Causes and effects of delay in Portuguese construction industry

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Abstract

Delays in construction projects are frequent in engineering projects all over the world and Portugal is no exception. These delays can cause severe impacts such as time and cost overruns, conflicts between parts and can also lead to total abandonment of the contract. This paper presents the findings of a national survey conducted to identify the most important causes of delay, the frequency of the impacts and the correlation between them. Among the respondents were representatives from all the parties involved: contractors, consultants and owners.

Relative Importance Index was used to classify the relative importance of the causes and the frequency of the effects. The results of the survey concluded that the main causes of delay were slow decision making by owner, change orders, unrealistic contract duration and specifications in contract, financial constrains of contractor and type of project bidding and award. It was also concluded that time and cost overruns are frequent in construction projects in Portugal. Factor analysis and correlation analysis were also conducted to identify the link between the causes and the relationship between causes and effects.

It is expected that these findings can improve the knowledge in the scientific community of project management and can help in the mitigation and prevention of these delays. This paper will also allow foreign companies to gain a better knowledge of the Portuguese industry and its problems, so they can prepare a more accurate approach to the market.

Keywords: Construction delays, Portuguese construction industry, Project management, Relative Importance Index, Factor analysis, Correlation analysis

1. Introduction

Delays in construction projects have always been a global issue in all sorts of projects. In construction, delay can be defined as the time overrun either beyond completion date specified in a contract, or beyond the date the parties agreed upon for delivery of a project (Assaf and Al-Hejji 2006).

The construction process is usually divided into 3 distinct phases: planning, design and construction (Baldwin et al. 1971) and it is in this last phase, where many unpredictable factors are involved, which usually occur most delays (Chan and Kumaraswamy 1997).

Time performance is one of the basic parameters for evaluating the success of a construction project and must always be one of the main concerns in project management. It is considered that a project is successful if it fulfills the requirements of 3 major indicators: time, cost and quality. Rwelamila and Hall (1995), also found that the timely completion of a project was frequently seen as one of the major parameters for evaluating project success. Considering that it is no surprise that project duration is a decisive criterion for clients when choosing a contract.

When a project faces delay it is usually extended or accelerated and both solutions have additional costs implied. Project delays are so frequent that common practice allows a contingency cost in the contract, which is normally a percentage of the total contract price, in case of delay (Akinsola 1996). As consequence of these delays several problems occur, especially financially wise, which often result in conflicts between parties involved: contractor, consultant and owner.

Despite all the efforts to prevent these delays, project design and construction complexity makes it often difficult to identify the causes responsible for delays. Identifying the causes may be even more difficult since many of them are often interconnected (Alkass et al. 1996) which means that delays can be consequence of one another.

In Portugal the scenario is no different and delays affect a great percentage of construction projects. In recent years the financial crises has lead to a major stagnation in the construction industry forcing

several companies to declare bankruptcy or move abroad. With all this financial constrains the market is becoming increasingly more competitive and optimizing cost and time is essential for contractors. Therefore, identifying the causes of delay is a key factor for process optimization.

Several papers have been developed in the last 2 decades over this matter but most of them far from the Portuguese context. Thereby the main goal of this study is to identify the main causes of delay in the Portuguese construction industry and its effects and understand the link between them. It is also important to understand the differences of opinion between the various parties involved.

2. Literature review

2.1. Studies on causes of delay

Many researchers have studied causes and effects of delay in construction industry in recent decades. Although there are several more studies about the causes of delay than about effects of delay this review cover both of them.

Mansfield et al. (1994) identified 16 major causes of delay and cost overrun in Nigerian construction projects through a questionnaire survey that was conducted with contractors, consultants and clients. They concluded that the main causes of delay and time overrun were related to finance and paying arrangements, poor contract management, shortage in materials inaccurate estimation and price fluctuations.

Al-Ghafly (1995) studied delays in public water and sewerage system in Saudi Arabia identifying 60 different causes of delay. One of his major findings was that delays occurred more often in medium and large projects but the effects were much more severe in small projects. Among his findings he also concluded that the main causes of delay were financial issues, change orders by owner, slow decision making by owner, difficulties in obtaining work permit and coordination problems between parties.

