

Establishing measures to improve design quality in the Portuguese construction industry

J. P. Couto

University of Minho, Guimarães, Portugal

ABSTRACT: The Portuguese construction industry is currently experiencing great challenges. 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. It is very important to find ways to correct the problems and to make the sector more competitive. Recently there have been several conferences, symposiums and publications which have studied the reasons for its lack of competitiveness. One of the main reasons that have been identified is the recurrent poor quality of project designs. Previous studies have often found that designs contain a lot of errors and omissions. This paper will critically discuss the problem of poor quality design in Portugal using literature and data from a set of interviews with expert construction managers. The reasons for the poor quality of designs have been established from the outcomes of a national survey undertaken and a series of interviews of experts.

1 INTRODUCTION

1.1 *General considerations*

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 fail-safe 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 conversion of buildings and selective demolition with a view to the reuse of most of the material.

Here it would be relevant to point out that this is a trans-disciplinary sector, involving professionals

from several fields of expertise whose primary bond, would be to contribute towards a more transparent, efficient, qualification-driven, credible market unhindered by bureaucracy.

1.2 Goals and aims of the present study

The aim of this study is to draw attention to prior research into the reasons and consequences of this specific problem. Then, taking cues from the extant research and the opinions/suggestions gleaned from several parties to the process on the lack of competitiveness in the Portuguese construction industry in the research project the author of the present study is currently working on, will be point out some preventative measures that would lessen the impact of the problems discussed.

2 DIAGNOSTIC OF PROJECT DESIGN ERRORS (ROOTS)

2.1 What previous literature says

The way projects are prepared often leads to systematic repetition of previous construction mistakes, which impacts costs, causes extra work and time overruns and frequently calls for design changes.

One of the areas which tends to cause more problems is the adaptation of the foundations and structure of the building to the terrain itself, due to the lack of valid data at the design stage.

Constructive elements that touch the divide between businesses do cause some of the deviations verified.

Owners display little care in the preparation of the elements they supply to project designers. These are prepared by a number of independent specialists who in turn hire their own surveyors with little thought given to coordination. That is why incompatibility and deficiency issues arise.

Among more frequent causes for lack of quality in design projects conceived for bidding and building purposes, we would point out the following (Santo 2002):

- A lack of up-to-date topographical surveys and geotechnical studies that would describe on-site conditions so as to allow for an appropriate design of foundations and structures, evaluation of soil processes and outside work
- Little coordination among differing projects with an integrated vision, so as to make compatible the work assigned to different specialty teams, extending the scope of work to the surroundings, namely landscaping and connecting with infrastructures
- Lack of accuracy in defining work schedules, especially with measurement maps, surface works lists contract provisions and construction details, finish maps and designed pieces

- Non-existence of an on-site quality control system that would allow for the identification of mistakes, evaluate their consequences and generate guidelines to help in future projects.

Some of the errors listed above stem from the structural model of many architect and engineer teams which more often than not are small-scale businesses and must subcontract with specialists. In each project there must be different architectural specialists, engineers, designers, surveyors and budget specialists. These professionals do not, as a rule, hold coordination meetings. Nothing but incompatibility and on-site lack of accuracy can follow, as is later detected.

3 MAIN CONSEQUENCES

3.1 Previous literature approach

The growing competition in the 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 labor 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 labor 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 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, 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 a classification proposed by 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 are:

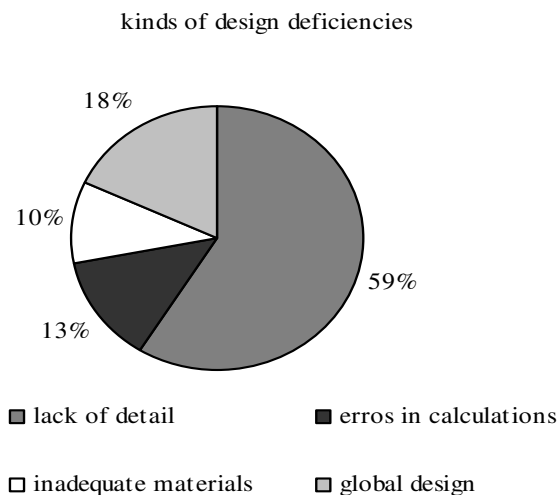


Figure 1. Frequency of different kinds of error in the sum total of errors (Brito 2005).

