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A CONCEPTUAL MODEL OF DELAY FACTORS AFFECTING ROAD CONSTRUCTION PROJECTS IN LIBYA

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Abstract

Coping with delays is an ever-present challenge for construction projects throughout the world, and both practitioners and researchers have focused their attention on ways to prevent them or to mitigate their effects. Civil engineering projects in Libya, too, especially projects involving road construction, constantly face construction delays. This study proposes a conceptual model of delay factors and provides an analysis of the level of impact of identified delay categories on the completion of the road construction projects. Data for the study were obtained from 256 valid responses to questionnaires and analysed using the Statistical Package for Social Sciences (SPSS) software. Thirty-nine delay causes that influence delay in road projects were identified and classified into 8 core groups of factors in the final conceptual model. The five most significant factors affecting the completion of the project are: (US1) Delays in the conversion and transfer of utility services by the competent authorities (such as power lines, water, etc.) (mean = 4.03); (OW1) Difficulty in Budget availability for the project (mean = 4.02); (PR1) Original contract duration is too short (mean = 3.96); (OW4) Delay in progress payments by the owner (mean = 3.96); (US4) Effects of subsurface (underground) conditions (mean = 3.89). Since the contractor has the most significant impact on the delay in road projects, control of the delay is influenced by the group of factors pertaining to the contractor. Parties involved in government construction projects can benefit from the findings of the study, which can help them find suitable solutions to resolve delays.

Keywords: Conceptual model, Delay factors, Road projects, Libya.

Abbreviations

CO	Contractor
OW	Owner
CN	Consultant
US	Utility Service
GR	Government Regulations
PR	Project
EX	External
EM	Equipment and material

1. Introduction

The road construction industry, especially in developing countries [1], faces a number of weaknesses including incompetent contractors, insufficient modern equipment, and lack of understanding of the project. As a result, projects are often negatively affected in terms of cost overrun, lack of safety, and poor quality. The effects of these failings are not limited to the project itself; because these are often very large projects, the consequences can be very far-reaching, and may have an effect on the national economy. The Libyan road construction industry is no exception, and due to the unique circumstances within the country, the challenges it faces are even greater.

The current capacity and capability within Libya is unable to meet the current national construction demand, and hundreds of construction projects have been suspended, delayed or abandoned. Because of it poor performance over the past few decades, the Libyan road construction industry has a poor reputation in the construction market [2]. However, there is expected to be a high demand for construction projects in Libya in the future. If it is well managed, the road construction industry can have a positive impact on a country's economic growth and development processes. To ensure that the Libyan road construction industry fulfils its important socio-economic role in the country's future development, it is vital to that these large-scale projects are managed efficiently. This requires a more comprehensive understanding of the Libyan construction industry, and its associated processes, characteristics and delay factors.

The purpose of the study reported here, therefore, was to identify the major causes that result in delays in road construction and to propose a structural model representing the causes of delays in the Libyan construction industry. The objectives of the study are to:

- Identify causes that influence delays in road construction projects in Libya;
- Assess the impact level of the delay factors, as perceived by different stakeholders; and
- Propose a conceptual model of delay factors and to analyse the impact level of the delay groups on road project completion.

2. Literature Review

Many studies have been carried out to identify the major causes of delays in road projects in numerous countries. The following review is limited to studies in India, Africa, and the Middle East, which are more relevant to the situation in Libya.

Patil, Gupta, Desai and Sajane investigated causes of delays in transportation infrastructure projects in India [3]. Respondents confirmed that construction delays in transportation infrastructure projects were frequent and significant. The five most important causes of construction delay they identified were: land acquisition, environmental impact of the project, financial closure, change orders by the client, poor site management, and supervision by the contractor.

A number of studies have been carried out in Africa to investigate causes of delays in road construction projects. The top five causes of project delays were identified as: payment by client, slow decision making and bureaucracy in the client's organization, inadequate planning, project scheduling, and delays caused by rain [4]. It was recommended that clients should improve their financial management systems so that they could able to pay contractors in a timely manner, and that bureaucracy and red tape should be reduced in client organizations to speed up the slow decision-making process.