Ogunlana et al. (1996) conducted a study on causes of delay in Thailand analyzing 12 skyscraping projects in Bangkok. They identified 26 causes of delay and concluded that shortage of material, especially cement, lack of qualified workforce, change orders by owner and inadequate contractor experience were the most important ones.

Chan and Kumaraswamy (1997) conducted a survey research in Hong Kong with contractors, consultants and clients to classify the relative importance of 83 causes of delay. They concluded that the main causes of delay were poor site management and supervision, unforeseen ground conditions, low speed of decision making involving all projects teams, client initiated variations and necessary variations of work.

Noulmanee et al. (1999) developed a study on causes of delay in highway construction projects in Thailand. The study concluded that the main causes of delay were inadequacy of subcontractors, lack of organizational resources, inadequate project definition and bad communication between parties.

Odeh and Battaineh (2002) conducted a survey research in Jordan to identify the main causes of delay in traditional contract projects. A questionnaire survey was carried out between contractors and consultants to evaluate the relative importance of 28 causes previously selected. They concluded that the major causes of delay were: inadequate contractor experience, owner interference, delay in progress payment by owner, slow decision making by owner, improper planning, low productivity level of labor and problems with subcontractors.

Doloi et al. (2012) conducted a survey research to indentify the main causes of delay in different types of construction projects in India. They selected a group of 45 causes of delay and classified them according to the respondents' answers. The most important causes of delay indicated by the respondents were delay in material delivery by vendors, non availability of drawings on time, financial constrains of contractor, increase in scope of work and obtaining permissions from local authorities.

Gündüz et al. (2012) conducted a survey research to identify the relative importance of 83 different causes of delay in Turkish construction industry. They carried out a questionnaire between 64 specialists on the field and concluded that inadequate contractor experience, ineffective project planning and scheduling, poor site management and supervision, design changes by owner and late delivery of materials.

Fallahnejad (2013) developed a study on causes of delay analyzing 24 gas pipeline projects in Iran. He carried out a questionnaire survey to evaluate the relative importance of 43 different causes of delay. He concluded that the main causes of delay were low ability of contractor to provide imported material, unrealistic contract durations imposed by client, slow delivery of material by client, slow land expropriation due to resistance from occupants and clients' change orders.

2.2. Studies on effects of delay

Aibinu and Jagboro (2002) evaluated the effects of delays in Nigerian construction industry. They discover that construction delays have several consequences such as time overrun, cost overrun, dispute, arbitration, litigation and total abandonment. The also found out that time and cost overrun were the most frequent effects.

Manavazhi and Adhikari (2002) conducted a survey research to evaluate the effects of material delays in 22 highway construction projects in Nepal. They found out a link between the material delays and final project cost and concluded that when delays occured project cost were 0.5% higger than inicially expected.

Sambasivan and Soon (2007) conducted a survey research on causes and effects of delay in construction porjects in Malaysia and identified the relationship between them. They were able to link time overrun with causes related to owner and contractor. They also concluded that cost overrun was mostly connected with causes related to the contractor.

3. Research methodology

For this research a questionnaire survey methodology was used to find the importance of the causes and the frequency of the impacts. Major progress has been made through out investigations based on survey research methodology in recent years (Rungtusanatham 1998). Several authors have used survey research methodoly in similar investigations on causes and effects of delay (Mansfield et al. 1994, Chan and Kumaraswamy 1997, Manavazhi and Adhikari 2002, Odeh and Battaineh 2002, Sambasivan and Soon 2007, Doloi et al. 2012, Gündüz et al. 2012).

3.1 Preparation of the questionnaire

Questionnaire design is a key part of survey research methodology. It is important that the questionnaire is clear and has no mistakes or descrepancies in its design. To acomplish that basic ground rules for social surveys were adopted in questionnaire design (Fowler 2009). The questionnaire was developed to assess the importance of the causes of delay and the frequency of the effects. For that purpose a five point Likert scale was adopted (1 - very low; 2 - low; 3 - average; 4 - high; 5 - very high).

A total of 47 causes of delay reported in the literature were considered for this research. These causes were divided into 9 categories namely client related causes, contractor related causes, consultant related causes, material related causes, labor and equipment related causes, design related causes, contract and contract relationships related causes, external causes and authority related causes. In addition 6 effects were considered: time overrun, cost overrun, dispute, arbitration, litigation and total abandonment (Aibinu and Jagboro 2002).

