

Expert analysis of causes of time deviation in construction contracts

Perspective of the Contractor, Owner and Designer

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Abstract - The construction sector is one of the main engines of the economy, which relies on the success of companies and their ability to manage and adapt. The economic failure of the construction works is, in the great majority, a consequence of the inaccurate cost and time estimates and/or the defective analysis/forecast of potential deviations, which can negatively influence the total costs of the works and leading to the economic failure of the companies. It is therefore essential to ascertain the causes of deviations from deadlines and their importance, according to the project participants, so that in the future it is possible to manage and reduce the risk of occurrence, avoiding past mistakes.

This study aims at contributing towards improving the effectiveness and efficiency of constructions by identifying the main causes of time deviation in construction contracts in Portugal. This was done through an expert survey. Based on 104 responses were obtained from Contractors, Owners and Designers, the vast majority with 10 or more years of experience, the most common causes of construction delays, from an initial list of 23 causes defined based on the literature review carried out: (1.) Unrealistic imposed contract duration, (2.) Changes to the project during execution, (3.) Occurrence of extra/overwork, (4.) Slow decision making by the owner, (5.) Problems with designs (incomplete, lack of data, errors), (6.) Problems in managing subcontractors, (7.) Improper planning, (8.) Financial difficulties and/or payments from owner, (9.) Difficulties in obtaining authorizations and licenses from authorities and institutions, (10.) Low productivity and/or lack of skilled labor. The main causes of construction delays vary with the perspectives of the respondents and a list of recommendations / measures to mitigate delays is proposed.

Keywords: Deviations from deadlines; risk management; construction projects; construction delays

1. Introduction and objectives

As the construction sector is an engine of the economy, more effective and efficient models of management must be implemented in the construction companies, boosting the production of sustainable and safe construction with simplification of costs, with guarantees of acceptable quality and environmental levels and a better management of established deadlines (Dias 2013).

Time management must be improved as time is an essential resource for the performance of a project that should be managed and treated carefully, otherwise negative consequences may arise for the work and for the company that performs it. Associated with time, the concept of deadline is defined as the time or date in which a task must be completed. Deviations of time are delays or advances relatively to the estimates defined for the projects. Positive deviations of time (delays) tend to have negative consequences and, in most cases, lead to increases in the expected costs. These situations may cause unease among owners and, in extreme cases, lawsuits (Ramos 2013).

With the high frequency of delays in construction projects, frequently associated cost deviations (as a minimum, the site cost increase), questions such as “Why are the expected deadlines often exceeded?”, “What are the causes for delays?”, “Where do these occur?” and “Whom or who are responsible?”. Since there is little information on this topic applied to the construction sector in Portugal, this study emerged as an attempt to answer these questions. The goal of this work was to identify the causes for the occurrence of time deviations, classify them according to their importance, analyze the different perceptions of the parties involved in the construction and create a basis of measures that can minimize or eliminate these factors that alter the deadlines. This group of procedures may be important in risk management and decision-making in future construction projects, since they are based on the experience acquired by the respondents, on site context.

2. Literature review

Many delays in construction result from the lack of proper planning or poor planning and

scheduling (Marques 2012, Sears et al. 2015). Scheduling is the basis or support several construction management activities, such as cost and time estimation and control, health and safety control, quality control, among others (Mubarak 2010).

The International Organization for Standardization developed ISO 21500 (2012) which is a guide for project management, where methods are described in order to detail the planning to be able to evaluate and monitor the performance of the project and manage its implementation. These guides are not methodologies, however due to their recognized international importance they have become base standards for the management of projects. In other hand, more related to quality, the ISO 10006 (2003) is a guide that support the planning, organization, monitoring, control and information of all aspects of a project, helping all stakeholders to achieve the project targets, namely in guaranteeing the quality of an organization, product or service.

The problem of construction delays is a worldwide phenomenon. There have been several efforts to understand it better, making it possible to organize studies in two types: i) qualitative; and ii) quantitative (Figure 1).

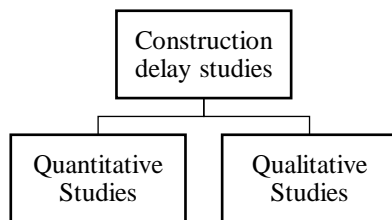


Figure 1 – Approaches to construction delay studies

Quantitative studies tend to be based on the statistical analysis of records of completed projects and provide information about the frequency and/or magnitude of the deviations. Of the quantitative studies, a study carried out by Al-Momani (2000), which analyzed 130 public projects in Jordan, among residential buildings, offices, schools, medical centers and communication facilities, having found that 81.5% of the projects suffered delays. The author concluded that the main cause is related to design defects.

Koushki et al. (2005) analyzed 450 private residential projects that have just been completed or were in the process of being completed in Kuwait, having validated that, on average, it was spent 93.6% more time compared to the initial deadline estimations.

In Portugal, a study by Moura et al. (2007) analyzed 66 public works contracts with a value greater than € 10,000,000, observing an average delay of 40%, and that in only 4 of them the final deadline was shorter than the initially established.

It is distinguished in Antunes (2012) a study of 41 public projects for construction and requalification in Portugal, where in 61% of them there were delays with an average of 115%, that is, the completion period increased to more than double.

In greater numbers, qualitative studies, carried out based on surveys and/or interviews with technicians in the construction area, evaluate the causes of deviations in deadlines that have occurred. These studies consider several factors associated with the undertakings such as the type of respondents involved (eg, owners; designers, consultants, contractors), types of work and their nature (eg, construction; rehabilitation; buildings; infrastructure; etc.), their size, location, to be able to assess the different perspectives and the existence of standards.