A study was conducted to identify the causes of delay in completing road construction projects [5]. The authors found that the ten most serious causes of delay in Malawi were related to contractors, external factors, and resources. The top causes (in descending order) were shortage of fuel, insufficient contractor cash-flow, shortage of foreign currency for importation of materials and equipment, slow payment procedures adopted by the client in making progress payments, insufficient equipment, delay in relocating utilities, shortage of construction materials, delay in paying compensation to land owners, and shortage of technical personnel.

Al-Hazim identified 19 factors likely to cause delays of road construction projects from a review of the literature [6]. Of these, the principal causes affecting time and cost overrun in road construction projects in Jordan were: terrain conditions, weather conditions, variation orders, and availability of labour.

The most serious cause of delay in infrastructure projects was the land acquisition factor [7]. Other factors that contributed to delay included contractors' lack of expertise, haphazard underground utilities (line services), and re-designing. The researcher concluded that the majority of project delays were caused by the owner rather than contractors, consultants, and other project stakeholders.

A study in Qatar carried out exploratory interviews with industry experts to investigate the relevance of causes identified in the literature [8]. A survey questionnaire was distributed to clients, consultants, and contractors. The results showed that over 80% of infrastructure projects suffered from delay, with an average delay of 25%. The most frequently cited causes of delay were: long response times from utility agencies; major changes in design during construction; ineffective planning and scheduling; ineffective control of progress; and changes in the scope of projects. Meanwhile, a [9] investigated the causes of delay in road construction projects found that improper planning and scheduling by

contractors, delays in decision making by owners, and lack of experienced consultants were the main problems.

Jahanger studied the causes of delay in construction projects (building, sewage networks and lines, water networks, bridge, tunnel and road projects) [10]. Based on responses from a sample of 60 engineers, the most important causes of delay in the construction projects were identified as: mistakes, discrepancies in design documents, ineffective planning, and poor scheduling of the project by the contractor.

In their study that explored road construction projects in Egypt, Aziz and Abdel-Hakam [11] found the main causes of delay were as follows:

- Owner's financial problems
- Shortages of equipment
- Inadequate contractor experience (work)
- Shortage of construction materials
- Equipment failure (breakdown)
- Design errors due to unfamiliarity with local conditions and environment
- Soil investigation is the first step in decision of the design of road with traffic capacity, loads on road, number of layers of pavement.
- Poor subcontractor performance delays,
- Rework due to change of design or deviation order; and
- Poor site management and supervision by the contractor.

The literature review has covered several studies conducted mainly in Middle Eastern countries and identified a range of delay factors in road construction.

3. Research Model and Hypotheses

From the literature review, 59 delay factors were identified, which were then classified into 8 categories of factors according to the main cause responsible for the delay. The categories were labelled as: contractor-related, consultant-related, owner-related, government-regulations related, utility services-related, external factors-related, project-related and (equipment and material-related). Figure 1 depicts the proposed initial conceptual model of delay factors based on 8 of categories of factors.

The following hypotheses were derived from the model:

H1: (CO) Contractor related factors have significant effect on Construction Delay (CD).

H2: (OW) Owner related factors have significant effect on Construction Delay (CD).

H3: (CN) Consultant related factors have significant effect on Construction Delay (CD).

H4: (US) Utility Services related factors have significant effect on Construction Delay (CD).

H5: (GR) Government Regulations related factors have significant effect on Construction Delay (CD).

H6: (PR) Project related factors have no significant effect Construction Delay (CD).

H7: (EX) External related factors have significant effect on Construction Delay (CD).

H8: (E&M) Equipment and Material related factors have significant effect on Construction Delay (CD).

