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Programme and Abstracts

MANAGEMENT FUNCTIONS AND COMPETITIVENESS IN THE PORTUGUESE CONSTRUCTION INDUSTRY

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The construction industry faces a wide range of challenges that ought to be addressed if it is to maintain and, if possible, improve its competitiveness. The key interrelated elements of competitiveness have been the focus of many international research projects and studies. The measurement of this success and the quality of the project's performance depends on the achievement of the main construction management function objectives, namely time, cost, quality and safety, which are the focal indicators for a healthy and a competitive construction sector. However, frequent delays, cost overruns, insufficient quality and lack of safety are symptoms of the lack of competitiveness recognized in most construction projects concluded in the last years in Portugal. As a result, a research project has been launched to better understand and clarify the reasons behind the lack of achievements of these management functions that affect the competitiveness of the Portuguese construction industry. Results of the survey obtained so far indicate that the main causes for the lack of achievement of the construction functions are due to design and client responsibilities, inadequate construction management and lack of specific training.

Keywords: cost overruns, delays, quality, health & safety, Portugal.

INTRODUCTION

The approach to assess competitiveness is multi-faceted. It can be evaluated at different levels – national, firm or economic activity — as well as domestically, regionally and internationally. At each level, there are different indicators for competitiveness. For a nation, competitiveness is the capacity to achieve sustained economic growth and employment while remaining open to international trade. For a firm, being competitive involves increasing market shares over competitors, through either more competitive pricing or quality improvement of products (Reinaud 2005). Measuring competitiveness is a key issue in any economic activity and construction is not an exception.

Different frameworks have been suggested to measure competitiveness for countries, economic activities and single firms. Obviously, the ways this may be achieved is highly dependent on the purpose and aim of the study but the so-called Porter's diamond seems to be in widespread use. The diamond (Porter 1990) has been used to explain each country's industrial trends, depending on four major determinants (factor conditions, market conditions, industrial environment and corporate strategy) and two external factors (government and chance).

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Recent critical reviews suggest new factors and a different organization of Porter's Diamond to better suit the construction industry (Ofori 2003), for instance the Hexagon framework proposed by Flanagan *et al.* (2005). This report considers that the industry is competitive if it satisfies the national needs of the four main stakeholders: shareholders, clients, employees and the overall society. To achieve these goals, it must be profitable, predictable in time and cost, innovative, achieves harmonious relationships, achieves competitive wages, has a safe and healthy work environment, behaves ethically and complies with environment and sustainable regulations.

However, to be effective these goals should be measured in order to evaluate the industry's performance. The most common approach to measure the performance of a project is with the use of key performance indicators if comparable data on similar projects is available. An alternative quantitative approach is to measure the three fundamental indicators at project level: time, cost and quality, commonly known as the iron triangle (Atkinson 1999). More recently, the consolidate framework for measuring project success also includes health and safety (Chan and Chan 2004).

The lack of fulfilment of cost and time management functions often leads to project overruns producing immediate effects on construction stakeholders and on the country's economy and competitiveness. National construction projects that have experienced extreme cost overruns and delays include a performance hall in Porto (Casa da Música, 2005), a bridge in Coimbra (Ponte Europa, 2004), an urban tunnel in Lisbon (Túnel Rodoviário do Marquês, 2007) and an underground railway tunnel in Lisbon (Metro do Terreiro do Paço, 2007).

Cost and time overruns have been thoroughly studied internationally but unfortunately, at national level, research results on these overruns continue to be very rare. Only recently did the Board of Engineers submit to the National Court of Audit a proposal with recommendations for the reduction of cost and time overruns in public works construction projects (OE 2006). Simultaneously, the Board of Architects also decided to take affirmative action by undertaking a project with the National Court of Audit regarding the identification of situations that originate cost overruns in public works construction projects (OA 2006).

