CHAPTER V

EXPLORING FACTORS INFLUENCING SUPERVISOR'S BEHAVIOR ON SAFETY ACTION BASED ON THEIR PERCEPTION

Chapter 5 explains the statistically analysis of collected data which were obtained from supervisors' surveys. This chapter aims to explore the group factors influencing supervisor's behavior in safety action at construction site. It begins with section 5.1 in other to give overview of collected data which used for this chapter. Next is the factor analysis process to explore the factors influencing supervisors' behavior on safety action, see details in section 5.2. Finally section 5.3 establishes a model to explain how these factors influencing supervisors' behavior using structural equation modeling. It is important to emphasize that all of information analyzed in this chapter based on Supervisors' opinion.

5.1 Descriptive Survey Data for Factor Analysis

5.1.1 General Survey Details

The research questions were developed with the intent of exploring factors influencing supervisor's behavior in safety action. The list of variables was asked in the second section among four section of questionnaire (see in Appendix A). It comprised twenty five statements, which are considered factors that affect the Supervisor's behavior in safety.

Data were screened using the complete sample (N = 434) prior to the main analyses to examine for accuracy of data entry, missing values, and fit between distributions and the assumptions of necessary analyze tools. After deleting unusable cases, 403 data are used for factor analyses. Exploratory factor analysis was used to examine the construct validity of the questionnaire. Reliability analyses (Cronbach's alpha) were conducted on the items remaining to test the internal consistency of the scales.

5.1.2 Data Screening

Prior to analyses and using the usable sample (N = 403) for factor analysis, it is important to check for mistake initially. So data were examined for accuracy of data entry, missing values. The data screening process involves a number of steps which are first step checking for error; second step finding the error in the data file and third step correcting the error in the data file. The accuracy of the data file was checked by proofreading a random sample of 100 of the original data against a computerized listing. In addition, the Frequencies and Descriptive statistic command in SPSS Version 17 was used to detect any out of range values. None were found.

5.1.3 Respondent Profile

The details of respondent profile were discussed in section 4.2 Respondent Profile of Chapter 4. In summarized, of those supervisors responding, the average age was 29.67 years and cover from 20 to 68 years old. All of them were male (100%) and had experience as supervisor in construction site from beginning to 30 years experience, average 3.49 years experience. Almost all responders have acceptable education background (91.0% undergraduate) and at least 1 time attends the Supervisor Course (78.2%). The data show that 34.0% of the respondents are having little knowledge about safety, 46.1% have necessary safety information and knowledge and only 19.9% satisfy supervisor requirement, can control or avoid all potential hazards. The characteristics of respondents cover all possible expected, so they can be representative for supervisor level at construction site.

5.2 Factor Analysis

As an early step in the data analysis, all questionnaire responses were checked to ensure completeness and readability before the data was processed using the Statistical Package for Social Sciences (SPSS) version 17. The questionnaire (Appendix B) comprised 25 variables dealing with supervisor's behavior on safety actions at construction site. The data gathered were factor-analyzed to examine the interrelationships among the 25 variables and to reduce this number of original variables into a smaller set of factors. It is important to remind this factor analysis is based on supervisors' perception on factors influencing their behavior.

The construct validity of the scales in sample (N = 403) was investigated by factor analyzing the items using the Maximum Likelihood (ML) technique with Varimax rotation. Although structural equation modeling was later used, factor analysis was used to help refine the measurement model.

5.2.1 Factor Analysis

Factor analysis, a multivariate statistical technique, is commonly used to identify a smaller number of relevant factors than the original number of individual variables. The application of this technique can reduce the data to a representative subset of variables or even create new variables as replacements for the original variables, while still retaining their original characteristics (Pallant, 2004).

5.2.2 Checks for Factor Analysis

Collected data is required to check whether it appropriates for performing factor analysis. Checking data contents three steps includes checking adequacy of sample size, assessing the factorability of the correlation matrix, and examining the anti-image correlation matrix.

The first step was checking adequacy of sample size. Factor analysis prefer sample size larger than 100 and at least five time of observations (Hair, Black et al., 2010). The sample size of the supervisor is 403, with the ratio of 16.12 cases to 1 variable, which satisfies the specified limit.

The second step was assessing the factorability of the correlation between observations via the correlation matrix of survey. Factor analysis requires a number of correlation which higher than 0.30 (Hair, Black et al., 2010). Result from correlation matrix among 25 observations in this research points out more than 20 percent of correlations greater than 0.30 at the 0.01 level of significance (see Appendix C1).

The third step was examining the anti-image correlation matrix, the diagonals on that specific matrix should have an overall Measure of Sampling Adequacy (MSA) of 0.50 or above (Hair, Black et al., 2010). The same criterion of MSA applies to the values of individual variables, which should be considered for elimination from further analysis if they are low on this measure (Hair, Black et al., 2010). After omitting the above variables, the MSA test was conducted again, to check the revised values for overall and individual MSA. The set of variables exhibited satisfactory values above 0.50 and therefore were deemed fit for further analysis. The checked data set of 25 variables resulted in a Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy of 0.845, which is considered as meritorious. Another mode of determining the appropriateness of factor analysis is the Bartlett test of sphericity. The analysis of Bartlett test of sphericity reached statistical significance with chi-square 3807.97, degree of freedom 300 and significance level of 0.000. Therefore factor analysis was deemed appropriate.

5.2.3 Factor Analysis Process

Table 5.1 Pattern Matrix, Eigenvalues, Percentage of Variance explained for factor influencing supervisor's behavior on safety actions (N = 403)

Item	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Safety management system	.816					
Safety regulations and procedures	.796					
Company vision about safety	.777					
Financial supports for safety	.740					
Workplace environment	.660					
Providing of safety training programs	.648					
Project schedule		.804				
Amount of work responsibility		.766				
Project scale		.752				
Type of project owner		.678				
Weather conditions		.484				
Project owner			.832			
Top manager			.804			
Community pressure			.665			
Workers			.507			
Safety knowledge				.706		
Working experience				.674		
Supervisor capability to control workers				.594		
Education background				.518		
Family					.720	
Coworkers					.629	
Age					.580	
Salary satisfaction					.495	
Smoking						.874
Drinking						.849
Eigenvalues	3.707	2.914	2.679	2.128	1.953	1.578
Percentage of Variance Explained	14.827	11.656	10.714	8.513	7.813	6.311

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization

Factor analysis is used to explore factors influencing supervisor behavior on safety actions. The initial captures of these factors are extracted by using principal component analysis. The factor solution without rotation presents six (6) distinct factors with eigenvalues equal to or greater than unity (Tabachnick and Fidell, 2007). After that, varimax rotation is performed for easier interpret the factors structure and name the factors. The final results of factor analysis are shown in details in Table 5.1 above.