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.

4 NATIONAL SURVEY ON CONSTRUCTION DELAYS

4.1 Approach and the most objectives

The Construction Management and Technology Group of Department of Civil Engineering - University of Minho - have been carrying out a several research activities whose goals are aiming at clarify the reasons to lacking in competitiveness (Couto et al. 2005).

Basically, the aim is to provide answers to the following questions:

- 1 Why are construction projects systematically delayed?
- 2 Why are there budget overruns in practically every single project?
- 3 Why is safety, still badly overlooked in Portuguese construction?
- 4 Why isn't quality satisfactory yet, even in recent projects?
- 5 How do promoters and contractors to deal with growing environmental demands?

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", financed by FCT (Science and Technology Foundation, in Portuguese) (Couto et al. 2005).

More recently in scope of PhD thesis program it has been carried out a national survey on construction delays.

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. However, 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 Portugal there are no known studies of any relevance on the causes for time overruns, although their consequences are often discussed. There are however some studies about lack of quality, coordination problems and project errors. The importance

of the problem *per se* constitutes enough grounds for the development on Portuguese construction a specific research focuses on this topic.

The goal here is to make information available that will help develop and deploy attenuating measures as well as strategies and techniques geared specifically towards the management, prediction and control of the causes for delays. These would have an impact on the project design and construction management stages and would then ensure greater success where compliance with schedules and deadlines is concerned. This would substantially improve the competitiveness of the Portuguese construction industry.

To make this possible, not only it has been collected bibliographical information and proceeds with the analysis of the traits found in the national construction sector but it has been also asked a number of people for their opinions. These people were promoters, company owners, construction owners, public institutions, contractors, designers and other relevant construction personnel. They were asked to provide a data set that would validate our current concern and allow for a more realistic insight into the problem, and increase our knowledge and understanding of the reasons behind overruns caused by lack of design quality. A nation-wide survey was administered.

4.2 Drafting and implementation of the nation-wide survey

Having studied the bibliography and complemented, double-checked and contrasted the data therein against a number of opinions published by several relevant parties in the sector, and following an analysis, drafted a map that breaks down causes for delay in Portugal into 12 origin-related categories (see Table 1).

Table 1. Categories of contemplated causes for delay.

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

In the category DT - Design Team - the causes considered were as following:

Table 2. Causes for delays into category Design Team.

Nº	Enumeration causes
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 were consulted a few national specialists, consultants and researchers in construction management about the adequacy of this cause map that we'd drafted, and then elicited opinions from national and specialists about the importance and meaning of studies of this kind to the delay control and competitiveness in the construction sector. This cooperative effort was important. It helped us adjust the cause map to the actual characteristics of the national construction sector. It would be apposite to say that the whole process evolved as we conducted our survey.

Once defined the cause map, we 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 is to establish a classification and consequently rank the relevant causes. The Average Relevance positions have been obtained through combination between frequency and impact rankings (Couto 2005, Couto & Teixeira 2006b).

A hundred questionnaires were sent out to contractors, 85 to consultants and project designers and 100 to construction owners. On stage two, we contacted the respondents who did not get back to us within the prearranged response time, proposing an interview as an alternative. The latter suggestion was gladly accepted by these respondents. Were carried out 39 interviews. The main intent was to ask questions that would clarify the causes mentioned in the survey and observe procedures so as to resolve them.

4.3 Research methodology implemented (in short)

In conclusion, the fundamental stages of investigative procedures were:

- Bibliographical research and analysis
- Discussion with relevant professionals and construction management specialists
- Implementing a questionnaire
- Analysis of the data gathered

5 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 Private owners, Contractors, Designers/Consultants) (Couto 2006b) is presented.

