

How Time Constraints Affect Safety Conditions at Construction Sites: Analysis of the Perception of *Portuguese* Construction Participants

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ABSTRACT

Construction companies are currently subject to enormous pressure to achieve time and budget objectives. However, this situation can result in an unsafe accident-prone workplace because, often, when meeting deadlines takes priority, the implementation of occupational safety measures is relegated to the background. In order to discuss the relationship between the intensification of activities and work accidents at construction sites, a survey of the views of various construction participants (public and private owners, contractors and designers/consultants) was conducted as part of a national survey on construction delays. It was found that most respondents agree with the growing evidence regarding this problem. However, many believe that it is possible to reconcile the growing pressure imposed by compliance to deadlines with essential requirements for quality and safety through more efficient coordination.

KEYWORDS: Construction management, construction sites, construction safety, labour conditions, occupational injury and illness, time constraints, coordination of activities, construction delays.

INTRODUCTION

The failure to meet deadlines is a problem affecting a large part of the construction industry and one of the oft-suggested reasons for the lack of competitiveness in Portuguese construction, a problem for which there is still no solution, in light of its enormous complexity.

The consequences of failing to meet deadlines are often severe and difficult to solve. Generally they impose losses on users, often reducing profitability for promoters, and worsening safety conditions at the site.

Construction companies are currently under enormous pressure to meet time and budget objectives, since the market situation does not allow any extra margin. Working under schedule pressure and in a stressful environment has become a routine phenomenon at many construction sites. According to previous research studies, although accelerating a project may seem rewarding, the consequences are potentially troublesome (Nepal et al, 2006). Great effort must be put into controlling the parameters, conditions, costs, and duration of construction work, which often involves the implementation of measures to recover delays by strengthening human resources and intensifying equipment use. However, those measures can worsen safety at the worksite and increase the rate of accidents because, often, for the purpose of complying with deadlines, measures that prevent occupational hazards are relegated to the background. In addition, there are known cases of contractors who, under high pressure, are not adequately prepared to manage the work under such conditions, leading to excessive waste of resources, lack of resources, quality issues, disregard for the safety conditions of workers, etc. It follows, therefore, that, in many cases, it is at the expense of a great effort from the developer and principal contractor that deadlines are met. Unfortunately, often the most elementary rules of health and safety of workers are sacrificed in favour of compliance with deadlines (Couto, 2008).

In order to clarify this point, a PhD thesis on construction project delays gathered the views of the main participants in construction (owners of public and private constructions, contractors and designers/consultants), using a national survey on the failure to meet deadlines. It was found that the majority of respondents in all participant groups agrees with the growing evidence of this problem and considers the period of least supervision the most propitious for the occurrence of accidents. However, many nevertheless believe that it is possible to reconcile the increasing pressure imposed by compliance with deadlines with the essential requirements for quality and safety through more efficient coordination.

In order to support the subject of the paper, substantiate the research study objective, and to enrich the discussion of the results, a theoretical basis for international references was extended and a literature review was done. The Portuguese state-of-the-art in safety construction was also summarized.

LITERATURE REVIEW

The construction industry is inherently risky, with the potential for many occupational injury and fatality hazards, making it both unique and challenging to study. Construction is risky because of working outdoor, working at heights, and often working in dynamic and complex environments (i.e., diverse construction methods, working conditions, and materials). Therefore, diverse factors are relevant to understanding the causes of work-related injuries and fatalities in the construction industry and to assist in setting prevention strategies and priorities. Different types of studies including surveys, interviews, questionnaires, case studies, accident/incident records, observations, and controlled laboratory experiments in various disciplines have been conducted to determine these factors. Given the multiplicity of factors involved, the volume of studies, and the diverse methods of research used, building an overall understanding that benefits different participants is still challenging. The importance of organizational and individual factors related to construction and safety planning when under time constraints and their influence on safety conditions has been also studied in some researches.

Problems related to construction planning, coordination management, and changes during the construction phase are often referred to as main causes for the negative effects on construction safety conditions. A study of 500 accident records provided by the U.K. Health and Safety

Executive shows that accidents in construction projects involve inappropriate construction planning (28.8%), inappropriate construction control (16.6%), inappropriate construction operation (88.0%), inappropriate site condition (6.0%), and inappropriate operative action (29.9%) (Suraji et al., 2001).

