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IDENTIFYING OF THE REASONS FOR THE PROJECT DESIGN ERRORS IN THE PORTUGUESE CONSTRUCTION INDUSTRY

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ABSTRACT

The European construction industry is currently experiencing great difficulties and challenges but in Portugal the sector is facing a critical moment which will decisively impact its future. Along with the redefinition of its legal framework, so as to make it more efficient and bring it up to date, the sector is going through stagnation in the private market and a slump in the public construction market, mostly on account of the current state of economy country. Furthermore, the lack of accomplishment of cost, time, safety, and quality, has been recurrently mentioned in the press and in technical literature as one of the main causes for the lack of competitiveness of sector. The poor quality of project designs has been considered as main reason for the recurrent time and cost overruns. Previous studies have often found that designs contain a lot of errors and omissions. This paper wills critically to discuss the problem of poor quality design in Portugal using literature and data from a set of interviews with expert construction managers. The main reasons for the poor quality of project designs have been established from the outcomes of a national survey undertaken and a series of interviews of experts. Some measures that would lessen the problem have been identified.

Keywords: construction competitiveness, design quality, construction delays, national survey, improvement measures.

INTRODUCTION

The European construction sector is confronted by a number of structural problems, such as a shortfall of skilled workers in many companies, low attractiveness to young people due to the working conditions, limited capacity for innovation and the phenomenon of undeclared work. However, the construction sector continues to play an important role in the European economy. It generates almost 10 % of GDP and provides 20 million jobs, mainly in micro and small enterprises. Thus, current challenges require a concerted and coordinated approach at European level to implement a strategy for the sustainable competitiveness of the construction sector and its enterprises.

In addition to the all general and European challenges, the Portuguese construction sector now faces a critical moment which will decisively impact the future. Along with a much called-for reform of a number of construction laws, so as to bring them up to date, the sector is mired in the stagnation of the real estate market, as well as a slump in the public construction market. This can be chalked up to the bad shape the economy is in at the moment, a situation everyone in the country is well aware of.

In this context it becomes especially important for all the relevant intervenient to think about, discuss and share their experience and deploy an adequately-structured campaign for greater awareness.

Design deficiencies are a major cause of problems and conflicts in large-scale undertakings and sometimes even spell their doom where efficiency is concerned. The poor quality of project designs and its coordination has a direct or indirect bearing on its success. All too often the media have divulged audits on public construction that presented significant cost, deadline and quality overruns or deviations. The root cause was often the contracting model as well as quality management and control.

On the other hand, it now appears evident that project designers face growing concerns as new challenges emerge: sustainable construction, project life cycle, ease of deployment of construction

techniques to facilitate completion before deadlines, rationalizing costs and management of the construction project.

The fundamental causes of overall lack of quality in buildings are the increasing complexity in construction projects, the lack of systemic knowledge, the non-existence of an effective warranty and failsafe framework, the demands for speedier construction, new architectural concerns, use of new materials and the absence of specialists on construction physics and technology in project teams.

The extraordinary diversity of materials now available to civil engineers has brought to the fore a problem of increasing complexity (Vieira, 2003). Now project designers, engineers, managers and even owners must learn more about choice of material, its implementation, use and quality control. The choice of material entails additional constraints. At times initial creative options will have to be sacrificed, as will the volumetric, morphological and aesthetic. These will be more and more affected by many parameters which demand heightened attention, such as adequate use, budgetary constraints, life cycle, recycling or reuse of said materials. Construction systems will have to be designed so as to facilitate the deconstruction or selective demolition of buildings with a view to the reuse of most of the material.

DESIGN ERRORS IN BUILDING WORKS

General overview

Previous researches carried out by the Building Research Establishment (BRE) in the U.K. (Building Research Establishment, 1981) found that errors in buildings had 50% of their origin in the design stage and 40% in the construction stage. Later, in 1987, a survey conducted by the National Economic Development Office (Nat. Economic Development Office, 1987) concluded that the main factors that influence quality of building works were attributed to design (e.g., lack of coordination of design, unclear and missing documentation) and poor workmanship (e.g., lack of care and knowledge) (Love et al., 2004). The findings suggest that most of the project-based errors are avoidable by having adequate knowledge and better management practices.

Design errors can adversely influence project performance and can contribute to failures, rework in constructions phase, time and cost overruns, accidents, and loss of life.