3.2. Questionnaire pilot test and administration

After the questionnaire design was concluded a pilot test was carried out with a limited number of companies to verify the effectiveness in collecting information and to identify possible mistakes or misunderstandings. After this pilot test some changes were made in the questionnaire. The questionnaire was then distributed through electronic mail to a selected sample of 150 contractors, 100 consultants and 70 clients.

Sample selection plays a decisive role in survey research methodology and mistakes in this process will reduce confidence in the results. Furthermore, non-respondents can alter a sample frame and lead to non-response bias which can compromise the validity of the results. To avoid these issues all recommendations by Forza (2002), regarding sample size and design and non-response bias were taken in consideration. Of the 320 questionnaires send out, 139 were returned: 62 contractors, 46

consultants and 31 clients. With the responses obtained from the survey, data was then analyzed with various statistical tools to extract the maximum information.

4. Ranking of causes and effects

4.1. Relative importance index

The RII method was adopted in this study evaluate the relative importance of causes of delay and the relative frequency of effects of delay. This use of methodology is common in survey research and has been used by several authors (Assaf et al. 1995, Chan and Kumaraswamy 1997, Aibinu and Jagboro 2002, Odeh and Battaineh 2002, Frimpong et al. 2003, Sambasivan and Soon 2007, Doloi et al. 2012, Gündüz et al. 2012)

RII, relative importance index, can be calculated using the following equation:

$$RII = \frac{\sum W}{A \times N} \quad [1]$$

W - Weight given to each cause by respondent (1 to 5)

A - Highest weight (A = 5)

N - Total number of respondents

4.1.1. Ranking of causes

The ranking of causes is present in table 1. The most important cause, according to the respondents, was slow decision making by owner. Timing of decision making is crucial in construction projects and delays in this process can stop the work progress. The following causes in the top 5, according to the respondents, were: change orders, unrealistic time schedule and specifications in contract, financial constrains of contractor and type of project bidding and award. Delay in progress payments by owner, improper planning and scheduling, owner interference, increase in scope of work and mistakes and discrepancies in drawings were also indicated as important causes of delay by respondents.

Along with this ranking it is important to identify the differences of opinion between the various entities of respondents. Contractors indicated slow decision making by owner as the major cause of delay. Consultants have identified unrealistic time schedule and specifications in contract as the most important cause of delay while clients indicated that financial constrains of contractor as the major cause of delay. To a better comparison, table 2 presents the ranking of categories according to each entity and the global ranking.

Client related causes and contract and contract relationships related causes are the most relevant categories of causes of delay. It can also be inferred that the major difference between the entities responses is the importance given to contractor related causes. Consultants and clients agree on the decisive role of this category but contractors give more importance to design related causes and consultant related causes. The main conclusion is that consultants and clients agree more with each other than with contractors. The same conclusion can be inferred analyzing the Spearman's rank of correlation (Assaf and Al-Hejji 2006), presented in table 3, which tests the degree of agreement between entities. Since data was collected based on a Likert-scale it can be considered as interval data and correlation analysis is an effective method to study relationships between this types of variables (Sekaran and Bougie 2010). It can also be concluded that contractors and clients have the most significant differences in their opinion.

