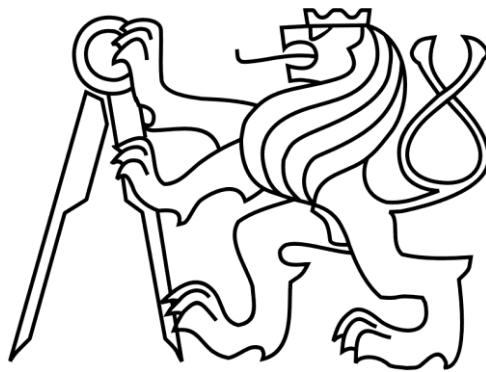


Czech Technical University

Faculty of Civil Engineering

Department of Economics and Management in Civil Engineering



Diploma Thesis



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I hereby declare that this diploma thesis entitled “Selection of a Project Delivery System for a Construction Project” is a result of my own research based on consulting with my supervisors Mr. Doc. Ing. Aleš Tomek, CSc. and Mr. Ing. Luis Kompel.

Furthermore I declare that all my resources are listed in the List of References and that this work is not currently submitted in candidature of any other degree.

.....

Signature
(Adam Kořený)

Výběr dodavatelského systému stavby pro
stavební projekt

Selection of a Project Delivery System for a
Construction Project

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Abstract

This Thesis is focused on a Selection of the project delivery system for a particular construction project. There are generally vast options for the Owners while deciding for the most suitable project delivery system. These are combinations and variations of five fundamental systems: Design-Build (DB), Design-Bid-Build (DBB), Construction Management at Risk (CMAR), Multiple Prime Contracting (MPC) and Integrated Project Delivery (IPD).

The first chapter of this Thesis is focused on defining the construction industry and the unique environment of this project. Furthermore it states research questions which will be further discussed in the Thesis.

The second part describes project delivery systems with their background and presents management structure of every single system along with main processes that the owner needs to understand. Furthermore a list of advantages and disadvantages of every one of the systems is shown.

The third part is dedicated to methodology and selection process of the best project delivery system itself. The method used for the evaluation is called Analytical Delivery Decision Approach and consists of set steps in order to properly analyze all constraints.

In the fourth part the reader can find a structured manual for the contractor selection process. This document will serve the Owner in his own decision making.

Fifth and sixth chapter provide Thesis conclusion along with an idea for further research.

Keywords

Project, Project Delivery System, Construction

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Introduction

Project delivery system is a method of assigning responsibilities for a construction project during its design and construction phases. This means it is the essential thing for full control of all the operations, designs, construction and maintenance services for a project. This is achieved with multiple legal agreements with legal entities.

Selecting the most suitable project delivery system for the project is one of the first and most important decisions that the owner has to make in the construction process. There are many variable options that were used in different projects all over the world due to specific variables and constraints each and every project has.

The selection of the project delivery system automatically impacts the key project considerations. Amongst these are especially the scope of works meant to be performed by particular parties, the designated budget, the accurate schedule which represents the realistic performance period and risk identification and allocation to the project participants.

It may seem like a difficult decision making first but thanks to the amount of information available to wide public it is a key factor that is needed to be understood thoroughly for correct consideration of the possibilities.

All the systems available in the industry are derived from five fundamental project delivery systems which are following: Design-Build (DB), Design-Bid-Build (DBB), Construction Management at Risk (CMAR), Multiple Prime Contracting (MPC) and Integrated Project Delivery (IPD).

Every one of the systems above carries a different level of risk for the owner.

There is no flawless general method that could be universally used for particular types of projects. There will always be pros and cons during the selection process, but it is the owner's main responsibility to assess his priorities, main requirements and goals to find the delivery method which provides the best outcome of the project when it comes to planning, design and ultimately construction process.

This study focuses on thorough examination and comprehension of the delivery methods and furthermore their evaluation through modern evaluating system which is called Analytical Delivery Decision Approach and which consists of set steps in order to properly analyze all constraints.