Ramanathan et al. (2012) carried out a study to review research and studies carried out until the date of its publication on causes of delays and cost in construction projects. These authors concluded that each study has a unique approach and each one of them obtained unique results from data collected through surveys, even studies that used similar factors such as the study of Sambasivan & Soon (2007) that was based on the factors of Odeh & Battaineh (2002).

Although there are many studies, there are some areas where there are limited studies and information. As such Zafar et al. (2019) analyzed the time overrun risk factors in highway projects in Pakistan, which is a terrorism-affected country, and showed that ‘stakeholder interference and insecurity threats’ is the most critical time overrun risk factor grouping followed by ‘inexperienced contractors and unproductive workforce’.

Other causes also mentioned, associated to contractors, although in lesser number are “Poor site management and supervision by the contractor”, which may also be related to the “Inexperience of the contractor; Lack of capacity of companies; Underestimated project cost” and poor construction planning and scheduling. Poor initial scheduling manifests during execution, causing delays, and only

proper planning can be carried out well (Sambasivan & Soon 2007).

Shortages of material and/or late purchase of those, as well as shortages of equipment or availability and equipment failures are also reported in many studies and are usually associated with developing countries. Mahamid et al. (2012) concluded that the group of causes associated with materials and equipment is the one with the highest degree of agreement between contractors and consultants in road construction projects in the West Bank. Also associated with developing countries, Prasad et al. (2019) carried out a study which evaluated the critical causes in India by type of project, namely transport, energy, buildings and water / irrigation projects.

Regardless of whether studies assess public or private works, problems with payments by the owner are a cross-cutting issue in many studies (Assaf & Al-Hejji 2006, Sambasivan & Soon 2007, Kaliba et al. 2009, Doloi et al. 2012, Aziz 2013).

Owner changes during construction and overwork are also considered by many authors to be the main causes of delays. Koushki et al. (2005) and Sweis et al. (2008) who assessed the causes of delays in residential works in Kuwait and Jordan, respectively, revealed that many requests by the owner to change were one of the 3 main causes of delay.

The delay in responses or the slow decision-making by inspections or owners are, according to Faridi & El-Sayegh (2006) pointed out by construction professionals in the United Arab Emirates, as the main causes of delays in construction projects. The studies by Odeh & Battaineh (2002) and Assaf & Al-Hejji (2006) indicate this as one of the main causes, revealing a pattern in the countries of the Middle East.

Related to designers, there are also mentioned in large numbers in the analyzed studies, the "Errors and Omissions of Design; Incomplete projects, ambiguities, inadequate details, inconsistent details between various specialties, inappropriate designs, etc.". Umar et al. (2020), concluded that the main cause in Oman related to designers/consultants is the lack of clarity or inadequate details in the design drawings.

Al-Momani (2000), Ellis & Thomas (2003), Frimpong et al. (2003), Assaf & Al-Hejji (2006) refer as well to weather conditions as one of the main external causes to the work's stakeholders.

Although the cause most mentioned in international studies is not the same in national studies, which may be related to the fact that most of the existing studies are about developing countries, it appears that in general they are common in the national panorama. At national level, the most cited cause is the occurrence of "Extra/Overwork; Changes by owners during construction".

The "Design Errors and Omissions; Incomplete projects, ambiguities, inadequate details, inconsistent details between various specialties, inappropriate designs, etc." are also widely referenced among national studies. Monteiro (2010) also mentions that it is due to the lack of importance given to the project, design errors, structure and dimension of the design companies, poor preparation of the designers, among others.

Some of the quantitative studies can be classified in a third category since they attempt to link quantitative data with qualitative aspects. Studies in this category are rarer, but some authors have attempted to assess the statistical significance of certain aspects of the projects on the pattern of the time deviations. Typical aspects that have been analyzed include the type of project, the type of contract, the nature of the promoter. Recently, Catalão et al. (2021) explored the influence of exogenous determinants on time deviations. Authors concluded that better economic cycle tends to reduce the occurrence of time overruns, politics have influence on the probability and magnitude of time overruns and improvements in governance and the institutional context reduce time overruns.

It must also be added that, the few existing national studies mainly cover the causes of deviations in time in a generalized way, since they do not explore or compare the different perspectives of the parties involved in a project. Thus, opposing to this trend in the national bibliography, the elaboration of this study is fundamental as it analyzes and discusses, through the results collected in the elaborated surveys, a list of causes and their importance according to a group of respondents composed mainly of Contractors, Owners and Designers. Through this method it is possible to verify the different perceptions of the parties involved in the construction and create a set of measures that can minimize or eliminate these factors that intend to alter the anticipated deadlines

Construction projects are fraught with high-level risks, having a link between the construction industry and risk management, to minimize their negative consequences and maximize the positive consequences. The work developed creates a foundation of knowledge built through experience and intuitive component acquired by the respondents throughout their professional life. In this way, construction companies and their decision-makers will have a tool to support risk management and aid decision-making, to promote risk mitigation measures inherent to the construction activity.

3. Methodology and Questionnaire design

The identification of the main causes of delay in construction projects in Portugal was done through questionnaires. The target respondents were professionals directly linked to the execution phase of the works and covering the

main perspectives, namely owners, contractors and designers.