Table 1 – Ranking of causes of delay

Causes of delay	RII	Rank	Causes of delay	RII	Rank
Client related causes			**Labor and equipment related causes**		
C1 - Delay in progress payments by owner	0.770	**6**	C29 - Lack of qualified labor	0.626	**30**
C2 - Slow decision making by owner	0.849	**1**	C30 - Low labor productivity	0.651	**27**
C3 - Owner interference	0.736	**8**	C31 - Equipment availability and failure	0.574	**38**
C4 - Delay to deliver the site to the contractor by owner	0.574	**38**	C32 - Inadequate equipment	0.596	**34**
C5 - Increase in scope of work	0.732	**9**	**Design related causes**		
C6 - Change orders	0.845	**2**	C33 - Mistakes and discrepancies in drawings	0.728	**10**
C7 - Bureaucracy in owner's organization	0.670	**22**	C34 - High complexity of drawings	0.587	**35**
Contractor related causes			C35 - Delay in producing design documents	0.632	**29**
C8 - Delays and changes of subcontractors	0.655	**26**	**Contract and contract relationships causes**		
C9 - Inadequate construction methods	0.626	**30**	C36 - Type of project bidding and award	0.828	**5**
C10 - Improper planning and scheduling	0.755	**7**	C37 - Unrealistic time schedule and specifications in contract	0.845	**2**
C11 - Mistakes during construction	0.645	**28**	C38 - Mistakes and discrepancies in contract	0.666	**24**
C12 - Inadequate contractor experience	0.677	**18**	C39 - Lack of motivation for contractor for early finish	0.560	**41**
C13 - Site accidents	0.474	**47**	C40 - Lack of communication between parties	0.696	**16**
C14 - Poor site management and supervision by contractor	0.577	**37**	C41 - Disputes and negotiations between parties	0.711	**14**
C15 - Financial constrains of contractor	0.843	**4**	**External causes**		
C16 - Delay in site mobilization by contractor	0.657	**25**	C42 - Unforeseen site condition	0.687	**17**
Consultant related causes			C43 - Problems with neighbors	0.566	**40**
C17 - Inflexibility of consultant	0.668	**23**	C44 - Unavailability of utilities in site	0.511	**45**
C18 - Delay in approval of drawings	0.674	**20**	C45 - Weather condition	0.672	**21**
C19 - Delay in quality control	0.621	**32**	**Authority related causes**		
C20 - Lack of control over subcontractor	0.521	**44**	C46 - Changes in government regulations	0.530	**42**
C21 - Waiting time for approval of tests and inspections	0.598	**33**	C47 - Delay in obtaining permits from authorities	0.726	**11**
Material related causes					
C22 - Inadequate material quality	0.585	**36**			
C23 - Damaged materials	0.511	**45**			
C24 - Shortage in material	0.677	**19**			
C25 - Delay in material delivery	0.711	**14**			
C26 - Changes in material specifications during construction	0.717	**13**			
C27 - Delay in material procurement	0.721	**12**			
C28 - Change in material price	0.523	**43**			

Table 2 - Rank of categories of causes of delay

Category	Respondents							
	Contractor		Consultant		Client		Global	
	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking
Client	0.764	1	0.701	2	0.727	1	0.740	**1**
Contractor	0.664	6	0.623	3	0.711	3	0.657	**3**
Consultant	0.685	4	0.509	9	0.578	9	0.617	**7**
Material	0.647	8	0.588	4	0.704	4	0.635	**5**
Labor and equipment	0.633	9	0.582	5	0.591	7	0.612	**8**
Design	0.693	3	0.576	6	0.636	5	0.649	**4**
Contract and contract relationships	0.723	2	0.704	1	0.724	2	0.717	**2**
External causes	0.659	7	0.530	8	0.582	8	0.609	**9**
Authority	0.668	5	0.557	7	0.627	6	0.628	**6**

Table 3 - Spearman's rank of correlation coefficients

Entity	Contractor	Consultant	Client
Contractor	1		
Consultant	0.727*	1	
Client	0.648*	0.831*	1

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

4.1.2. Ranking of effects

The ranking of effects based on the overall answers is presented in table 4. Time and cost overrun are the most frequents effects of delay according to the respondents. It can also be inferred by analyzing the RII that time and cost overrun and disputes are more frequent than arbitration, litigation and total abandonment.

Table 4 - Ranking of effects

Effects of delay	RII	Ranking
E1 - Time overrun	0.804	**1**
E2 - Cost overrun	0.785	**2**
E3 - Disputes	0.700	**3**
E4 - Arbitration	0.506	**4**
E5 - Litigation	0.485	**5**
E6 - Total abandonment	0.415	**6**

4.2. Factor analysis

Factor analysis is a statistical tool that provides correlation between variables that doesn't seem related and group them into much fewer underlining factors (Doloi 2009). Factor analysis was useful in this study to identify correlations between causes of delay that didn't seem related as first and it was used before in similar studies (Doloi et al. 2012). To evaluate the adequacy of the survey results for

factor analysis, KMO and Bartlett's test of sphericity were conducted (Field 2013). The result of KMO value was 0.748, which is higher than 0.5, the minimum value suggested by Kaiser (1974).

