CHAPTER 5

CRITICAL SUCCESS FACTORS OF IT INFRASTRUCTURE FLEXIBILITY: QUESTIONNAIRE DATA ANALYSES

5.1 Introduction

This chapter presents the analysis and results of the conducted questionnaire survey. This step is important to determine the success factors for information technology infrastructure flexibility (ITIF) specifically for the construction; which started with literature review, expert opinion, and findings from the pilot study.

The analysis started with a report on the demographic profiles of the respondents to show that the survey covered views from different business sectors within the construction industry, reflecting the overall perspective about ITIF success factors specifically for construction organizations. Descriptive analysis was undertaken based on the frequency distribution of the respondents. The variables were also tested for the normality of distribution. In the second part, the discussion focused on the ITIF success factors. It was started with the data ranking process that involved mean, severity index and a non-parametric statistical test, which is Kendall's W mean rank. Eighteen top-ranked variables were shortlisted. The selected variables were subject to another set of

statistical examination for their significance association between them through Spearman Rho correlation coefficient, which resulting to fourteen factors as critical success factors (CSF). The findings from these analyses is essential to identify the critical ITIF success factors to be measured in the development of ITIF maturity model, which will be discussed in the later chapter.

5.2 Respondent Characteristic

The response rate was 21.1% representing 211 respondents out of 1000 questionnaires sent out. Figure 5.1 through Figure 5.7 describes the respondent characteristics of the final 211 responses. The number of respondents fulfils the general rule of having at least five times as many items to be analysed, in this case 190 respondents (with 38 items) (Hair, et al., 2006) . These characteristics were based on data collected from Section A, the background information part of the questionnaire.

The respondents hold IT-related management-level positions, with 7.1% respondents were General Manager, 3.8% were IT Directors, 56.8% respondents were IT Managers/Heads of IT Department, 7.1% respondents were IT professionals that include IT Programmer and Developer, and 25.2% respondents were construction professionals. A managerial perspective is important to provide valid evaluations of strategic measures. The respondents also have a technological background and a certain level of IT familiarity and understanding. Majority of the respondents, 52.6% have had more than 10 years working experience in IT department within construction, 18% worked between 7 to 10 years, 19% worked between 3 to 6 years, and only 10.4% of the respondents have had less than 3 years working experience (Figure 5.2).

The respondents worked for construction business sectors with majority of them were from building sector (Figure 5.3 and 5.4). The coverage reflects the myriad of professional of the construction industry. The size and revenue of the organisations are shown in Figures 5.5 and 5.6. Majority of the respondents were from G7 contractor's classification of One Registration of Contractors (1RoC) (CIDB Malaysia, 2011), which total up of 83.9%. The remaining 16.1% of the respondents' organisations were G6, G5, and G3. The G7 and G6 contractors are categorised as large-sized companies with no limit of tender capacity, followed by G5 and G4 as medium-sized companies with tender capacity is not more than RM3 million, and G3, G2 and G1 contractors were small-sized companies with tender capacity is not more than RM1 million (Begum, Siwar, Pereira, & Jaafar, 2007). Big organizations usually employ advanced IT infrastructures that generate the expected technological and organizational impacts.