The outcome of this thesis shall be a conclusion with a specific project delivery method selection that will be the most suitable for the particular construction project.

1.1 Construction Industry

The construction industry has been undergoing the Great Recession in the beginning of the 21st century. Most countries have overcome this crisis by 2013 and the market has finally opened the doors to new perspectives and opportunities.

In following chapters there will be described essential terms, typical construction participants and current construction environment in construction management in the areas that are important for the given project.

1.1.1 Definition of Terms

The following list of terms is essential for the construction parties as well as for the whole construction management of the project (Construction Management Association of America, 2010).

Agency - A legal relationship by which one party is empowered to act on behalf of another party.

Bid - An offer to perform the work described in contract documents at a specified cost.

Budget - The amount of financial resources allocated by the owner for a project.

Construction Cost - All costs attributed to the construction of the project, including the cost of contracts with the contractor(s), construction support items, general condition items, all purchased material, labor and fixed equipment.

Construction Schedule - Representation of the time of construction of the project showing activities and duration of activities in sequential order

Contract - A document representing an agreement and setting forth the relationships and obligations between two parties, as the CM and owner or contractor and owner.

Contract Administration - The function of implementing the terms and conditions of a contract, based upon established systems, policies and procedures.

Construction Contract Documents - The documents that provide the basis for the contract entered in-between the parties. They usually include the updated bid documents reflecting the agreements between the parties.

Cost Management - The act of managing all or partial costs of planning, design and construction processes to remain within the budget.

Drawings - Graphic representations showing the relationships, geometry and dimensions of the elements of the work.

Final Design - Stage of the design process when drawings and specifications are completed for construction bid purposes.

Final Completion - The date on which the terms of all construction contracts shall be satisfied.

General Conditions - A section of general clauses in the Contract Specifications that establish how the project is to be administrated. Obligations such as providing temporary work, insurance, field offices etc. are included.

Guarantee - A legally enforceable assurance by a third party included in the contract for the case when the works fail to be performed properly.

Owner's representative - The individual representing the owner in the project team.

Prime contract - A direct contract with an owner.

Project - The total effort required in all phases from conception through design and construction completion in order to accomplish the owner's objectives.

Project Management - Usage of integrated systems and procedures by a team of professionals during project design and construction.

Project Team - A team of professionals belonging to different groups with different functions assigned to activities for the successful finishing of a project.

Quality - The degree to which the project and its components meet the owner's expectations, objectives and standards.

Scope - Identification of all the requirements of a project or contract.

Work - All construction-incorporating labor, material and equipment required by the contract documents.

1.1.2 The Typical Parties

The important parties certainly include the following major entities, although there may be involved other parties (Bartholomew, 2002).

Construction Owner - The owners for whom the works are done are the driving force of the construction industry, because there would be no construction without the source of money. It is necessary to distinguish construction for private and public sector. The private owners

include any entity that is not local state or government such as any person or a developer. The public owner can be local, state or federal governmental bodies.

Architect/Engineers - A/E who design the works and often administer the construction phase of the project personifies the second important group of participants. The designers are the creators of the drawings and specifications for the planned construction.

Construction Contractor and Subcontractors - Contractors and subcontractors are obviously the key participants. These entities are charged with the responsibility of actually putting construction work in place. Those are the entities that determine means, methods, techniques, sequences, procedures and direct the actual construction activities.

Supply and Service Organizations - The fourth segment consists of segments such as the firms that manufacture and market construction equipment. Other examples include the producers of the basic materials of construction, insurance companies, sureties, consultants or attorneys.

Labor Force - Very important category because without this segment nothing would be built. These include not only organized labor but also a group of workers who comprise the shopping segment.

Local and State Government - Another category of player is local, state and federal government in their regulatory capacity as the promulgators of many of the rules and regulations governing the operation of the industry.