In concerning cost effects, a recent study in Australia has estimated the design error costs from 139 projects. The mean direct and indirect costs for design errors were revealed to be 6.85 and 7.36% of contract value, respectively (Lopez & Love, 2012). Although the research provides invaluable insights into practitioners' perceptions of design errors costs, their actual costs remain relatively unexplored.

Portuguese context

The growing competition in the Portuguese construction sector has highlighted the responsibilities that fall to owners as consequence of deficiencies in the work projects they have agreed to. Contractors then acknowledge responsibility for carrying out the construction work, strictly adhering to the design project that motivated the bid and was the starting point for the building contract.

The separation of functions and responsibilities was implied already, as well as material and labour costs. The law now determines that a contract can only state a global budget if the project allows for the definition of the nature and quantity of work to be carried out, as well as material and labour costs. More often than not, projects do not adhere to this rule. Their clauses do not accurately define or quantify the work to be carried out. The contractor is increasingly perceived as a machine that provides a specific output at a set date, for a set price, adhering to the design project, regardless of that project's quality (Santo, 2002) (Couto & Teixeira, 2006a). It then follows that on-site corrections, changes or increased detail may cause changes in pricing and scheduling, and the owner will take on the burden of responsibility.

Even though construction has evolved and businesses are now clearly separated, owners have not invested in improving project quality, the accuracy of the specifications, have not worked out compatibility issues, significant details or bothered do quantify the nature of the work. As a consequence, building projects may present significant deviation regarding budget and scheduling,

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depending on the quality of each project design, the criteria-driven work developed by the owner, save for the deviations attributable to the contractor, which fall outside the scope of the owner's responsibilities. Besides the changes in cost and deadline, design deficiencies may entail serious consequences where constructive pathologies are concerned and clients are sure to present claims during the warranty period. To judge whether a given pathology is attributable to the project's design or the construction methodology is a permanent source of conflicts between inspectors and contractors. It would recommend resorting to constructive details that have already been evaluated and solutions that would warrant a desirable quality standard, whether dealing with project design or the materials to be used, and how they are to be used.

According to the classification proposed by Brito (Brito, 2005), design errors are those whose origin can be traced to the non-existence of information relevant to construction work and the constructive methodologies already recommended. In that subgroup we may include errors arising from flawed contract provisions, quantity lists, coordination among specialty projects and level of detail. According to a study undertaken by Bureau Securitas, the design deficiencies has become a major contributor to the occurrence of anomalies during construction work and the mandatory warranty period thereafter can be shared according to Figure 1.

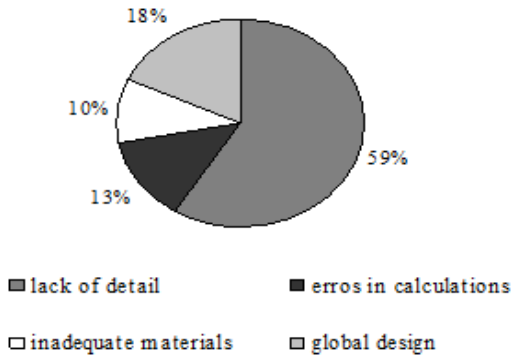

Figure 1. Frequency of different kinds of design deficiencies. Source: (Brito, 2005)

Where private construction is concerned, very often the work is carried out based on the clauses necessary to obtaining a municipal building permit. The lack of a construction project/schedule severely worsens the possibility and occurrence of mistakes. Consequently, items related to budgetary forecasts on a given undertaking, as well as the entire process to coordinate the demands of projects from different trade teams, will necessarily be compromised or even omitted.

The constructive solutions necessary to the singular elements of a building are especially affected by deficiencies in project designs. It is precisely where diverse constructive systems must be coordinated or made compatible and materials of a varying nature and behaviour are put together that new anomalies are more likely to arise. Some recurring examples are associated with the deployment of singular elements in permeability systems or the conjunction of materials in the building's immediate surroundings, which most of the time appear as water leaks or excessive, unwanted moisture.

Often, errors in the design stage give rise to makeshift solutions on-site. These in turn necessitate changes to the architectural project and as a consequence alter the workflow and execution of the projects other specialty teams would carry out.

NATIONAL SURVEY ON CONSTRUCTION DELAYS: IDENTIFYING OF MAIN REASONS RELATED WITH ACTIVITIES OF DESIGN TEAM

Background

The lack of accomplishment of management functions (cost, time, safety, and quality) in the Portuguese environmental has been recurrently mentioned in the press and in technical literature.