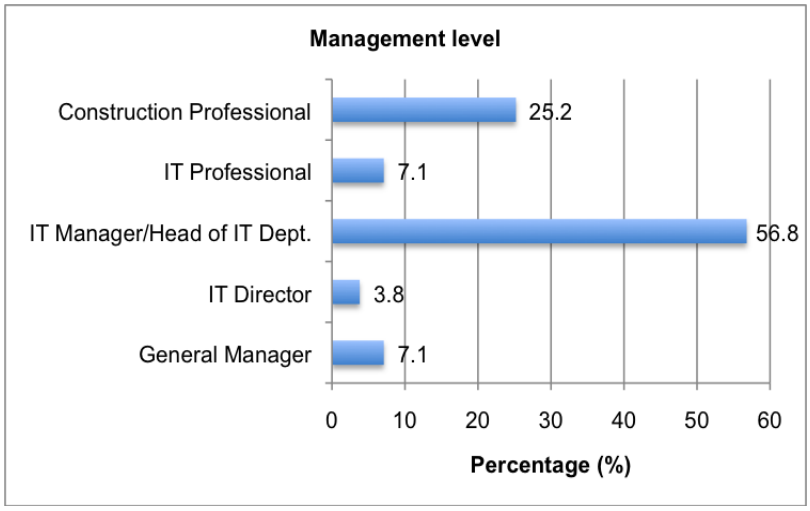

Figure 5.1: Distribution of responses

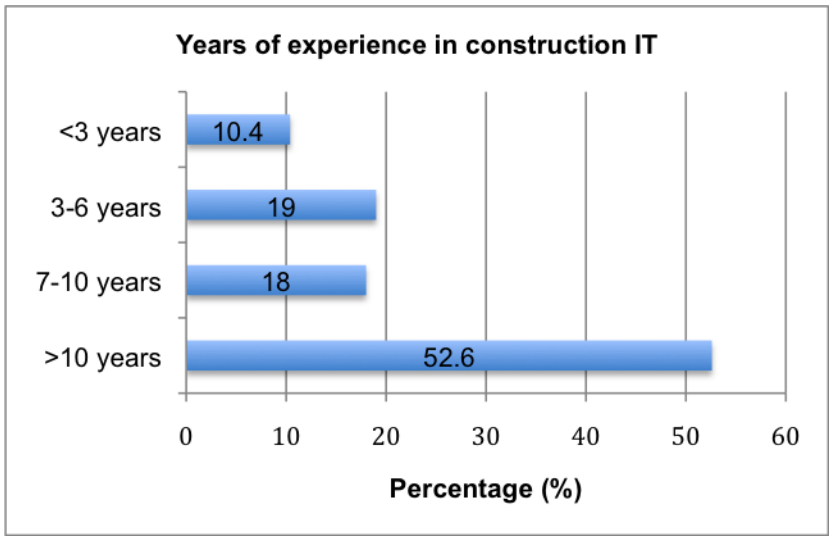

Figure 5.2: Distribution of responses

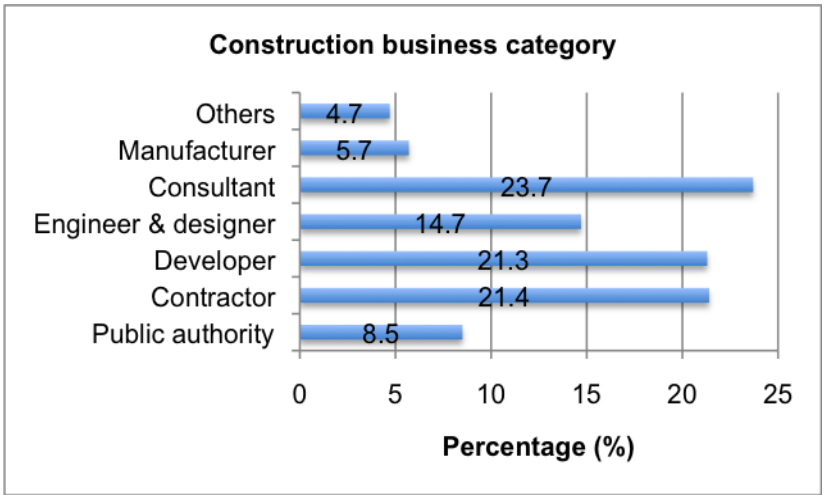

Figure 5.3: Distribution of responses

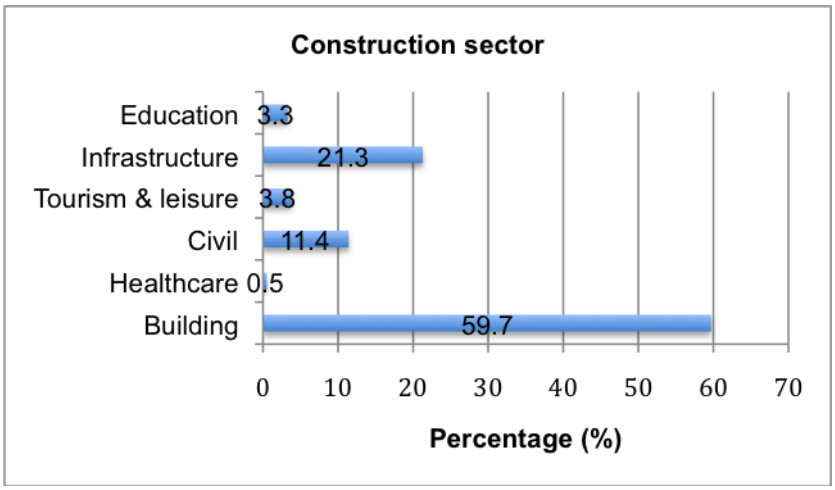

Figure 5.4: Distribution of responses

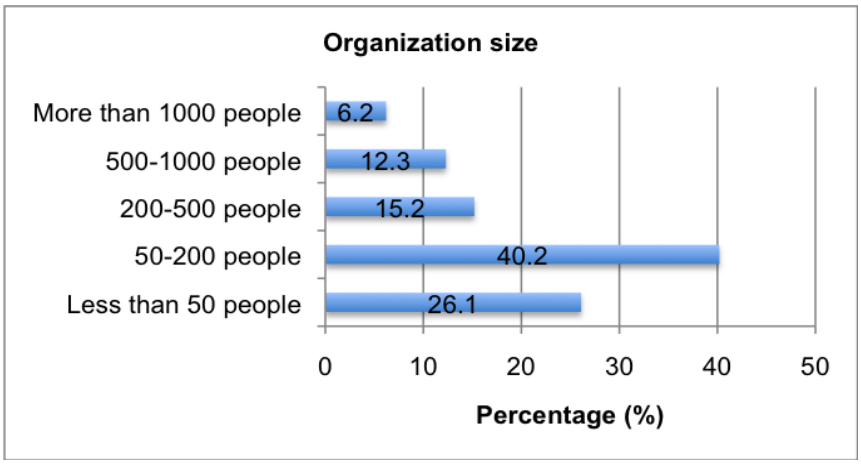

Figure 5.5: Distribution of responses

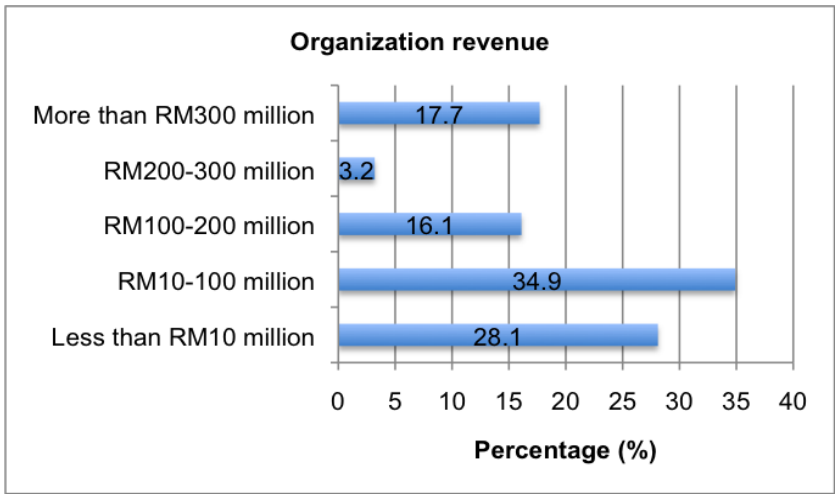

Figure 5.6: Distribution of responses

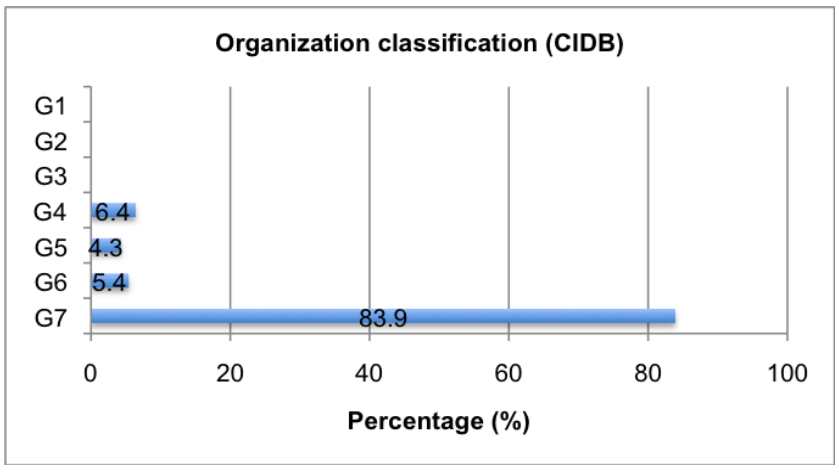

Figure 5.7: Distribution of responses

5.3 Descriptive statistic

The items measured were ranked from 1 as the lowest to 5 as the highest (Field, 2009). Table 5.2 shows the descriptive analysis of each questionnaire item for those thirty-eight records. The minimum and maximum statistical output are within the appropriate range for each variable, and the numbers of the variables (N) are 211, without missing any respondents. This concludes that, the data was free from errors from the data input process. The statistical variables are approximately normally distributed because the skewness values were between -1 and 1. The variables have means of approximately 3.5 on 1-5 rating scales. Standard deviations were more than 1.000 with a range of 0.900 to 1.295.