Another issue reportedly pointed out in the media is the lack of safety in the Portuguese construction sector that continues to lead the number of work-related accidents and fatalities. Although responsibilities of all who intervene in the construction process have been reinforced by recent law amendments on risk prevention at work, numerous violations continue to occur with dramatic consequences. Costs related to work accidents as well as health problems related to this profession affect not only injured workers but also the employer, insurance companies and society in general.

According to the General Labour Inspection, 157 fatalities occurred in all the economic activities in Portugal during 2006. The construction industry was accountable for 71 (or 45%) of those fatalities (IGT 2007). But more important than statistical data on labour fatalities is the analysis of available information on the causes for these unfortunate events and find solutions for their mitigation. In 2005, the incidence rate of work-related fatalities in the Portuguese construction was 30.5 per 100,000 workers.

A further aspect regarding the need for better quality in the Portuguese construction sector has impelled proposals for the revision of legislation, namely increasing the guarantee period of buildings. Shorter life cycles of construction materials and

components cause unexpected expenses that new end-users have to endure. However, to help mitigate these intolerable costs leaving end-users more satisfied, it is necessary to improve the quality of construction materials and its components.

In brief, cost and time overruns, the lack of safety during the construction phase and insufficient quality of the final built facilities have diverted the industry from fully advancing towards a more competitive ground in this country. A number of explanations have pointed out for these situations: the specifics of the industry, the production structure, the phased development of projects, the lack of adequate labour training, the weather conditions, etc. However, these do not explain why it evidences the above symptoms in national territory while it seems to be more competitive in the international market.

Therefore, in order to better understand and clarify the reasons behind the lack of achievements of the main management construction functions, a research project was launched, entitled "Reasons for lack of accomplishment of schedule, costs and safety objectives in construction", financed by the Science and Technology Foundation (FCT). Comprehending the causes and formulating methods to better manage and control these issues is essential for improving the competitiveness of the Portuguese construction industry, influencing the credibility of professionals and the country's image in this sector.

Results from the project will be used to recommend measures to increase competitiveness of the Portuguese construction industry. Work accomplished so far over the last two years is presented in this paper.

RESEARCH METHODOLOGY

The inquiry

Prior to the creation of the inquiry, specific boundaries were set to define the cluster of information that would be gathered from the industry and compiled in a database for subsequent treatment. Consequently, only information regarding construction projects launched between 1998 and 2004 and with an initial contract value over €10,000,000 was gathered.

Gathering information on public projects was unproblematic due to the available information on the procurement phase of these projects in Official Journals. Information on approximately 500 public projects had been collected. However, efforts to gather information on private projects were abandoned due to the scarcity of available data.

Opinions were collected from relevant client and contractors involved in the projects previously assessed through an internet-based questionnaire available on the project's website. This was created with the intent of disseminating the project and its objectives and encouraging respondents to take part in it.

Clients and contractors involved in the projects assessed were contacted by email and fax. These included information on the ongoing project, link to the project's website, questionnaire and its direct internet link and also an individual database that contained only the projects that respondent had been involved in the specified time period.

The questionnaire focused on the characteristics of each project and evidence of the lack of achievement of cost, time, safety and quality management functions. The first part of the questionnaire aimed at gathering specific information on the project under

assessment (project description, client and contractor(s) identification, initial contract value, type of contract, starting date and initial project duration).

Subsequently, respondents were asked to quantify the lack of fulfilment of each management function. Consequently, information was requested on the final cost and duration, number of accidents (fatal and non-fatal), number of workers, number of work-hours, days lost and the number of quality non-compliances and claims).

For each project, respondents were asked to point out and graduate in a scale of 1 (less important) to 4 (most important) the possible causes for the lack of fulfilment of each management variable:

- Main causes for delays: materials, equipment, workforce, contractor management, client responsibility, design, project managers, financial problems, contract, institutional relations, project specifics, external factors.
- Main causes for cost overruns: design errors and omissions, site conditions, client responsibility, cardinal changes imposed by third parties, external factors.
- Main causes for lack of safety: lack of individual protection, lack of collective protection, lack of specific training, high risk activity, lack of equipment maintenance, insufficient and inadequate task preparation, direct orders from client/client representative, inadequacy of selected materials and/or equipments, force majeure.
- Main causes for poor quality: inadequate design solutions, poor work execution or construction errors, inaction or errors in clients decisions and performance of project managers, inaction or errors in clients decisions and performance, inadequate materials, products or construction processes, inadequate or poor inspection to site conditions, external factors

Respondents were given also the opportunity to indicate other causes not mentioned in the questionnaire and possible actions for mitigating these.