The survey was carried out using an online platform for making it possible to create and perform it easily and quickly. It consisted of two parts: i) in a first section, respondents were asked to answer general questions related to their experience; and ii) a second, with questions associated with delays. The second part of the survey included a list of 23 causes, where respondents were asked to mark and rank them in terms of occurrence and greater degree of influence on the variation of deadlines. The list of 23 causes contained in the survey (Table 1) was prepared based on the literature review on the main causes of delays in the construction. It was also requested ways/solutions to avoid or minimize the causes of delays previously selected. An initial test was also carried out on a small group of interviewees like those of the final research, to validate a preliminary set of causes of delay obtained in the bibliographic research.

Table 1 – List of causes of delays selected for the survey

1.Inexperience of the contractor / 8.Inappropriate construction methods	(Odeh & Battaineh 2002),(Frimpong et al. 2003),(Sambasivan & Soon 2007),(Fugar & Agyakwah-Baah 2010),(Haseeb et al. 2011),(Aziz 2013),(Aziz & Abdel-Hakam 2016),(Umar et al. 2020)
2.Financial difficulties and/or payments from owner	(Koushki et al. 2005),(Assaf & Al-Hejji 2006),(Sambasivan & Soon 2007),(Kaliba et al. 2009),(Monteiro 2010),(Fugar & Agyakwah-Baah 2010),(Haseeb et al. 2011),(Antunes 2012),(Mahamid et al. 2012),(Kamanga & Steyn 2013),(Aziz 2013),(Prasad et al. 2019)
3.Low productivity and/or lack of skilled labor	(Odeh & Battaineh 2002),(Assaf & Al-Hejji 2006),(Faridi & El-Sayegh 2006),(Couto 2007),(Sambasivan & Soon 2007),(Kaliba et al. 2009),(Kamanga & Steyn 2013),(Gluszek & Leśniak 2015),(Al-Emad et al. 2017),(Prasad et al. 2019),(Raja K. M. Gopang et al. 2020)
4.Problems in managing subcontractors	(Odeh & Battaineh 2002),(Assaf & Al-Hejji 2006),(Sambasivan & Soon 2007),(Prasad et al. 2019),(Yap et al. 2020)
5.Slow decision making by the owner	(Odeh & Battaineh 2002),(Assaf & Al-Hejji 2006),(Faridi & El-Sayegh 2006),(Monteiro 2010),(Doloi et al. 2012),(Owolabi et al. 2014),(Arantes et al. 2015),(Tafazzoli & Shrestha 2017),(Raja K. M. Gopang et al. 2020)
6.Improper planning / 21.Mistakes in planning/scheduling due to lack of knowledge of the project sites	(Odeh & Battaineh 2002)Odeh & Battaineh(2002),(Frimpong et al. 2003),(Assaf & Al-Hejji 2006),(Faridi & El-Sayegh 2006),(Couto 2007),(Sambasivan & Soon 2007),(Sweis et al. 2008),(Fugar & Agyakwah-Baah 2010),(Haseeb et al. 2011),(Antunes 2012),(Aziz 2013),(Al-Emad et al. 2017),(Umar et al. 2020),(Yap et al. 2020)
7.Unrealistic imposed contract duration	(Ordem dos Engenheiros 2006),(Monteiro 2010),(Doloi et al. 2012),(Aziz 2013),(Arantes et al. 2015)
9.Environmental and archaeological limitations	(Haseeb et al. 2011),(Aziz 2013),(Alamri et al. 2017)
10.Changes to the project during execution / 23. Occurrence of extra/overwork	(Al-Momani 2000),(Ellis & Thomas 2003),(Koushki et al. 2005),(Assaf & Al-Hejji 2006),(Couto 2007),(Sweis et al. 2008),(Tribunal de Contas 2009),(Kaliba et al. 2009), (Monteiro 2010),(Antunes 2012),(Doloi et al. 2012),(Owolabi et al. 2014), (Arantes et al. 2015),(Tafazzoli & Shrestha 2017),(Alamri et al. 2017),(Prasad et al. 2019),(Umar et al. 2020),(Yap et al. 2020),(Raja K. M. Gopang et al. 2020)
11.Adverse weather conditions	(Al-Momani 2000),(Ellis & Thomas 2003), (Frimpong et al. 2003),(Assaf & Al-Hejji 2006),(Tribunal de Contas 2009),(Monteiro 2010),(Antunes 2012),(Gluszek & Leśniak 2015),(Alamri et al. 2017)

12.Unavailability/failure of materials and equipment	(Sambasivan & Soon 2007),(Kaliba et al. 2009),(Haseeb et al. 2011),(Mahamid et al. 2012),(Kamanga & Steyn 2013),(Aziz 2013),(Aziz & Abdel-Hakam 2016),(Gebrehiwet & Luo 2017)
13.Lack of communication and/or conflicts between parties	(Couto 2007),(Sambasivan & Soon 2007),(Owolabi et al. 2014),(Al-Emad et al. 2017)
14.Errors during the construction	(Sambasivan & Soon 2007),(Aziz 2013)
15.Underestimated project cost and complexity	(Moura et al. 2007),(Fugar & Agyakwah-Baah 2010)
16.Difficulties with relocation of networks (electricity, water and sewage)	(Ellis & Thomas 2003),(Kamanga & Steyn 2013)
17.Delay with expropriations	(Ellis & Thomas 2003),(Tribunal de Contas 2009),(Monteiro 2010),(Antunes 2012),(Kamanga & Steyn 2013)
18.Delay with site mobilization	(Tribunal de Contas 2009),(Monteiro 2010),(Kamanga & Steyn 2013),(Prasad et al. 2019)
19.Problems with designs (incomplete, lack of data, errors)	(Al-Momani 2000),(Ellis & Thomas 2003),(Assaf & Al-Hejji 2006),(Couto 2007),(Tribunal de Contas 2009),(Monteiro 2010),(Antunes 2012),(Doloi et al. 2012),(Owolabi et al. 2014),(Głuszek & Leśniak 2015),(Tafazzoli & Shrestha 2017),(Al-Emad et al. 2017),(Umar et al. 2020),(Raja K. M. Gopang et al. 2020)
20.Difficulties in obtaining authorizations and licenses from authorities and institutions	(Ellis & Thomas 2003),(Assaf & Al-Hejji 2006),(Couto 2007),(Doloi et al. 2012),(Alamri et al. 2017),(Prasad et al. 2019),(Raja K. M. Gopang et al. 2020)
22.Neglect of critical activities (this cause is related to site management)	(Frimpong et al. 2003),(Assaf & Al-Hejji 2006),(Faridi & El-Sayegh 2006),(Sambasivan & Soon 2007),(Fugar & Agyakwah-Baah 2010),(Haseeb et al. 2011),(Doloi et al. 2012),(Aziz 2013),(Alamri et al. 2017),(Umar et al. 2020),(Yap et al. 2020)

