# PROJECT DELIVERY METHODS FOR LARGE SCALE BUILDING PROJECTS: A CASE STUDY

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This paper aims at contributing to clarify the major problems of project delivery of large scale building projects and inputting the lessons learned during the development and construction of the Colombo Centre in Lisbon. Traditional project delivery methods are ill suited for delivering a large size building project. Issues such as developing a project delivery strategy and contractual relationship, project structure, selecting project participants and improving constructability are crucial to deliver a large size project on time and under budget. Colombo project used a project deliver approach that combines the strengths of the construction management with design-build methods. This project delivery approach and the management tools described in this paper lead to the overall success of the Combo project, including meeting owner's goals related to cost, schedule, and quality.

Keywords: Case study, construction management, partnering, project delivery methods.

## INTRODUCTION

Construction industry, due to its important economical role and as a large scale employer, grew to become an area that can not be neglected by any government or economical group. This sector is under pressure to reduce project delivery times and costs despite increased uncertainties and complexities that surround today's construction projects. A host of new project delivery methods and management techniques have been promoted to help achieve this. Mid and large size building projects involving several workers and sums of hundreds of millions pounds are common throughout the world, especially in Europe, in the fast growing east Asian countries and in the USA. Delivering a large size building project on time and under budget is still an increasingly complex and risky business. Issues such as developing a project delivery strategy and contractual relationships, project structure, selecting project participants and improving constructability are crucial to deliver a large size project on time and under budget (Kluenker 1996). The project delivery solutions used in the Colombo centre are new and they worked well. The project's owner developed and implemented a project delivery approach that combines construction management and design-build with partnering, concurrent construction to deliver the project on time and within the budget. This paper tries to contribute to the body of knowledge on construction management with lessons learned with the Colombo Centre project in Lisbon.

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Ribeiro, F L (1998) Project delivery methods for large scale building projects: a case study. *In:* Hughes, W (Ed.), *14th Annual ARCOM Conference*, 9-11 September 1998, University of Reading. Association of Researchers in Construction Management, Vol. 2, 553-64.

## METHODS OF PROJECT DELIVERY

There is no perfect project delivery method for every building project. Also, there are no absolutes in project delivery methods, just variations along a spectrum (Kluenker 1996). Traditional projects use design-bid-build delivery process and fixed-price contract type, with little opportunity for designer/builder interaction. This approach entails the owner engaging separate organisations for three key services: design, cost advice, and construction. Design-bid-build delivery is ill suited to managing and delivering large scale building projects with multidisciplinary jobs for the following reasons: (i) each phase of the project is managed separately; (ii) information generated and used in each phase is often held by separate organisations and not shared by all the project participants; (iii) no direct link is maintained between decisions made in each phase and the objective functions of the project; (iv) the emphasis is normally on control rather than on proactive management of the project or continuous value addition; (v) the management emphasis is on contract administration.

To overcome these problems, the construction industry is moving towards non-traditional project delivery methods such as design-build, construction management, bridging, fast-track, and concurrent construction, and some other similar methods of project delivery have been practised widely in recent years with varying degrees of success (Newcombe 1996; Jaafari 1997; Puddicombe 1997). Design-build is a form in which one firm or joint venture is responsible to the owner for both design and construction, setting up conditions for good co-operation between them. This method is a solution that depends upon a design-build contractor having all the necessary design and construction skills within one organisation - a situation that would be rare for large size building projects with multidisciplinary jobs.