On the other hand, the recent research findings of Spillane (2011) suggest that lack of space, problems of coordination and management of site personnel, and overcrowding of the workplace are the main factors affecting health and safety management at confined construction sites.

The results from another recent study conducted in three Australian organizations highlight the critical role played by first-level supervisors in acting as the conduit through which organizational safety priorities are communicated to the workforce (Lingard et al, 2012).

Construction professionals are subjected to a plethora of occupational difficulties that can have a negative effect on their psychological well-being. According to the Chartered Institute of Building (CIOB) (2006), work-related stress has become an inherent feature of the workplace environment in the construction industry and can negatively pass into personal and family life, if not properly managed. It has been widely reported that construction professionals, particularly construction-site managers, estimators, and on-site operatives, are subjected to considerable work-related stress, though only very limited empirically-based studies have been undertaken (Love et al, 2010).

A study on factors contributing to injury during construction of the Denver International Airport (DIA) revealed that designers are one group of project participants who have a significant opportunity to incidentally reduce health and safety hazards at the construction site (Glazner et al, 2005). Designers' earliest decisions fundamentally affect the health and safety of construction workers. These decisions influence later design choices, and considerable work may be required if it is necessary to unravel earlier decisions. It is therefore vital to address health and safety from the very start.

Based on responses analysed from 10,793 Americans participating in the National Survey carried out between 1976 and 2000, it was possible to evaluate workers' job histories, work schedules, and the occurrence of occupational injury and illness. A total of 110,236 job records were analysed, encompassing 89,729 person-years of accumulated working time. The research results revealed that working at jobs with overtime schedules was associated with a 61% higher injury hazard rate compared to jobs without overtime. Working at least 12 hours per day was associated with a 37% increased hazard rate and working at least 60 hours per week was associated with a 23% increased hazard rate (Dembe, 2005).

CURRENT CONSTRUCTION SAFETY SITUATION IN PORTUGAL

In Portugal, the lack of safety during building construction remains a serious problem. There are still many shortcomings at construction sites with potentially dramatic consequences for workers and for society in general. Indeed, the social costs of accidents and worker health problems is a burden for future generations and it is therefore imperative to minimise such costs as much as possible. In addition to the social harm of such high casualties, the cost of these accidents is enormous for workers, employers, for insurers and for society in general (Sousa et al, 2004). Added to the direct costs – including medical treatment and financial compensation to which workers are entitled under insurance or social protection systems – are indirect costs

which, according to some studies, may vary between two to 20 times the direct costs (Usmen, 1994).

These costs of “lack of safety” and their effects, which are not always easy to calculate, are factors contributing to the lack of competitiveness in construction enterprises (CSO, 2004).

Contrary to what happens in other areas of construction management, such as those of time, cost, and quality, in the construction safety area, there is a lot of information available, namely accident indicators in Portugal and their comparative analysis with other countries in the European Union (EU). This information comes in large part from the obligations of the Portuguese State to the International Labour Organisation, and consequently from the requirement of the Portuguese Authority for Working Conditions (Autoridade para as Condições do Trabalho - ACT) to annually disclose their activities.

Although there has been a substantial improvement in Portugal in recent years (ACT, 2004), the country still has a very high rate of occupational accidents in construction – generally higher than those of other EU partners.

As documented in Table 1, the construction sector continues to bear the greatest responsibility for such events (Araújo, 2009), representing about half of the fatal accidents that occur in all sectors of activity in Portugal (see Table 1 and Figure 1), highlighting the seriousness and importance of seeking solutions to reduce work-related construction accidents. From 2007 to 2008, there was a significant decrease in fatal accidents in construction but also across all industries. This decrease in the number of fatalities is most likely related to reduction of economic activity in construction that has been reflected in a lower volume of works in progress, while the percentage of fatal accidents in construction is still close to 50% of the total, in other words, roughly equivalent to that of recent years.

Table 1: Construction fatalities from 2003 to 2010 (ACT, 2012).