4. Research findings and results

The 104 complete responses received were mostly from contractors (49.0%). Replies from owners and designers were 29.8% and 16.4%, respectively. Regarding experience, 52.9% of respondents have more than 10 years of experience followed by professionals with 1 to 3 years of experience (23.1%) and with 5 to 10 years of experience (11.5%).

Respondents revealed more experience in housing and services buildings projects (46 responses), housing and services rehabilitation projects (30 responses) and road construction projects (28 responses). It was asked to whom they would attribute the responsibility for the delays that occurred, and it was verified that more than half of the respondents (58.25%) considered the group of the Owner and Contractor to be the main responsible. For most

Table 2).

Table 2 - Percentage of projects whose deadlines have been delayed due to experience

Years of experience	% delayed projects responses						Number of answers
	0%	0-20%	20-40%	40-60%	60-80%	80-100%	
	1	23	17	25	27	11	
Less than 1 year	0,00%	0,00%	40,00%	20,00%	30,00%	10,00%	10 (9,62%)
Between 1 and 3 years	4,17%	16,67%	20,83%	20,83%	20,83%	16,67%	24 (23,08%)
Between 3 and 5 years	0,00%	0,00%	33,33%	66,67%	0,00%	0,00%	3 (2,88%)
Between 5 and 10 years	0,00%	33,33%	16,67%	16,67%	25,00%	8,33%	12 (11,54%)
More than 10 years	0,00%	27,27%	9,09%	25,45%	29,09%	9,09%	55 (52,88%)
							104 (100%)

respondents, the frequency of delays is correlated with the type of work, e.g., there are types of work that reveal a higher frequency of delays. Residential and service buildings are the most frequently delayed, regardless of whether they are construction or rehabilitation projects. To classify the causes of different groups of respondents, was used the Relative Importance Indices (RII) method. From this index it was possible to rank the causes by their frequency and identify the most relevant causes of delays in construction in Portugal, resulting in Table 3. Regardless of the type of projects, position or years of experience, respondents consider that practically all projects suffer delays and did not comply with the deadlines initially planned. There was only one respondent (0.96%) considering that the projects met the expected

Based on the frequency of delays, Table 3, the analysis of the 104 questionnaires allowed to obtain the 10 main causes of construction delay in Portugal.

1.Unrealistic imposed contract duration

The most identified cause by the sample as being responsible for causing delays is the unrealistic estimated deadline to execute the project, and the time to execute the project does not fit with the reality of the work. The incompatibility of deadlines between procedures contracting projects and contracts

2.Changes to the project during execution

The possible changes to the project during execution is the cause that brings together the major consensus in previous studies. As the design is the guiding thread of the project, its alteration, obliges to alter its initial foundations. These changes often occur due to the lack of integration and communication between the people who develop the designs and those who execute them.

These changes can also occur due to requests from the owner, such as improvements or modifications, at the request of the designers/architects, to improve functionality or aesthetic aspects (Couto 2007). In rehabilitation projects, the uncertainty of the existing constructions leads to a complete change in the techniques and materials initially planned, causing delays, either in the time required to find the new solution or in the new duration of execution.

3.Occurrence of extra/overwork

Related to the previous one comes the cause “Occurrence of extra/overwork”. Doing more work within a construction project consumes material, human and time resources. Several times during the projects, there is a need to perform interventions that were not included in the initial project. These extra jobs often appear due to inadequate planning of activities and resources to be used (Odeh & Battaineh 2002).

4.Slow decision making by the owner

The owner is the one who has the final word in the decisions to be made about the course of action. The delay in making decisions will naturally cause delays in the progress of the project, being several times structural decisions that, if not taken quickly, can stop the project and irrevocably delay it. The delays caused by the owners are pointed out by several authors as being one of the main causes of delays, either in

with the politically desirable deadlines for the accomplish of electoral programs is one of the main causes of delays in works, since deadlines are often short, complicating management and the natural course of project by Contractors. This cause promotes poor planning, specifically, with the lack or poor management and planning of time. Therefore, the management of time, since the beginning of the project implies that there must be a careful and strict preparation, with frequent inspection, so that the project is completed in the expected time.

the slow decision or in the constant changes in the work (Couto 2007, Cabrita 2008). These delays can be classified as excusable and compensable to the Contractor, once they are out of his control. They are the responsibility of the owner and can cause delays in the execution of the project, and consequently requests for extension and compensation by the Contractor.

5.Problems with designs (incomplete, lack of data, errors)

A complete and efficient design, free from errors and omissions, gives better guarantees of success in the realization of the projects. On the other hand, a design with deficiencies has unpredictable consequences for their development, with results below the stipulated level in terms of planning, cost and quality (Ferreira 2016).