Principal componets analysis were used in factor analysis. 8 factors were extracted representing a total of 30 causes of delay. 17 causes of delay were found to have no significant correlation with another one. These 8 factors explained approximately 70% of total variance and are presented in table 5.

4.2.1. Discussion of extracted factors

Factor I - related to contractor

First factor contains 6 causes of delay all of them directly related to the contractor: delays and changes of subcontractors, inadequate construction methods, improper planning and scheduling, mistakes during construction, inadequate contractor experience and poor site management and supervision by contractor. Contractor plays a decisive role in construction projects and the quality of his performance is crucial to avoid delays. If the contractor is not committed in finishing the project on time than his performance will be poor and delays will occur frequently. Contractor performance and commitment brings together all these causes of delay into one unique factor and it is simple to understand the correlation between them.

Factor II - related to productivity

Second factor groups 5 causes of delay related with materials, labor and equipment: shortage in material, delay in material delivery, low labor productivity, equipment availability and failure and inadequate equipment. Unavailability of equipment or inadequate equipment can decrease significantly labor productivity and it is a clear sign of improper planning and poor site management. Along with that shortage in material, which can be consequence of delays in material delivery or improper planning, also leads to a decrease in labor productivity. Low labor productivity combined with work stoppages due to shortage of material or equipment failure can also be considered a major reason for construction delays.

Factor III - related to consultant

Third factor joins 4 causes of delay, all of them related to the consultant: inflexibility of consultant, delay in approval of drawings, delay in quality control and waiting time for approval of tests and inspections. Consultant also plays an important role in construction projects and his rigidity and inflexibility can cause significant delays in work progress. Consultant has to assure the quality of contractor's performance and has the power to stop the work progress to perform tests and inspections. Therefore, if the consultant takes too long on this process or is inflexible on his demands, delays can occur and work schedule can be compromised.

Factor IV - related to subcontractors

Fourth factor associates 4 causes of delay related with various categories: lack of control over subcontractor, inadequate material quality, change in material price and lack of motivation for contractor for early finish. Although these causes of delay may seem unrelated their correlation relies mostly on subcontractor's work. Lack of motivation of the contractor makes him sloppier in the process of choosing and controlling the subcontractors which makes it harder for the consultant to control and monitor all of them. As a consequence of this, subcontractors feel free to decrease the quality material and change material price in order to increase their profits.

Factor V - related to lack of communication

Fifth factor groups 3 causes of delay related with contract and contract relationships: unrealistic time schedule and specifications in contract, lack of communication between parties and disputes and negotiations between parties. In order to be competitive, contractors reduce time schedule beyond reasonable terms and then are unable to meet the their initial proposal. This issue immediately originates time overrun and frequently leads to disputes between parties that slow down or stop work progress. Along with this, lack of communication between all parties involved also lead to disputes and negotiations.

Table 5 - Factor analysis

Factors extracted	Factor loading
Factor I - related to contractor	
C8 - Delays and changes of subcontractors	0.660
C9 - Inadequate construction methods	0.650
C10 - Improper planning and scheduling	0.818
C11 - Mistakes during construction	0.753
C12 - Inadequate contractor experience	0.652
C14 - Poor site management and supervision by contractor	0.710
Factor II - related to productivity	
C24 - Shortage in material	0.592
C25 - Delay in material delivery	0.596
C30 - Low labor productivity	0.624
C31 - Equipment availability and failure	0.714
C32 - Inadequate equipment	0.737
Factor III - related to consultant	
C17 - Inflexibility of consultant	0.717
C18 - Delay in approval of drawings	0.802
C19 - Delay in quality control	0.762
C21 - Waiting time for approval of tests and inspections	0.756
Factor IV - related to subcontractors	
C20 - Lack of control over subcontractor	0.725
C22 - Inadequate material quality	0.536
C28 - Change in material price	0.660
C39 - Lack of motivation for contractor for early finish	0.617
Factor V - related to lack of communication	
C37 - Unrealistic time schedule and specifications in contract	0.576
C40 - Lack of communication between parties	0.597
C41 - Disputes and negotiations between parties	0.770
Factor VI - related to client	
C2 - Slow decision making by owner	0.833
C3 - Owner interference	0.794
C6 - Change orders	0.546
Factor VII - related to financial constrains	
C1- Delay in progress payments by owner	0.689
C15 - Financial constrains of contractor	0.567
C36 - Type of project bidding and award	0.624
Factor VIII - related to bureaucracy	
C7 - Bureaucracy in owner's organization	0.736
C46 - Changes in government regulations	0.610