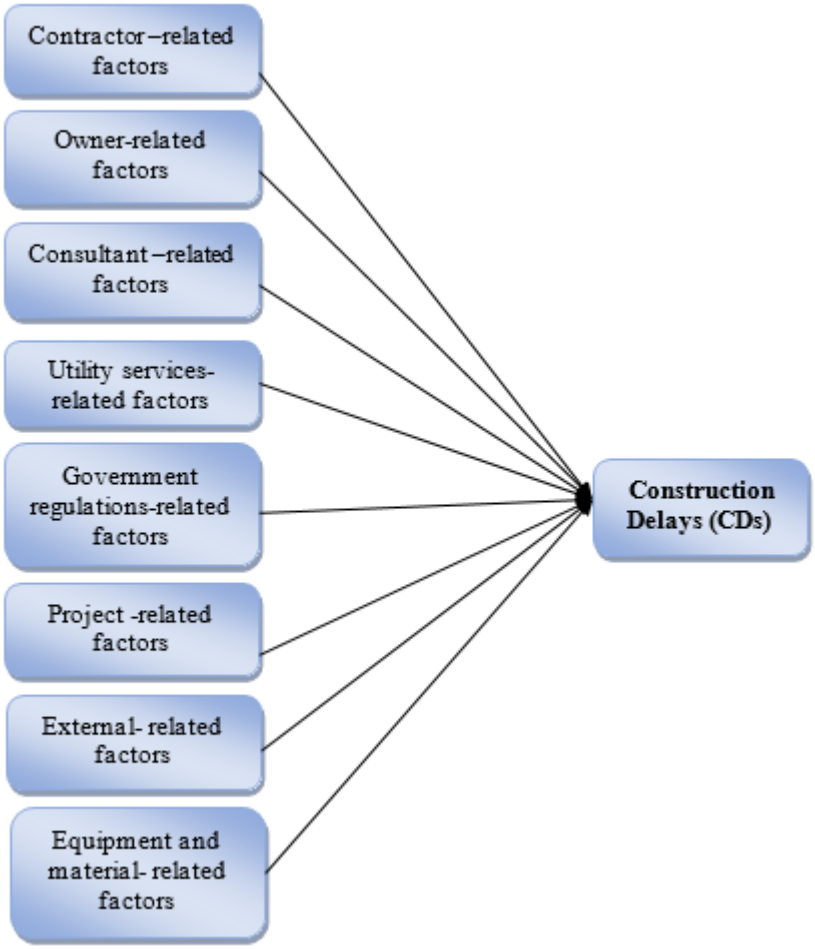

Fig. 1. Initial conceptual model.

4. Research Methodology

The research methodology included two phases. The first phase consisted of the literature search, questionnaire design, pilot test, and data collection. The questionnaire was designed to determine the perceptions of the parties involved in government road projects in Libya on the causes and outcomes of delay in the construction industry of Libya. There were four parts to the questionnaire.

- Part one captured general information about the respondent's experience and that of associated company. Questions enquiring about experience in the construction industry were directed to owners, contractors, and consultants.
- Part two concerned the respondents' experience of project performance and their perceptions of time delays in projects that they had been involved in.

- Part three contained the list of fifty-nine delay causes that were identified earlier from the literature review. These causes were subsequently classified into eight categories based on the sources of delay.
- Part four contained a list of 12 delay effects, identified earlier from the literature review.

Respondents were required to assess the effects of the delay factors using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). To encourage the participation of respondents, the questionnaire communicated that the findings of the study would be shared with the respondents upon completion.

Prior to the distribution of the questionnaire to respondents, thirty-one engineers (owners, contractors and consultants), who were experienced in the road construction industry, took part in a pilot study. The primary aim of the pilot study was to test the relevance and comprehensiveness of the questionnaire, to explain the intention of the study, to validate the content of the questionnaire and the accuracy of the translation, and to assess the questionnaire's overall structure. The experts were well equipped with the requisite knowledge and skills to enable them to assess the relevance and adequacy of the factors included in the questionnaire for conditions in Libya. Following an analysis of the pilot study, 5 delay causes out of the 59 delay causes identified in the literature review were deleted for the purpose of our study. The questionnaire was finalized based on the feedback received, and the formal survey was carried out in Libya.

Sample size was determined using the table of [12] with Confidence Level = 95%, Margin of Error = 5%. 360 questionnaires were distributed to a random stratified sample of owners, contractors and consultants.

The outcomes achieved at this phase included the identification of 54 delay causes of road construction projects, followed by the development of a conceptual model of delay factors that influence project completion.

Of the 360 questionnaires that were distributed, 256 valid and completed questionnaires were received, representing a response rate of 71%. In the first phase of data analysis, the collected data were analysed using SPSS software to determine the relative importance of the various factors that contribute to causes of road construction project delays. In the second phase, two main statistical analyses were run on the data: ranking the factors of delay, and exploratory factor analysis (EFA). Prior to the testing and assessment of the research hypotheses and impact level of the groups in the model, the final conceptual model was identified using EFA.