The consequences of a time overrun are almost always serious and hard to resolve. Failure to meet deadlines represents financial losses to the users and, more often than not, it has a negative impact on the profitability of the project for the promoters. Now, also there is a consensus to consider the projects designs deficiencies and project team's performance as one of main reasons for construction delays. So, understanding the causes may help in curbing the problem and contribute to an improvement in management and productivity, inevitably making the sector a more productive one.

In order to evaluate the present situation, clarify the reasons for the problem and indicate possible solutions for it, a research project has been conducted, named as "*Reasons for lack of accomplishment of schedule, costs and safety objectives in construction*". The project is financed by the Portuguese Science and Technology Foundation (Fundação para a Ciência e Tecnologia – FCT) (Couto *et al.*, 2005).

Parallel to the project development, a PhD thesis on construction delays has been undertaken by the author. In the scope of the latter, a large survey to Portuguese construction stakeholders has been conducted (Couto, 2007).

Drafting and Conducting of the National Survey

Based on the conducted literature research and an analysis of opinions published by several relevant parties, has been drafted a map that breaks down causes for delay in Portugal into 12 origin-related categories as shown in Table 1.

Table 1. Categories classification for construction delays

Categories Classification for Delays			
MT	Material-related	DT	Design Team-related
EQ	Equipment-related	PM&I	Project Management and Inspection-related
LB	Labour-related	CCR	Contract and Contractual Relationships-related
CM	Contractor Management-related	IR	Institutional Relationships-related
FMP	Financial Management of Project-related	PS	Project Specificity-related
OW	Owner-related	OF	Outside Factors-related

Table 2. Causes for delays into category Design Team

No.	Causes description
75	Delays in preparation of technical documentation by project designers while construction is in progress
76	Errors in design originating from the project designers due to a lack of knowledge of local conditions and the surroundings
77	Incomplete projects, ambiguities, errors, omissions, inadequate details, details inconsistent throughout special teams, inadequate design, etc.
78	Deficient communication among owners and designers during design stage
79	Lack of time/labour overload during design and construction stages
80	Lack of coordination and communication in design team
81	Lack of experience of design team
82	Insufficient team elements
83	Excess and complexity of design norms and rules
84	Inadequate analysis and preliminary studies
85	Complex and unusual project
86	Slowness in project and materials changes revision and approval

Then, a few national specialists, consultants and researchers in construction management were consulted about the adequacy of this cause map, and then elicited opinions from national and specialists about the importance and meaning of studies of this kind to the delay control and

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competitiveness in the construction sector. This cooperative effort was important. It made possible adjust the cause map to the actual characteristics of the national construction sector.

In the category DT - Design Team - the causes considered were as in Table 2. Once defined the cause map, was drafted a questionnaire based on it. It was shared in 2 sections. In section A, the goal is to obtain general information on the institution or company that is taking the survey. In section B was present a list with 118 possible causes for delays. The respondents were asked to attribute to each cause degrees of frequency, impact on workflow and the types of construction project where they are most likely to occur. The aim was to establish a classification and consequently a relevant causes ranking. The average relevance positions have been obtained through combination between frequency and impact rankings (Couto & Teixeira, 2006b) (Couto, 2007).

Initially, a hundred questionnaires were sent out to contractors, 85 to consultants and project designers and 100 to construction clients. A response time was set out for responses. On stage two, direct contacts were made to missing respondents suggesting an interview instead. This alternative was gladly accepted by most of them. As a result, 39 interviews took place during which the questionnaire was filled up.

Answers to the questionnaire were provided by management staff personnel or technical staff in management positions of the organisations inquired (line managers, project managers, site managers and senior engineers).

Finally, 59 answers by contractors, 26 by designers/consultants and 79 by owners were collected. These answers include 8 interviews to contractors, 8 to designers, 18 to public clients and 5 to private clients, for the above reasons.

Table 3 presents a summary of requests and responses obtained, distributed across the four groups of stakeholders surveyed.

Table 3. Summary of survey results (Couto, 2010)

Group	Questionnaires sent	Answers	Interviews	Total number of answers	Percentage of answers
Contractors	100	59	8	51	59%
Public clients	75	62	18	44	83%
Private clients	25	17	5	12	68%
Designers/Consultants	85	26	8	18	30.5%
Total	285	164	39	125	57.5%

It is noteworthy that the percentage of answers from contractors and owners is about 70% and the percentage of interviews reached 24%, which in practice comes to ¼ of the answer total. Comparing these figures to those obtained in similar studies, and weighing the typical difficulties in persuading sector participants to respond to this kind of study/survey, it could be argued that the percentage of answers is quite significant.