Factor VI - related to client

Sixth factor joins 3 causes of delay related with client: slow decision making by owner, owner interference and change orders. Along with the contractor and the consultant, client plays another major role in construction projects. All these causes of delay are related to client intervention in the process so the correlation between them makes sense. Slow decision making and interference can slow down or even stop the work progress and generate delays. Change orders by owner also lead to scheduling modifications that can delay the completion of the project.

Factor VII - related to financial constrains

Seventh factor associates 3 causes of delay related with financial issues: delay in progress payments by owner, financial constrains of contractor and type of project bidding and award. These causes of delay are directly related with the financial problems faced by both owner and contractor. Delay in progress payments by owner forces the contractor to use their own financial resources to supply the project activities or otherwise work progress will stop. Type of project bidding and award is also associated with these causes due to its financial nature. Owners frequently choose the lowest bidder to award their contracts. In order to become more competitive and lower prices, contractors reduce their profit margins and become more vulnerable to payment delays.

Factor VIII - related to bureaucracy

Eighth factor contain 2 causes of delay related with bureaucracy: bureaucracy in owner's organization and changes in government regulations. Both causes of delay are related to the formal requirements demanded by the owner and the legislation. The bureaucracy in owner's organization can delay the work progress in many ways. Most common types of bureaucracy are excess of paper work and inefficient communication chain. Changes in legislation are also a major problem in construction projects due to its external nature and its unpredictability.

4.2.2. Mathematical validity of factor analysis

To confirm that extracted factors measure what they are intended it is necessary to cross check if the causes within each factor are related to each other (Doloi 2009). To measure the degree of correlation between causes of delay in each factor, Pearson correlation coefficient was calculated and it is presented in table 6. For coefficient values greater than 0.7 correlation is found strong and for coefficient values between 0.3 and 0.7 correlation is considered moderate. All correlation coefficients between causes present values higher than 0.3 so it can be concluded that the factors extracted from factor analysis contain related causes.

Along with this correlation analysis it is necessary to conduct a reliability analysis to ensure the consistency of measured causes and its scale (Doloi et al. 2012). For that purpose, Cronbach's alpha test was conducted to the causes of delay of each factor and to all 30 causes of delay extracted of the factor analysis. Results of this test are presented in table 7. Although there is no established minimum for an acceptable value of Cronbach's alpha, Doloi (2009) suggests the following scale: $C_\alpha > 0.9$ - excellent; $0.9 > C_\alpha > 0.8$ - good; $0.8 > C_\alpha > 0.7$ - acceptable; $0.7 > C_\alpha > 0.6$ - questionable; $0.6 > C_\alpha > 0.5$ - poor and $0.5 > C_\alpha$ - unacceptable. All values of Cronbach's alpha are greater than 0.6 and overall result is 0.917 which is considered excellent. Therefore all results of factor analysis can be accepted and have statistical meaning.

4.3. Correlation between causes and effects

The final step of this investigation was to identify the relationships between causes and effects. For that purpose, a correlation analysis was carried out between the 8 factors extracted from the factor analysis and the six effects previously identified in the literature. Pearson correlation coefficients were calculated to identify these relationships and are presented in

table 8.

Several correlations were found between factors of causes and effects. Positive correlation means that an increase in the occurrence of a cause of a certain factor will increase the frequency of the correspondent effect. Negative correlation means the opposite: an increase in the factor occurrence will decrease the frequency of the effect.