5. Data Analysis and Discussion

5.1. Profiles of respondents

A frequency analysis was carried out on the information pertaining to respondents and projects. The information included the organization to which respondents were associated, the number of years of experience respondents had, project value, and the causes of construction delays.

The largest number of responses 110 (43%) was received from owners, while the remaining 77 (30%) and 69 (27%) were from consultants and contractors,

respectively (see Table 1). Table 2 sets out the results for respondents' experience. More than half (56%) of respondents had more than 11 years of experience, with 29% having more than 15 years of experience in road construction. The high proportion of experienced respondents enhances the relative reliability and value of the collected data.

Table 1. Numbers of questionnaires distributed and responded.

Questionnaires	Contractors	Owners	Consultants	Total
Distributed	96	146	118	360
Respondents	69	110	77	256
Percentage of 256 Responses	26.95%	42.96%	30.07%	100%

Table 2. Number of years' experience.

	Years of experience				Total
Years	**<5 years**	**5 – 10 years**	**11 – 15 years**	**>15 years**	
Respondents	35	78	68	75	256
Percentage	13.67%	30.46%	26.56%	29.29%	100%

In terms of value of projects, Table 3 shows that while nearly two-fifths (39.10%) respondents were working in small-size construction projects (under 5 million D.L), 25% were working in medium-size construction projects (5-15 million D.L), 12.90% were working in large-size construction projects (16-30 million D.L) and 23% were working in very large size construction projects (over 30 million D.L). Significantly, just under half (47.25%) of all projects were delayed (Table 4).

Table 3. Value of project.

	Value of project				Total
Value	**Over 30 million**	**16 - 30 million**	**5 - 15 million**	**Under 5 million**	
Respondents	59	33	64	100	256
Percentage	23.00%	12.90%	25.00%	39.10%	100%

Table 4. Percentage of delayed projects.

No of projects	Delayed projects	None delayed projects
2986	1463	1633
100%	47.25%	52.75%

5.2. Ranking of delay factors

The ranking of the factors of delay in accordance to the value of their mean scores is set out in Table 6. Means exceeding 3.5 indicate that respondents rated the respective factors relatively high (maximum score = 5). The five most significant factors delaying project completion, according to the ranked means, are:

- (US1) Delays in the conversion and transfer of utility services by the competent authorities (such as power lines, water, etc.) (mean = 4.03);
- (OW1) Problems in budget availability for the project by owner (mean = 4.02);
- (PR1) Original contract duration is too short (mean = 3.96);
- (OW4) Delay in progress payments by the owner (mean = 3.96);
- (US4) Effects of subsurface (underground) conditions (mean = 3.89).

The SU1 group possessed the highest value of means. The most significant cause in this group is "delays in the conversion and transfer of utility services". Delays in the conversion and transfer of utility services, and obstructions or undefined positioning of service networks beneath the surface of the earth can cause delays to the project. This is because there will be alterations to the schedule and often, the newly unearthed cable or pipe needs to be relocated or diverted temporarily, which necessitates extra financial investment and time. Insufficient financial incentives for contractors to complete the project on time can also contribute to project delays by contractors.

Another cause of delays is problems in budget availability for the project by owner, and delay in progress payments by the owner. In this case, delays in the progress of payments by the financial management of projects pose a significant risk of delay, which eventually result in many Libyan projects not proceeding in accordance with the project schedule. There is an urgent need for clients to develop an explicit method to hasten the payment process. Projects in project financing on the part of the contractor is another significant cause of delay. Thus, contractors need to be able to manage their financial resources and plan cash flows by using progress payment.

Many owners and their legal advisors claim that the original contract duration is too short, and more time is needed for completion, and contractors should be offered financial incentives to finish their projects according to schedule. Factors that recorded the lowest means in comparison to other factors include: (EX7) Economic problems (mean = 3.18), and (EX3) Theft of contractor's resources. (mean= 3.05).