7.Improper planning

A good planning/scheduling of a project allows to solve possible problems and doubts that can naturally arise, preventing the appearance of more serious situations in the future, namely delays. Pereira (2013) says that experience is very important for the quality of project scheduling, and inexperience can manifest itself in improper planning, namely, less realistic.

8.Financial difficulties and/or payments from owner

The lack of payment to suppliers and workers implies lack of material and human resources to continue the project, and financial difficulties are responsible for long delays. According to Abdul-Rahman et al. (2009), the financial problems related to a project can be divided into poor cash flow management, late payment, insufficient financial resources and financial market instability

Table 3 – Ranking of Causes by Group

Causes of delay	Owner		Contractor		Designer		General	
	RII	Ranking	RII	Ranking	RII	Ranking	RII	Ranking
1.Inexperience of the contractor	61,94	13	52,00	20	57,65	13	56,31	15
2.Financial difficulties and/or payments from owner	55,48	17	73,20	6	71,25	3	67,25	8
3.Low productivity and/or lack of skilled labor	69,68	7	65,10	9	60,00	11	65,83	10
4.Problems in managing subcontractors	75,48	3	69,02	8	65,88	7	70,96	6
5.Slow decision making by the owner	69,03	8	83,14	4	66,67	5	75,88	4
6.Improper planning	75,48	2	64,00	10	69,41	4	68,93	7
7.Unrealistic imposed contract duration	77,42	1	80,00	5	81,25	1	78,83	1
8.Inappropriate construction methods	52,90	20	49,20	23	51,76	20	50,29	23
9.Environmental and archaeological limitations	54,84	18	53,33	18	63,75	9	55,15	17
10.Changes to the project during execution	74,19	4	83,92	1	71,76	2	78,46	2
11.Adverse weather conditions	54,84	19	58,82	13	50,00	22	56,12	16
12.Unavailability/failure of materials and equipment	56,13	16	54,90	17	43,75	23	53,59	19
13.Lack of communication and/or conflicts between parties	61,94	14	58,04	14	61,25	10	59,61	13
14.Errors during the construction	62,58	12	50,20	22	51,25	21	54,56	18
15.Underestimated project cost and complexity	66,45	9	62,35	11	56,25	16	62,33	11
16.Difficulties with relocation of networks (electricity, water and sewage)	48,39	22	55,29	16	52,00	18	52,55	20
17.Delay with expropriations	49,68	21	51,84	21	54,67	17	51,2	22
18.Delay with site mobilization	47,10	23	52,55	19	52,00	19	51,29	21
19.Problems with designs (incomplete, lack of data, errors)	72,90	6	83,53	2	57,50	14	75,69	5
20.Difficulties in obtaining authorizations and licenses from authorities and institutions	63,23	11	70,98	7	65,00	8	67,25	9
21.Mistakes in planning/scheduling due lack of knowledge of the project sites	64,52	10	61,57	12	60	12	62,18	12
22.Neglect of critical activities	60,00	15	57,65	15	57,33	15	58,02	14
23. Occurrence of extra/overwork	73,55	5	83,53	3	66,67	6	77,23	3

9. Difficulties in obtaining authorizations and licenses from authorities and institutions

Excessive bureaucracy and delays in licensing lead to delays in the execution of the work, also compromising the expenses with it. Contractors allocate teams for a specific date and location/work and the lack of licenses and authorizations causes not only delays but also the increase in costs resulting from this lack of teams' productivity. Difficulties and delays in obtaining licenses can also lead to the loss of subcontractors who may start other projects, conditioning Contractors to replace them and find new teams to do the work.

10. Low productivity and/or lack of skilled labor

One of the characteristics of civil construction workers is their low qualification and lack of adequate training for the tasks they must perform. Therefore, it is important to promote the training of the workforce, to develop human resources linked to civil construction, through their own training and the specialization of workers.

It was possible to observe, Table 3, that there is a certain lack of responsibility for each group of respondents when the cause blames the group itself. As can be seen in cause 1, where the fault is specifically on the Contractor's part, this is placed in 13th place by Owners and Designers and only in 20th place by the Contractors themselves. The same happens when the cause is directly related to Owners, as in cause 2 in which they devalue and place 17th in the ranking while it is placed in 6th and 3rd place by Contractors and Designers respectively. Through these data, it is possible to conclude that the respondents tend to protect the group in which they belong, seeking to hold the remaining parties responsible.

Performing a comparative analysis of the perceptions of owners, Contractors and designers, it is possible to conclude that both owners and designers blame or associate all

parties involved for the delays that occurred in the contract. However, for Contractors the delays in the works are mostly the fault of the owners and/or the designers. These refer to delays of their own responsibility to the background, associating only as the 8th and 9th main causes the "Problems in managing subcontractors" and " Low productivity and/or lack of skilled labor " respectively.

The hierarchy of different causes is common to two or more groups. Both owners and contractors reveal that the occurrence of extra/overwork is one of the main causes of delays. In turn, owners and designers agree that "Improper planning" should also be considered as one of the main factors. Contractors and designers agree that the "Slow decision making by the owner" conditions the achievement of initial predicted deadlines. However, all parties agree that unrealistic contract duration and changes during execution are the main causes of delay. Since the causes that occurs more frequently may not be those with the biggest impact on the delay of the project, the most influential causes of the delays were evaluated. According to the results (Figure 2), it was concluded that the three most influential are (5.) Slow decision making by the owner, (7.) Unrealistic imposed contract duration and (2.) Financial difficulties and/or payments from owner.

