International Journal of Engineering & Technology, 7 (2.29) (2018) 858-864

International Journal of Engineering & Technology

Website: www.sciencepubco.com/index.php/IJET

Research paper

Investigating Delays in Libyan Road Construction Projects Using Structural Equation Modelling (SEM)

Amiruddin Ismail[1,2], Aboubaker. Y. Y. Alfakhri[1,2*], Muhamad Azry Khoiry[1,2], Hassan M Abdelsalam[2], B. Elhub[3]

[1]Programme Of Civil Engineering, University Kebangsaan Malaysia [UKM], 436000 UKM Bangi, Selangor, Malaysia
[2]Smart And Sustainable Township Research Center [SUTRA], UKM, 436000 UKM Bangi, Selangor, Malaysia.
[3]Solar Energy Research Institute [SERI] UKM, 436000 UKM Bangi, Selangor, Malaysia.
**Corresponding Author E-Mail: Baker812008@Yahoo.Com*

Abstract

Transportation infrastructure, specifically road projects, is the backbone of economic and social development of many countries. Successful road infrastructure projects are delivered with reduced cost, on time. Factors contributing to Construction delay in road construction projects in Libya were identified and ranked through a questionnaire survey distributed to owners, consultants, and contractors involved in road projects. A total of 256 completed questionnaire forms were received and analysed. A Structural Equation Modelling SEM Path Model of relationship between delay factors and effects in road construction was formulated and evaluated using [SEM] 21 software. 49 factors classified into eight groups of factors and three groups of effects of delay. The contractor group in delay factors had the greatest impact on road construction delay with path coefficient β-values of 0.249, while financial groups in delay effects had the greatest impact on road construction delay with path coefficient β-values of 0.88. The R2 value of the model is 0.48, indicating that the developed model substantially explains Construction delay. This rigorous multivariate analysis has identified several causative factors that contribute to delay in road construction projects in Libya. The findings will help all parties involved in construction projects to achieve better control over construction delays, and will provide support for practitioners to incorporate risk analysis for potential Construction delay in future projects. As well as for researchers in the field of road construction and understanding of the factors causing project cost overruns in developing countries.

Keywords: *Construction Delays; Factors and Effects; Road construction projects; Libya; SEM*

1. Introduction

Delays can occur in any phase of a construction project, thereby increasing the total duration of a project and total cost. The main aim of project managers is to minimize cost and time. Hence, identification of the causes of delay is a crucial step in hindering their occurrence. Recently, a lot of attention has been focused on delay analysis and claims management. The most crucial feature in delay analysis is to identify the causes which influence the critical path and thereby delay project completions [1]. It is important to identify causes of schedule delays before they actually occur. A number of past research have found major reasons for delay example [2]. Others have used advanced techniques such as fuzzy logic [3] to measure reasons for delay and adapt activities and project durations; or have measured the effect of delay of specific delayed events like [4] who used mathematical models to evaluate the impact of delay on the cost of a concrete batch plant.

Although these researchers have investigated the major causes of delays, they did not look into the effects when different factors combine to cause schedule delays. If the influence of different causes, alone and in combinations, can be identified and quantified, managers have more information to help them prevent or reduce construction project delays.

SEM is a complex data analysis tool utilised when identifying data relationships quantitatively by utilising a multivariate method for predicting a series of interrelated dependent relationships concurrently [5]. Initially developed by social scientists, it is an extension of standardized regression modelling, but its ability to handle independent variables that are imprecisely measured has led to its widespread application in analysing consumer and marketing behavior [6]. However, these characteristics also make it well-suited for analysing many issues that arise in the field of management and construction engineering [7] .

The study reported here extends the work of a study by [8] that investigated significant factors of construction delay. The researchers utilised a structured questionnaire that has listed well known causes of delay and respondents were asked to rank them in terms of importance, frequency and severity of impact. The present study seeks to use SEM to analyse the relationships among delay items that have been identified and effects of delay as having significant delay effects on Libyan road construction projects. Similar to Shebob et al., a questionnaire survey was conducted among the participants in road construction projects in Tripoli and Western Libya.

2. Literature Review

Gunduz & AbuHassan [9]conducted a study to identify the factors contributing to delays in construction projects in Turkey. They identified 83 factors related to nine different categories, from which they identified 15 factors that contributed to delays. These included: construction inadequate contractor experience, poor project planning, inefficient site management, and frequent changes in project process and orders. Other researchers like [10] identified a number of factors related to delays in the construction industry of Malaysia. They concluded that material delivery, labour productivity, inadequate decision-making process, inadequate equipment, and inflation were the most important factors causing delays in the projects. Among these factors are some not previously highlighted in other studies in Malaysia. [11] presented a statistical model of factors contributing to delays in the construction industry, classified into four categories related respectively to owners, consultants, law and regulations, and general defects. They concluded that the most important and significant factors among these were budgeting and resource allocation defects.