Reply from the industry

Although approximately 500 projects had been previously identified, only 66 answers were received after a six-month period of inquiry. Additionally, two global responses representing 53 projects were also received. Therefore, analysis will only be based on the 64 individual answers. Table 1 illustrates the distribution of answers by types of projects ands respondents.

Table 1: Distribution of projects by type of construction

Type of projects	Distribution of answers (%)	Clients	Contractors
Civil works (buildings, urban development)	19%	58%	42%
Infrastructure (water, gas, sewer)	17%	64%	36%
Industrial	8%	60%	40%
Dam/maritime	16%	70%	30%
Roads/highway/railway	36%	48%	52%
Environment	5%	33%	67%

Responses were only obtained after several diligences. Persisting phone calls, emails, faxes, letters to the board of directors and personal contacts with key personnel of

contractors and clients were strategies adopted by the research team. A large number of the companies inquired had no available data readily available to provide. In other cases, although data was available, it had not been adequately treated. This lack of relevant records on past projects has been identified as the first reason for the lack of competitiveness of Portuguese construction industry (Moura and Teixeira 2006).

The conservative behaviour of the industry, key personnel involved in the projects no longer with the company, fears that data would be misused against respondents, and that records were too hard to retrieve or missing were just a few aspects that led to the lack of response from the industry.

ANALYSIS OF RESULTS

Information gathered from the industry was quantified by measuring the frequency and the intensity of the causes pointed out by the clients and contractors. In order to measure the importance and the intensity of these causes, an index (I) is used given by the expression $I = \sum_{i=1}^{4} x_i a_i$ where a_i is the constant that expresses the weight given to I (ranges from 1 = less important to 4 = most important) and x_i is the frequency of the answers.

The following results emerged from this analysis.

Time function

The quantitative measure for the time function was the delay in each project, expressed in calendar days, in relation to the initial duration. The average initial contract duration was 512 calendar days and the actual duration was 713 days. Therefore, the average delay was 201 days approximately 40% above the expected duration period.

Aggregate answers point out client (61%) and designer responsibility (59%) as the most frequent delay causes, followed by project specifics, contractor responsibility and external factors, with 47%, 41% and 34% of responses.

Compared to the overall results, the clients surveyed firstly point out designer responsibility (61%) and only afterwards client responsibility (58%) as the most frequent delay causes. Contractor responsibility was ranked third with 50% of responses and project specifics ranked forth with 44% of the responses.

As for the contractors' response, the most frequent delay causes ranked similarly as the overall results. Contractors mostly blame the clients (64%), designer responsibilities (57%) and project specifics (50%) as the most frequent delay causes. Contractors blame themselves with only 29% of responses, taking up fifth place. The frequencies of these causes are represented in Figure 1.