Although delays are frequent, 74% of respondents believe that the delays experienced could have been avoided, with a greater emphasis on professionals with more than 10 years of experience. As such, only 9% do not consider that tighter and more frequent inspection would contribute to a reduction in delays.

However, the lack of monitoring of the schedule does not appear to be a reason for this, as most reveal that they are frequently accompanied by the owner and the contractor (Figure 3).

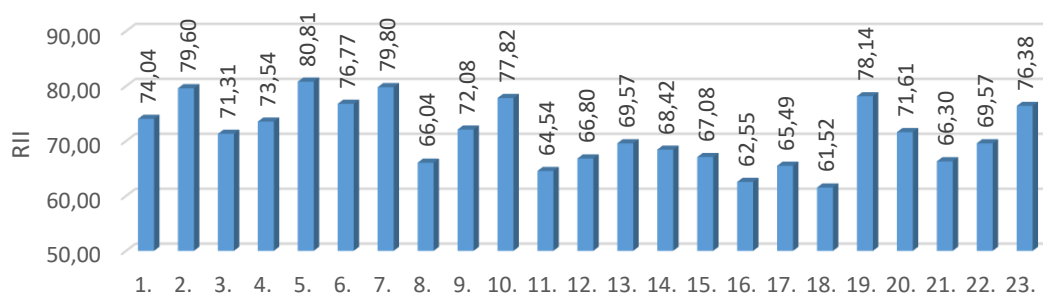


Figure 2 - Severity Index

According to 57% of the sample, the application of more stringent fines it would also contribute to a reduction in construction delays.

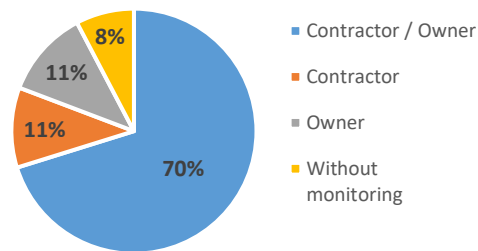


Figure 3 – Monitoring of the schedule

Table 4 - Measures to mitigate delays in civil construction works

Contract	Establish executable, real and reasonable construction deadlines.
Project	Good planning of the project (viability, budget, schedule, regularization); Clear, objective and constant communication with designers; Increase the rigor of the designs, namely in the measurements; Have a good knowledge of the project and its conditions; Perform the design review to discover possible errors and omissions
Owner	Behavioral change; Clear, objective and constant communication between the various parts involved; Do not compromise the Contractor's pace; Make a real forecast of the contract, avoiding complaints;
Contractor	Clear, objective and constant communication between the various parts involved; Good site management and control of production and project execution; Predict alternative plans and strategies; Implementation of control systems;
Subcontractor	Clear, objective and constant communication between the various parts involved; Strict planning of subcontracts; Maintain a good relationship with subcontractors, keeping them motivated Application of fines and benefits in case of delays or advance of the execution deadlines, respectively; Have alternative subcontractors in case of failures and defaults Prior analysis of subcontractors (quality of work, technical quality)
Labor resources	Promote professional training; Awards and incentives; Strict planning of the number of workers needed for the different tasks of a project;
Supervision	Clear, objective and constant communication between the various parts involved; Stricter and continuous monitoring and supervision;
Material	Correct provisioning; Control of material on site; Place orders of materials on time;
Safety	Implement security measures;
Other factors	Perform frequently weather forecast; Good organization of the construction site;

6. Summary and conclusion

If all stakeholders were aware of the causes of construction delays, this problem could easily be solved by minimizing budget overruns.

There is a clear consensus that delays can be avoided or have a lower percentage if the causes analyzed in this study were subject to greater control by the parties involved.

However, awareness of the problem alone does not solve it, and there is a need to enunciate and

5. Guidelines for reducing delays

The study revealed that 93% of respondents consider it important to have a methodology/guide of measures to minimize delays, and more than half consider that they would use it in their daily work practice. Based on the results obtained, the measures explained in Table 4 summarize that a well-planned project, safe, with good human resources, with good communication between the stakeholders will be closer to accomplish deadlines and less likely to have unexpected events.

apply measures to prevent the appearance of delays and should be applied throughout the construction process.

The study made it possible to analyze and identify the various causes responsible for delays in construction projects in Portugal, as well as to identify those which, according to professionals in the field, are the most frequent. Looking at the causes of the delays identified in this study, it is concluded that the problems in

terms of planning, design and communication between the stakeholders involved in the construction, are mainly responsible for the appearance of problems related to time. Although there are more identified causes, these are the beginning for all other causes that can cause delays in a project.

With a comparative analysis of the perceptions of owners, Contractors and Designers, it was concluded that everyone agrees that mismatched lead times and changes during execution are the main causes of delay.

The Rehabilitation projects are identified as those where the most delays occur, possibly due to their specificities and lack of knowledge of the existing construction.

Regarding to the scheduling and planning of the projects, it is concluded that many of them are not well planned. Unrealistic deadlines, poorly adjusted activity and task schedules, poorly assessed human resources, are common mistakes found in poor planning and that influence the good progress. It is essential that good planning be done as it is one of the main delay prevention tools. In addition, it is also important to monitor and update it during the project.

Designs that are not rigorous, with little clarity, with errors and omissions and several changes, contribute to delays, being essential to review the project, which often does not happen, with the excuse of saving time, having the opposite effect. After the completion of the design elements, their review must be carried out, and the owner and the Contractor must be involved with the team of designers. In order to find possible errors and omissions that will cost a lot of time and money.