General Public - The general public must be also included. Construction as the act does not occur unnoticed and the great majorities of projects often affect lives of many persons who are not the part of the construction itself but simply are living or working in the area. This influences the project in two major ways. Firstly the impact on the public during the construction works and secondly the effects during the actual usage of the building.

1.1.3 Construction Management Globally

Project owners are continually striving for balance between power, responsibility and control (KPMG, 2015). They also bear responsibilities and have to cede huge risks both financial and reputational along with potential failures of any project. It is then completely evident that they seek delegation possibilities that would distribute the responsibility and lower their own burden (Gallion, 2013).

The key factors for any owner are thorough planning, financial forecasting, risk allocation, risk management, project management along with contingency management.

Talking globally we can simplify the owner's performance with four major indicators.

Preparation - Planning and prioritizing is globally considered as strength of private and public executives. Kinds of financial analyses and plans are widely used and majority of investors complete a contract strategy analysis prior to approval. Most owners appear to have a formal ranking process for prioritizing potential projects using pre-established criteria such as operational safety, environmental, legal and regulatory factors, and overall return on investment.

Risk Control - The owners are also confident in the level of control in their projects. Great majority of them states that their controls are either optimized or monitored, meaning that they are documented and integrated. This is closely connected with the availability of new software possibilities (such as Project management information system PMIS) and their implementation to improve the project controls.

Performance - The actual performance indicator is not as optimistic as the first two. Every second investor encountered a project failure in the previous year. This means huge amount of underperformance. Big issue for the owners is also the inability to comply with the set deadline.

“Scheduling is one of the most difficult and least understood aspects of a project. As well as helping to plan ahead and model outcome, it can track progress and provide realistic expectations.” (Gerald Long, KMPG)

Relationship - Collaboration is a vital variable in construction. All the small details are dependent upon teamwork. The vast majority of owners expect a better cooperation with their contractors in order to drive down the prices and create a credible environment for the project.

The survey reflects current owners experience worldwide with planning, risk management and execution in recent years as well as points out deficiencies in the management of projects.

As we can see bellow, the most popular project delivery strategies worldwide for past year were Design-Bid-Build, Engineering Procurement Construction and Design-Build. The overall sample was derived from all the sectors that the survey covered, i.e. technology, energy and natural resources, public sector and others.