Cronbach's coefficients are commonly used to estimate the reliability of the items by determining the internal consistency of the test (Glover, et al., 2011). From the 211 valid responses, the ITIF success factors have significantly high internal consistency with Cronbach's coefficients for frequency of technical, people, and management's dimensions were 0.867, 0.867, and 0.849. The reliability of questionnaires was proven because the value equal to or greater than 0.70 is considered high (Morgan, et al., 2011), as shown in Table 5.1.

Table 5.1: Cronbach Alpha test for reliability

	Cronbach Alpha
Technical dimension	0.855
People dimension	0.852
Management dimension	0.849
All variables (No. of items = 38)	0.929

Table 5.2: Descriptive statistic.

Independent Variable	N	Range	Minimum	Maximum	Mean	Std. Deviation	Skewness
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic
Utilization of IT communication	211	4	1	5	3.55	1.384	-.654
24 hours connection	211	4	1	5	3.20	1.424	-.186
Utilization of VLAN	211	4	1	5	3.11	1.251	.072
Utilization of VPN	211	4	1	5	3.13	1.295	-.037
Minimal step for data access	211	4	1	5	3.32	1.183	-.254
Utilization of analytical processing	211	4	1	5	3.38	.926	-.255
Utilization of ACL	211	4	1	5	3.27	1.272	-.253
Central data processing	211	4	1	5	3.15	1.188	-.184
Real-time	211	4	1	5	3.60	1.002	-.328
Common OS	211	4	1	5	3.73	1.072	-.625
Standardization of file formats	211	4	1	5	3.75	1.149	-.837