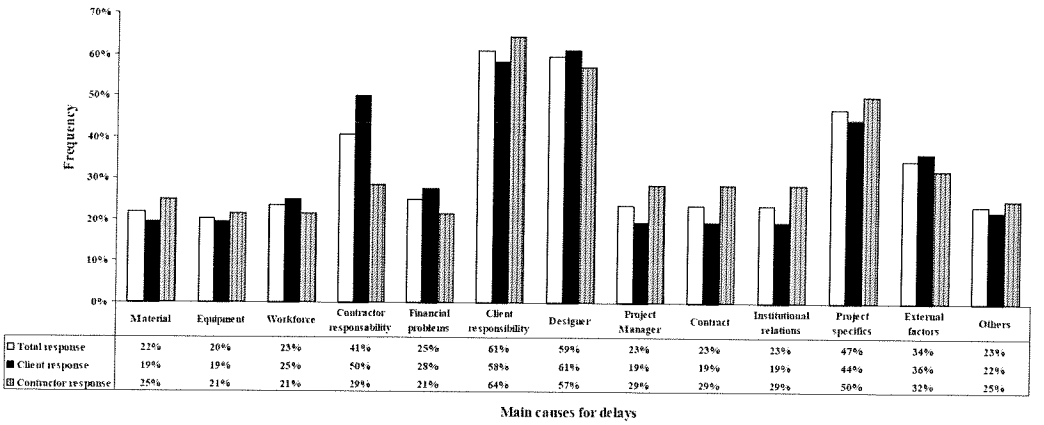

Figure 1: Frequency of delay causes

According to Figure 2, the intensity of delay causes ranks similarly to the frequency causes pointed out by participants for the lack of achievement of project's time management function.

Aggregate answers show that client and designer responsibility reach 116 and 104 points, respectively, followed by project specifics with 71 points (third place) and contractor responsibility with 66 points (forth place).

Contrary to the most frequent cause for delays, previously identified by the clients (designer responsibility), client responsibility has been ranked the most intense cause and designer responsibility second. In the clients' perspective, although designer responsibility contribute more frequently to delays, its **intensity** on the lack of achievement of the project's time function **is not as significant** as the client's responsibility. This is an interesting detail because clients are actually aware that they contribute significantly to the delays and thus low performance of the project.

Compared to the overall response, clients point out contractor responsibility as the third most intense reason for delays (47 points) and only after projects specifics as the forth reason (38 points).

Contractors rank the same causes for delays as the overall response: client responsibility (56 points), designer responsibility (47 points); project specifics (33 points). Results distinguish slightly from the overall response since their responsibility only ranks sixth with 19 points. Figure 2 illustrates the intensity of the main causes for delays.

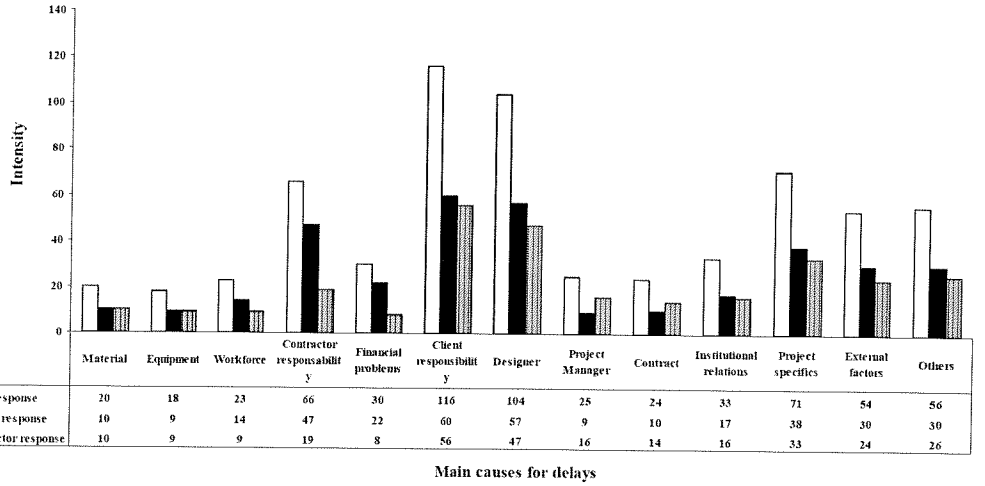

Figure 2: Intensity of delay causes

Cost function

Analysis of the cost function was done by comparing the final cost of the project with the initial contract value. The average initial cost of the 64 construction projects surveyed was €16.183.327 while the average final cost reached €18.384.341. As a result, the average cost overrun was € 2.201.014 or 14% of the initial average cost.

Traditionally cost overruns in public projects normally reach the maximum permitted by law: 50% for projects launched up to 1999 and 25% afterwards. However, some caution must be taken when analysing these results, as the reasons behind this low rate of cost overruns can be due to scope changes especially on those projects experiencing final cost reduction.