The use of varimax rotation technique makes result as easy as possible to identify each variable with a single factor. The six grouped factors accounted for 60 percent of the total variance. The factors were then examined to identify the number of items that loaded on each factor. The rotated pattern matrix for the remaining 25 items is presented in Table 5.1. The eigenvalues, percentage of variance explained are also displayed in this table. The correlation matrix of factor is displayed in Table 5.2. The results show the strength of the relationship among 6 factors is not high; only correlation between factor 1 and factor 3 is -0.326, factor 2 and factor 5 is 0.325 exceed 0.3. So the assumption underlying the use of varimax rotation is satisfied.

Table 5.2 Component Correlation Matrix

Factor	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Factor 1	1.000					
Factor 2	-.205	1.000				
Factor 3	-.326	.280	1.000			
Factor 4	.000	-.134	-.112	1.000		
Factor 5	-.040	.325	.182	-.116	1.000	
Factor 6	.216	-.118	-.269	.097	-.201	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Oblimin with Kaiser Normalization.

5.2.4 Reliability Analysis

To ensure that the items comprising the factors produced reliable scales, Cronbach's alpha coefficient of internal consistency was calculated for each scale. The results are shown in Table 5.3 below. The Cronbach's alpha ranged from 0.604 to 0.867, which are higher than standard value of 0.600, indicating adequate internal consistency (Pallant, 2004; Hair, Black et al., 2010).

Table 5.3 Cronbach's Alpha for each factor scale (N = 403)

Items of Scale	Cronbach's Alpha	Cronbach's Alpha if Item Deleted
Factor 1. Organizational and Management	0.867	
Safety management system		0.831
Safety regulations and procedures		0.838
Company vision about safety		0.846
Financial supports for safety		0.841
Workplace environment		0.853
Providing of safety training programs		0.856
Factor 2. Project Characteristics and Work Assignment	0.796	
Project schedule		0.727
Amount of work responsibility		0.735
Project scale		0.739
Type of project owner		0.767
Weather conditions		0.800
Factor 3. Project Stakeholder Influence	0.794	
Project owner		0.691
Top manager		0.685
Community pressure (government, law, neighbors)		0.777
Workers		0.800
Factor 4. Personal Background and Safety Knowledge	0.643	
Safety knowledge		0.520
Working experience		0.521
Supervisor capability to control workers		0.594
Education background		0.643
Factor 5. Social Influence	0.604	
Family		0.458
Coworkers		0.460
Age		0.604
Salary satisfaction		0.570
Factor 6. Supervisor Habits	0.708	
Smoking		-
Drinking		-

5.2.5 Factors Interpretation

From factor analysis present above, there are six factors may influencing supervisor's behavior from their won perception. Each of them contents a group of items which have a strongly correlation and provides amount of variance explained for the features. They are named in accordance with the meaning of all items that they representative. The following section will discuss about the meaning of each factor.

The first factor, "Organizational and Management Influence", accounts for 14.827% of the total variance and comprises 6 items. It includes Safety Practice, Safety Regulation, Financial Supporting, Control Capacity, and Commitment of Top Managers. It indicates the degree of supervisor's belief about organization role. Organizational management's safety responsibilities strongly influence their safety behavior. The majority of items enjoy relatively large factor loadings (>0.65). Loadings, however, suggest that the item "Providing of safety training programs" is relatively weakly associated with this factor. It is an interesting result, contrary to normal expectations; supervisor received less influence from safety training programs to their work. The highest factor loading item is "Safety management system" indicating the important role of management system. They recognize management as a safety associate. This result stresses the role of organization level in creating a safety environment in which their employers can work safely. This finding adds further support to earlier researches on health and safety about the role of organization and management such as Jannadi (1996), Holt (2001) and Mearns (2003). Holt (2001) pointed out the important role of policy, organizing, planning and implementing, measuring and auditing the performance in successful safety management system. Jannadi (1996) also found that roles and functions of safety management system, or safety management system to control risk can be essential factors. Mearns (2003) emphasized that organizational policies and procedures can protect their workers from hazard workplace and reduce hazard in workplace. This research give additional evidence about the way that organization impact on the worker safety through the middle level, supervisors who direct influence workers daily.

The second factor, "Project Characteristics and Work Assignment", contains five items and accounts for 11.656% of the total variance. This factor includes five items relating to properties of project, and the other to the weather influence. Collectively, this group of items demonstrates the supervisors' perception of the influence from project properties to their behavior in safety actions. The majority of items enjoy relatively large factor loadings (>0.65), except item "Weather conditions". The first and the second are "Project schedule" and "Amount of work responsibility". The tight project schedule and overload of work assignment maybe reinforces peoples' unsafe behavior. Supervisors sometimes are turning a blind-eye or encouraging employees to take a short-cut to do the job. They themselves also get the pressure to ensuring the project schedule rather than keeping safe workplace. Next are "Project scale" and "Type of project owner". Different scale and owner of project causes different interest of supervisor about safety. Real practices at small construction site demonstrate supervisors usually negligent and leave workers unsafe working. In the great scale or main important project in which the safety has a strong influence to their successful, the supervisors are remarked about their safety role. In that case their safety behavior is improved. The last item, weather conditions in which project was placed, weakly associated with this factor with the factor loading low. However, it also expresses the influence to supervisor behavior.

The third factor, "Project Stakeholder Influence", has four items and accounts for 10.714% of the total variance. Three of four items in this group factor are related to supervisors' pressure, namely project owner, top manager and community, impact supervisor behavior. Supervisors' behavior is influenced strongly by the community. Community conception believes that construction site accident is evident truth, there is no-site can get the zero-accident. The most common responses of supervisors to questions on safety practice is "Construction work is dangerous, so people have to look out for themselves" (Holt, 2001). This concept not only impacts on supervisors' behavior but also creates a fulcrum for unsafe behavior. Supervisor perception indicated project owner and top manager also have certain influence to them. The last item is an influence from workers. It shows moderately factor loading because workers normally have less influence on supervisors' behavior in term of command line. But workers can influence supervisors' behavior through their commitment on work safety.