Elawi, et al. [12] noted the most important reason for delay in infrastructure projects in Mecca, Saudi Arabia and made a comparison with other projects in the country and in other Gulf nations. The most severe cause of delay is land acquisition factor. Other factors which can contribute to delay are lack of expertise among the contractors, disorganised underground utilities or services lines and re-designing. It is revealed that most of the project delays are caused by the owner rather than the consultants, contractors and other stakeholders of the project. [13] conducted exploratory interviews with the industry experts in Qatar to verify the causes identified in the literature. A survey questionnaire was distributed to consultants, contractors and clients. It is discovered that over 80% of infrastructure projects are delayed, with an average delay of 25%. The most common cause of delay are [a] utility agencies taking longer time to response [b] major changes made in the design during construction [c] inefficient planning and scheduling [d] inefficient control of progress and [e] changes in the scope of the projects.

A study in Bahrain by [14] investigated the reasons for road construction projects to be delayed that lead to cost and time overruns. Improper planning and scheduling by contractors, delays in decision making by owners and lack of experienced consultants are the main problems. [15] conducted a study to find out the reasons for road construction projects in Malawi to be delayed. In Malawi, the causes of delay are related to contractors, external factors and resources. In descending order the main reasons for delay are fuel shortage, contractors' insufficient cash-flow, shortage of foreign currency for importing equipment and materials, clients are slow in making progressive payments, lack of equipment, delay in relocating utilities, construction materials, shortage, delays in compensation settlement to land owners and shortage of technical experts. In a study carried out in Egypt, [16] identified the main reasons for delay in road projects and the findings revealed a good correlation among the reasons and groups between contractors and site/design engineers and between consultants and site design engineers but a low correlation between contractors and consultants. Therefore, none of these reasons can be considered to be most or least cause of delay.

3. Relationship between Factors of Delays and Effects of Delays.

The relationship between causes and effects are of two types. These are direct and indirect relationships. These relationships are studied by many authors. [17] in their study in Nepal linked the material-related causes with effects of cost and time overruns in construction projects. In their study about the large construction projects in the Kingdom of Saudi Arabia, [18] connected the causes related to contractor and causes related to labour with the time overrun of the project. The other study carried out by [19] in Jordan, they connected the causes related to contract with the disputes and negotiations occurred among the parties participating in the project.

[20] investigated to analysis the empirical relationships between the causes and the effects, so he found Client-related and contractor-related factors have impact on the time overrun, Contract-related factors result in cost overrun, Client-related, contract-related, contract relationship related, and external factors have impact on the disputes, factors Client-related and contract relationship-related factors escalate disputes to be settled by arbitration process. Client-related factors, labor-related, contract-related, contract relationship-related, and external factors escalate disputes to be settled by the litigation process. Correlation analysis is a good way to evaluate the relationship between variables that have interval data. The correlation analysis was carried out to evaluate the empirical relationship between the categories of causes and effects [21].

In Libya, many projects have been temporarily abandoned during the turmoil since 2011. Obviously, security factors are the main reason to be blamed for this. Furthermore, the security conditions are more severe in rural areas where most construction projects are realized. The political instability in the country means also payment difficulties, poor cash flow, and low determination which are essential factors for big-scale international projects held in Libya. Many of these projects have now become so prohibitive that they have been abandoned permanently [22].

In this research, we attempt to establish relationship between causes and effects through observable data. Since the data we have collected through survey is based on Likert-scale, it can be considered as interval data.

4. Theoretical Framework

The above review provides the theoretical basis to develop the research framework for this study and In order to explore the influences of these factors and effects on road construction delays, the research sets out eleven hypotheses as follows:

H_1: Contractor-related factors [CO] have significant effects on Construction delay.

H_2: Owner-related factors [OW] have significant effects on Construction delay.

H_3: Consultant-related factors [CN] have significant effects on Construction delay.

H_4: Utility-services-related factors [US] have significant effects on Construction delay.

H_5: Government-regulations-related factors [GR] have significant effects on Construction delay.

H_6: Project-related factors [PR] have no significant effects on Construction delay.

H_7: External factors [EX] have significant effects on Construction delay.

H8: Equipment- and material-related factors [E&M] have significant effects on Construction delay.

H_9**:** Construction delay has significant government-related effects [EG].

H_{10}**:** Construction delay has significant site-related effects [ES].

H_{11}**:** Construction delay has significant financial-related effects [EF].