	2003		2004		2005		2006		2007		2008		2009		2010	
	Total	Construction	Total	Construction	Total	Construction	Total	Construction	Total	Construction	Total	Construction	Total	Construction	Total	Construction
Annual Total	181	88	197	101	165	85	157	71	163	82	120	59	115	56	130	55
% Accidents in Const.	48.6%		51.3%		51.5%		45.2%		50.3%		49.2%		48.7%		42.3%	

In Figure 1, the history of fatal accidents in the construction sector from 2003 to 2010 is shown.

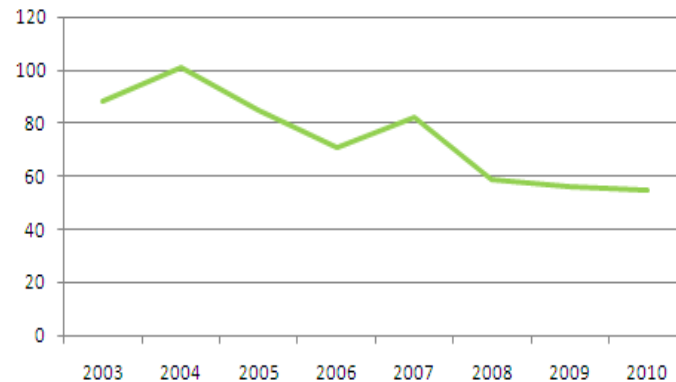


Figure 1: History of fatalities in construction from 2003 to 2010 (ACT, 2012).

Through analysis of Figure 2, it can be verified that fatalities in construction during the year 2008 were mainly caused by crushing, falls from height, impact with objects, burial, and electrocution. It is important to note that causes such as crushing, drop height, and burial are highly correlated with rehabilitation projects, where activities such as demolition, basement work, remodeling of parts of the building at height (front), are performed. In general, the risk of occupational accidents is higher with new buildings (Egbu, 1999), because they perform more complex jobs, with a greater degree of risk to the health and safety of workers.

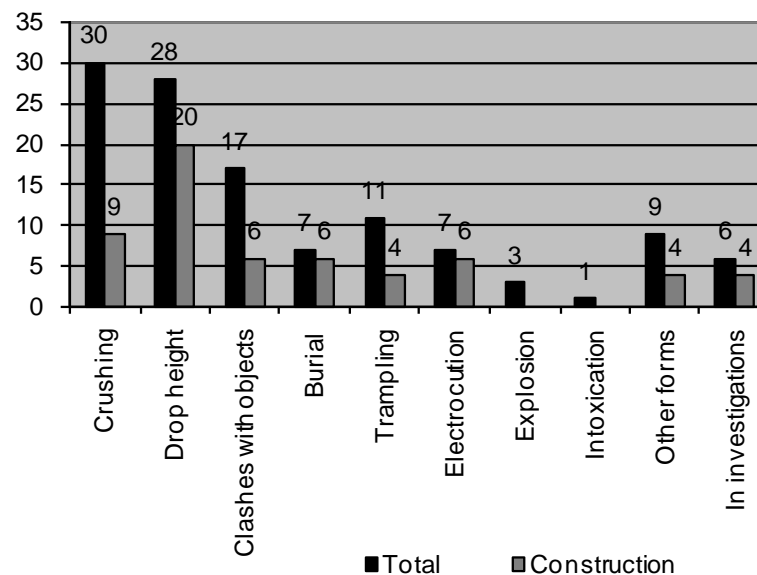


Figure 2: Fatalities according to cause, in 2008 (ACT, 2008).

On the other hand, since the investment in health and safety only becomes visible after some time, it appears that it is mostly Small and Medium Enterprises (SMEs) that have more difficulty in implementing such measures, mainly due to a lack of easily understandable information and guidance, a lack of capacity and skills to manage occupational health and safety, and a lack of resources to ensure training in this area (Table 2).