Bridging is a variation of the design-build method. It puts side by side designers and construction managers with clients and contractors to improve business and deliver cost-effective solutions. It attempts to secure all benefits of design-build yet retain control for the client whenever the client needs it (Kluenker 1996). Construction management is a method of project delivery that differs significantly from design-bid-build and design-build. In the construction management method the client contracts directly with a series of trade contractors, thus eliminating the role of general contractor. The construction management method is a solution that depends upon a project and construction management organisation having all of the necessary engineering, procurement and construction skills within one composite team (Hughes 1997). The project management method has been around for many years in the construction industry. This method is justified when there is a need for overall project management and an integration role with other delivery methods, even with the design, management and construction management. In the fast track method the project is executed in a phased manner except that design and construction activities are merely overlapped to save time. This practice is claimed to cause sub-optimal design, cost and time overruns and lack of teamwork between designers and contractor (Fazio et al 1988, Mohamed and Tucker 1996, Jaafari 1997). Concurrent construction (CC) may be defined as an integrated approach to the planning and execution of all project activities, from the planning stage through to the handover of the facility. Under concurrent construction, all project activities are integrated and all aspects of design, construction, and operation are concurrently planned to maximise the value of objective functions while optimising constructability, operability and safety (Jaafari 1997). Partnering has received significant attention in the project and construction management literature (Abudayyeh 1994; Albanese 1994; McGeorge and

Palmer 1997). Partnering attempts to change the nature of the adversarial relationship between owners, contractors, architects, and other project team members by getting them to commit to common objectives, formalising improved communication, and preventing disputes (Gardiner and Simmons 1998). Combination projects are those using a combination of two or more approaches, including partnering, design-build, and/or formal constructability programs (Pocock et al. 1997).

## RESEARCH METHODS

The objectives of the research were met through an intensive literature review, interviews, and a case study. A real construction project utilising a combined project delivery approach was chosen to study the major problems of delivering a large scale building project. A total of 32 interviews were carried out with project owner's staff, construction management contractor's staff and trade contractors senior staff. The interviewees, who had worked on the case study project throughout the construction process, were asked to identify: (1) issues regarding the selection of project delivery strategy and contract relationships for delivering a large scale building project; (2) advantages and disadvantages in the construction management method combined with design-build method at trade contractor level; (3) key factors that should be considered in applying partnering and concurrent construction with the construction management method; (4) critical schedule and cost implications associated with the project delivery solutions. The writer also solicited the lessons that the project managers learned using the construction management delivery method together with design-build methods in the actual project and how those lessons can be applied in subsequent projects. All 32 interviews were recorded on audio cassette, and were subsequently transcribed and evaluated. The data collected were enhanced if necessary through further contact with the original respondent and by carrying out interviews with additional project personnel.

## QUALITATIVE ANALYSIS

The study was first carried out by analysing the interviews and then studying the project. The analysis of the interviews are summarised into two topics: (1) project delivery strategy; (2) critical schedule and cost implications associated with the project delivery strategy.

### Project delivery strategy

The following questions were asked:

1. Is the traditional project delivery method -design-bid-build- suited to meet the performance requirements of a technically complex and large size building project?
2. What are the main advantages of the combination of construction management with design-build at trade contractor level?
3. Does partnering contribute to reduce the conflicts and disputes related to the design-build method together with the fixed-price contract type?
4. Does partnering help to improve integration and interaction among project parties?

### Critical schedule and cost implications associated with the project delivery strategy

The following questions were asked:

5. Does construction management with design-build method at trade contractor level help to reduce construction time and costs?
6. Does concurrent construction contribute to maximise the value of schedule while optimising constructability?

To perform the analysis for these questions, a total of 32 interviews were evaluated. The results are summarised in tables 1 and 2.

**Table 1:** Summary of Yes/No questions

| No. of – Inter-views | Is the traditional project delivery method – design-bid-build- suited? | Does partnering contribute to reduce the conflicts and disputes? | Does partnering help to improve integration and interaction among project parties? | Does construction management with the design-build method at trade contractor level contribute to reduce construction time and costs? | Does concurrent construction contribute to maximise the value of schedule? |
|---|---|---|---|---|---|
| YES | 6 | 20 | 18 | 28 | 19 |
| NO | 26 | 12 | 14 | 4 | 13 |