The fourth factor, "Personal Background and Safety Knowledge", includes four items and accounts for 8.513% of the total variance. Factor includes "Safety knowledge", "Working experience", "Supervisor capability to control workers" and "Education background". This is one of the most important influences on construction site safety. According to Anderson and John (1999), lack of education and training is one of seven factors that cause existing high accident rate in construction industry. Among four items of this factor, "Safety knowledge" and "Working experience" have high factor loading. It demonstrates a high perception of supervisor about the important of safety knowledge to their job. The other two items have lower factor loading. All of the respondents may have moderately influenced by education background.

The fifth factor, "Social Influence", includes four items and accounts for 7.813% of the total variance. This factor includes the influence from family members, coworker, age and salary satisfaction. From the factor loading, the important from family members remind them working safely is pointed out. There is no doubt about family role in supervisors' behavior. Supervisor should keep safe for themselves and their worker because they are very important to their family. This concept is quite often used in the safety training in order to improve supervisors and workers behaviors. Another response of supervisors is "I don't want to become unpopular by going on about safety – I'd always be complaining and we wouldn't get the job done" (Holt, 2001). Despite the violation of organization's safety policy, supervisors became socialized and accepted the unsafe practice as "normal" work behavior. They let worker perform work unsafely to avoid being teased or made fun of their co-worker, avoid to be a wimp in workers' eyes when he always remind about safety. Influence from co-worker is latent but very dangerous impact to supervisors' behavior in safety action. There is a relationship between age and personal behavior. Younger supervisor in many cases possess certain capabilities over older workers including increased strength, speed, and precision. However, they may lack to aware the hazard. Difference age can directly influence on their experience. Older supervisor may have some advantages in realizing and controlling hazards at the site through their experience. Under construction site environment, the older supervisor may present more competence than younger supervisor to give a command for work safety. Conversely, changing the unsafe behavior of older supervisor is quite difficult. Lastly the satisfaction of salary can influence on supervisors' behavior because supervisors who did not satisfy to their salary may not have organizational commitment. Therefore, they may neglect on safety practice while they supervised the construction work task.

The sixth and the last factor, "Supervisor Habits", combines two items which are "Drinking habit" and "Smoking habit" accounts for 6.311% of the total variance. All of items enjoy relatively large factor loadings (>0.80). Among 403 respondents were asked, more than 66% person respond have a habit of drinking and more than 24% have a habit of smoking. Although all of respondents are aware the extremely influence of these habits to their behavior on safety actions, they still keep their habits. This results should be consider in further analyze.

5.2.6 Descriptive Factors

The correlation matrix showing relationships among the various factors, together with the means, standard deviations and important index is presented in Table 5.4.

Table 5.4 Summary statistics and correlations for all factors (N = 403)

Factor	Mean	SD.	Index	F1	F2	F3	F4	F5	F6
F1	4.249	.725	5.864	1					
F2	3.654	.877	4.167	.334**	1				
F3	3.798	.894	4.250	.286**	.506**	1			
F4	4.211	.703	5.993	.516**	.296**	.298**	1		
F5	3.294	.869	3.789	.215**	.372**	.470**	.345**	1	
F6	3.676	1.261	2.916	.180**	.152**	.084	.188**	.125*	1

**. Correlation is significant at the 0.01 level; *. Correlation is significant at the 0.05 level (2-tailed).

Correlation matrix was used for communicating the pattern of relations among factors. These descriptive statistics were calculated using SPSS Version 17. Level of influence of six factors, Organizational and Managerial Influence, Project Characteristics and Work Assignment, Superiors Pressure and Workers Influence, Safety Knowledge and Learning, Social Influence and Supervisor Habits, on supervisor's behavior were all measured using a 5-point scale. All of mean responses to these factors were high, exceed 3.0, suggesting that all of these factor considerable impact to supervisor's behavior. However, the variance was high for all of these factors, all of them above 0.70, showing that the same portion numbers of respondents either agree or disagree. The highest responses pertained to the fourth and first factor, Safety Knowledge and Learning and Organizational and Managerial Influence, suggests that all of supervisors remarked the strong influence from these factors on their behavior on safety action. Mean responses of four remaining factor were not too high but above threshold of average 3.0. It proved that these four factors also affected supervisor behavior from themselves opinion. The influence rankings of each item in each factor are also presented in Table 5.5. From the important index, five most important items are Safety Knowledge, Safety Management System, Safety Regulation and Procedure, Supervisor Experience, and Company Safety Vision.

The correlation matrix indicated that all organizational factors were significantly related to each other with the exception of Superiors Pressure and Workers Influence and Supervisor Habits. Coefficients ranged from 0.125 to 0.516. All these coefficients were positive and significant at the .01 level.

Table 5.5 Descriptive and influence ranking of factors and their items (N=403)

Factor	Mean	SD.	Index	Influence Ranking
Factor 1. Organizational and Management	**4.249**	**.725**	**5.864**	**II**
Safety management system	4.397	0.865	5.086	2
Safety regulations and procedures	4.298	0.898	4.785	3
Company vision about safety	4.248	0.950	4.469	5
Financial supports for safety	4.206	0.972	4.327	7
Workplace environment	4.104	0.959	4.280	8
Providing of safety training programs	4.241	0.962	4.410	6
Factor 2. Project Characteristics and Work Assignment	**3.654**	**.877**	**4.167**	**IV**
Project schedule	3.918	1.124	3.484	11
Amount of work responsibility	3.692	1.199	3.080	16
Project scale	3.660	1.218	3.005	18
Type of project owner	3.382	1.211	2.794	20
Weather conditions	3.615	1.156	3.127	15
Factor 3. Project Stakeholder Influence	**3.798**	**.894**	**4.250**	**III**
Project owner	3.893	1.131	3.442	12
Top manager	3.940	1.084	3.634	10
Community pressure	3.742	1.147	3.261	13
Workers	3.618	1.181	3.062	17
Factor 4. Personal Background and Safety Knowledge	**4.211**	**.703**	**5.993**	**I**
Safety knowledge	4.591	0.837	5.486	1
Working experience	4.290	0.934	4.591	4
Supervisor capability to control workers	4.032	1.003	4.019	9
Education background	3.931	1.228	3.201	14
Factor 5. Social Influence	**3.294**	**.869**	**3.789**	**V**
Family	3.258	1.292	2.522	23
Coworkers	3.387	1.143	2.962	19
Age	3.166	1.419	2.231	25
Salary satisfaction	3.365	1.275	2.639	22
Factor 6. Supervisor Habits	**3.676**	**1.261**	**2.916**	**VI**
Smoking	3.355	1.357	2.472	24
Drinking	3.998	1.505	2.655	21

5.3 Structural Equation Modeling (SEM)

Structural equation modeling (SEM) is performed to establish the model for explaining supervisor's behavior. This technique is applied by using AMOS 16.0 software. Six independent variables which are Organizational and Management Influence, Project Characteristics and Work Assignment, Project Stakeholder Influence, Personal Background and Safety Knowledge, Social Influence, and Supervisor Habits are explored their influence on behavioral intention and actual behavior that were discussed on Chapter 4. With SEM technique, researchers can explore the complex relationship among several dependent variables and independent variable in multi layer of linkage at a time. This research expects to develop model for explaining complex relationship among factors, behavioral intention and behavior, so SEM is an appropriate technique to apply.