5 Theoretical Model

Theoretical model or hypothetical model is developed from a review of past research works [23]. The theoretical model is basis for testing the relationships of independent and dependent variables [24]. Hence, based on a review of the literature, a structural model of factors and effects of delay is developed as presented in Figure 1.

Each of the 11 independent variables [8 Delay Factors and 3 Delay Effects] includes a number of separate indicators or sub-variables which are as listed below:

1 - Delay Factors:

- CO is the variable for the group of contractor-related factors, which consist of the following sub-variables: CO1 for Rework due to errors during construction; CO2 for Poor site management and supervision by contractor; CO3 for Improper planning and scheduling of project by contractor; CO4 for Inexperienced manpower employed by contractor; CO5 for Poor qualification of the contractor's technical staff; CO6 for Difficulties in project financing by contractor; CO7 for Shortage of manpower; and CO8 for Poor communication between contractor and other project parties.

- OW is the variable for the group of owner-related factors, which consist of the following sub-variables: OW1 for Difficulty in Budget availability for the project; OW2 for Delay in decision making by the owner; OW3 for Interference by the owner during construction operations; OW4 for Delay in progress payments by the owner; OW5 for Poor communication between owner and other project parties; and OW6 for Change of project scope by the owner during construction.
- CN is the variable for the group of consultant-related factors group which consist of the following sub-variables: CN1 is Delay in performing testing and inspection by consultant; CN2 is Delay in approving major changes in the scope of work by consultant; CN3 is Lack of flexibility by consultant; CN4 is Delay in reviewing and approving design documents by consultant; and CN5 is Insufficient experience of consultant.
- US is the variable for the group of Utility Services-related factors which consist of the following sub-variables: US1 is Delays in the conversion and transfer of utility services by the competent authorities [such as power lines, water, etc.]; US2 is Long time for response from utilities agencies; US3 is Effects of subsurface [underground] conditions; and US4 is Smaller utilities are restrained by funding limitation.
- GR is the variable for the group of Government Regulation-related factors which consist of the following sub-variables: GR1 for Complexity and delays in administrative and financial procedures of project; GR2 for Tendering system requirement of selecting the lowest bidder; GR3 for Non-activation of punitive deterrent measures for delays; GR4 for Change in government regulations and rules; and GR5 for Delay in obtaining permits from different government offices.
- PR is the variable for the group of project related factors which consist of the following sub-variables: PR1 for Original contract duration is too short; PR2 for some designs are not suitable for implementation; PR3 for Non-provision of bonus for early completion; and PR4 for Lack of financial liquidity of the project.

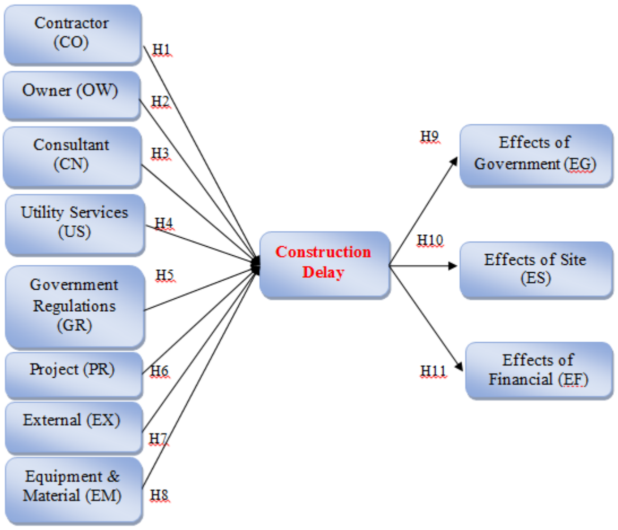

Fig. 1: Theoretical Model of Construction Delay [CD]

- EX is the variable for the group of external related factors which consist of the following sub-variables: EX1 is Delays in construction activities due to weather changes; EX2 is Delays in acquiring land from citizens; EX3 is Economic problems; and EX4 is Poor political situation and security, especially after revolution in Libya.
- EM is the variable for the group of Equipment and Material-related factors which consist of the following sub-variables: EM1 is Shortage of equipment; EM2 is Re-work because of poor quality materials; and EM3 is change in prices of materials.

2. Delay Effects:

EF is the variable for of Effects related to Financial which consist of the following sub-variables: EF1 is Time overrun; EF2 is Cost overrun and EF3 is Poor quality.

- ES is the variable for of Effects related to Site which consist of the following sub-variables: ES1 is Disruption of traffic movement, ES2 is Obstruction of economical and ES3 is development Delay of other projects related to the main one.
- EG is the variable for of Effects related to Government which consist of the following sub-variables: EG1 is Litigation, EG2 is Arbitration, EG3 is Breach of contract and EG4 is Disputes.