Survey Results

The results have revealed that responsibility for delay can be ascribed to all parties involved. From 118 causes included in the survey, an extract of the 15 that were most highly ranked on a scale of relevance by 4 groups involved in the construction sector (Public and Privative owners, Contractors, Designers/Consultants) is presented in Table 4 (Couto, 2007).

Table 4. Raking of 15 most relevant causes

No.	Cat	Causes for delays in construction projects	Average Relevance Ranking
77	**DT**	**Incomplete designs, ambiguities, errors, omissions, inadequate or inconsistent detailing, etc**	**1**
102	IR	Excessive dependency on authorizations from several institutions and ruling bodies	2
100	IR	Difficulties in obtaining licenses and permits from authorities	3
97	CCR	Tendency to use procurement systems with a bias toward the cheapest solutions	4
28	CM	Deficient, activity/material/labor and equipment planning, management and control	5
18	LB	Shortage of skilled laborers	6
76	**DT**	**Errors in design due to a lack of knowledge of local conditions and environment**	**7**
75	**DT**	**Delays while preparation technical documents by designers while construction is in progress**	**8**
49	CM	Neglect of critical activities	9
51	CM	Overly optimistic planning	10
62	OW	Frequent change orders during construction	11
44	CM	Deficient coordination among participants	12
26	LB	Low productivity	13
98	CCR	Lack of financial incentives for meeting anticipating deadlines	14
103	IR	Difficulty and delay in the drafting and submitting requests for institutional authorization	15

As survey results prove that stakeholders contemplate the design team as a one of main categories for delays. The extract present 3 causes concern to design team category with relevant rank positions.

To finish the collect data research proceeding about this problematic – causes for delays related to design activities - it was collected the opinion of Portuguese Association of Designers and Consultants (APPC).

PREVENTIVE MEASURES AND CORRECTIVE SOLUTIONS TO BE IMPLEMENTED

Based on the opinions provided by the survey respondents, specialists, as well as prior studies conducted outside Portugal, it is our purpose to prepare a comprehensive file on preventative measures and recommendations, guided by strict criteria, which will help lessen the problems under scrutiny. The recommendations are many and target every single participant. Not meaning to establish definite hierarchies now, is possible however single out the following:

1. The need to implement a national database with the quantity works list for different construction projects - this project is now under way;
2. Implementing more appropriate and efficient organizational systems within design teams;
3. A need for greater care on the part of the owners when they prepare their schedules, preliminary programmers and viability studies;
4. Raising awareness with those involved about the risks inherent to construction;
5. A need to optimize management with a basis on qualification and the use of more adequate techniques;

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6. A need to update some inadequate legislation so as to clearly define and segregate responsibility and liability.
7. APPC has recently set forth two proposals that might be of great help (Meneses, 2005):
8. Any project above a certain level of importance should be subject to a mandatory review by an independent party;
9. The terms of the bid should demand that the team be experienced in works of a like nature and should limit the range of bidders to companies with a set minimum economic and financial leverage.

According to the APPC, these aspects should constitute exclusive terms. Ignorance and mismanagement go hand in hand with unrealistic, often surrealistic bids that do much to worsen the quality of the work, bring project prices.

Look at any business and you will find that only the quality of demand is responsible for the quality in supply. The Portuguese state is responsible as a regulator and an inescapable reference owner.

CONCLUSIONS

The increase of competition among construction businesses, followed by the progress in organization, technical and legal aspects, along with the glut of deficient projects have led to more and more claims arising from errors and omissions; also, to more conflicts among the many participants. As a consequence, will there are cost and time overruns, with the contractor trying to derive advantages for him/herself, as in this particular setting contract bids are quite inferior to reasonable prices.

However, nowadays, according to research projects undertaken the shortage and/or an unsuitability of project details, the lack of information by projects designers and an inadequate construction support by designers are the main reasons for the lack of projects quality.

The solution should include a greater accuracy and investment by the owners on preparation and analysis the preliminary phases of projects with a view to make available as soon as possible more and better information to designers. A need to optimize the designer team's management and to update the legislation in concerning to clear and segregate the responsibility by errors, were also considered by survey respondents very important measures.

Those procedures will be a very important help to improve the designers performance what will contribute to avoid or mitigate the overruns and conflicts during the construction stage.

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