Sample size is a strict requirement in SEM in order to achieve a stability and reliability of the parameter estimates. In SEM, sample size has to exceed fifteen cases per measured variable (Bacon, 1997). Replication with multiple samples would demonstrate the stability of the results, but many times this is not feasible. For one sample analysis, there is no exact rule for the number of participants needed; but fifteen cases per estimated parameter appear to be the general consensus (Bacon 1997). Since factor analysis reduced the number of variables to six factors, combined with behavioral intention and behavior measured variable, a satisfactory ratio of 15:1 cases per measured variable was achieved. Moreover, the developed model needs to satisfy conditions for a number of statistic criteria. The reader is referred to Table 5.6 and Section 5.3.1 for a complete description of these and their threshold acceptance levels.

5.3.1 Goodness-of-fit Measures

Researcher typically uses the following criteria to obtain the statistical significant and substantive meaning of developed model. Table 5.6 provides a summary on the most common SEM model fit indexes. In reference to model fit, numerous goodness-of-fit indicators were used to assess the model (Tabachnick and Fidell, 2007; Hair, Black et al., 2010). The more criteria a model satisfy, the better its fit.

Table 5.6 Cutoff criteria for several fit indexes

Indexes	Short-hand	General rule for acceptable fit	Recommend
Absolute/predictive fit			
Chi-square	$\chi 2$	Ratio of $\chi 2$ to $df \leq 2$ or 3, useful for nested models/model trimming	Used
Akaike information criterion	AIC	Smaller the better; good for model comparison (nonnested), not a single model	
Browne–Cudeck criterion	BCC	Smaller the better; good for model comparison, not a single model	
Bayes information criterion	BIC	Smaller the better; good for model comparison (nonnested), not a single model	
Consistent AIC	CAIC	Smaller the better; good for model comparison (nonnested), not a single model	
Expected cross-validation index	ECVI	Smaller the better; good for model comparison (nonnested), not a single model	
Comparative fit		Comparison to a baseline (independence) or other model	
Normed fit index	NFI	>0.95 (Good); > 0.9 (Acceptable)	Used
Incremental fit index	IFI	>0.95 (Good); > 0.9 (Acceptable)	
Tucker–Lewis index	TLI	>0.95 (Good); > 0.9 (Acceptable)	Used
Comparative fit index	CFI	>0.95 (Good); > 0.9 (Acceptable)	Used
Relative noncentrality fit index	RNI	Similar to CFI but can be negative, therefore CFI better choice	
Parsimonious fit			
Parsimony-adjusted NFI	PNFI	Very sensitive to model size	
Parsimony-adjusted CFI	PCFI	Sensitive to model size	
Parsimony-adjusted GFI	PGFI	Closer to 1 the better, though typically lower than other indexes and sensitive to model size	

Table 5.6 Cutoff criteria for several fit indexes (Continued)

Indexes	Short-hand	General rule for acceptable fit	Recommend
Others			
Goodness-of-fit index	GFI	>0.95 (Good); > 0.9 (Adequate)	Used
Adjusted GFI	AGFI	>0.95 Performance poor in simulation studies	Used
Hoelter .05 index		Critical N largest sample size for accepting that model is correct	
Hoelter .01 index		Hoelter suggestion, $N = 200$, better for satisfactory fit	
Root mean square residual	RMR	Smaller, the better; 0 indicates perfect fit	
Standardized RMR	SRMR	<0.08	
Weighted root mean residual	WRMR	<0.9	
Root mean square error of approximation	RMSEA	< 0.06 to 0.08 with confidence interval	Used

Some common fit indexes, the Normed Fit Index (NFI), Non-Normed Fit Index (NNFI, also known as TLI), Incremental Fit Index (IFI), Comparative Fit Index (CFI), and root mean square error of approximation (RMSEA), will be used. The following section will report the fit indexes chosen for this study together with the justification for choosing those indexes.

The $\chi 2$ statistic. This statistic is an absolute fit index indicating how well an analysis succeeded in minimizing the discrepancy between the hypothesized covariance matrix and the sample covariance matrix. The smaller the value of $\chi 2$ the better the fit, with zero indicating perfect fit and a value with an associated probability greater than .05 indicating acceptable fit (Tabachnick and Fidell, 2007). However, a number of writers have raised concern about the use of this statistic as a test of model fit because of its sensitivity to data that are not multivariate normally distributed and its tendency to indicate misfit as sample size increases (because of power). Despite these reservations, it has been used here as it allows for comparisons between models, with the $\chi 2$ statistic for the hypothesized model providing a baseline value against which all subsequent tests of invariance can be compared. Furthermore, in cross-validation analysis, the $\chi 2$- difference test can be used whereby a non-significant difference between the $\chi 2$ for the calibration sample and the $\chi 2$ for the validation sample indicates no difference between the two models.

The $\chi 2$ /DF ratio. Researchers have addressed some of the limitations of the $\chi 2$ statistic by developing a number of alternative goodness-of-fit indices (Bacon, 1997; Tabachnick and Fidell, 2007). One of these indices is the $\chi 2$ /degrees of freedom ratio (reported as CMIN/DF), an index that is designed to compensate for the tendency of the $\chi 2$ test to reject models when sample sizes are large. As with the $\chi 2$ statistic, this ratio provides an indication of the efficiency of the hypothetical model in reproducing the sample data. Values of 2 or less represent a good fit (Schreiber, Nora et al., 2006).