Once the model had been constructed, the SEM algorithm function was used to perform simulations. Loadings on each indicator or sub-variable were calculated and path coefficients of the structural model were estimated. Parameters needed to assess the structural model were generated by the software, as shown in Figure 2.

Assessment was carried out in two stages: first, at the measurement level, internal consistency was assessed to ensure that the relationships between the independent and manifest variables were sufficiently strong; and second, at the structural level, the relationships between the dependent and independent variables were examined. The criteria for assessment parameters followed those suggested by [25] and [26]. Figure 2 shows the values generated.

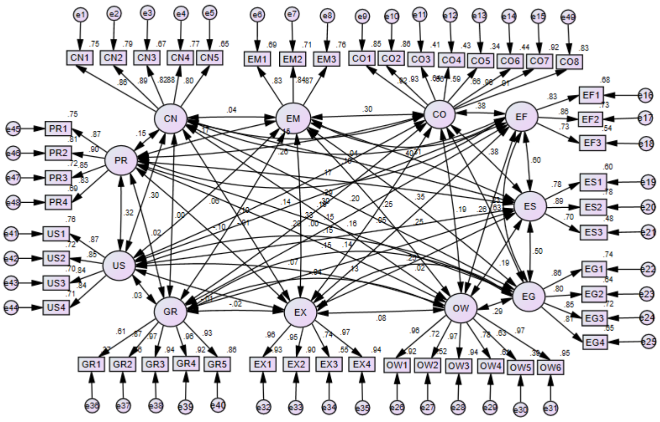

Fig. 2: Results from the simulation process

A theoretical model was constructed to represent delay factors in the Libyan road construction industry. Factor analysis was used to generate 49 delay indicators classified into 11 categories [8 factors and 3 effects], Delay factors and effects were identified through a rigorous review of the literature and subsequently were verified by experts in a pilot study. The model demonstrates the concept with its key elements [i.e. constructs][24, 27].

The steps involved in constructing the model in SEM software included the following: construction of the model based on a hypothetical model; assigning names of the constructs or variables; connecting the independent variables to the dependent variable; and assigning indicators to the respective independent variables. Connecting the dependent variable to the effects of delay; the constructed model consisted of 11 categories or constructs that incorporated the 49 [39 factors and 10 effects of delay]. Input data for the dependent variable consisted of a single value item: "1" if the factor causes delay, and "0" indicating that the factor does not cause delay. Since it had been previously determined that all the factors cause delay, a value of 1 was assigned to each factor and was applied to the model.

6. Assessments of the Measurement Model

The internal consistency of the measurement [or outer] model is evaluated to conclude whether the relationships between independent and manifest variables are sufficient. Evaluation is done in two phases. Phase one examines the performance of the model after each iteration of computation for reliability of single items and convergent validities. Phase Two analyses the final iteration of the model to evaluate discriminant validities.

6.1. Reliability and Convergent Validity

After the dimensionality of the constructs was established, each construct was assessed for its reliability and validity. Cronbach's alpha, construct reliability [CR] and average variances extracted [AVE] were employed to assess reliability, while convergent and discriminant validity were used to assess the validity of the constructs. These assessments are described below. Table 1. Shows results of Cronbach Alpha and Convergent Validity

In Phase One of the evaluation, reliability of individual items and convergent validities which are generated simultanously are inspected after each simulation process. The suggested threshold values for reliability of individual item are Average Variance Extracted [AVE] ≥ 0.5, Convergent Validity [CR] ≥ 0.7, and Cronbach's alpha ≥ 0.7. Three parameters are utilised to determine convergent validity which are Average Variance Extracted [AVE], Convergent Validity [CR] and Cronbach's alpha [23, 28, 29]. Each sub variable is significant if its loading value is greater than 0.5 [30]. Sub variables that load at less than 0.6 are omitted. The computational process and assessment is repeated over a few iterations until the criterion values for reliability of individual items and convergent validities are achieved. In the present study, reliability for all remaining factors are achieved after six iterations. Six weak sub variables are omitted, leaving 43 significant sub variables that are reliable for the final output. On completion of the 6th iteration, the necessary threshold values for the average convergent validity are Average Variance Extracted [AVE] = 0.734, Composite Reliability [CR] =0.908 and Cronbach's Alpha [Alpha] = 0.876 [23, 28] which shows that the model meet the necessary requirements for validity. Table 1 shows the generated parameters values for the eight groups obtained from the final iteration.