5.3. Reliability analysis

Testing of the reliability of the five-point scale utilized in the survey was carried out using Cronbach's alpha coefficient. This assesses the internal consistency among the factors [13]. The value 0.7 is usually taken as the acceptable lower limit for Cronbach's alpha, although values as low as 0.6 are occasionally accepted for the purpose of exploratory research [14]. Assessment of the consistency and reliability in this study within the ranges assigned in Table 5 was performed using the Cronbach's alpha test. After excluding weak items such as OW5, EX4, CN9 and CN8, the five-point scale measurement was found to be reliable at the 5% significance level for 50 delay causes. The total results of responses per factor causing delays to Libyan road construction projects is listed in Table 6.

Table 5. The Cronbach's alpha test of delay factors.

No.	Construct measurement scales	Number of items	Cronbach's alpha
1	Contractor (CO)	9	0.911
2	Owner (OW)	8	0.854
3	Consultant (CN)	7	0.806
4	Utility Service (US)	5	0.810
5	Government Regulations (GR)	7	0.805
6	PROJECT (PR)	4	0.920
7	External (EX)	6	0.857
8	Equipment & Material (E&M)	4	0.883
9	All Construct Measurement Scales	50	

Table 6. Ranking of delay causes.

Codes	Delay causes	Mean	Rank
US1	Delays in the conversion and transfer of utility services (such as power lines, water	4.03	1
OW1	Difficulty in Budget availability for the project	4.02	2
PR1	Original contract duration is too short	3.96	3
OW4	Delay in progress payments by the owner	3.96	4
US4	Effects of subsurface (underground) conditions	3.89	5
PR3	Unavailability of incentives for contractor for finishing ahead of schedule.	3.87	6
PR4	Corruption.	3.86	7
GR4	Delay in performing final inspection and certification.	3.85	8
GR6	Summer restriction on time of work	3.85	8
PR2	Accidents at construction site.	3.84	9
US3	Long response from utilities agencies	3.79	10
GR3	Ineffective delay penalties.	3.71	11
US5	Smaller utilities are restrained by funding limitation.	3.70	12
GR5	Change in government regulations and rules	3.70	12
EM4	Poor quality of construction materials.	3,67	13
OW9	Change of project scope by the owner during construction	3.64	14
GR2	Tendering system requirement of selecting the lowest bidder	3.63	15
OW2	Delay in decision making by the owner.	3.63	15
OW8	Delay to deliver the site to contractor	3.62	16
EM5	The change in prices of materials.	3.61	17
CO4	Inexperienced contractor's manpower	3.60	18
EM1	Shortage the materials in the market such as soil, asphalt, etc.	3.59	19
CO7	Difficulties in project financing by contractor	3.58	20
OW6	Suspension of work by owner	3.57	21
EM3	Shortage of equipment.	3.57	21
GR1	Complexity and delays in administrative and financial procedures of project.	3.55	22
US2	Unclear or undefined positions of services networks	3.55	22

	in drawing and underground.		
GR7	Delay in getting permits from different government offices	3.55	22
CO5	Lack of motivation among contractor's members	3.54	23
CO1	Rework due to errors during construction	3.52	24
OW3	Interference by the owner during construction	3.52	24
CO9	Poor communication between contractor and other project parties	3.52	24
CO6	Poor qualification of the contractor's technical staff.	3.50	25
CO2	Poor site management and supervision by contractor	3.48	26
CO8	A shortage of manpower	3.48	26
CO3	Improper planning and scheduling of project.	3.46	27
OW7	Poor communication between owner and other project parties	3.45	28
CN2	Delay in approving major changes in the scope of work by consultant	3.39	29
EX1	Delays in construction activities due to weather changes	3.38	30
CN4	Lack of competent person to monitor the progress at site.	3.36	31
CN1	Delay in performing testing and inspection by consultant	3.35	32
CN5	Insufficient experience of consultant	3.35	32
CN7	Missing dimensions in the drawings	3.35	32
EX8	Poor Political situation and security especially after revolution.	3.34	33
EX6	Unforeseen circumstances as war, revolution and strike, etc.	3.31	34
CN10	Poor design and delays in design.	3.29	35
EX2	Delays in acquiring land from citizens.	3.23	36
CN3	Lack of flexibility by consultant	3.22	37
EX7	Economic problems	3.18	38
EX3	Theft of contractor's resources.	3.05	39