The Root Mean-Square Error of Approximation Index (RMSEA). The RMSEA takes into account the error of approximation in the population and relaxes the stringent requirement on $\chi 2$ that the model holds exactly in the population. Values of .05 or less indicate the hypothetical model is a close fit to the sample data (Schreiber, Nora et al., 2006). However, some authors suggest that models with RMSEA values of .08 or less can be accepted (Tabachnick and Fidell, 2007; Hair, Black et al., 2010).

The Tucker-Lewis Index (TLI). This index is an incremental (or comparative) fit index which provides a measure of improvement in fit when the hypothesized model is compared with a more restricted baseline model. TLI is recommended when the maximum likelihood estimation method is used as was the case in this study. TLI should be greater than 0.95 although values greater than 0.9 indicate reasonable fit (Schreiber, Nora et al., 2006). This index can exceed a value of 1 (i.e., it is a non-normed fit index), however, this indicates a lack of parsimony.

The Confirmatory Fit Index (CFI). The CFI is also an incremental fit index and is recommended when data are not multivariate normally distributed, as the CFI shows minimum estimation bias when this is the case. This index is normed with values constrained to fall between 0 and 1. CFI should be greater than 0.95 although values greater than 0.9 indicate reasonable fit (Schreiber, Nora et al., 2006; Hair, Black et al., 2010).

The Goodness-of-fit index (GFI). The GFI is the goodness of fit index, which indicates the proportion of the observed covariances explained by the model-implied covariances. GFI varies from 0 to 1, but theoretically can yield meaningless negative values. By convention, GFI should be equal to or greater than 0.90 to accept the model (Schreiber, Nora et al., 2006).

The Adjusted GFI (AGFI). The AGFI is the adjusted goodness of fit index. This adjustment is to cater for the phenomenon of SEM, whereby more complex models fit the same data better than simpler models. The AGFI takes this accommodation into account by adjusting the GFI value downwards as the number of model parameters increases. AGFI varies from 0 to 1, but theoretically can yield meaningless negative values. AGFI should be at least 0.9 to accept the model (Schreiber, Nora et al., 2006).

The Normed fit index (NFI). The NFI indicates the proportion of improvement of the model relative to a null model that assumes the variables are uncorrelated. NFI ranges from 0 to 1, with value over 0.9 indicative of an acceptable fit of the model to the data, and values close to 1 indicating perfect fit (Schreiber, Nora et al., 2006).

5.3.2 Structural Equation Model for Supervisors' Behavior Based on Their Perceptions

Structural model was undertaken using the SEM technique to uncover the significant interrelationships between the factors retained from EFA in section 5.2. The conceptual model was described in Figure 5.1. Six constructs related to factor influencing supervisors' behavior which was explored from EFA, one construct represented for behavioral intention and one construct represented for current behavior were in this model. The details of each observed indicators were shown in Table 5.7.

The final significant model without link between errors was called middle model shown in Figure 5.2. In order to achieve a higher Goodness-of-Fit model, some links between errors were sequential added based on the result from Modification Indices (MI). The final model which was described in Figure 5.3 was the optimum model that achieved almost criteria for several fit indexes without too complex relationship.

Table 5.7 Observed indicators used in perception model explaining supervisors' behavior

Construct	Variable	Scale	Item
Organizational & Management Influence	Safety management system	1-5 (Disagree – Agree)	System
	Safety regulations and procedures	1-5 (Disagree – Agree)	Regu
	Company vision about safety	1-5 (Disagree – Agree)	Vision
	Company financial supports for safety issue	1-5 (Disagree – Agree)	Financial
	Workplace environment	1-5 (Disagree – Agree)	Envi
	Providing of safety training programs	1-5 (Disagree – Agree)	Train
Project Characteristics & Work Assignment	Project schedule	1-5 (Disagree – Agree)	Schedule
	Amount of work responsibility	1-5 (Disagree – Agree)	Load
	Project scale	1-5 (Disagree – Agree)	Scale
	Type of project owner	1-5 (Disagree – Agree)	Otype
	Weather conditions at construction site	1-5 (Disagree – Agree)	Weather
Project Stakeholder Influence	Project owner	1-5 (Disagree – Agree)	Owner
	Top manager	1-5 (Disagree – Agree)	Top Man
	Community pressure (government, law, neighbors)	1-5 (Disagree – Agree)	Social
	Workers	1-5 (Disagree – Agree)	Worker

Table 5.7 Observed indicators used in perception model explaining supervisors' behavior

(Continued)

Construct	Variable	Scale	Item
Personal Background & Safety Knowledge	Safety knowledge	1-5 (Disagree – Agree)	Know
	Working experience	1-5 (Disagree – Agree)	Exp
	Supervisor capability to control workers	1-5 (Disagree – Agree)	Control
	Education background	1-5 (Disagree – Agree)	Edu
Social Influence	Family	1-5 (Disagree – Agree)	Family
	Coworker	1-5 (Disagree – Agree)	Coworker
	Age	1-5 (Disagree – Agree)	Age
	Salary satisfaction	1-5 (Disagree – Agree)	Salary
Habits	Drinking	1-5 (Disagree – Agree)	Drinking
	Smoking	1-5 (Disagree – Agree)	Smoking
Behavioral intention	The situations include 2 main parts which related to falling from height hazard and electrocution hazard	0-10 (Frequency)	S1 – S10
Behavior	Performances include 4 main responsibility related to safety role	0-4 (Never - Always)	P1 - P12