Table1: Results of Cronbach Alpha and Convergent Validity

Construct	Item	Internal reliability cronbach alpha	Convergent Validity		
			Final Factor Loading	**Composite Reliability [CR][B]**	**Average Variance Extracted [AVE][A]**
Government Regulation [GR]	GR1	0.903	0.611	0.930	0.775
	GR2		0.975[D] deleted		
	GR3		0.951		
	GR4		0.975		
	GR5		0.933		
Consultant [CN]	CN1	0.929	0.865	0.929	0.725
	CN2		0.890		
	CN3		0.818		
	CN4		0.876		
	CN5		0.805		
Project [PR]	PR1	0.920	0.866	0.920	0.742
	PR2		0.901		
	PR3		0.846		
	PR4		0.832		
Contractor [CO]	CO1	0.915	0.946	0.947	0.784
	CO2		0.940		
	CO3		0.637[D] deleted		
	CO4		0.633		
	CO5		0.585[C] deleted		
	CO6		0.654[D] deleted		
	CO7		0.960		
	CO8		0.904		
Effects related to Financial [EF]	EF1	0.744	0.826	0.848	0.652
	EF2		0.855		
	EF3		0.736		
Effects related Site [ES]	ES1	0.775	0.775	0.831	0.623
	ES2		0.884		
	ES3		0.698		
Effects related Government [EG]	EG1	0.820	0.818	0.889	0.667
	EG2		0.747		
	EG3		0.867		
	EG4		0.829		
Utility Services [US]	US1	0.912	0.875	0.913	0.725
	US2		0.849		
	US3		0.839		
	US4		0.843		
Equipment and Material [E&M]	EM1	0.887	0.828	0.885	0.719
	EM2		0.842		
	EM3		0.873		
Owner [OW]	OW 1	0.909	0.963	0.958	0.853
	OW 2		0.718[D] deleted		
	OW 3		0.975		
	OW 4		0.768		
	OW 5		0.627[D] deleted		
	OW 6		0.971		
External [EX]	EX1	0.925	0.954	0.947	0.818
	EX2		0.952		
	EX3		0.709		
	EX4		0.974		
Average		**0.876**		**0.908**	**0.734**

A-Composite reliability = [square of die summation of the factor loadings]/[[square of the summation of the factor loadings] + [summation of the error variances]].

B- Average Variance Extracted = [summation of the square of the factor loadings] /[[summation of the square of the factor loadings] + [summation of the error variances]].

C- Denotes for discarded item due to insufficient factor loading below the cut-off 0.6

D- Denotes for discarded item due to high M,I, value of error co-variance.

The proportion of deleted items [6 items, or 12.2%] is moderate. It is unlikely that their removal would change the content of the constructs as originally conceptualized in any significant way. From Table 1, it can be seen that the remaining indicators have high factor loadings, ranging from 0.611 to 0.975, which indicates that they retain the conceptual integrity of the factors.

The AVE values, which reflect the overall amount of variance in the indicators that accounts for the latent construct, were above 0.5 for all constructs, [the cut-off point recommended by [31] , and ranged from 0.625 to 0.853. For all constructs, composite reliability values, which signify the degree to which construct indicators represent the latent construct, exceeded the threshold value of 0.6 recommended by [32] , and ranged from 0.831 to 0.958. Cronbach's alpha coefficient is the most commonly used test of inter-item consistency reliability that indicates how well the items in a set are positively correlated to one another. The Cronbach's alpha coefficient measures internal consistency reliability among a group of items combined to form a single scale and reflects the homogeneity of the scale measured. In this data set, the Cronbach's alpha values ranged from 0.744 to 0.929, which were above the threshold of 0.7 suggested by [31]. Therefore, for all constructs, the Cronbach's alpha was considered to be acceptable.

6.2 Discriminant Validity

Discriminant validity assesses the level to which a construct is dissimilar from and unrelated to other constructs. In the measurement model here, the correlations between factors are less than

0.85, the value recommended by [33]. Validity is tested by comparing the correlations between constructs and the square roots of the average variance extracted for a construct [34] Discriminant validity values for the modified measurement model are set out in Table 2, the inter-correlations between the deconstructs range from -.041 to 0.665. Hence, it is below the threshold 0.85, the squared correlations are smaller than the square root of the average variance obtained by the indicators. Hence, there is good discriminate validity between these items [33]. When evaluating the goodness to fit of data, discriminate validity and convergent validity of the modified measurement model, the final modified measurement scale utilised in this study to measure the constructs and their relative items are reliable and valid.

Table 2: Discriminant Validity Index Summary for the Construct.