**Table 2:** Summary of the advantages of the project delivery strategy

| | Why choose a combination of the construction management with design-build method? | | | | |
|---|---|---|---|---|---|
| | Reduce management layers | Improve constructability | Provide the owner with an early price guarantee | Provide opportunities to reduce time and cost | The owner could keep a closer monitoring of the design and construction process |
| No. of – Interviews | 27 | 16 | 28 | 23 | 29 |

As can be deduced from the Table 1, for the first question, 81% all respondents answered that the traditional method -design-bid-build- is not suited for technically complex and large scale building projects while 19% answered yes. 63% of all respondents agreed that partnering contributes to reduce the conflicts and disputes within the construction management method. Moreover, it can be seen that 56% all respondents expressed that partnering helps to improve integration and interaction among project parties. A large number of the interviewees (88%) were of the opinion that construction management with design-build at trade level contributes to reduce construction time and costs. 59% of all respondents expressed that concurrent construction contributes to maximise the value of schedule. Table 2 shows the opinions expressed by all interviewees regarding the advantages of the combination of the construction management method with design-build method at trade contractor level.

## CASE STUDY: CONSTRUCTION MANAGEMENT AT COLOMBO CENTRE IN LISBON

This section provides a description of the project delivery framework used for the Colombo Centre project.

**Colombo project characteristics**

Colombo Centre is a commercial complex consisting of retail, office and leisure areas. Its total construction area is on first phase approximately 400,000 m2 over six floors, and two twin 16 story office towers, the final construction area will exceed 450 000 m2. The centre includes more than 6800 car parking places, 400 shops, 10 cinemas, a carting track, a roller coaster, a jogging circuit, a golf driving range, swimming pools, 12.000 m2 for entertainment areas and 7.000 m2 of open air restaurants and coffee shops on the top floor. The building structure consists of an orthogonal 8x8 mesh of concrete columns and 7 slabs, from -3 to +3 levels. The underground slabs are beamless, and from level 0 up the slabs are supported by beams. The Colombo project also includes the construction of three flyovers, the longest being approximately 400 meters long, more than 4 km of roads and one tunnel road as counterparts to the city's administration. The capital investment for this project was 50.000.000.000 Escudos (about 167 million pounds), construction works of the first phase started in November 94 and finished in September 1997.

**Project delivery approach**

Delivering the Colombo project on time and within the budget was a major goal set up by the owner in the early planning stage. The owner had to consider the trade-off between issues such as: assigning and sharing of risk, conflict interests, designers/contractors as agents, designers/contractors as vendors, partnering, and selection of the project deliver strategy, contract types, project structure and project participants. The Colombo project required a combination of different of project-deliver solutions which cloud provide means to delivery the project in time and within the budget at minimum risk. Thus, it used a project delivery framework (Figure 1) which combines construction management with design-build, partnering, concurrent construction and constructability at trade contractor level to achieve the goals set up by the owner.

The experience on large scale building projects with a high degree of multidisciplinary jobs has led to a move to reduce the number of management levels and increase the degree of decentralisation (Harrison 1992). The construction management delivery method was justified because it provides a way to reduce the management levels by eliminating the role of main contractor and to approximate the owner to the trade contractors. The construction management contract was awarded to a consortium of three firms each one with experience in architectural, engineering, procurement and construction fields. Design-build was chosen as the delivery method of the different parts of the project (work packages). In such arrangement the trade contractors were not given a complete design, but to complete the design and construct the work package put under bid.

Why choose design-build? The value of design-build within the construction management approach shown in Figure 1 comes in: (i) the integration of the design and construction of each work package within the same contract arrangement, which can then bring construction technology and experience; (ii) lump-sum contract and design-build providing the owner with an early job price guarantee; (iii) design-build offering opportunities to reduce construction time and costs.