Quick integration of new system	211	4	1	5	3.65	1.009	-.414
Transparent access	211	4	1	5	3.41	.964	-.296
Design to be reconfigurable	211	4	1	5	3.76	.943	-.635
Reusable applications used	211	4	1	5	3.33	1.052	-.365
Utilization of OOP	211	4	1	5	3.38	1.112	-.332
Multiple OS skills	211	4	1	5	3.43	1.125	-.150
Multiple programming languages skills	211	4	1	5	3.01	1.084	.085
Network management & maintenance	211	4	1	5	3.47	1.249	-.881
Data warehousing	211	4	1	5	3.23	1.128	-.016
Cross-trained	211	4	1	5	3.53	1.180	-.566
Commitment to learn	211	4	1	5	4.05	1.066	-1.154
Updated	211	4	1	5	3.91	.908	-.590
Wiling to change	211	3	2	5	3.93	.867	-.304
Able to interpret management & technical needs	211	4	1	5	3.75	1.064	-.513
Teamwork in multidisciplinary environment	211	4	1	5	3.71	.994	-.627
Self-directed and pro-active	211	3	2	5	4.02	.900	-.632
Awareness of CSF	211	4	1	5	3.56	1.199	-.462
Environment constraints	211	4	1	5	3.43	1.037	-.385
Construction processes	211	4	1	5	3.50	1.053	-.414
Communication channel management	211	4	1	5	3.48	.933	-.417
IT security & management	211	4	1	5	3.78	.972	-.732
Connectivity	211	4	1	5	3.85	.949	-.805
Data management	211	4	1	5	3.73	.960	-.706
Standards operating procedures	211	4	1	5	3.49	.968	-.234
IT project management	211	4	1	5	3.51	.992	-.478
Training & education	211	4	1	5	3.16	.942	-.018
Research & development	211	4	1	5	3.23	1.077	.010
Valid N (listwise)	211						