Construct	GR	CN	PR	CO	EF	ES	EG	US	EM	OW	EX
Government Regulation	**0.880**										
Consultant	0.000	**0.851**									
Project	0.037	0.154	**0.862**								
Contractor	0.000	0.151	0.245	**0.885**							
Effects of Financial	0.170	0.104	0.293	0.361	**0.807**						
Effects of Site	0.136	0.044	0.166	0.361	0.597	**0.789**					
Effects of Government	0.153	0.200	0.155	0.223	0.665	0.522	**0.816**				
Utility Service	0.042	0.303	0.324	0.136	0.304	0.151	0.154	**0.852**			
Equipment & material	0.005	0.045	0.174	0.284	0.404	0.306	0.359	0.056	**0.848**		
Owner	-0.041	0.191	0.206	0.197	0.257	0.195	0.304	0.070	0.251	**0.923**	
External	-0.019	0.083	-0.103	0.039	0.251	0.021	0.244	-0.017	0.328	0.080	**0.904**

Note: Diagonals represent the square root of the average variance extracted while the other entries represent the correlations.

7. Test of Hypotheses

7.1. Path Coefficients

Path coefficients [β-value] indicates the impact of a path on dependent variable [35, 36]. According to [37] as cited in [29], a model can be considered acceptable if β-value above 0.1. The result of the path coefficients as in Figure 3 shows that all β-value are above 0.1. This means that the developed model is acceptable.

Hypotheses H1 to H11 were tested through evaluating the significance of the path coefficients as well as β for between the constructs in the structural equation model which had been specifically established for this research study [see table 3]. In addition, the paths among the variables were also scrutinized. In the hypothesized model proposed in this research study. As shown in Table 3, eleven paths were statistically significant [p-values < 0.05]. Thus, These path coefficient values of the model indicate that CO [factor of contractor], with the highest co-efficient value [0.25] has the greatest impact on road construction delay in Libya, while the greatest impact of effects was Effects related to Financial [EF] [0.880] due to the delay of road projects.

Table 3: Results of Examining Hypotheses in the Developed Structural Model [change this table]

H	Dependent variable	path	Independent variable	Value of path coefficients [β]	C.R	P-value	Significance Yes / No
H1	Construction Delay	←	CO	0.249	3.753	0.000	Yes
H2	Construction Delay	←	OW	0.229	3.074	0.002	Yes
H3	Construction Delay	←	CN	0.132	2.009	0.045	Yes
H4	Construction Delay	←	US	0.218	3.602	0.000	Yes
H5	Construction Delay	←	GR	0.175	2.714	0.007	Yes
H6	Construction Delay	←	PR	0.159	2.291	0.022	Yes
H7	Construction Delay	←	EX	0.139	2.184	0.029	Yes
H8	Construction Delay	←	EM	0.157	2.275	0.023	Yes
H9	EG	←	Construction Delay	0.764	7.766	0.000	Yes
H10	ES	←	Construction Delay	0. 670	7.397	0.000	Yes
H11	EF	←	Construction Delay	0. 880	8.643	0.000	Yes