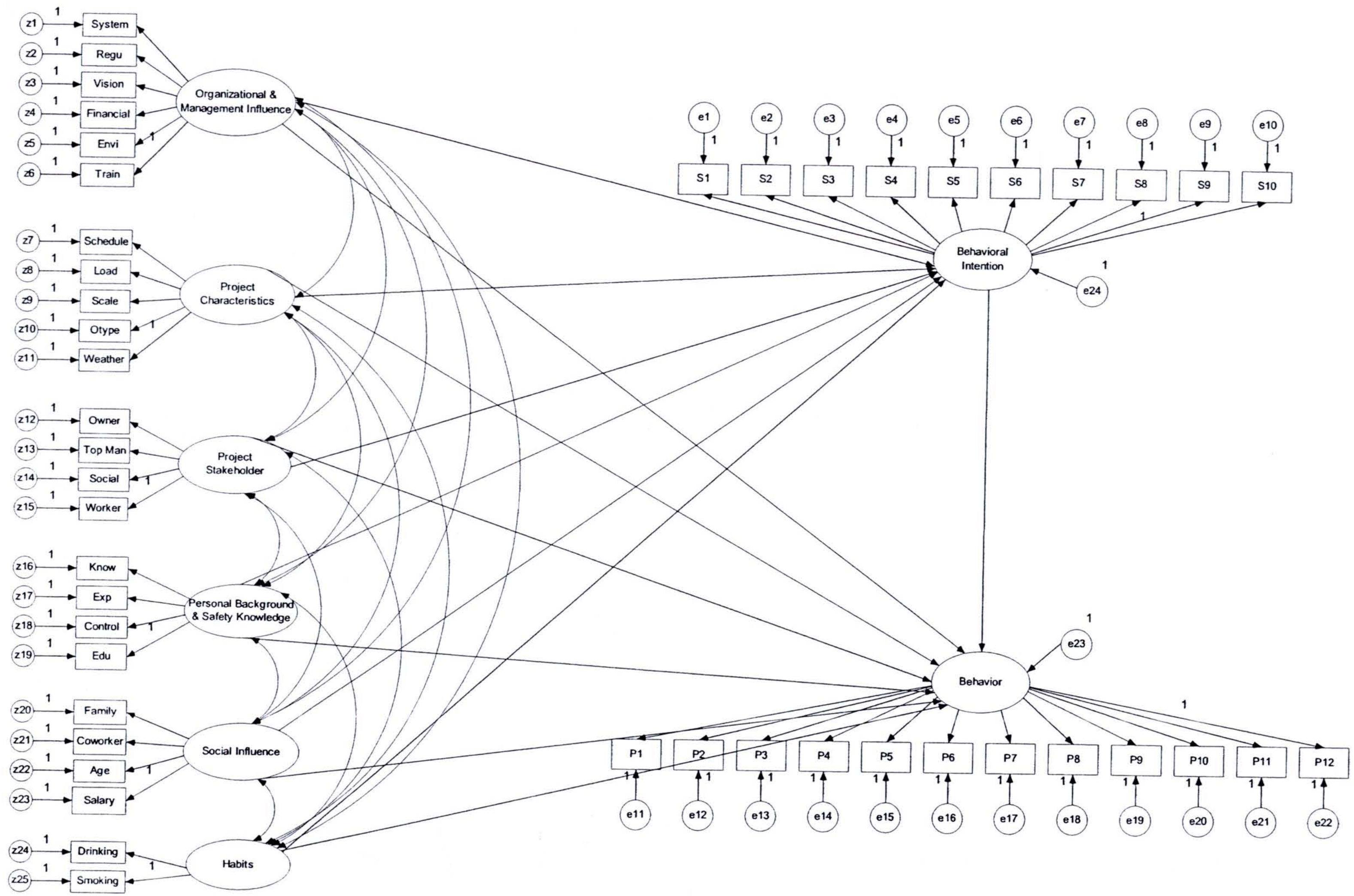
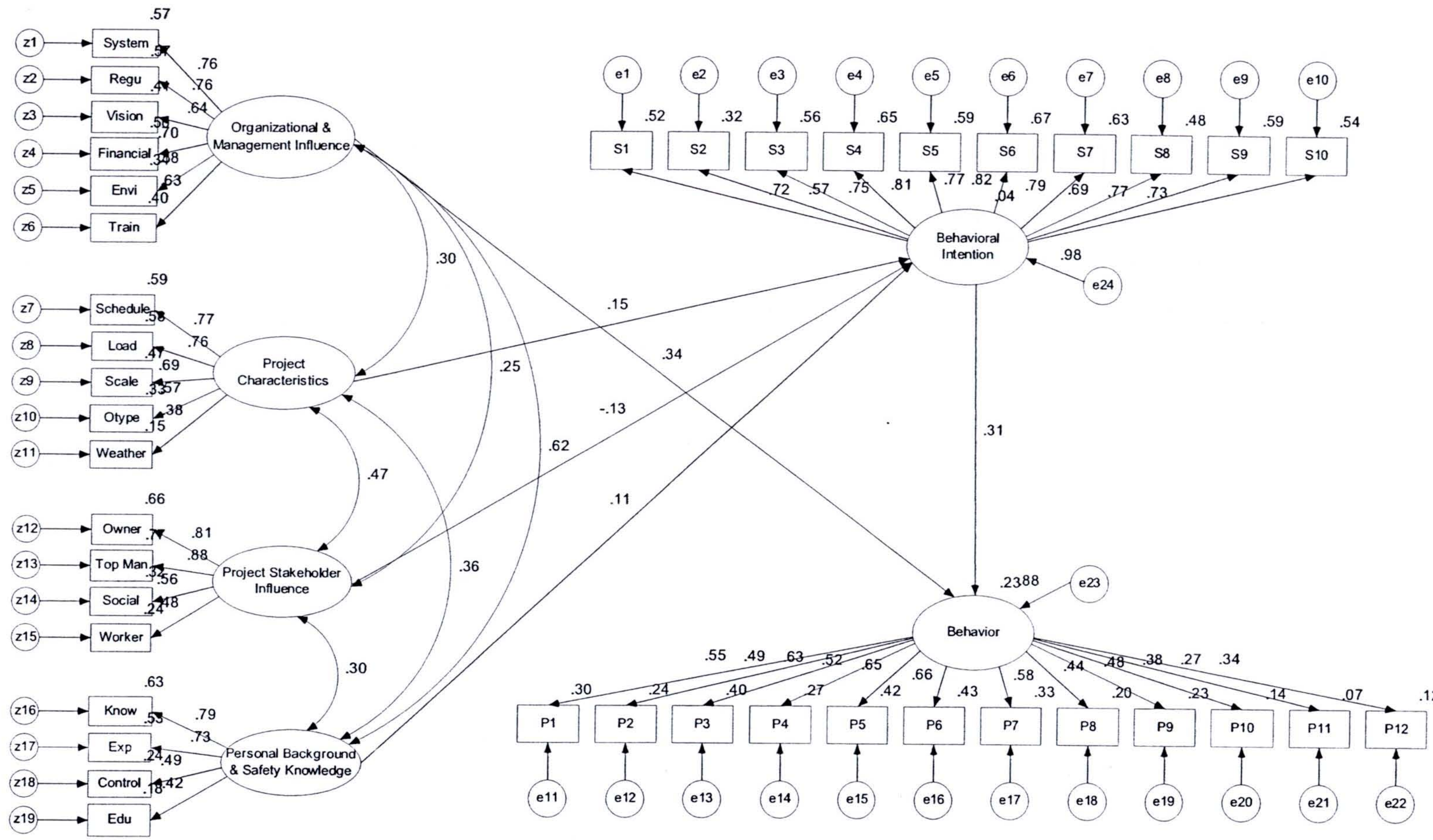