5.4 Data ranking

In the questionnaire, the item values on the 5-point Likert-scale (ranging from "Not Relevant at All" to "Strongly Relevant") are a kind of ranks; therefore, the data is treated as an ordinal data (Hennig, Mullensiefen, & Bargmann, 2003). For this reason, non-parametric tests were employed (Foster, 2001). In order to identify the CSF of

ITIF, four tests were used including non-parametric tests; mean, Severity Index (SI) ranking, Kendall's W mean rank, and supported by the Spearman Rho correlation coefficient. All the tests were done with the help of the statistical software package of SPSS and also Microsoft Excel.

The relative importance index is used to rank the variables according to their degree of importance. Before proceeding with the analyses, the 'mean score' method was used to analyse the questionnaire findings to establish the relative importance and relevance of the respondents' opinions respectively. Having observed the most likely important ITIF success factors based on frequencies, a test of severity will be carried out to establish its validity. The SI analysis was conducted on the sample data to rank the variables according to their relative importance. Several studies had employed this method to rank variables in academic studies within the construction industry (Doloi, et al., 2011; Odeh & Battaineh, 2002; Yang & Rei, 2010). In this procedure, frequency analysis was first carried out to obtain the percentage ratings of different selection variables that was done is used to calculate severity indices. The Kendall's W mean rank was then applied to compare the ranking of the variables in order to check the consensus of agreement between respondents.

The overall ranking of these variables was attached in Appendix A. Table 5.3, 5.4 and 5.5 show the results of the three tests for ranking. It is important to rank data according to its categories, because each category is needed for the development of the maturity model.

Table 5.3: Ranking of success factors of flexible IT infrastructure for technical dimension

Code	Independent Variable	Mean	Kendall Mean		Severity Index		Overall ranking
			Value	Rank	Percentage (%)	Rank	
TCon1	Utilization of IT communication	3.55	23.52	1	70.90	6	**6**
TCon2	24 hours connection	3.20	17.20	11	63.98	13	**13**
TCon3	Utilization of VLAN	3.11	15.28	16	62.18	16	**16**
TCon4	Utilization of VPN	3.13	15.66	15	62.65	15	**15**
TCon5	Minimal step for data access	3.32	16.92	13	66.36	11	**11**
TDat1	Utilization of analytical processing	3.38	17.09	12	67.68	8	**8**
TDat2	Utilization of ACL	3.27	19.73	7	65.40	12	**12**
TDat3	Central data processing	3.15	15.73	14	62.94	14	**14**
TDat4	Real-time	3.60	20.00	6	71.94	5	**5**
TCom1	Common OS	3.73	21.74	3	74.69	3	**3**
TCom2	Standardization of file formats	3.75	21.92	2	75.07	2	**2**
TCom3	Quick integration of new system	3.65	20.17	5	73.08	4	**4**
TCom4	Transparent access	3.41	17.27	10	68.25	7	**7**
TMod1	Design to be reconfigurable	3.76	20.71	4	77.17	1	**1**
TMod2	Reusable applications used	3.33	17.31	9	66.54	10	**10**
TMod3	Utilization of OOP	3.38	17.75	8	67.58	9	**9**

Table 5.4: Ranking of success factors of flexible IT infrastructure for people dimension

