involves knowledge, skill, knowledge application, continuous learning, follow-up technology trends, standards for software development, transfer knowledge, understanding of client's requirements, understanding of the business process, and prioritize of tasks	
Teamwork; Teamwork involves individual work as well as team work; cooperation, collaboration, coordination with each other, follow-up policy-making and acceptance of other's idea.	
Relation and communication; Relation and communication involve communication with others: communication in teams, good relationships, and respect for older people.	
Service mind; Service mind involves appreciation and understanding of client's/user's needs.	
Achievement; Achievement involves motivation, enthusiasm, diligence, patience, circumspection, responsibility and time management.	
Flexibility; Flexibility involves compromise and flexibility	
Leadership and influence; Leadership and influence involve leadership, influence of others, and control of situations.	
Emotion and ethic; Emotion and ethic involves emotional intelligence, sympathy, empathy, kindness, playfulness, calmness, consideration, willingness to help and honesty.	
Logical thinking; Logical thinking involves an ability to design algorithms.	
System thinking; System thinking involves being able to design for the whole system.	
Future thinking; Future thinking involves planning for the future.	
Creative thinking; Creative thinking involves an ability to solve problems in different ways.	

Response rate and analysis

The response rate was 80.57%. Two hundred and eighty two individuals returned the questionnaire among the 350 potential respondents. We analysed demographic data by descriptive statistics (sum, mean, and standard deviation). To determine the rankings, we totalled the numbers from 1-12 assigned by all 282 participants for each competency. We also calculated the mean and standard deviation for each competency. We then used factor analysis to identify the correlations among the 12 competencies.

FINDINGS

Table 1 provides a summary of the demographic or respondent profile, classified by gender, age, position and year of experience. Table 2 provides descriptive data of 12 competencies as ranked by respondents. Finally Table 3 provides factor analysis.

Table 1: Demographic information

Characteristic	Item	Frequency	Percent
Gender	Male	130	46.1
	Female	152	53.9
Age (years)	20-24	47	16.6
	25-29	87	30.8
	30-34	71	25.1

<i>Characteristic</i>	<i>Item</i>	<i>Frequency</i>	<i>Percent</i>
	35-39	37	13.1
	40-44	20	7
	45-49	10	3.5
	> 49	10	3.5
Position	Software Developer	72	25.5
	System Analyst	42	14.9
	Lecturer in ICT	14	5
	ICT Manager	14	5
	Other (related to ICT)	140	49.6
Year of experience	1-3	96	34
	4-6	58	20.6
	7-9	37	13.1
	10-12	36	12.8
	13-15	20	7.1
	> 15	35	12.4

Table 2: Descriptive data of 12 competencies as ranked by respondents

<i>Competencies</i>	<i>Total</i>	<i>Mean</i>	<i>Std. Deviation</i>
Expertise	2,637	9.35	3.215
Teamwork	2,347	8.32	2.979
Logical Thinking	2,247	7.97	2.923
System Thinking	2,131	7.56	2.977
Relation and Communication	2,052	7.28	2.909
Creative Thinking	1,897	6.73	3.217
Achievement	1,855	6.58	2.900
Future Thinking	1,588	5.63	3.139
Emotion and Ethic	1,472	5.22	3.173
Flexibility	1,460	5.18	2.542
Service Mind	1,373	4.87	3.437
Leadership and Influence	941	3.34	3.019

Table 3: Factor Matrix – After Rotation

<i>Variables</i>	<i>Factors</i>	
	<i>F1: Teamwork thinking</i>	<i>F2: Leadership professional</i>
Future Thinking	.823	
System Thinking	.800	
Relation and Communication	.766	
Teamwork	.679	
Leadership and Influence		.731
Expertise		.688
Emotion & Ethic		.575
Flexibility		.463

We used factor analysis (principal components analysis varimax with Kaiser Normalization, rotation converged in 3 iterations) to determine the correlation among the 12 competencies. Factor loading of 12 items of the scale produced two factors. We labelled Factor 1 as “Teamwork Thinking”. We labelled Factor 2 as “Leadership Professional” as shown in Table 3.

DISCUSSION

The results indicate that software developers' competencies should be professional worker, who has experience, can work in team, show logical and systematic thinking and be able to communicate and create relations within a team and with other people. This ranking reflects the perceptions of those working in the software development industry in Thailand. Spencer and Spencer (1993) conducted a similar study in which they ranked competencies of software developers, engineers, applied research scientists, and technicians in a bank department in 24 countries. A comparison of ranked competencies between our results and Spencer and Spencer's is as follows

Table 4: Comparison between Spencer and Spencer (1993) and the present rankings (1=highest)

Spencer & Spencer		Our Study	
Competency	Rank	Rank	Competency
Achievement Orientation	1	7	Achievement
Impact and Influence	2	12	Leadership and Influence
Conceptual Thinking	3	3	Logical Thinking
Analytical Thinking	4	4	System Thinking
Initiative	5	8	Future Thinking
Self-Confident	6	6	Creative Thinking
Interpersonal Understanding	7	5	Relation and Communication
Concern for Order	8	11	Service Mind
Information-Seeking	9	10	Flexibility
Teamwork and Cooperation	10	2	Teamwork
Expertise	11	1	Expertise
Customer Service Orientation	12	9	Emotion and Ethic

Spencer and Spencer's study was similar to ours in that we were both working with a similar set of 12 competencies. In terms of similarities between the results of their study and ours, we note for example that they ranked Conceptual Thinking (3) Analytical Thinking (4) similarly to ours Logical Thinking (3) and System Thinking (4). These types of thinking are not exactly the same however; it is interesting to note that in both studies, these thinking skills were ranked at the same level. This would appear to indicate that Thai software developers hold similar beliefs about the competencies related to thinking as do their counterparts in other countries. It should not be surprising that thinking skills would rank so high (at a level of 3 or 4) in this profession which involves working with algorithms and abstractions.