Figure 5.1 Conceptual perception model for explaining supervisors' behavior



Chi-square=1477.605;df=768;P=.000;
Chi-square/df=1.924;
GFI=.765;TLI=.808;CFI=.820;
RMSEA=.062

Figure 5.2 Perception model for explaining supervisors' behavior (before add link between errors)

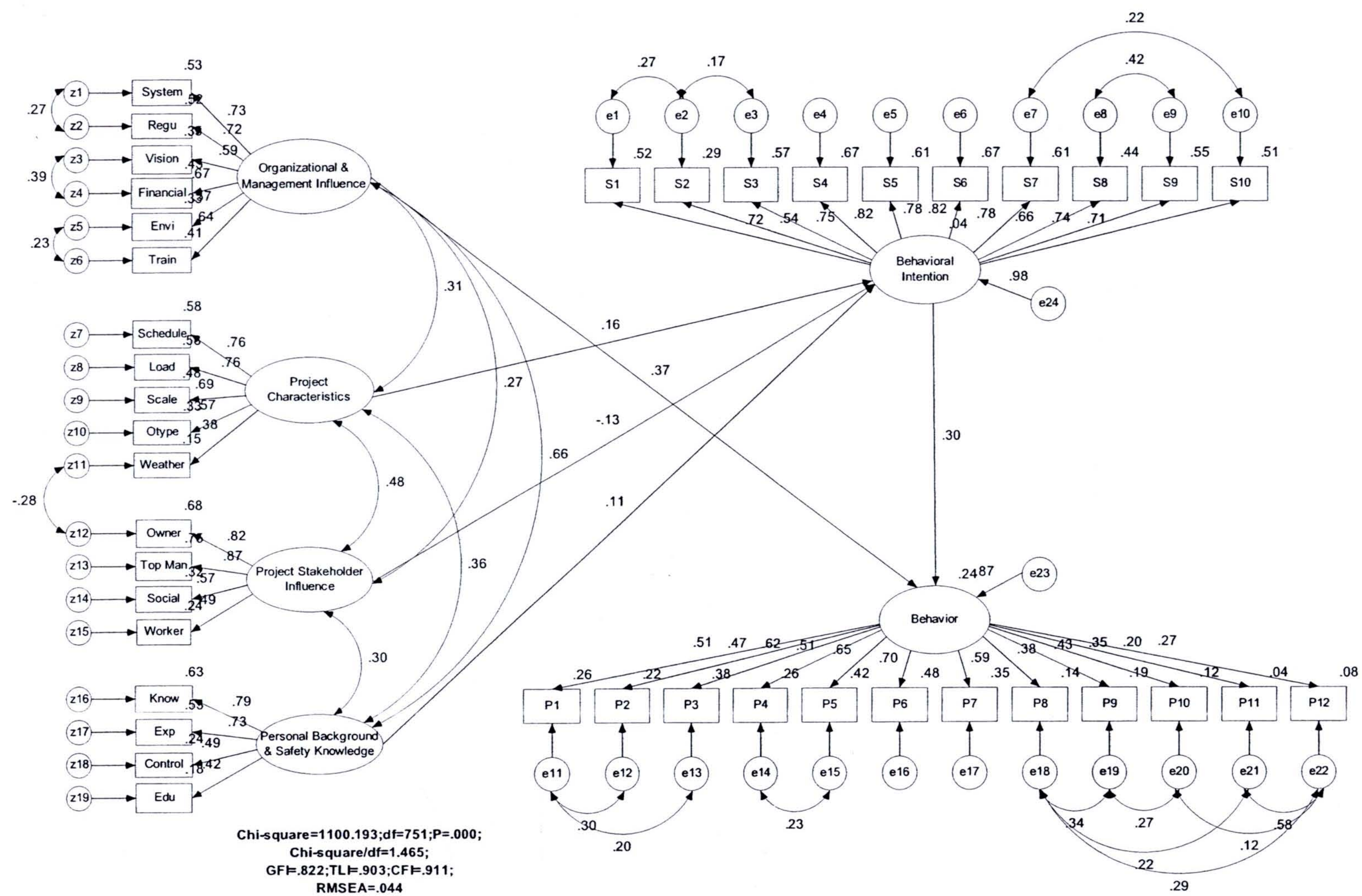


Figure 5.3 Final perception model for explaining supervisors' behavior

5.3.3 Assessing and Results of SEM

From the analysis it was determined that social influence and habits influence did not appear in the final model. It was not contradict with the result of EFA and was not difficult to understand. Although these two factors existed as important factors but their percentage of variance explained were low than 8%. SEM results indicated the non-significant from Social and Habit Influence on both behavioral intention and behavior. The remaining factors were significant influence on behavioral intention or behavior as shown in Figure 5.3. Additionally, scatter plots between the four retained factors were conducted to ensure that a linear trend best represented (i.e. highest R_2 fit) their relationship. This model has the following fit coefficients: CMIN/DF = 1.465; RMSEA = 0.044; GFI = 0.822; AGFI = 0.796; NFI = 0.769; CFI = 0.911; and TLI = 0.903, comparing with the critical value are shown in Table 5.8. The final model satisfied more than 50% of critical standards and above the threshold of almost important standards. Thus, it can be concluded that the model is valid and can continue to analyze the outcome of the causal effects.

Figure 5.3 provides the results of testing the structural links of the proposed research model using AMOS program. The estimated path coefficients (standardized) are given. All path coefficients can be considered significant at the 90% significance level providing support for five relationships. These results represent was explaining supervisor behavior towards intention and other factors. The effects of the behavioral intention and four remained factors (Organizational and Management Influence, Project Characteristics and Work Assignment, Project Stakeholder Influence, Personal Background and Safety Knowledge) accounted for over 24% of the variance in behavior variable. This is an indication of the good explanatory power of the model for supervisor behavior.

In total, structural equations explained the five causal relationships (paths) which exist between the four retained enablers and outcome factors, shown in Figure 5.4. A summary of the developed structural equations, path coefficients and significance levels is provided in Table 5.9, for more details authors can reference in Appendix D1. The following section discusses the practical implications of each structural equation and its' associated predictor variables.