Code	Independent Variable	Mean	Kendall Mean		Severity Index		Overall ranking
			Value	Rank	Percentage (%)	Rank	
PTech1	Multiple OS skills	3.43	19.06	10	68.53	11	**11**
PTech2	Multiple programming languages skills	3.01	14.45	14	60.28	12	**13**
PTech3	Network management & maintenance	3.47	22.77	5	69.48	10	**10**
PTech4	Data warehousing	3.23	16.00	13	55.45	14	**14**
PTech5	Cross-trained	3.53	20.47	8	70.62	8	**8**
PMngt1	Commitment to learn	4.05	24.00	2	81.04	2	**2**
PMngt2	Updated	3.91	23.27	4	86.16	1	**1**
PMngt3	Wiling to change	3.93	23.64	3	78.58	4	**4**
PMngt4	Able to interpret management & technical needs	3.75	21.86	7	74.98	5	**5**
PPer1	Teamwork in multidisciplinary environment	3.71	21.95	6	74.22	6	**6**
PPer2	Self-directed and pro-active	4.02	24.78	1	80.38	3	**3**
PCKnow1	Awareness of CSF	3.56	19.62	9	71.28	7	**7**
PCKnow2	Environment constraints	3.43	18.00	12	68.53	11	**12**
PCKnow3	Construction processes	3.50	18.98	11	69.95	9	**9**

Table 5.5: Ranking of success factors of flexible IT infrastructure for management dimension

Code	Independent Variable	Mean	Kendall Mean		Severity Index		Overall ranking
			Value	Rank	Percentage (%)	Rank	
MSup1	Communication channel management	3.48	18.61	6	69.57	6	**6**
MSup2	IT security & management	3.78	22.28	2	75.55	2	**2**
MSup3	Connectivity	3.85	22.41	1	76.97	1	**1**
MSup4	Data management	3.73	21.08	3	74.60	3	**3**
MSup5	Standards operating procedures	3.49	19.01	5	69.86	5	**5**
MSup6	IT project management	3.51	19.27	4	70.14	4	**4**
MSup7	Training & education	3.16	15.01	8	63.22	8	**8**
MSup8	Research & development	3.23	16.46	7	64.64	7	**7**

Based on the statistical means and ranking-tests, the most generally favourable ITIF success factors were short-listed. The variables were selected based on the consistent ranking made by statistic tests. Severity indices for selected variables (for all dimensions) were more than 70.00% with means were above 3.50. This indicates that respondents perceived these variables as highly critical and influential to the ITIF implementation in construction organizations. It was supported by Kaming et al. (1997) and Oyewobi & Ogunsemi (2010), that the higher the value of a variable ranking, the higher the contribution of that variables. In support of the high ranking for the variables through the means and severity indices, the variables also show high consistency of consensus in the Kendall's W mean ranking values, which indicate that a high proportion of respondents agreed with this perception.

Table 5.3 shows the ranking results for technical dimension. All the variables under this dimension have an overall mean in the range of 3.11 to 3.76. There are six ITIF factors were consistently ranked in the highest indicators, namely TCon1, TDat4, TCom1, TCom2, TCom3, and TMod1. Their severity indices vary from 70.90% to 77.17%, and Kendall's W mean vary from 20.00 to 23.52.

Eight variables were ranked in the highest position under people dimension, namely PTech5, PMngt1, PMngt2, PMngt3, PMngt4, PPer1, PPer2, and PCknow1 with severity indices were from 70.62% to 86.16%. The variable PMngt1 marked as the highest ranked in overall ranking. Table 5.4 shows that the mean for all variables fall under this dimension was ranged from 3.01 to 4.05, and Kendall's W mean values were between 14.45 and 24.78.

In the management dimension, the variables' means range from 3.16 to 3.85, the severity indices vary from 63.22% to 76.97%, and Kendall's W mean were between 15.01 and 22.41. Table 5.5 shows the consistency in ranking of all the variables. The variables of MSup3, MSup2, MSup4, and MSup6 ranked the top 4 under management dimension.