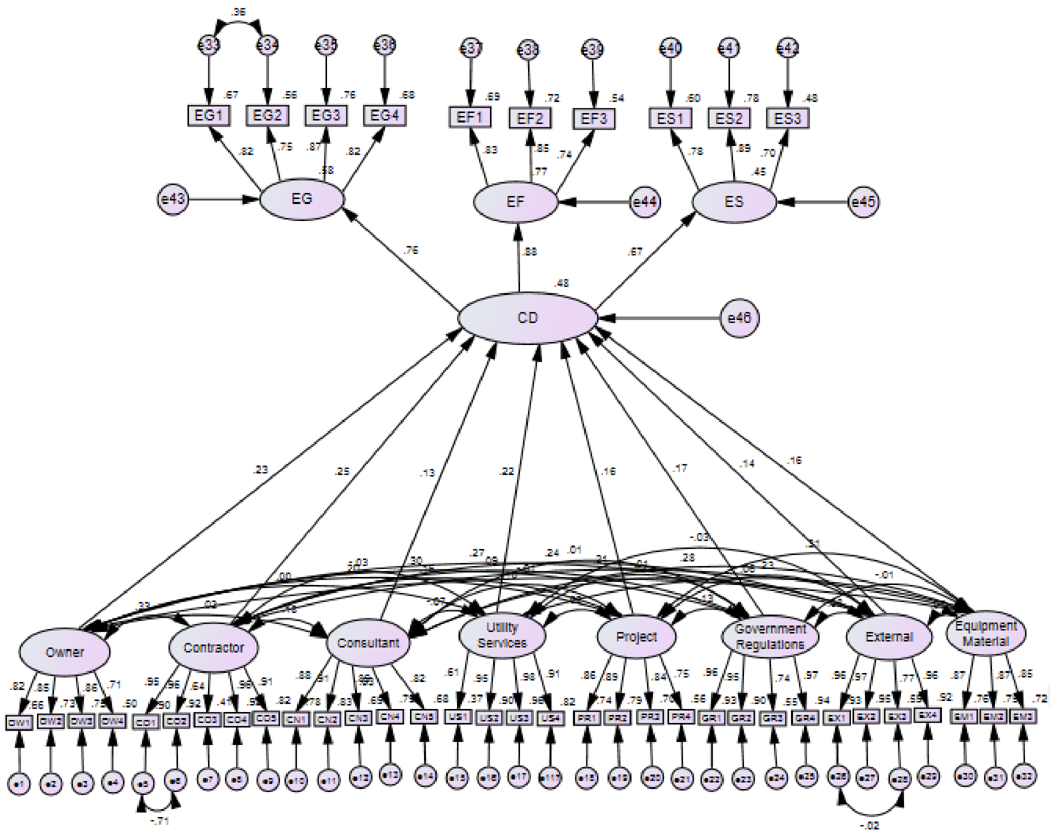

Fig. 3: Structural Equation Model – [Factors-Effects] of Construction Delay.

7.2. Coefficient of Determination

Coefficient of determination [R2] describes the degree of explained variance of dependent latent variable [28, 29]. It is used to determine the explanatory power of the structural model [27, 30]. According to [38], a model can be considered substantial if R^2 = 0.26, moderate if R^2 = 0.13 and weak if R^2 = 0.02. The result of the model is as illustrated in Figure 3 which shows that R^2 is 0.480. This means that the developed model has substantial explaining power on the construction delay.

8. Conclusion

Using Structural Equation Modelling [SEM], this study examined relationship between 49 variables [39 factors and 10 effects], previously identified as contributing to road construction delay in the Libyan construction industry and the effects consequences of this delay. The SEM path model which has been developed incorporated these factors and effects which are classified into eleven categories [variables]. Evaluation of the model shows that all the sub-variables in the outer model are valid and reliable. In the inner model, contractor-related factors display the most dominant path with a β-value of 0.25. On the other hand, consultant-related factors have the least influence on delays in the construction field with a β-value of 0.13. Also was effects the consequences of the delay related to financial most dominant path with a β-value of 0.88. Therefore, the overall model has substantial explanatory power R^2= 0.48 can be generalized as a representation of the situation faced by the Libyan road construction sector. This model is useful to people in the construction sector especially in Tripoli to analyse risk for delays, as well as for researchers in the field of construction.

Acknowledgment

The authors wish to thank Universiti Kebangsaan Malaysia [UKM] for supporting this research and providing research facilities. In addition, the authors are grateful to construction practitioners working in Tripoli city for their generosity and cooperation in providing comprehensive and important information for this study.

References

[1] Al-Saggaf HA. The five commandments of construction project delay analysis. Cost Engineering-Morgantown. 1998;40[4]:37-41.
[2] Assaf SA, Al-Khalil M, Al-Hazmi M. Causes of delay in large building construction projects. Journal of management in engineering. 1995;11[2]:45-50.
[3] Oliveros AVO, Fayek AR. Fuzzy logic approach for activity delay analysis and schedule updating. Journal of Construction Engineering and Management. 2005;131[1]:42-51.
[4] Zayed TM, Nosair IA. Cost management for concrete batch plant using stochastic mathematical models. Canadian Journal of Civil Engineering. 2006;33[8]:1065-74.
[5] Hair J, Andreson R, Tatham R, Black W. Multivariate data analysis. 5th [ed] Prentice-Hall Inc. Unites States of America. 1998.
[6] Baumgartner H, Homburg C. Applications of structural equation modeling in marketing and consumer research: A review. International journal of Research in Marketing. 1996;13[2]:139-61.
[7] Molenaar K, Washington S, Diekmann J. Structural equation model of construction contract dispute potential. Journal of Construction Engineering and Management. 2000;126[4]:268-77.
[8] Shebob A, Dawood N, Xu Q, Egbu C, Lou E. Analysing construction delay factors: A case study of building construction project in Libya. Management. 2011;1005:1012.
[9] Gunduz M, AbuHassan MH. Causes of Construction Delays in Qatar Construction Projects. World Academy of Science, Engineering and Technology, International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering. 2016;10[4]:516-21.
[10] Hamzah N, Khoiry M, Arshad I, Tawil NM, Ani AC. Cause of construction delay-Theoretical framework. Procedia Engineering. 2011;20:490-5.

[11] Samarghandi H, Tabatabaei SMM, Taabayan P, Hashemi AM, Willoughby K. Studying the Reasons for Delay and Cost Overrun in Construction Projects: The Case of Iran. Journal of Construction in Developing Countries. 2016;21[1]:51.