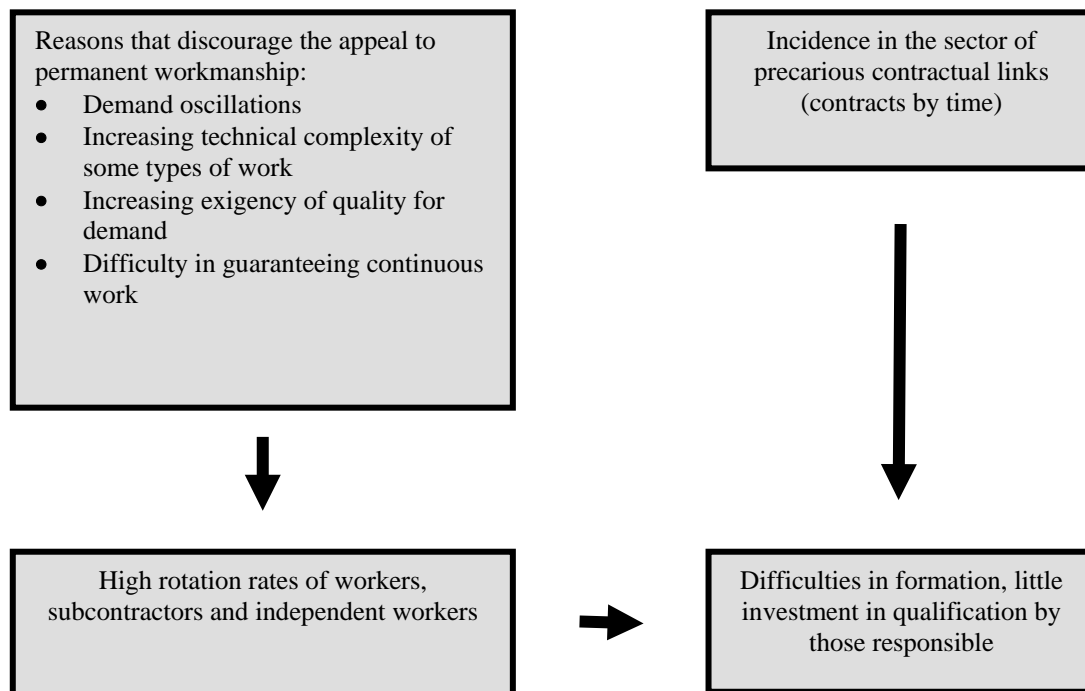
Table 2: Fatal work accidents according to company size in 2008 (ACT, 2008).

Company size	Total	Construction	Percentage
1-9 workers	48	24	42.9%
10-20 workers	16	8	14.3%
21-50 workers	23	12	21.4%
50+ workers	27	12	21.4%
Total	114	56	

In addition to examining the number of occupational accidents in construction, it is important to examine and investigate the causes and the ways to combat them. For that analysis to be effective, it is absolutely necessary to understand and characterise the current sector in economic and organisational terms. In particular, and according to the ACT, the sector has been characterised as follows (Reis, 2008):

- A proliferation of micro and small enterprises;
- Increased outsourcing;
- A lack of training for decision makers and employees;
- An environment having significant economic competition:
 - o Cutting costs;
 - o Demanding deadlines/intensification of rhythm and duration of work.

Regarding labour, the origin of an accident remains to be identified by a combination of various reasons, usually interconnected according to Figure 3 (Couto, 2006):

**Figure 3:** Interconnection of accident causes with labour (COUTO, 2006).

Similarly, another related to the act of construction may have an effect; namely, that each project is a unique product, strongly dependent on market demands, architectural options,

geological conditions, weather, and environmental factors that are unlikely to be the same in other times and places. This may be one reason that the Portuguese construction industrialisation ratio is still much lower than that of other EU countries. It is known that one of the advantages of prefabricated construction is that it minimises the quantity and time of work required and with it the likelihood of accidents.

Moreover, the act of building currently includes a great diversity of participants coming from diverse companies, consultants and staff who often do not know each other, and workers subject to different contractual arrangements. This represents an increased risk of accidents and occupational hazards and has, in practice, removed any sense of the idea that prevention is the involvement of all actors in the act of building. This context indicates the need for integrated safety management from the design to the construction stage as well as effective and independent safety coordination (Vieira, 2006).

The ACT also identifies the causes of work accidents: scheduling, inappropriate timing, overlap of incompatible work, inadequate equipment, sites not being regularly inspected, or inadequate planning and lack of prevention (Reis, 2008).