Table 3. Raking of 15 most relevant causes.

No.	Cat	Causes for delays in construction activities and projects	Average relevance ranking
77	DT	Incomplete projects, ambiguities, errors, omissions, inadequate details, details inconsistent throughout special teams, inadequate design, etc	1
102	IR	Excessive dependency on opinions and authorizations from several institutions (city/town halls, Portuguese Institute for Architecture and Patrimony, Environment Institute, etc.)	2
100	IR	Difficulties in obtaining licenses and permits from authorities	3
97	CCR	A tendency to use procurement systems with a bias toward the cheapest solutions	4
28	CM	Deficient planning, activity/material/labor and equipment management and control	5
18	OW	Shortage of skilled laborers	6
76	DT	Errors in design due to a lack of knowledge of local conditions and the surroundings	7
75	DT	Delays in preparation of technical documentation by project 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	OW	Low productivity	13
98	CCR	Non-existence of financial incentives that would encourage meeting deadlines of completing the works before the deadline	14
103	IR	Difficulty and delay in the drafting and submitting of requests for institutional opinions and authorizations	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).

6 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:

- The need to implement a national database with the quantity works list for different construction projects - this project is now under way
- Implementing more appropriate and efficient organizational systems within design teams
- A need for greater care on the part of the owners when they prepare their schedules and preliminary programmers
- A need for greater precision when preparing viability studies
- Raising awareness with those involved about the risks inherent to construction
- A need to optimize management with a basis on qualification and the use of more adequate techniques
- A need to update some inadequate legislation so as to clearly define and segregate responsibility and liability, and so on

APPC has recently set forth two proposals that might be of great help (Meneses 2005):

- Any project above a certain level of importance should be subject to a mandatory review by an independent party
- 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 unrealistic 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.

7 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's teams 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.

REFERENCES

- Brito, J. & Sequeira, J. 2005. Proposta para uma classificação dos erros na empreitadas de construção Civil. *Engenharia & vida*, Nº 19, December.
- Couto, et al. 2005. Análise das causas do incumprimento dos prazos, dos custos e da segurança na construção. *Progress report n° 1*, Project SAPIENS Nº 47625, Science and Technology Foundation, in Portuguese, June.
- Couto, J. P. & Teixeira, J. M. 2005. As consequências do Incumprimento dos Prazos para a Competitividade da Indústria de Construção – Razões para os Atrasos. In *3rd Conference Engenharia'2005*, UBI-University of Beira Interior, Covilhã, Portugal, 21-23 November.
- Couto, J. P. & Teixeira, J. M. 2006a. A baixa competitividade da indústria de construção portuguesa motivada pelos recorrentes incumprimentos. *NUTAU'2006, Technological Innovation – Sustainability, VI Brazilian seminary of design management process in building projects*, School of Architecture and Urbanization, University of S. Paulo, October 9-13, São Paulo, Brasil. (Full text and Oral communication).
- Couto, J. P. & Teixeira, J. M. 2006b. Reasons for the lack of competitiveness of Portuguese construction industry. *Construction in the XXI century: Local and global challenges, Joint International Symposium of CIB Working Commissions - W55: Building Economics, W65: Organization and Management of Construction, W86: Building Pathology*. Roma, Italy, 18-20 October.
- Meneses, J. 2005. A má qualidade dos projectos é endémica?. *Boletim of APPC (Associação Portuguesa de Projectistas e Consultores)*, December.
- Santo, F. 2002. *Edifícios - Visão integrada de projectos e obras*. Lisbon. Engenium Editions.
- Vieira, J. P. 2003. Racionalização do Processo de Desenho: Coordenação e Gestão de Projectos de Construção para Edifícios de Habitação de Custo Controlado. *MSc Dissertation*, University of Minho, Guimarães, Portugal.