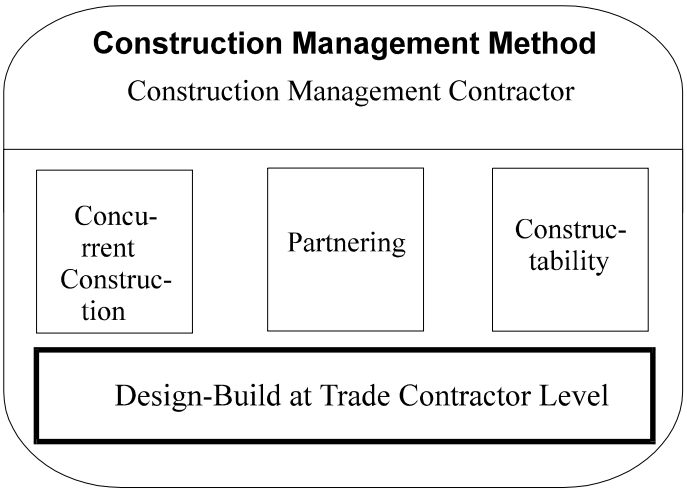


**Figure 1:** Project delivery approach used for Colombo project

**Implementation of the project**

The design-build method followed at trade contractor level combines the strengths of the design-build process and the fixed-price contract type. The trade contractors were selected by competitive bid based on a concept design and well defined requirements. Also, the contract price was fixed and enforceable. The client selected the trade-contractors on the basis of their qualifications, delivery and financial record, reputation, and negotiated in every instance a firm price at concept. This process allowed the trade contractor (design-builder) to collaborate in completing the design with the best technology and cost-effective solutions. The Colombo project was divided into 60 design-build packages of work according to a work breakdown structure developed for the project (Figure 2). Each one of these package corresponded to a distinct area of work which was awarded to one trade contractor and in some cases to a consortium of trade contractors by competitive bidding on the basis of the design-build delivery method. These packages were contractually managed in an integrated manner.

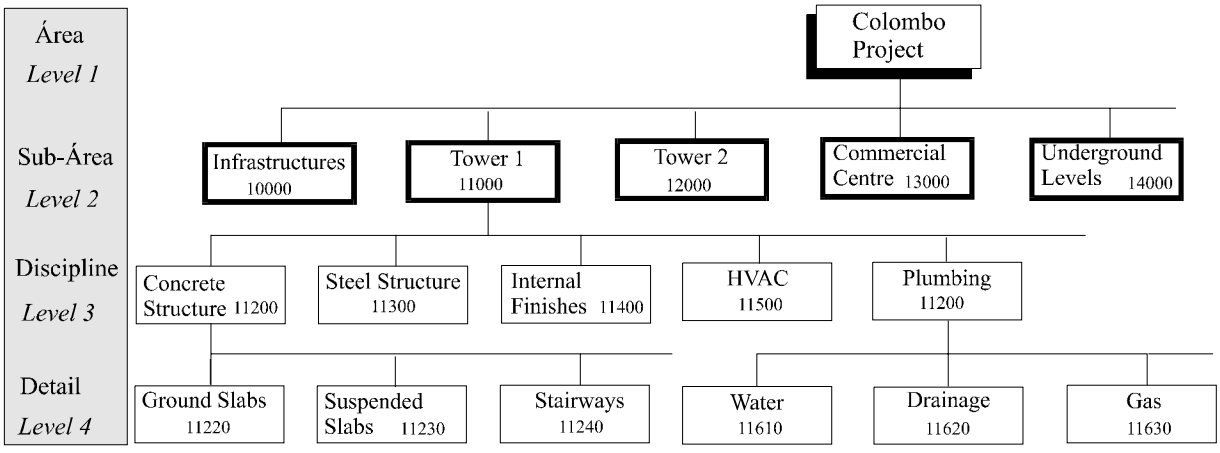


**Figure 2:** Partial view of the breakdown structure of the Colombo project

The construction management contractor assisted the client in defining, co-ordinating, reviewing and managing the project designs, establishing a master schedule and an achievable budget. The first step in its work was to follow the execution and co-ordination of the several design projects. Once the works had enough definition, a master schedule and a general budget were developed. This budget served as upper limit and guideline for the prices of the different packages during the negotiations with the contractors. It is extremely important to have a master schedule and a budget as accurate and detailed as possible from day one. The definition of activities and the division by packages will reflect throughout the entire period of works by the project management team. Figure 3 presents a diagram showing the procurement process at trade contractor level.