Table 5.8 Goodness of Fit Indexes for Perception Model

Indexes	General rule for acceptable fit	Final Model	Comment
$\chi2 / df$	Ratio of $\chi2$ to $df \leq 2$ or 3, useful for nested models/model trimming	1.465	Good
NFI	>0.95 (Good); > 0.9 (Acceptable)	0.769	Not Acceptable
TLI	>0.95 (Good); > 0.9 (Acceptable)	0.903	Acceptable
CFI	>0.95 (Good); > 0.9 (Acceptable)	0.911	Acceptable
GFI	>0.95 (Good); > 0.9 (Adequate)	0.822	Not Acceptable
AGFI	>0.95 Performance poor in simulation studies	0.796	Not Acceptable
RMSEA	< 0.06 to 0.08 with confidence interval	0.044	Good

Table 5.9 Path coefficients and structural equations

Path	Estimate Un-stand	Estimate Standardized	S.E.	C.R.	P
e24 - Behavioral intention	2.233	.981	.182	12.266	***
Personal Background & Safety Knowledge - Behavioral intention	.465	.106	.373	2.447	.013
Project Characteristics & Work Assignment - Behavioral intention	.800	.158	.490	1.422	.103
Project Stakeholder Influence - Behavioral intention	-.484	-.127	.337	-1.435	.101
Behavioral intention - Behavior	.037	.303	.013	2.888	.004
e23 - Behavior	.241	.869	.062	3.860	***
Organizational & Management Influence - Behavior	.163	.366	.054	2.995	.003

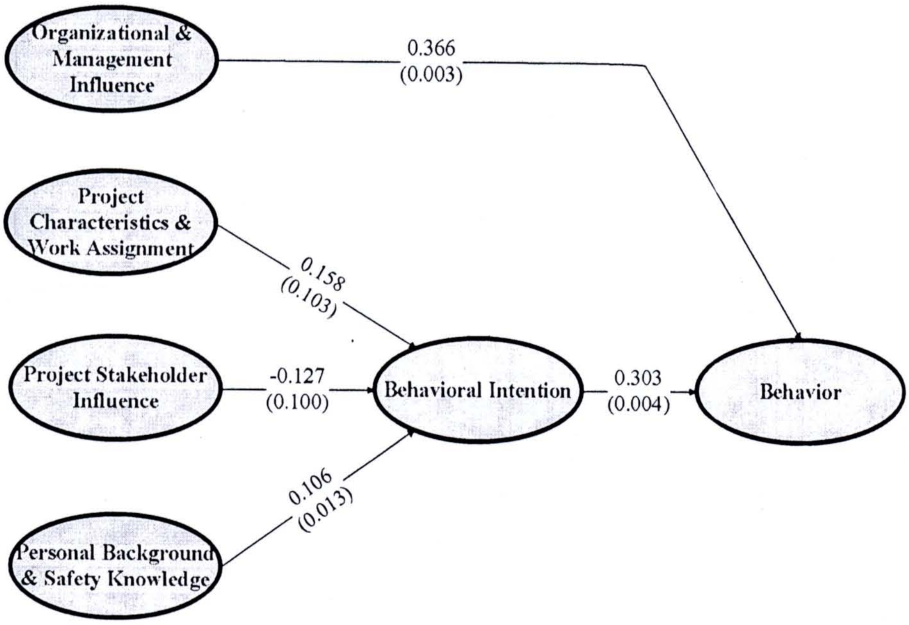


Figure 5.4 Path Perception Model for Explaining Supervisors' Behavior

From the SEM results in Table 5.9 and path perception model in Figure 5.4, supervisors' behavior on safety actions at construction site are positively affected by their behavioral intention (β= 0.30, P<0.01) and organizational management influence (β= 0.37, P<0.01). This result appropriates with some previous theory of behavior that individual behavior can be change through intention positively. However, this result indicates, behavior can be positive influenced strongly by organization in which they are working for. These results stressed the important role of organization in improving supervisors' behavior on safety.

Results from SEM also indicated the influence of project characteristics and work assignment, project stakeholder influence, personal background and safety knowledge on supervisor behavioral intention. Project characteristics and safety knowledge are positive influence in changing behavioral intention as our expected but the significant is quite low (β= 0.16, P=0.1; β= 0.11, P=0.01). In generally, statistical report is seldom expressing the results less than 95% significant. However in this results explanation, authors expect to show some results in 90% confident to extend the outcome. It helps to achieve comprehensive understand about factors affect supervisor behavior. Unexpected result is negatively affected by project stakeholder influence on behavioral intention. Normally, we expect that supervisor may constantly concern with safety if they received higher awareness from project stakeholder such as top manager, project manager, community and worker. But the output is reverse direction. The pressure from project stakeholder may influence behavioral intention in negative direction (β= -0.13, P=0.1). This result is an interesting outcome. The negative relationship indicates the way that superior impact to improving supervisor on safety is counterproductive.

5.4 Summary

This chapter aims to explore what factors influencing supervisors' behavior on safety action in order to get more understanding how to improve their current safety status. Factor analysis indicate high significant levels of variable influencing supervisor's behavior in safety action such as "Organizational and Management Influence", "Project Characteristics and Work Assignment", "Project Stakeholder", "Personal Background and Safety Knowledge", "Social Influence", and "Supervisor Habits". As a result, Supervisor's behavior can be influenced by several levels of factor which are organizational level, project level, individual level and especially social level. Some issues related to social level were discovered and highlight as family awareness about safety, influence from coworkers and salary satisfaction. Besides, the outputs pointed out the influence from learning and knowledge factor as an important factor in changing supervisor behavior. Additionally, it was interesting from the results of factor analysis that supervisor behavior may be influenced by some of their habits such as drinking and smoking.

Until SEM, the relationships of these factor and behavior are explored carefully. There is no doubt about the positive influence of organizational management influence and behavioral intention on supervisors' behavior while behavioral intention can be changed by project characteristics and safety knowledge. Unexpected and interesting outcome is the negatively influence of project stakeholder on intention. It is hoped that the current study can contribute to the improvement safety approach at construction site. By understanding the factors, manager can change and improve the supervisor behavior. The changing supervisors' behavior can directly influence on to the safety culture and workers because supervisors are the key persons who works in between senior managers and workers. However, it should to notice that, all of responses in this chapter base on supervisor perception only.