The aggregated answers from respondents revealed that design errors (56%), direct changes ordered by clients (56%) and different site conditions (55%) are the most frequent causes for cost overruns in construction projects.

Moreover, the clients' point of view and the contractors' point of view on this issue barely diverge (see Figure 3). Design errors have been ranked by both groups as the second most frequent cause for cost overruns in the projects surveyed with 56% and 57% of responses. While clients rank site conditions (58%) as the most frequent cause for cost overruns, contractors rank direct change orders from clients (61%) as the most frequent cause. On the other hand, whereas direct change orders (51%) ranks third for clients, site conditions fill the spot with 50% of responses from contractors.

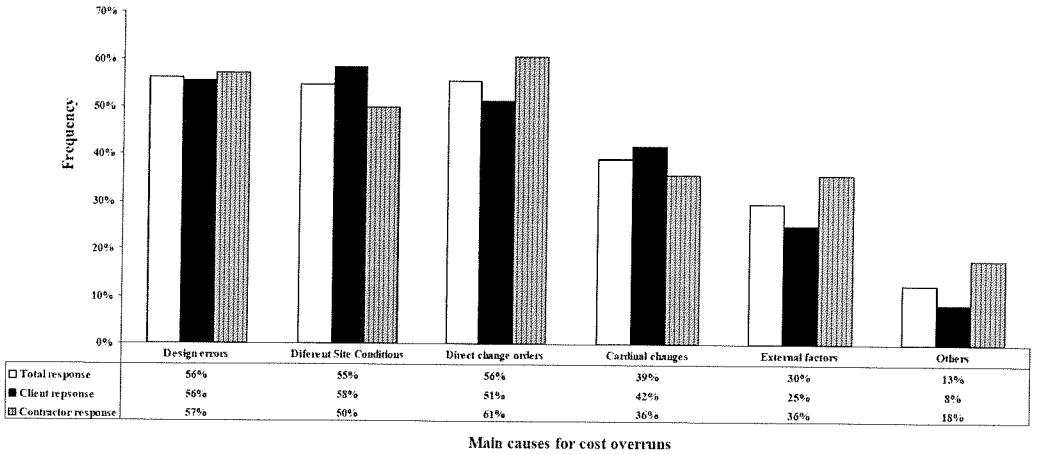

Figure 3: Frequency of cost overrun causes

According to Figure 4, the intensity of these causes rank similarly when compared to the frequency causes previously pointed out. Aggregate responses portray design errors (100 points), direct change orders (97 points) and site conditions (86 points) as the most intense causes for the lack of achievement of the project's cost management function.

Clients rank the same causes as the overall response while contractors position direct change orders instead of design errors as the most intense cause.

On the other hand, different site conditions, previously ranked first by clients as the most frequent cause, ranks third as the most intense cause. In the clients' perspective, although site conditions contribute more frequently to cost overruns, its **intensity** on the lack of achievement of the project's cost management function **is not as significant** when compared to design errors and direct change orders.