**Contract relationship between owner and trade contractors**

The contract relationship between the owner and trade contractors chosen was the fixed-price contract type, more precisely the lump-sum contract between the client and the trade contractors. According to this contractual arrangement the trade contractor or the joint venture of trade contractors was required to establish a stipulated sum for the completion of defined scope of work. In such a contract arrangement the trade contractor of the joint venture agreed on completing a defined design-build package of work for a fixed sum of money.

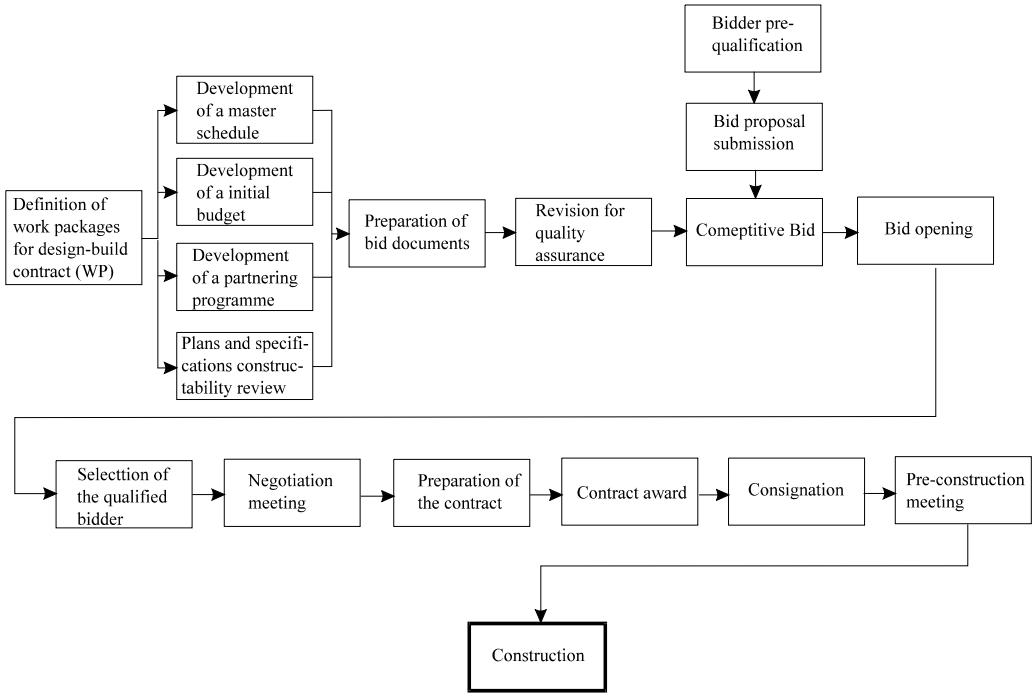


**Figure 3:** Diagram of the procurement phase at trade contractor level

Risks were allocated primarily towards the trade contractor. Hence, trade contractors bear all the financial burdens of cost overruns if the scope or site conditions do not change.

**Project structure**

The project delivery approach required an efficient and cost-effective project structure. Figure 4 shows the project structure including major participants and relationships between them. One of the key elements of this project structure was the ‘Manual of Procedures’ (MP) and the partnering programme which were developed in

the early planning stage of the project and carefully followed until the end of the project. The aim of the MP was to provide orientation and guidelines for all project participants and to regulate the relationship between them throughout the construction process. These written standards and procedures together with the partnering programme provided orientation for efficient integration of all project participants around common objectives and a high level of interaction between. The project owner consists of a major Portuguese private economic group and a large size Dutch real estate company. The owner awarded the construction management job to a consortium composed of four specialised companies, being two American and two Portuguese, instead of contracting a main contractor to construct the Colombo project.