5.4. Factor analysis

The 50 delay factors were grouped into core factors and categorized together with a manageable number of factors using factor analysis. The communalities of each variable were used to check the reliability of the factor model. All communalities above 0.5 may be acceptable since the sample size of this study is 256 samples [13]. Eleven factors (CO5), (CN10), (OW6), (OW8), (CN7), (US2), (GR4), (GR6), (EX3), (EX6) and (EM1) were discarded because some their communalities were below 0.5 respectively, and some factors were cross loading, leaving 39 factors. The factor model in this study is reliable because the communalities of all the other factors of delay were found to exceed 0.5. The running of the factor analysis was by Varimax Rotation and Principle Component Analysis. Test results show that Bartlett's test of sphericity is significant ($p = 0.000$), while the KMO index stands at 0.856 (higher than 0.5). As such, the data are suitable to undergo factor analysis. The results identified eight factors extracted with eigenvalues greater than 1, according to Kaiser's criteria. 79.324% of the total variance in the data was explained by these eight factors. Table 7 shows the results of the EFA.

Table 7. Factor analysis of delay factors.

Codes	F1	F2	F3	F4	F5	F6	F7	F8
CO8	.911							
CO2	.910							
CO9	.890							
CO1	.888							
CO7	.758							
CO4	.753							
CO3	.736							
CO6	.669							
OW9		.941						
OW1		.915						
OW3		.914						
OW4		.862						
OW2		.824						
OW7		.745						
GR3			.962					
GR5			.955					
GR7			.940					
GR2			.892					
GR1			.704					
CN4				.882				
CN1				.881				
CN2				.871				
CN3				.857				
CN5				.850				
EX1					.961			
EX8					.950			
EX2					.940			
EX7					.814			
PR4						.875		
PR2						.874		
PR3						.864		
PR1						.838		
US3							.873	
US1							.871	
US5							.871	
US4							.856	
EM5								.864
EM3								.852
EM4								.843

Figure 2 depicts the final conceptual model of the relationship between the road projects delay and the extracted factors of delay, after applying EFA. Within this model, the 39 factors of delay were categorized into the 8 core groups of factors.

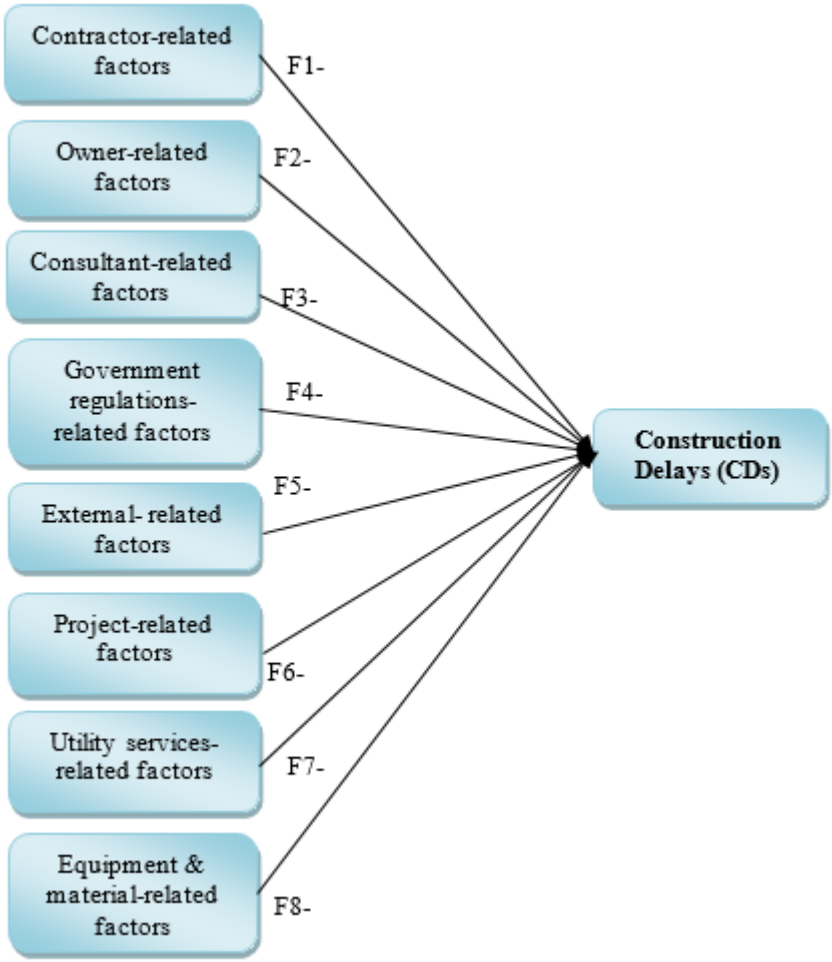

Fig. 2. Final conceptual model after applying EFA.