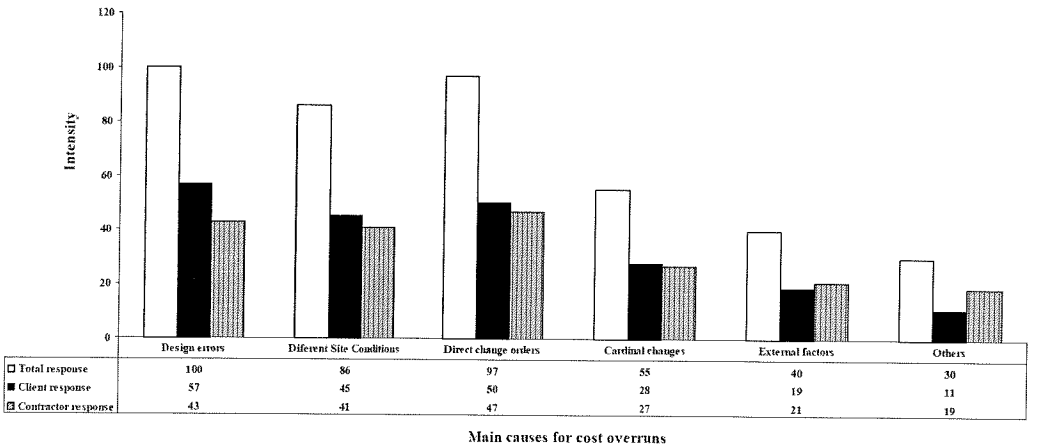

Figure 4: Intensity of cost overrun causes

Safety function

The number of fatal and non-fatal accidents, number of workers involved in the projects, number of work hours and the total working days lost due to accidents occurred was the data surveyed for the safety management function. However, the most reliable data is in fact the labour accidents that are reported to the authorities: 3 fatal and 159 non-fatal accidents occurred in the 66 projects surveyed.

According to the aggregate answers, the most frequent reasons for the occurrence of labour accidents are the lack of specific training, insufficient task preparation, high-risk activities and lack of individual protection.

Separate analysis of clients' and contractors' responses showed an equal understanding on the causes for the lack of safety in construction, although more severely classified by contractors. Contractors insist on the high risk of the activities (36%), an issue that normally is beyond their control, while clients attribute a higher degree of severity to contractors as they indicate insufficient task preparation (22%) and lack of specific training (22%). Contractors also hold themselves liable having reported the lack of specific training and insufficient task preparation with 32% of responses. The lack of individual protection and inadequacy/lack of material/equipment are other causes summoned by contractors.

The frequency of the main causes for the lack of achievement of the safety function is represented in Figure 5.

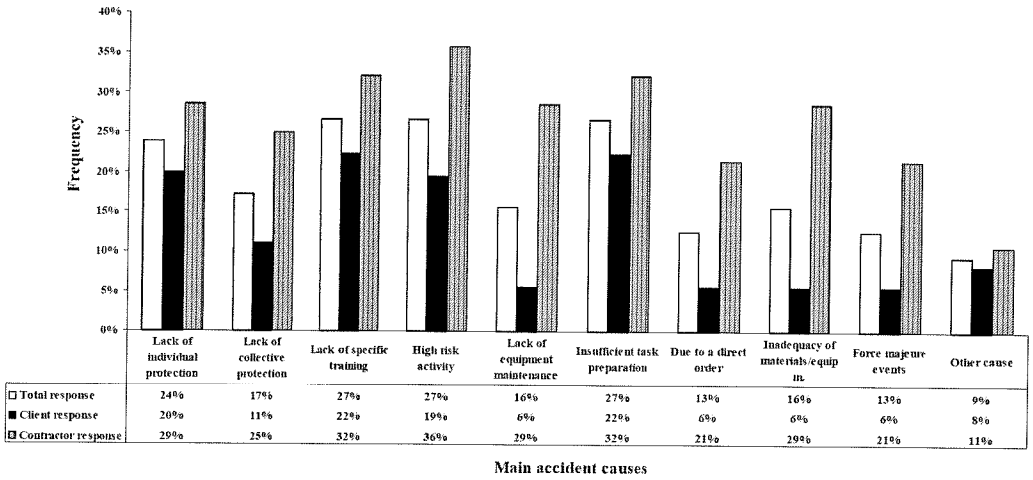

Figure 5: Frequency of accident causes

The intensity of these causes rank similarly when compared to the frequency causes previously specified. However, contractors rank insufficient task preparation as the most intense cause whereas it was ranked second as the most frequent cause. In their opinion, although the high-risk activity contributes more frequently to the lack of safety, its **intensity** on the lack of achievement of the project's safety management function **is not as significant** when compared to insufficient task preparation and lack of specific training. Thus, this only comes to show that contractors acknowledge their own fault in contributing to the lack of safety in construction.

The intensity of the main causes for the lack of achievement of the safety function is represented in Figure 6.