SURVEY ON PORTUGUESE CONSTRUCTION DELAYS

Survey context

In Portugal, there were no relevant studies on the causes of failure to meet deadlines in construction, although their consequences were discussed (Couto et al, 2005). However, understanding the causes can help control the problem.

Recently, a national survey was carried out on the failure to meet deadlines, conducted at the Centre for Civil Engineering, University of Minho, and included in the activity programme of the doctoral thesis “Construction projects delays” (Couto, 2007).

The central objectives of the survey on construction delays were the analysis, understanding and classification of the causes for the failure to meet deadlines, to gather and provide relevant information to develop and implement measures, strategies, management and prevention techniques for the causes of delays in the development stage of the project and during construction control and management, and thus provide more guarantees of success in meeting deadlines, contributing to a substantial improvement in the competitiveness of the Portuguese construction industry (Couto, 2007).

Survey structure

Apart from the central section on the analysis and classification of the causes of delays on accident frequency and impact (Couto, 2007), two additional sections were included for analysis of the safety and working conditions under deadlines and a review of legislation and administrative procedures involved.

Respondent selection and survey implementation methodology

The construction companies were selected according to their classification by the National Office of Real Estate and Construction Markets (NORECM); the body responsible for regulating and issuing permits. The engineering firms were selected from the list of members of the Portuguese Association of Engineering and Management Consultants (PAEMC), by geographical location and speciality. The private owners were selected from the Association of Real Estate Promoters (AREP) and the public owners were selected from among the principal municipalities of the continent and islands, institutes, and other state agencies. In all of the selection processes, two things were kept in mind as essential: to ensure that the selection constituted a representative sample of the whole country and islands and, moreover, that would provide a cross-section of the size range of participants and projects.

The implementation of the survey materialised in the form of a questionnaire sent to 100 contractors, 85 designers/consultants and 100 owners. For those who did not respond in time, the carrying out of an interview/survey was proposed as an alternative.

The questionnaire was responded to by managers or technicians with management positions in construction companies, owners of public projects, engineering and consultancy offices, and studios, directors of departments of management and works, project managers, and senior engineers (Couto, 2007).

Of the responses, 59 were collected from contractors, 26 from designers/consultants and 79 from the owners of projects (62 public and 17 private). It is noted that not all participants responded to the additional sections; nevertheless, there was a very considerable rate of participation.

Relationship between accidents at work and time constraints

This section was intended to clarify and assess the actual relationship between workplace accidents and the pressure to meet deadlines in construction. It was considered appropriate to briefly describe the problem in the study, asking the respondents to indicate how much they agreed with it.

"Currently, construction companies are subject to enormous pressures of time and cost which often involve the implementation of urgent measures, including strengthening of human resources and intensive use of equipment. We seek to recover the objectives set out or minimise the periods of delays, thereby causing the workplace to be unsafe and prone to accidents. Unfortunately, issues of quality are often neglected and the most basic rules of worker health and safety are sacrificed in favour of compliance with deadlines and opening dates."

Figure 4 shows the results for the 56 responses received from contractors, 59 responses from public owners, 16 responses from private owners, and the 26 responses from designers and consultants.