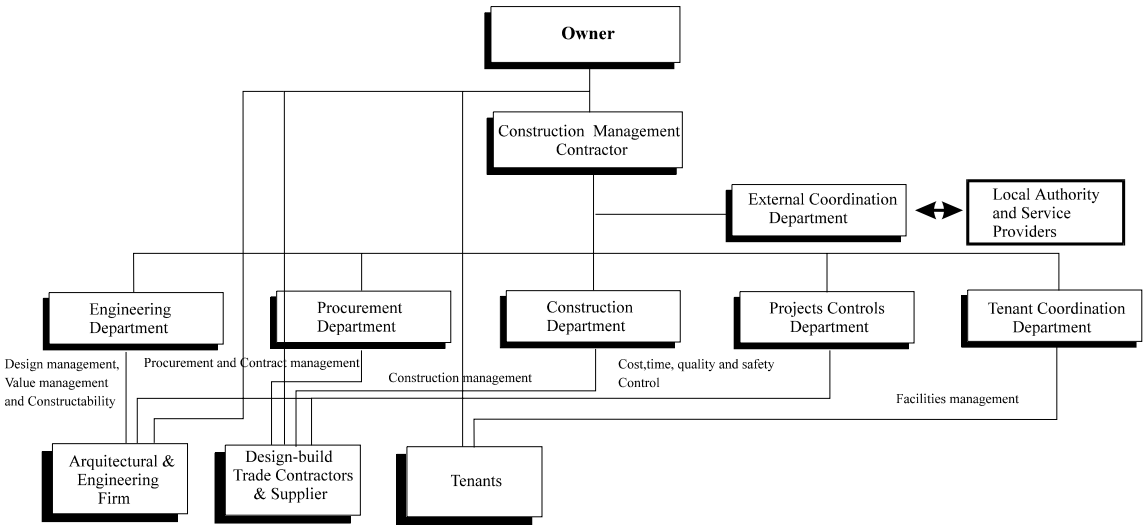


**Figure 4:** A schematic representation of the project structure

The construction management consortium represented a balanced association of leading edge companies with high degree of professionalism, experience and skills in design, consultancy, procurement and construction, and real state. Thus, among these companies, there were both styles of project management the “consultant” and the “general contractor” styles. The consortium was divided into 6 departments (Figure 5): procurement, engineering, construction, project controls, tenant co-ordination and co-ordination of external parties.

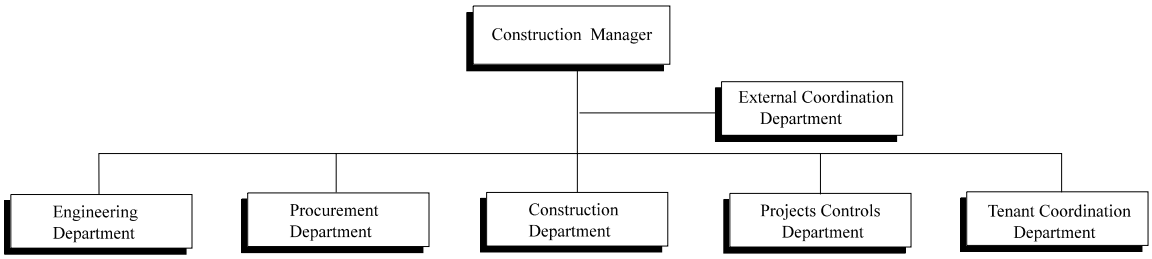


**Figure 5:** Construction management contractor organisational structure

Each one of these departments had a director who reported to the project manager. To each of these department corresponded a set of management functions.