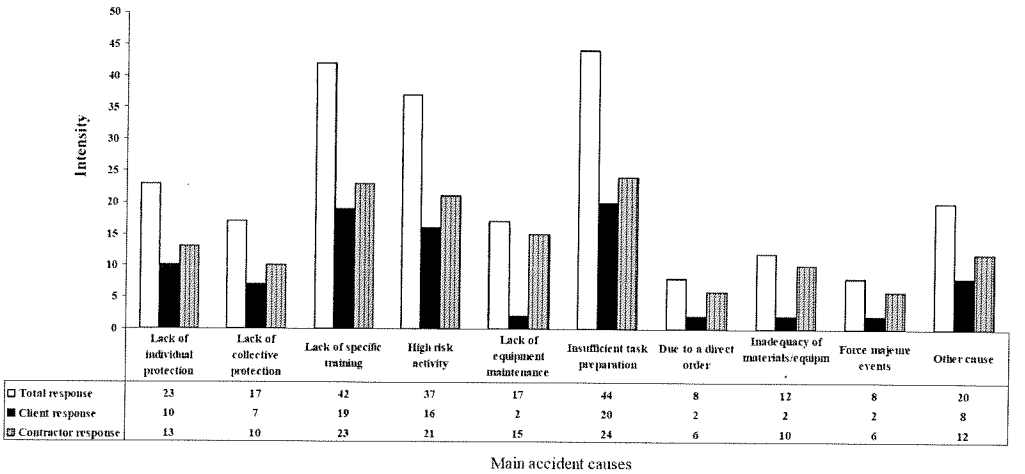

Figure 6: Intensity of accident causes

QUALITY FUNCTION

The number of non-compliances presented during the construction and operation period of the constructed facility was used to analyse the project's quality function. Table 2 illustrates an abnormal frequency distribution of non-compliances that vary from zero non-compliances in 27% of the projects to more than 1000 non-compliances in 3% of the projects, whereas 44% had no available data.

This abnormal frequency distribution must be handled with some care as it might not explain the real situation of the Portuguese construction projects. Instead, it might explain the consequences and the inexperience in dealing with the recent implementation of Quality Management Systems, which is not compulsory for construction companies in Portugal.

Table 2: Weight of non-compliances

Number of non-compliances	Distribution of answers (%)
0	27%
1	6%
2	5%
3	6%
4–10	5%
100–1000	5%
>1000	3%
No answer	44%

Poor work execution (31%) and inadequate design solutions (27%) are the most frequent causes of poor quality of Portuguese construction projects. The same causes identified in the aggregated answers have also been pointed out in the separate answers given the by clients' and by contractors'. Contractors acknowledge their own low performance identifying poor work execution with 39% of responses and inadequate design solutions with 32% of responses while clients consider these causes to be less frequent (see Figure 7).