[12] Elawi GSA, Algahtany M, Kashiwagi D, Sullivan K. Major Factors Causing Construction Delays in Mecca. Journal for the Advancement of Performance Information & Value. 2015;7[1].

[13] Emam H, Farrell P, Abdelaal M. Causes of delay on Infrastructure Projects in Qatar. 31stAnnualARCOMConference. 2015.

[14] Hasan R, Suliman SM, Malki Y. An investigation into the delays in road projects in Bahrain. International Journal of Research in Engineering and Science. 2014;2[2]:38-47.

[15] Kamanga M, d M Steyn WV. Causes of delay in road construction projects in Malawi. Journal of the South African Institution of Civil Engineering= Joernaal van die Suid-Afrikaanse Instituut van Siviele Ingenieurswese. 2013;55[3]:79-85.

[16] Aziz RF, Abdel-Hakam AA. Exploring delay causes of road construction projects in Egypt. Alexandria Engineering Journal. 2016;55[2]:1515-39.

[17] Manavazhi MR, Adhikari DK. Material and equipment procurement delays in highway projects in Nepal. International Journal of Project Management. 2002;20[8]:627-32.

[18] Assaf SA, Al-Hejji S. Causes of delay in large construction projects. International journal of project management. 2006;24[4]:349-57.

[19] Odeh AM, Battaineh HT. Causes of construction delay: traditional contracts. International journal of project management. 2002;20[1]:67-73.

[20] Sambasivan M, Soon YW. Causes and effects of delays in Malaysian construction industry. International Journal of project management. 2007;25[5]:517-26.

[21] Samarah A, Bekr GA. Causes and Effects of Delay in Public Construction Projects in Jordan. 2016.

[22] Kusakcı AO, Ayvaz B, Bejtagic E. An Analysis of causes and effects of delays in construction projects in Libyan oil industry. Karaelmas Fen ve Mühendislik Dergisi. 2017;7[1]:274-82.

[23] Aibinu AA, Al-Lawati AM. Using PLS-SEM technique to model construction organizations' willingness to participate in e-bidding. Automation in construction. 2010;19[6]:714-24.

[24] Fellows R, Liu A, editors. Impact of participants’ values on construction sustainability. Proceedings of the Institution of Civil Engineers–Engineering Sustainability; 2008: Citeseer.

[25] Hair JF, G.T.M.Hult, C.M.Ringle, and M.Sarstedt. A Primer on Partial Least Squares Structural Equation Modeling [PlS-SEM]. . United State of America: SAGE Publications2014. p. pp. 95-198.

[26] Henseler J. On the convergence of the partial least squares path modeling algorithm. Computational statistics. 2010;25[1]:107-20.

[27] Ringle CM, Sarstedt M, Mooi EA, editors. Response-based segmentation using finite mixture partial least squares. Data Mining; 2010: Springer.

[28] Akter S, D'Ambra J, Ray P. Trustworthiness in mHealth information services: an assessment of a hierarchical model with mediating and moderating effects using partial least squares [PLS]. Journal of the American Society for Information Science and Technology. 2011;62[1]:100-16.

[29] Hair JF, Ringle CM, Sarstedt M. PLS-SEM: Indeed a silver bullet. Journal of Marketing theory and Practice. 2011;19[2]:139-52.

[30] Memon AH, Rahman IA, Akram M, Ali NM. Significant factors causing time overrun in construction projects of Peninsular Malaysia. Modern Applied Science. 2014;8[4]:16.

[31] Bernstein IH, Nunnally J. Psychometric theory. New York: McGraw-Hill Oliva, TA, Oliver, RL, & MacMillan, IC [1992] A catastrophe model for developing service satisfaction strategies Journal of Marketing. 1994;56:83-95.

[32] Bagozzi RP, Yi Y. On the evaluation of structural equation models. Journal of the academy of marketing science. 1988;16[1]:74-94.

[33] Kline RB. Principles and Practice of Structural Equation Modeling, [Methodology In The Social Sciences]. 2004.

[34] Fornell C, Larcker DF. Evaluating structural equation models with unobservable variables and measurement error. Journal of marketing research. 1981:39-50.

[35] Chin WW. The partial least squares approach to structural equation modeling. Modern methods for business research. 1998;295[2]:295-336.

[36] Urbach N, Ahlemann F. Structural equation modeling in information systems research using partial least squares. JITTA: Journal of Information Technology Theory and Application. 2010;11[2]:5.

[37] Lohmöller J-B. Predictive vs. Structural Modeling: PLS vs. ML. Latent Variable Path Modeling with Partial Least Squares: Springer; 1989. p. 199-226.

[38] Cohen J. Statistical power analysis for the behavioral sciences Lawrence Earlbaum Associates. Hillsdale, NJ. 1988:20-6.