It must also be added that, according to the 104 respondents, the cost of the works was identified as the pillar most affected by the delays in the works, which is justified by the fact that the delays in the works can give rise to fines, financial charges, and lead to the highest costs of the shipyard.

The communication between the different actors in the construction must be as clear, transparent and objective as possible, under the risk that the messages will be badly transmitted and that there will be misunderstandings that cause delays. This also promotes a good environment and confidence, increasing the chances of success.

It is concluded that a work should not be started if a good planning and a good design has not

been done and if communication between all involved is not promoted through a climate of trust. Problems related to delays, whether public or private works, will continue to happen if measures are not taken that aim to mitigate and prevent delays. A real preparation of the project is necessary, which may take time and have associated expenses, that in the end it will be much more profitable for all involved.

Despite the results obtained being quite positive, there are always some limitations to note. First, the constitution of the sample was formed by convenience, direct contacts were made with professionals in the field of civil construction through social networks. Due to this form of communication, the constitution of the sample was dependent on the responses and the acceptance of people to participate in the study. Second, the assessment of the main causes comes from indexes that depend on the opinion of the participants, being perhaps the main limitation. Although the participants belong to different areas, opinion is always subjective. Through this work it was possible to perceive the difficulties of meeting the deadlines in the projects, a difficulty that has remained for decades. It is pertinent to develop other studies within the area to improve knowledge of the problems associated with the civil construction sector, contributing to an improvement in interventions aimed at correcting these.

References

- Abdul-Rahman, Hamzah, Roshana Takim and Wong Sze Min (2009). "Financial-related causes contributing to project delays." *Journal of Retail & Leisure Property* 8(3): 225–238.
- Al-Emad, Nashwan, Ismail Abdul Rahman, Sasitharan Nagapan and Yaser Gamil (2017). *Ranking of Delay Factors for Makkah's Construction Industry*. MATEC Web of Conferences.
- Al-Momani, Ayman H. (2000). "Construction delay: a quantitative analysis." *International Journal of Project Management* 18: 51-59.
- Alamri, Nasser, Omar Amoudi and Gibril Njie (2017). "ANALYSIS OF CONSTRUCTION DELAY CAUSES IN DAMS PROJECTS IN OMAN." *European Journal of Business and Social Sciences* 6: 19-42.
- Antunes, Pedro Alexandre Lopes Dias (2012). *Desvios De Prazos E De Custos Na Execução De Empreitadas De Obras*

- Públicas, Universidade Lusófona de Humanidades e Tecnologias.
- Arantes, Amílcar, Pedro Fernandez da Silva and Luís Miguel D. F. Ferreira (2015). Delays in construction projects - Causes and impacts. 6th IESM Conference. Sevilha, Espanha.
- Assaf, Sadi A. and Sadiq Al-Hejji (2006). "Causes of delay in large construction projects." *International Journal of Project Management* 24: 349-357.
- Aziz, Remon F. and Asmaa A. Abdel-Hakam (2016). "Exploring delay causes of road construction projects in Egypt." *Alexandria Engineering Journal* 55(2): 1515-1539.
- Aziz, Remon Fayek (2013). "Ranking of delay factors in construction projects after Egyptian revolution." *Alexandria Engineering Journal* 52(3): 387-406.
- Cabrita, André Filipe Nunes (2008). *Atrasos na Construção - Causas, Efeitos e Medidas de Mitigação*. Master Civil Engineering, Instituto Superior Técnico.
- Catalão, Francisco Pinheiro, Carlos Oliveira Cruz and Joaquim Miranda Sarmiento (2021). "The Determinants of Time Overruns in Portuguese Public Projects." *Journal of Infrastructure Systems* 27(2): 05021002.
- Couto, João Pedro (2007). *Incumprimento dos Prazos na Construção*, Universidade do Minho.
- Dias, Luís Alves (2013). *Organização e Gestão de Obras*, Instituto Superior Técnico.
- Doloi, Hemanta, Anil Sawhney, K.C. Iyer and Sameer Rentala (2012). "Analysing factors affecting delays in Indian construction projects." *International Journal of Project Management* 30(4): 479-489.
- Ellis, Ralph D. and H. Randolph Thomas (2003). *THE ROOT CAUSES OF DELAYS IN HIGHWAY CONSTRUCTION*. 82nd Annual Meeting of the Transportation Research Board. Washington, D.C.
- Faridi, Arshi Shakeel and Sameh Monir El-Sayegh (2006). "Significant factors causing delay in the UAE construction industry." *Construction Management and Economics* 24: 1167-1176.
- Ferreira, Ana Marta Freitas (2016). *Qualidade do Projeto e da Construção - Uma Revisão Bibliográfica Atualizada*. Mestrado Engenharia Civil, Faculdade de Engenharia da Universidade do Porto.
- Frimpong, Yaw, Jacob Oluwoye and Lynn Crawford (2003). "Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study." *International Journal of Project Management* 21: 321-326.
- Fugar, Frank D.K. and Adwoa B. Agyakwah-Baah (2010). "Delays in Building Construction Projects in Ghana." *Australasian Journal of Construction Economics and Building* 10 (1/2): 103-116.
- Gebrehiwet, Tsegay and Hanbin Luo (2017). "Analysis of Delay Impact on Construction Project Based on RII and Correlation Coefficient: Empirical Study." *Procedia Engineering* 196: 366-374.
- Głuszek, Michał and Agnieszka Leśniak (2015). "Construction delays in clients opinion – multivariate statistical analysis." *Procedia Engineering* 123: 182-189.
- Haseeb, M., Xinhai-Lu, Aneesa Bibi, Maloof-Dyian and Wahab Rabbani (2011). "PROBLEMS OF PROJECTS AND EFFECTS OF DELAYS IN THE CONSTRUCTION INDUSTRY OF PAKISTAN." *Australian Journal of Business and Management Research* 1: 41-50.
- ISO 10006 (2003). *Quality management systems - Guidelines for quality management in projects*. International Organization for Standardization (ISO).
- ISO 21500 (2012). *Guidance on project management*. International Organization for Standardization (ISO).
- Kaliba, Chabota, Mundia Muya and Kanyuka Mumba (2009). "Cost escalation and schedule delays in road construction projects in Zambia." *International Journal of Project Management* 27: 522-531.
- Kamanga, M J and W J v d M Steyn (2013). "Causes of delay in road construction projects in Malawi." *JOURNAL OF THE SOUTH AFRICAN INSTITUTION OF CIVIL ENGINEERING* 55: 79-85.
- Koushki, P. A., K. Al-Rashid and N. Kartam (2005). "Delays and cost increases in the construction of private residential projects in Kuwait." *Construction Management and Economics* 23: 285-294.
- Mahamid, Ibrahim, Amund Bruland and Nabil Dmaid (2012). "Causes of Delay in Road Construction Projects." *JOURNAL OF MANAGEMENT IN ENGINEERING © ASCE* 28(3): 300-310.
- Monteiro, Manuel Oliveira (2010). *PROCESSOS DE OBRAS DE INFRA-*