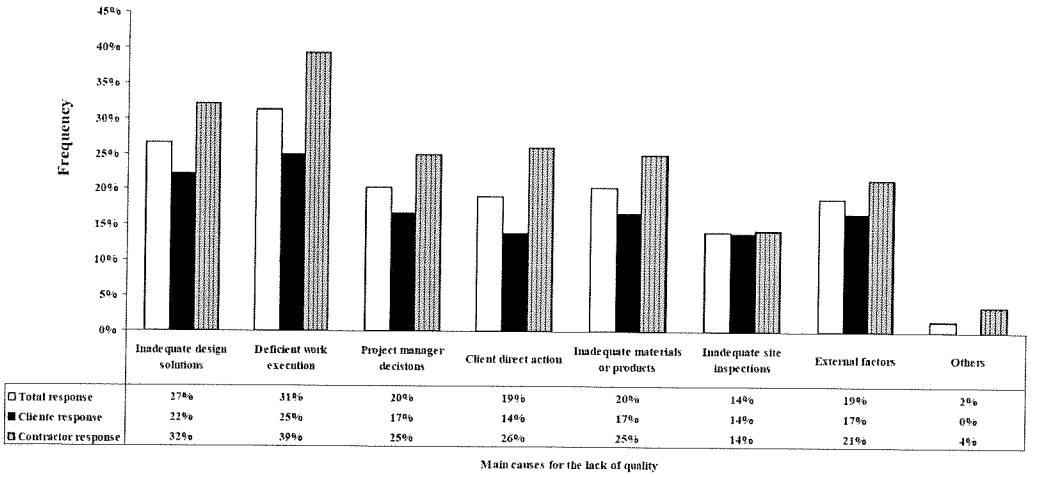

Figure 7: Frequency of causes for the lack of quality

As for the intensity of these causes, poor work execution and inadequate design solutions are more emphasized with 46 and 40 points, respectively. Clients maintain the preceding rank but with less intensity: poor work execution (24 points) and inadequate design (21 points). Contractors also weighed these causes with approximately the same intensity as clients along with external factors (21 points) and inadequacy of materials/products (18 points). Figure 8 illustrates these aspects.

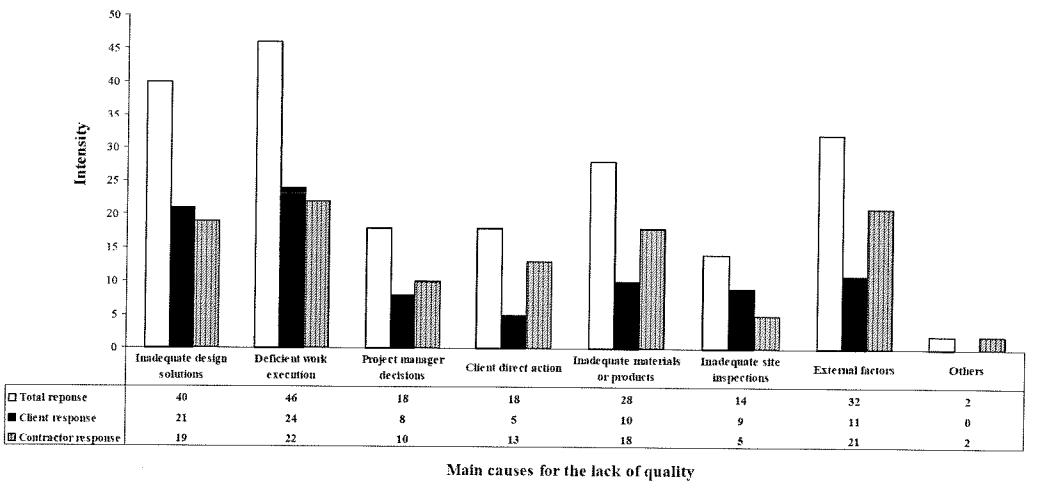

Figure 8: Intensity of causes for the lack of quality

CONCLUSIONS

Results from an ongoing research project on the lack of achievements of the cost, time, safety and quality management functions in the Portuguese construction sector have been reported. These results are an outcome of a survey to the industry involving clients and contractors but the number of replies obtained was bellow expectations, therefore limiting their significance.

The results of the survey on project delays indicate that both clients and contractors agree that major causes have to do with client responsibilities and designer responsibilities followed by inadequate construction management (for clients) and project specifics (for contractors).

Both clients and contractors ascribe major causes to design errors, different site conditions and direct change orders as the main causes for cost overruns.

Lack of specific training, insufficient task preparation, lack of individual protection and the high risk of the activities are the main reasons pointed out for the lack of safety. Contractors indicate the high risk of the activities as the major cause for the lack of safety while clients blame contractors for the lack of specific training and insufficient task preparation.

Poor work execution and inadequate design solutions are the most ascribed reasons by clients and contractors for the lack of quality. External factors and the use of inadequate materials or products have also been pointed out by contractors.

Further results and proposed measures to improve achievements in the cost, time, safety and quality management functions, positively influencing the competitiveness of the Portuguese construction industry, will be presented. The results of this research will be used to establish a set of recommendations for achieving better performance of the industry.

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