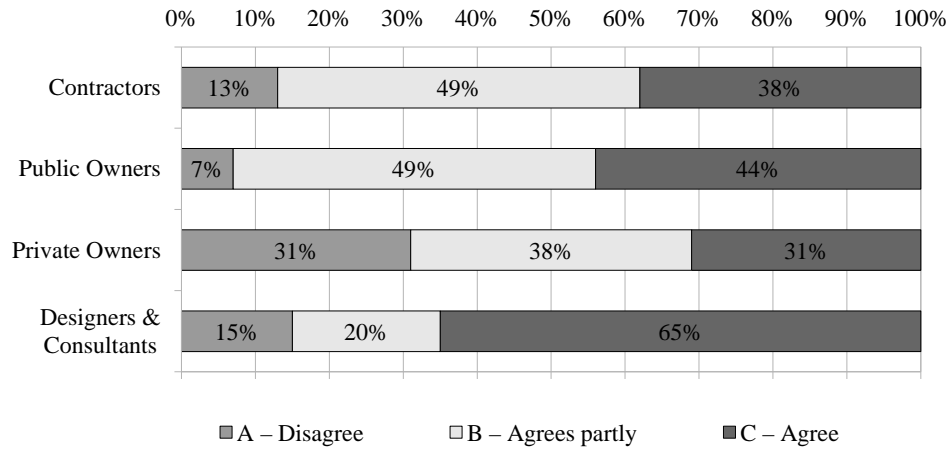


Figure 4: Opinion of contractors, public owners, private owners and designers/consultants, regarding the relationship of safety with deadlines (Couto, 2007).

As can easily be seen in Figure 4, the majority of respondents agreed fully or partly with the issue under review. It is also possible to conclude that, although the percentage of agreement (agree partly + agree) is greater for public owners, the percentage of “agree” is more expressive for designers and consultants. For the private owners, the relationship of safety to deadlines has the least acceptance.

Reasons for the increase in accidents during weekend and extra hours

There are several records of construction participant opinions indicating that the frequency and severity of accidents are intensified on weekends and during overtime hours. An international study also warns that extending working hours may have implications for alertness and reliable decision making (Health and Safety Executive (HSE), 2003). Asked about the possible causes for this, the results obtained are expressed in Figure 5 for a total of 54 responses from contractors, 61 responses from public owners, 16 responses from private owners, and 26 responses from designers and consultants.

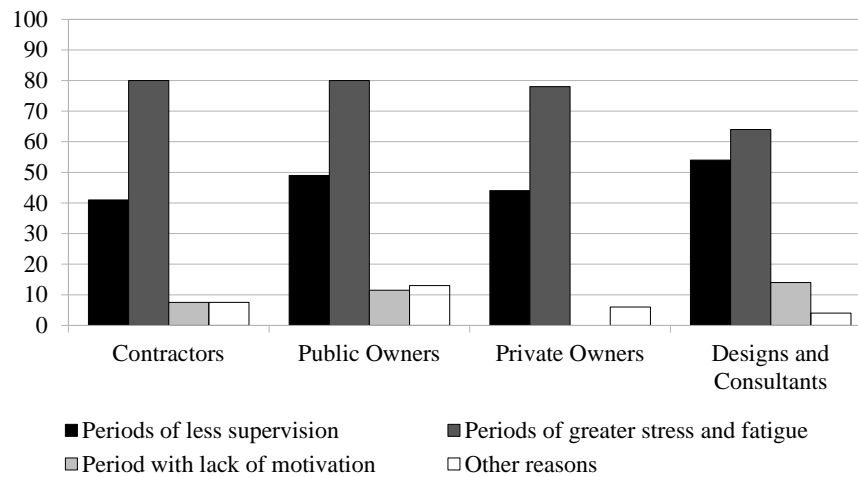


Figure 5: Causes for the intensification of work accidents from the point of view of four groups of participants surveyed (Couto, 2007).

For this question, the perception of the four groups is hardly coincidental. Periods of work resulting in less supervision and more fatigue are considered the main reasons for the increased frequency and severity of accidents.

Compatibility of Safety and Quality Rules with Time Constraints

In this section the respondents were asked whether increased pressure to comply with deadlines as well as to meet quality requirements and safety rules, are conflicting and difficult to achieve simultaneously.

Figure 6 shows the responses obtained from a set of 54 contractors, 62 owners of public projects, 16 owners of private projects, and 26 designers and consultants.