**The project management information system**

The project delivery approach shown in Figure 1 needed a unified, information management system to hold all key information relevant to the management of the design, procurement, and construction processes of the project. Thus, an integrated

information structure was set up as the core the project delivery system and all project management functions linked to it. Figure 6 shows how this framework works. The execution of a given project management function commanded the system to access all the information of the project relevant to the function under consideration stored in the project database, assemble this information, analyse or evaluate the information, and produce reports. All information relevant to the development and implementation of the project was stored in a relational database management system. On the top of this relational database were the project management system KMES property software) and the project planner PRIMVERA from Primavera Systems, Inc. KMES is project management system which can be easily integrated with other software such as PRIMAVERA.

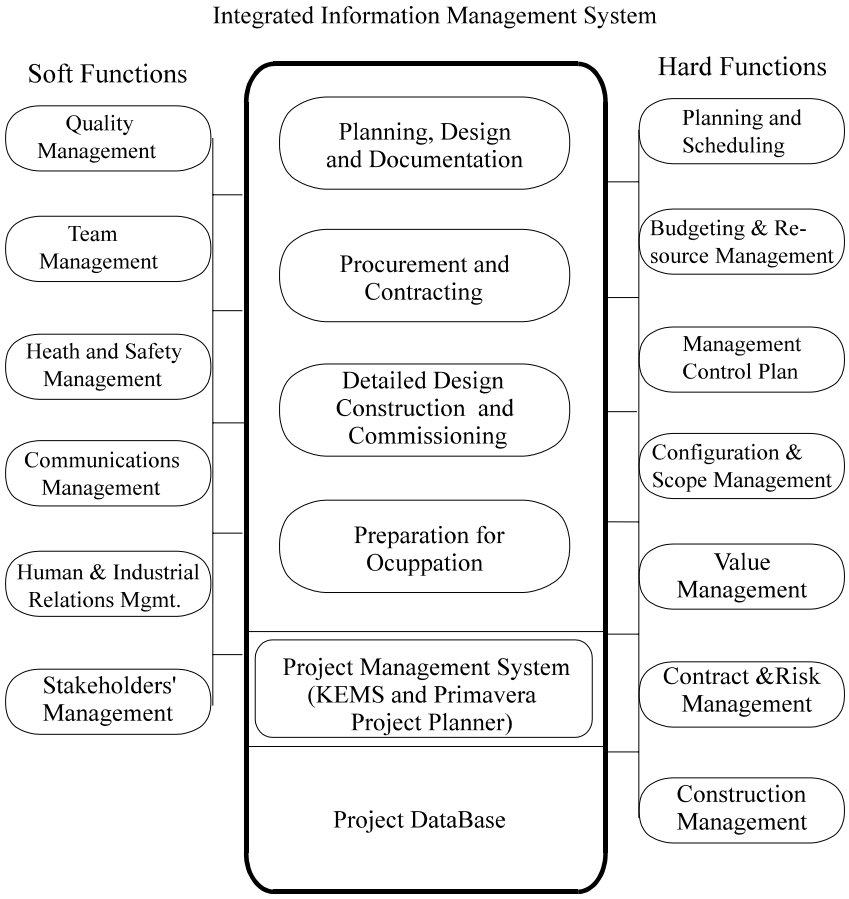


**Figure 6:** Schematic representation of the information management system of the project

## CONCLUSIONS AND LESSONS LEARNED

Delivering and managing a construction project is a complex process and any finished project has something to add to the extensive body of knowledge in construction management. Colombo project has successfully demonstrated that a project delivery approach that combines construction management and design-build methods with other management tools can produce better performance results in terms of schedule, costs and reduction of disputes on large scale building projects with multidisciplinary jobs. Partnering and concurrent construction are some of the means by which the Colombo project have obtained greater value from the resources committed by the owner to the project. Some of the major contributions of the Colombo project are the lessons learned during construction stage. They fall into the following categories: (i)

the project delivery approach; (ii) compensation scheme; (iii) effects of partnering on the construction process; and (iv) effects of concurrent construction on the construction process. The following sections summarise these lessons.

**Lesson 1: Project delivery approach**
Colombo is a technically complex and speedy building project. The combined project deliver approach was ideally suited to meet the schedule and cost goals of the Colombo project and avoid construction claims and cost/time overruns. The construction management method creates contractual relationships and liabilities that are unique in Portugal.