The similarities however are limited to those competencies. In fact, we observed more differences than similarities between their results and ours. We observed for example, that whereas our respondents ranked expertise at the top (# 1), in Spencer and Spencer's study, it was ranked almost at the bottom (# 11). Likewise, Teamwork and Cooperation ranked at the bottom (# 10) for Spencer and Spencer, yet it was ranked at the top (# 2) in our study. We note as a limitation in our study that expertise and teamwork were listed as items 1 and 2 respectively in the survey. It is possible, therefore, that our respondents were influenced by the position of the items in the survey. However, we also observe that items listed at the top in the survey were also ranked at the bottom in the respondents ranking. For example, Creative thinking was item 12 on our survey yet ranked as number 6 by respondents.

The difference between the importance of teamwork for Spencer and Spencer's respondents versus ours could possibly be due to the fact that teamwork may be considered a more important competency in general in all fields in 2008 whereas, in 1993, when Spencer and Spencer conducted their study,

teamwork may not have been as important. The fact that competencies may change over time and that they are subject to larger social, cultural or economic trends is to be expected. However, we do not know why teamwork ranked so differently in the two studies. We do not for example know if teamwork might be more important in the Thai culture. Cooley and Roach (1984, p.13) argue that “Competencies are cultural-specific and, ... behaviours that are understood as reflection of competency in one culture are not necessarily understood as competent in another culture”.

Other differences observed include the fact that while they ranked Impact and Influence at a high level (# 2), our respondents ranked Leadership and Influence at a low level (# 12). This difference may be due to a difference in terminology. Their label did not include the word leadership. While their respondents ranked achievement at the top, our respondents ranked it in the middle approximately. In general, the differences in results between Spencer and Spencer’s study and ours could be due to the fact that theirs was conducted more than 10 years before ours. Also, they focused on many countries whereas we focused specifically on Thailand. In addition, they included not only software developers but other related professions and practices.

In terms of demographics, we note that we had a slightly larger group of men than women respondents although we conjecture that the differences in gender are too small to account for any of the results. It was beyond the scope of this study to differentiate rankings based on gender. However, it would be interesting to observe whether, for example, females ranked higher than males the competencies such as emotion and ethics or relation and communication. We do not know whether fact that the largest group in terms of years of experience had only three year may have influenced the rankings. For example, it is possible that those with fewer years or experience may rank differently than those with more years of experience. We collected and provided demographic information on respondents in order to ensure that our group was not too weighted towards a particular demographic e.g. all males and few females. Our demographic appears fairly balanced we believe. However, in future studies, it may be of interest to study differences or similarities in rankings between for example females versus males or those with few versus a large number of years of experience.

CONCLUSIONS, LIMITATIONS AND IMPLICATIONS

The purpose of this study was to prioritize/rank 12 existing software developer competencies and to find the pattern correlation among these competencies. A survey was designed to elicit responses from a target group (N=350) of software developers, system analysts, lecturers in Information and Communication Technology (ICT), ICT managers and others related to software industry (e.g. information technologist, software architect, computer technicians) in 14 organizations in Thailand. The return rate was 80.57% or 282 out of 350. Data was analysed using descriptive statistics. Factor analysis was used to identify correlations among the 12 competencies.

The 12 competencies were previously identified in a study of competencies for software developers in Thailand. The ranking was as follows: expertise; teamwork; logical thinking; system thinking; relation and communication; creative thinking; achievement; future thinking; emotion and ethic; flexibility; service mind; leadership and influence. In terms of correlations Future Thinking System Thinking Relation and Communication Teamwork are correlated. The second set of correlated factors are as follows: Leadership and Influence; Expertise; Emotion & Ethic; Flexibility. This research was limited to an investigation of competencies for software developers in Thailand only.

Our study was limited to one country, Thailand. As Spencer and Spencer’s study has shown, results may have been different if other countries had been included in the sample. We do not know if our results are specific to Thailand. Other researchers may wish to use our survey in their countries to compare rankings. Our results may have been different if our survey had been designed differently. For example the survey listed expertise at the top and respondents ranked it at the top. We could have designed the survey so that not all respondents received a survey with the items ordered the same way. This approach may have yielded different results. The fact that we did not conduct our study to take

into account the demographic elements limits the breadth of our findings. Other researchers may wish to identify if competencies might be ranked differently based on certain demographic factors.

In terms of implications for organizations, these competencies should be part of human resource development, i.e. for selection, training and development, performance appraisal, and succession planning. The correlation between competencies for software developers shows that software developers should be competent in Teamwork Thinking (Factor 1) and be a Leadership professional (Factor 2). When organizations or institutes in Thailand use competencies for staff development or training, they should group related competencies. On the other hand, however, competencies that are not correlated (i.e. Logical thinking, Creative thinking, Achievement, and Service minded) may be considered important in contexts of staff development or training but not as important as the two factors. The same would be true for terms of implications for educators and curriculum content.

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