Table 6 - Pearson correlation between causes

Factor I

	C8	C9	C10	C11	C12	C14
C8	1					
C9	0.508	1				
C10	0.582	0.541	1			
C11	0.553	0.540	0.647	1		
C12	0.376	0.364	0.554	0.632	1	
C14	0.359	0.580	0.514	0.484	0.587	1

Factor II

	C24	C25	C30	C31	C32
C24	1				
C25	0.789	1			
C30	0.509	0.575	1		
C31	0.441	0.531	0.664	1	
C32	0.577	0.545	0.713	0.763	1

Factor III

	C17	C18	C19	C21
C17	1			
C18	0.703	1		
C19	0.570	0.646	1	
C21	0.609	0.616	0.651	1

Factor IV

	C20	C22	C28	C39
C20	1			
C22	0.648	1		
C28	0.476	0.371	1	
C39	0.386	0.327	0.389	1

Factor V

	C37	C40	C41
C37	1		
C40	0.301	1	
C41	0.416	0.634	1

Factor VI

	C2	C3	C6
C2	1		
C3	0.531	1	
C6	0.361	0.440	1

Factor VII

	C1	C15	C36
C1	1		
C15	0.486	1	
C36	0.300	0.391	1

Factor VIII

	C7	C46
C7	1	
C46	0.509	1

Table 7 - Cronbach's alpha for the causes

Factor	**C_α**
Factor I	0.867
Factor II	0.885
Factor III	0.873
Factor IV	0.750
Factor V	0.712
Factor VI	0.703
Factor VII	0.651
Factor VIII	0.670
All causes	**0.917**

Factors IV and V, which contain causes related with subcontractors and with lack of communication, are the ones that that present more correlations with the effects and his consequences as more measurable. On the other hand, factor I, which contains causes related to the contractor, has no significant correlation with any effect. Although these causes have no direct relationship with the effects it does not mean that they are not related at all.

Table 8 - Correlation between causes and effects

Effects of delay	Factors extracted							
	I	II	III	IV	V	VI	VII	VIII
E1 - Time overrun	-0.061	-0.059	**-0.179**	**0.229**	**0.152**	-0.139	0.062	-0.138
E2 - Cost overrun	-0.051	0.118	0.015	**0.183**	**0.264**	0.060	**0.162**	0.104
E3 - Disputes	0.043	0.049	-0.026	0.074	**0.299**	-0.039	0.119	-0.021
E4 - Arbitration	0.091	**0.221**	**0.240**	**0.263**	**0.223**	-0.094	**0.167**	0.117
E5 - Litigation	0.119	0.133	**0.186**	**0.235**	**0.248**	**-0.207**	**0.229**	**0.158**
E6 - Total abandonment	0.121	0.120	0.110	**0.277**	0.105	-0.103	0.098	0.065

Highlighted coefficients are significant at 0.05 significance level

It is also relevant to analyze the negative coefficients to ensure that they make sense and verify the quality these results. The first negative coefficient correlates causes related to consultant with time overrun. This means that when causes of delay related to consultant occur time overrun tends to happen less frequently. The second negative coefficient relates factor VI, causes related to client, with litigation. Most litigations are initiated by clients when specifications in the contract are not respected. Therefore it makes sense that when the causes of delay are related to client, frequency of litigation tends to diminish.

5. Conclusion

5.1 Main conclusions

Through this investigation it was concluded that slow decision making by owner was the major cause of delay in construction projects in Portugal. Change orders, unrealistic time schedule and specifications in contract, financial constrains of contractor, type of project bidding and award and delay in progress payments by owner are also important causes. It was also concluded that consultants and clients have similar opinions and both of them disagree in certain matter with the contractor. Client related causes, contract and contract relationships related causes and contractor related causes are the most important categories of causes of delay. It was also concluded that several causes of delay are connected and can be grouped into larger factors. The major factors identified grouped causes related to contractor, causes related to productivity and causes related to consultant.

Regarding to the effects it was concluded that time overrun is the most frequent effect followed by cost overrun. It can also be concluded that causes and effects have multiple correlations and are connected in many ways.

This study is hoping to contribute decisively for the development of construction management knowledge in the scientific community and also help the Portuguese industry to prevent the causes of delay and mitigate its effects.

5.2. Limitations of the research

Although the sample size is considerable (139 respondents), a greater number could provide more information and increase the statistical meaning of the results. Also, the sample is not equally distributed among the entities and, despite all the measures taken, that could induce some bias on the responses.

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