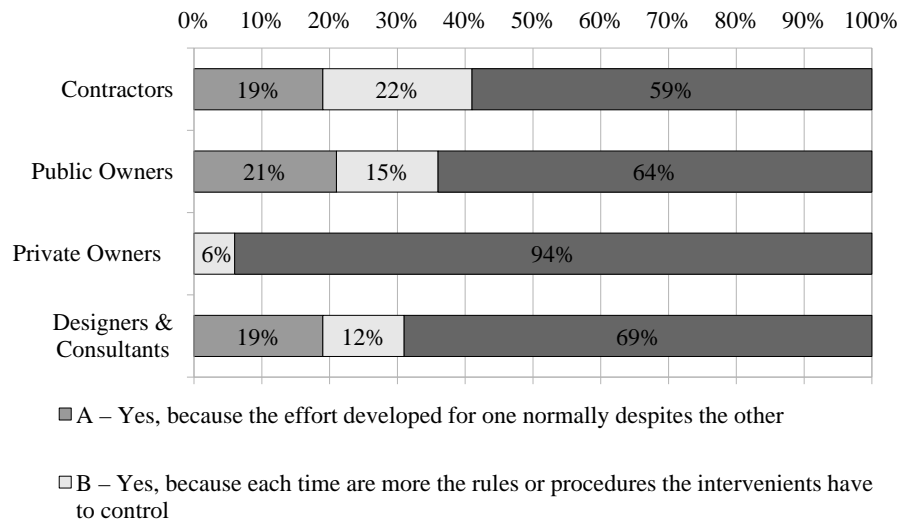


Figure 6: Opinions of the four groups of respondents regarding the possibility of conciliation deadlines and safety rules (Couto, 2007).

Most respondents from the four groups, with emphasis on private owners (94%) and designers and consultants (69%), believe it is possible to reconcile the demands of safety and time, since a policy for implementation of appropriate procedures and rules has been established. It should be mentioned that the lowest correlation was for contractors (only 59%), probably the result of practical difficulties that have been observed.

FINAL COMMENTS

The construction sector is strongly marked by a high level of economic competition, which is very demanding in cutting costs and time. The intensification of the rhythm and duration of labour have become the determining factors for competitiveness and “survival”. Moreover, the failure to meet deadlines is one of the reasons often suggested for the lack of competitiveness in Portuguese construction because of losses borne by users and developers.

On the other hand, among the main causes of work-related accidents referred to by authorities, are inappropriate phasing and timing, overlap of incompatible work, and lack of or inadequate planning of preventive safety measures.

The results of this study – except for some differences irrelevant in this context – make it possible not only to conclude that the various participants agree that time requirements influence safety conditions at construction sites but, more importantly, they agree that by using a concerted approach to implement procedures and rules, it is possible to reconcile those two requirements.

This issue requires an awareness of responsibility and efficient coordination from all participants beginning with the design phase and throughout all construction project phases. Furthermore, strategies to prevent work injuries should consider changes in scheduling practices and health protection programmes for people working in jobs involving overtime and extended hours.

Thus in the current context it is imperative that all participants become aware of the importance of reconciling and combining efforts to ensure effective widespread improvement of

safety conditions at construction sites. These challenges depend on achieving widespread improvement in understanding and knowledge of health and safety. Education is needed over training, so as to promote intelligent knowledge rather than unthinking rule-based attention to safety.

This will ensure that the level of fatal accidents in the country converges with that of other developed European countries and will thereby provide a significant contribution to the substantial improvement of the competitiveness of the Portuguese construction industry.

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Editor's note.

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Conditions at Construction Sites: Analysis of the Perception of Portuguese. Construction Participants. João Pedro Couto.

KEYWORDS: Construction management, construction sites, construction safety, labour. conditions, occupational injury and illness, time constraints, coordination of activities, construction delays. **INTRODUCTION.** The failure to meet deadlines is a problem affecting a large part of the construction industry. of the main participants in construction (owners of public and private constructions, contractors. and designers/consultants), using a national survey on the failure to meet deadlines. It was found. Weather conditions affect construction projects in a number of ways. Cold Weather Concrete mixtures do not set below a certain temperature, and therefore all work involving the drying of cement cannot proceed below a certain temperature. This in... In any case, if you are interested to have a more detailed view of the topic, I found this interview on the importance of weather alert systems in construction. I totally recommend it. **Weather Alert Systems in Construction - GenieBelt Blog.** Construction work is a hazardous land-based job. Some construction site jobs include: building houses, roads, tree forts, workplaces and repair and maintain infrastructures. This work includes many hazardous task and conditions such as working with height, excavation, noise, dust, power tools and equipment. The most common fatalities are caused by the fatal four: falls, being struck by an object, electrocutions, and being caught in between two objects. Construction work has been increasing in