- ESTRUTURAS VIÁRIAS MUNICIPAIS: UMA ANÁLISE DOS DESVIOS DE CUSTO E DE PRAZO, UNIVERSIDADE DE TRÁS-OS-MONTES E ALTO DOURO.
- Moura, Helder M. Pinto, José M. Cardoso Teixeira and Brígida Pires (2007). Dealing with cost and time in the Portuguese construction industry. CIB WORLD BUILDING CONGRESS. Cape Town, South Africa.
- Odeh, Abdalla and Hussein T. Battaineh (2002). "Causes of construction delay: traditional contracts."
- Ordem dos Engenheiros (2006). RECOMENDAÇÕES DA ORDEM DOS ENGENHEIROS PARA REDUÇÃO DOS DESVIOS DE CUSTOS E DE PRAZOS NAS EMPREITADAS DE OBRAS PÚBLICAS, Ordem dos Engenheiros.
- Owolabi, James D., Lekan M. Amusan, C. O Oloke, O. Olusanya, P. Tunji- Olayeni, Owolabi Dele, Joy Peter and OmuhIgnatious (2014). "CAUSES AND EFFECT OF DELAY ON PROJECT CONSTRUCTION DELIVERY TIME." International Journal of Education and Research 2(4): 197-208.
- Pereira, Ana Catarina Miranda (2013). PLANEAMENTO DE OBRAS – FATORES PREPONDERANTES QUE POSSIBILITEM O CONTROLO DE CUSTOS E O CUMPRIMENTO DE PRAZOS NO FINAL DE OBRAS DE REABILITAÇÃO. Mestrado Engenharia Civil, Faculdade de Engenharia da Universidade do Porto.
- Prasad, K. V., V. Vasugi, R. Venkatesan and Nikhil S. Bhat (2019). "Critical causes of time overrun in Indian construction projects and mitigation measures." International Journal of Construction Education and Research 15(3): 216-238.
- Raja K. M. Gopang, Qadir Buxalias Imran and Sasitharan Nagapan (2020). "Assessment of Delay Factors in Saudi Arabia Railway/Metro Construction Projects." International Journal of Sustainable Construction Engineering and Technology 11: 225-233.
- Ramanathan, Chidambaram, SP Narayanan and Arazi B Idrus (2012). "Construction delays causing risks on time and cost – a critical review." Australasian Journal of Construction Economics and Building 12: 37-57.
- Ramos, Juliana Amanda Dias (2013). "A GERÊNCIA DE TEMPO NA CONSTRUÇÃO CIVIL E SUAS INTERFACES COM AS DEMAIS ÁREAS."
- Sambasivan, Murali and Yau Wen Soon (2007). "Causes and effects of delays in Malaysian construction industry." International Journal of Project Management 25: 517–526.
- Sweis, G., R. Sweis, A. Abu Hammad and A. Shboul (2008). "Delays in construction projects: The case of Jordan." International Journal of Project Management 26(6): 665-674.
- Tafazzoli, Mohammadsoroush and Pramen Shrestha (2017). Factor Analysis of Construction Delays in the U.S. Construction Industry.
- Tribunal de Contas (2009). Auditoria a empreendimentos de obras públicas por gestão directa – Conclusões e Recomendações do Tribunal de Contas, Tribunal de Contas.
- Umar, Abdullahi Ahmed, Rashid Khalfan Al Rizeiqi and Atef Badr (2020). "Major Causes Assessment of Construction Delays." Journal of Engineering, Project, and Production Management 10(3): 179-186.
- Yap, Jeffrey Boon Hui, Pei Ling Goay, Yoke Bee Woon and Martin Skitmore (2020). "Revisiting critical delay factors for construction: Analysing projects in Malaysia." Alexandria Engineering Journal.
- Zafar, Irfan, Ibrahim Y. Wuni, Geoffrey Q. P. Shen, Sarfraz Ahmed and Tashfeen Yousaf (2019). "A fuzzy synthetic evaluation analysis of time overrun risk factors in highway projects of terrorism-affected countries: the case of Pakistan." International Journal of Construction Management: 1-19.