The other twenty variables gained a severity index less than 70.00% with mean were lower than 3.50, and Kendall's W mean ranking were below 19.00, indicating a relatively lower level of influence on the success of ITIF implementation.

Table 5.6: Highest ranked ITIF factors.

Dimension	Code	ITIF Success Factor	Rank
Technical	TMod1	Design to be reconfigurable	1
	TCom2	Standardization of file formats	2
	TCom1	Common OS	3
	TCom3	Quick integration of new system	4
	TDat4	Real-time	5
	TCon1	Utilization of IT communication	6
People	PMngt2	Updated	1
	PMngt1	Commitment to learn	2
	PPer2	Self-directed and pro-active	3
	PMngt3	Wiling to change	4
	PMngt4	Able to interpret management and technical needs	5
	PPer1	Teamwork in multidisciplinary environment	6
	PCKnow1	Awareness of KSFs	7
	PTech5	Cross-trained	8
Management	MSup3	Connectivity	1
	MSup2	IT security & management	2
	MSup4	Data management	3
	MSup6	IT project management	4

As a result, eighteen variables were short-listed (as shown in Table 5.6). They went through another test for final selection by investigating the factors' significance between them. The low correlation coefficient and significance value eliminate the variables to be measured for the purpose of the model development.

The Spearman Rho correlation coefficient test was used to investigate if there was a statistically association between ranked ordinal variables, further for comparing the ranked data results (Field, 2009). Table 5.7 shows that there were significant relationships between the ranked variables. Majority of the variables were positively correlated, $r > 0.200$, p (two-tailed) < 0.05. The results fits with the research hypothesis used for this task, based on the standard criteria of probabilities that is 5% significance level (Field, 2009), which were as followed:

H_0 *(p ≤ .05)* – The ITIF success factors significantly correlated among each other.

H_1 *(p > .05)* – There is no significant correlation among the respondents rating for the ITIF success factors.

Table 5.7: Spearman Rho correlation matrix

		TCon1	TDat2	TCom1	TCom2	TCom3	TMod1	PTech5	PMngt1	PMngt2	PMngt3	PMngt4	PPer1	PPer2	PCKnow1	MSup2	MSup3	MSup4	MSup6
TCon1	*R* *p*	--	.143 .038	.219 .001	.416 .000	.245 .000	-.038 .581	.079 .251	.035 .613	.371 .000	.436 .000	.207 .003	.143 .038	.228 .001	.281 .000	.129 .061	.373 .000	.362 .000	.282 .000
TDat2	*R* *p*	--	--	.104 .131	.240 .000	.214 .002	.209 .002	.299 .000	.212 .002	.111 .108	.099 .150	.273 .000	.351 .000	.033 .630	.278 .000	.339 .000	.207 .002	.325 .000	.142 .039
TCom1	*R* *p*	--	--	--	.399 .000	.528 .000	.290 .000	.036 .602	.071 .302	.212 .002	.303 .000	.285 .000	.115 .096	.259 .000	.256 .000	.348 .000	.287 .000	.271 .000	.202 .003
TCom2	*R* *p*	--	--	--	--	.513 .000	.250 .000	.154 .025	.134 .051	.344 .000	.477 .000	.218 .001	.293 .000	.147 .033	.304 .000	.256 .000	.596 .000	.253 .000	.297 .000
TCom3	*R* *p*	--	--	--	--	--	.245 .000	.160 .020	.143 .038	.271 .000	.481 .000	.344 .000	.290 .000	.327 .000	.497 .000	.257 .000	.356 .000	.311 .000	.249 .000
TMod1	*R* *p*	--	--	--	--	--	--	.106 .124	.331 .000	.206 .003	.159 .021	.166 .016	.233 .001	.203 .003	.258 .000	.379 .000	.149 .031	.267 .000	.328 .000
PTech5	*R* *p*	--	--	--	--	--	--	--	.286 .000	.349 .000	.204 .003	.267 .000	.342 .000	.268 .000	.323 .000	.232 .001	.008 .914	.137 .047	.446 .000
PMngt1	*R* *p*	--	--	--	--	--	--	--	--	.315 .000	.333 .000	.419 .000	.582 .000	.342 .000	.371 .000	.316 .000	.239 .000	.290 .000	.251 .000
PMngt2	*R* *p*	--	--	--	--	--	--	--	--	--	.541 .000	.372 .000	.349 .000	.439 .000	.434 .000	.291 .000	.295 .000	.371 .000	.430 .000
PMngt3	*R* *p*	--	--	--	--	--	--	--	--	--	--	.518 .000	.401 .000	.580 .000	.500 .000	.392 .000	.525 .000	.488 .000	.525 .000
PMngt4	*R* *p*	--	--	--	--	--	--	--	--	--	--	--	.675 .000	.404 .000	.547 .000	.451 .000	.381 .000	.310 .000	.354 .000
PPer1	*R* *p*	--	--	--	--	--	--	--	--	--	--	--	--	.453 .000	.530 .000	.433 .000	.374 .000	.207 .003	.367 .000
PPer2	*R* *p*	--	--	--	--	--	--	--	--	--	--	--	--	--	.546 .000	.524 .000	.381 .000	.360 .000	.441 .000
PCKnow1	*R* *p*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.329 .000	.343 .000	.254 .000	.344 .000
MSup2	*R* *p*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.397 .000	.438 .000	.433 .000
MSup3	*r* *p*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.462 .000	.227 .000
MSup4	*r* *p*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	.332 .000
MSup6	*r* *p*	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Indicators:

r = Correlation Coefficient
p = Significance
= H_1 ($p > .005$) – There is no significant correlation among the respondents rating for the ITIF success factors.

From the total eighteen variables, the Spearman correlation identified fourteen variables correlate with at least five variables and more (relate with at least more than 2/3 of the total variables), which each of the association in between two variables must score the value of Spearman correlation coefficient, $r > 0.1$, and meet the standard criteria of probabilities, $p < 0.05$. The criteria set concludes that a high confidence exists that there were genuine relationships between them. The variables are TCom2, TCom3, TMod1, PMngt1, PMngt2, PMngt3, PMngt4, PPer1, PPer2, PCKnow1, MSup2, MSup3, MSup4, and MSup6. These selected variables are marked as CSF for ITIF from the Malaysian construction industry perspective (listed in Table 5.8).

With this, it allows for eliminating the four variables, which could not satisfy the minimum significance criteria. Variables that were correlated ($r > 0.1$, $p < 0.05$) with less than five variables were removed from the shortlisted list (relate with less than 2/3 of the total variables). Based on this criterion, variables of TCon1, TDat2, TCom1, and PTech5 were not considered in the next phase of research.

Hence, subsequent analysis for the ITIF maturity model development was conducted by considering only fourteen most significant factors, or CSF (discussed in Chapter 6 to 8).

Table 5.8: Critical success factors of ITIF

Dimension	Code	ITIF Success Factor
Technical	TCom2	Standardization of file formats
	TCom3	Quick integration of new system
	TMod1	Design to be reconfigurable
People	PPer1	Teamwork in multidisciplinary environment
	PPer2	Self-directed and pro-active
	PMngt1	Commitment to learn
	PMngt2	Updated
	PMngt3	Wiling to change
	PMngt4	Able to interpret management and technical needs
	PCKnow1	Awareness of CSF
Management	MSup3	Connectivity
	MSup2	IT security & management
	MSup4	Data management
	MSup6	IT project management

5.5 Conclusion

As proposed by Tapia (2007), the development of a maturity model require a minimum set of the success factors to be measured for the improvement; as discussed in this chapter. From the thirty-eight factors found from the conducted pilot study, eighteen variables were shortlisted from data ranking process. Findings show that statistical means, Severity Index, and Kendall's W mean rank provided consistent ranking results. In order to build up a cut-off point of a number of the most important ITIF success factors, the Spearman Rho correlation coefficient test were used to test the correlation significance between the selected variables. Those variables that were significantly correlated ($r > 0.1$ and $p < 0.05$) to at least with five variables were selected. As a result, only fourteen ITIF success factors were considered as CSF for further measurement in the maturity model.

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