Why choose a project management team instead of a general contractor? A general contractor takes over the responsibility of meeting the schedule and the budget, usually on a lump sum basis (maximum price guaranteed). To cover its risk, the general contractor is entitled to a percentage around 15% of the contract price. In this case, that would mean 7500 million escudos (25 million pounds). Besides the client loses most of its control over the construction process and how the contractor gets the job done. Choosing a construction management team, although an increase of the management costs, the owner could keep a closer monitoring of the design and construction process and was in a better position to drive the project schedule and budget according to his goals. The other consequences were that the owner kept most of the responsibility of finishing the job on time, and the project had to be divided into 60 work packages. Most packages had different contractors, that greatly increased the complexity of the construction management task. The experience has shown that would be more profitable to divide the project into a number less than 60, 35 or forty packages of work. In addition, in the case of large packages of work, it is better to award the whole package of work to a consortium of trade contractors rather than dividing the package into smaller jobs and awarding each part to a single trade contractor, and hence avoiding task interdependence conflicts.

The design-build deliver approach used at trade contractor level gave access to construction knowledge during the design process, offered cost-effective solutions and a early price guarantee prior beginning construction of each work package.

**Lesson 2: The compensation scheme: Lump sum vs. unitary prices**
A lump sum contract type seems an obvious way to control the costs of the project. In a design-build job, the contractor will be responsible for the measurement indicated in his proposal and is not entitled to extra payments for larger quantities. The measurements of the different contractors can be compared during the bid process and adjusted if necessary. This transfers a large amount of quantity surveying work from the construction management team to the trade contractors. However, this procedure also has disadvantages. In the case of multidisciplinary building projects, many entities are involved. This represents a high potential for changes to the original design, often as late as during finishing.

**Lesson 3: Effects of partnering on the construction process**
Partnering is a co-operative management tool that was used was used on the Colombo project with other tools as a dispute prevention and interaction improvement tool. It represented a change in the way a design-build process is managed. The partnering programme developed and implemented in the Colombo project entailed a series of formal activities and mechanisms that were used to sustain collaborative teamwork and trust between parties from different parties, and commitment to common goals.

These mechanisms typically included: pre-construction team-building sessions, formulation of a project manual of procedures, periodic assessment of adherence to partnering principles, guidelines for resolving disputes in a timely and effective manner, and provisions for improvement and risk sharing. Partnering had three significant benefits. Foremost, it helped parties to approach problems with the attitude of "how can we resolve problems jointly rather than independently". Second, it provided excellent interaction between the construction management contractor and local trade contractors. This was particularly evident in situations involving physical work space, sharing equipment, joining skills to perform complex jobs, finding cost-effective design solutions. Third, it helped to reduce or even avoiding conflict due to: (i) job interdependency resulting from dependency upon others; (ii) differentiation resulting from organisational and technical differences among trade contractors; (iii) different values, interests, and objectives of the various trade contractors and designers; (iv) tension resulting from pressures of the job regarding schedule. Fourth, it improved communication within the construction management team and between them and owner's team.

**Lesson 4: Effects of concurrent construction on the construction process**
Under concurrent construction project activities were integrated and aspects of design, construction and preparation for occupation were concurrently planned to maximise the value of schedule while optimising constructability and operability. Concurrent construction in Colombo project was based on: (i) integration of design and construction activities at trade contractor level; (ii) establishment of a manual of procedures that integrate all planning, design and construction activities; (iii) formation of composite teams, having a representative from each of the pertinent parties, including designers, engineers, suppliers, trade contractor, tenants, facility manager and in some cases, representatives of the local government and service providers were included; (iv) division of work into separable work packages; (v) integration of total project information over its construction process; (vi) integration of the work of the joint trade contractors into a single design-build contract; (vii) establishment of direct and real-time control system to facilitate the whole process.

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