6. Conclusions

A conceptual model of factors of delay influencing the completion of the Libyan road construction projects was developed by this study. Following the literature review and pilot study, fifty-nine delay items were extracted and categorized into 8 groups of factors to form the initial conceptual model and, after testing and analysis, thirty-nine delay items were extracted and categorized into 8 groups of factors to form the final conceptual model. The five most significant factors affecting the completion of the project, as shown by the findings of the factor ranking are: (US1) Delays in the conversion and transfer of utility services by the competent authorities (such as power lines, water, etc.) (mean = 4.03); (OW1) Difficulty in Budget availability for the project (mean = 4.02); (PR1) Original contract duration is too short (mean = 3.96); (OW4) Delay in progress payments by the owner (mean = 3.96); (US4) Effects of subsurface (underground) conditions (mean = 3.89).

The final conceptual model was identified using EFA and the results of the eight extracted factors influencing the completion of the project include: (factor 1) Factors related to the contractor; (factor 2) Factors related to the owner; (factor 3) Factors related to consultants; (factor 4) Factors related to the government regulations; (factor 5) External-related factors; (factor 6) Factors related to the project; (factor 7) Factors related to the utility services; and (factor 8) Factors related to equipment and materials.

References

1. Van, L.T.; Sang, N.M.; and Viet, N.T. (2015). A conceptual model of delay factors affecting government construction projects. *ARPN Journal of Science and Technology*, 5(2), 92-100.
2. GPC. (2010). Retrieved April 15, 2010, from http//www.gpc.gov.ly.
3. Patil, S.; Gupta, A.; Desai, D. and Sajane, A. (2013). Causes of delay in Indian transportation infrastructure projects. *International Journal of Research in Engineering and Technology*, 2(11), 71-80.
4. Atibu, M. (2015). An investigation into factors causing delays in road construction projects in Kenya. *American Journal of Civil Engineering*, 3(3), 51-63.
5. Kamanga, M.; and Steyn, W.J. (2013). Causes of delay in road construction projects in Malawi. *Journal of the South African Institution of Civil Engineering*, 55(3), 79-85.
6. Al-Hazim, N. (2015). Delay and cost overrun in road construction projects in Jordan. *International Journal of Engineering and Technology*, 4(2), 288-293.
7. Elawi, G.S.A.; Algahtany, M.; Kashiwagi, D.; and Sullivan, K. (2015). Major factors causing construction delays in Mecca. *Journal for the Advancement of Performance Information*, 7(1), 1-11.
8. Emam, H; Farrell, P; and Abdelaal, M. (2015) Causes of delay on infrastructure projects in Qatar in: Raidén, A B; and Aboagye-Nimo, E (Eds) *Proceeding of 31st Annual ARCOM Conference*. Lincoln, UK, Association of Researchers in Construction Management, 773-782.
9. Hasan, R.; Suliman, S.M.; and Malki, Y.A. (2014). An investigation into the delays in road projects in Bahrain. *International Journal of Research in Engineering and Science*, 2(2), 38-47.
10. Jahanger, Q. (2013). Important causes of delay in construction projects in Baghdad city. *Australian Journal of Basic and Applied Sciences*, 7(4), 14-23.
11. Aziz, R.F.; and Abdel-Hakam, A.A. (2016). Exploring delay causes of road construction projects in Egypt. *Alexandria Engineering Journal*, 55(2), 1515–1539.
12. Cochran, W. (1977). *Sampling techniques* (3th ed.). New York: John Wiley and Sons Inc.
13. Field, A. (2009). *Discovering statistics using SPSS* (2th ed.). London: Sage Publications.
14. Hair, J.; Black, W.; Babin, B.; and Anderson, R.E. (2010). *Multivariate data analysis: a global perspective*. New Jersey: Pearson Prentice Hall.