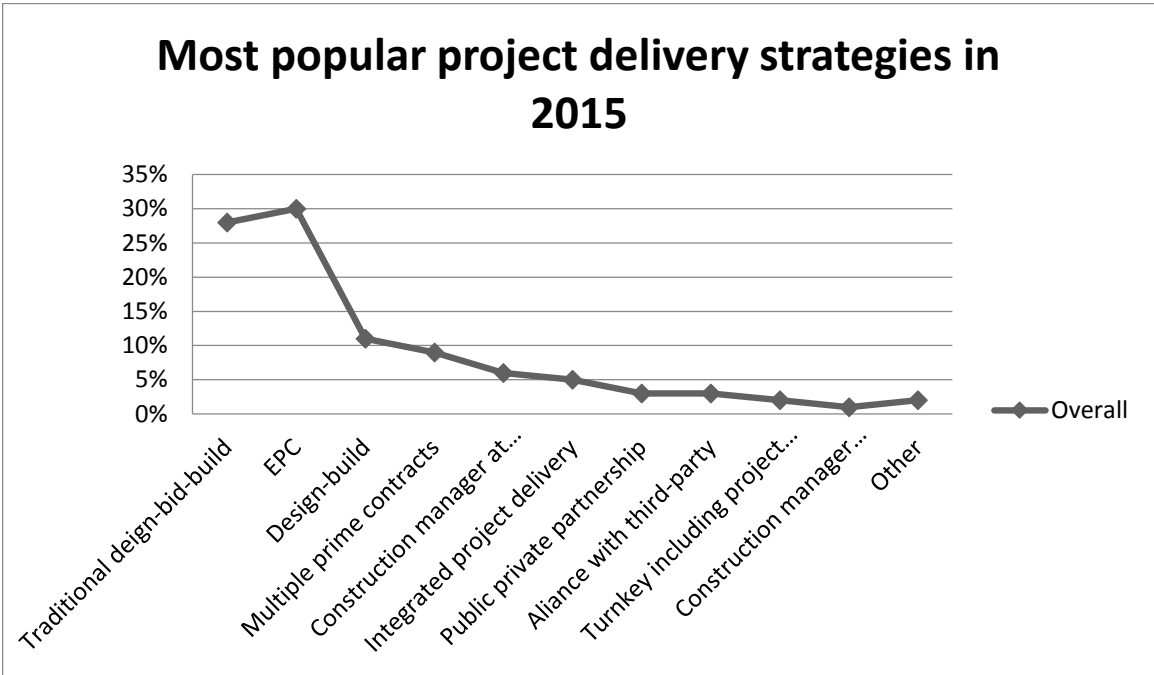


Figure 1 Most popular project delivery strategies worldwide (KPMG, 2015)

1.1.4 Construction Management in Seychelles

Due to the fact that the selected project is situated in the Seychelles it is necessary to take a closer look at the local situation when it comes to construction industry.

The Seychelles has a population of about 90 000 and a small real estate market. The local market has not been significantly affected despite the global decay. This occurred just because

of the size of the market where not many properties are sold in comparison with the rest of the world. Globally speaking the prices in Seychelles have been rising in the last years.

The amount of current construction works is very insignificant because of the lack of the area available (CWCIT, 2015). According to the director of Premium Realty Mr. Maurel the property value in Seychelles is mostly in the land. The restrictions are vast on the islands and exceptions for new projects are very rarely seen.

The majority of construction works being performed on the islands are infrastructure (both new and repaired), water distribution, industrial facilities and environmental projects. There are three major big construction companies in the area that have the capacity for big projects (Hubicka, 2015).

Given the size of the construction sector we can assume that there are not enough specialists in the field of project delivery systems and it will be necessary to utilize the knowhow from the Czech Republic, from where the project will be supervised. In the meantime it will be necessary to find and use a local expert as an agent for any selected delivery system. The agent will be available to the project team as an advisor in all the stages of the project.

1.1.5 Construction Management in the Czech Republic

Current construction industry practice uses several different types of delivery systems which are used in various forms according to their suitability. Project delivery systems applied in different countries vary slightly depending on how the labor is traditionally divided. Anyway the main characteristics are shared and applicable in any country and any market economy.

The Czech Republic is in this matter affected by the short history of the market economy and despite the fact that in principle all types of project delivery systems are used in our country, not all the characteristics are respected and used as much as in other developed countries (Dashöfer, 2010).

In our conditions the most common delivery method is still the classic Design-Bid-Build. That is no surprise due to the conservativeness of the investors and their attempt to minimize the risks.

Due to the amount of construction works and its quality in general, the Czech Republic definitely possesses the professionals that are required for modern delivery methods. The key factor for the industry is giving the opportunities to these professionals. We can definitely see

some examples in the industry, some pioneers incorporating innovative methods. These are usually experienced professionals with experience from other developed countries such as the United States, England or Germany.

The prognoses refer to local market as a market with a decade delay when it comes to implementation of new systems, but this gap is constantly being reduced. The owners are more and more understanding the general benefits such as time savings, cost reduction or cost control. The situation is getting even better with current revival of the industry, which gives the investors the opportunities and time to understand the constraints and consider all the new variables.

1.2 Project Overview

Investor's intention is to build 12 luxury villas on of the Seychelles islands Mahé. These villas are nestled into the upper reaches of the Bel Ombre mountain parcels owned by local partners of this venture. Each villa has been carefully positioned to offer individual views of the unparalleled sea view and is serviced by a proposed main road. This project shall be constructed on a parcel of 52 000 m² of land area. Total estimated investment is on this stage of preparation calculated on 60.000.000 USD and is planned to be finished in 2020.

Each villa will provide approximately 1000m² of living area.

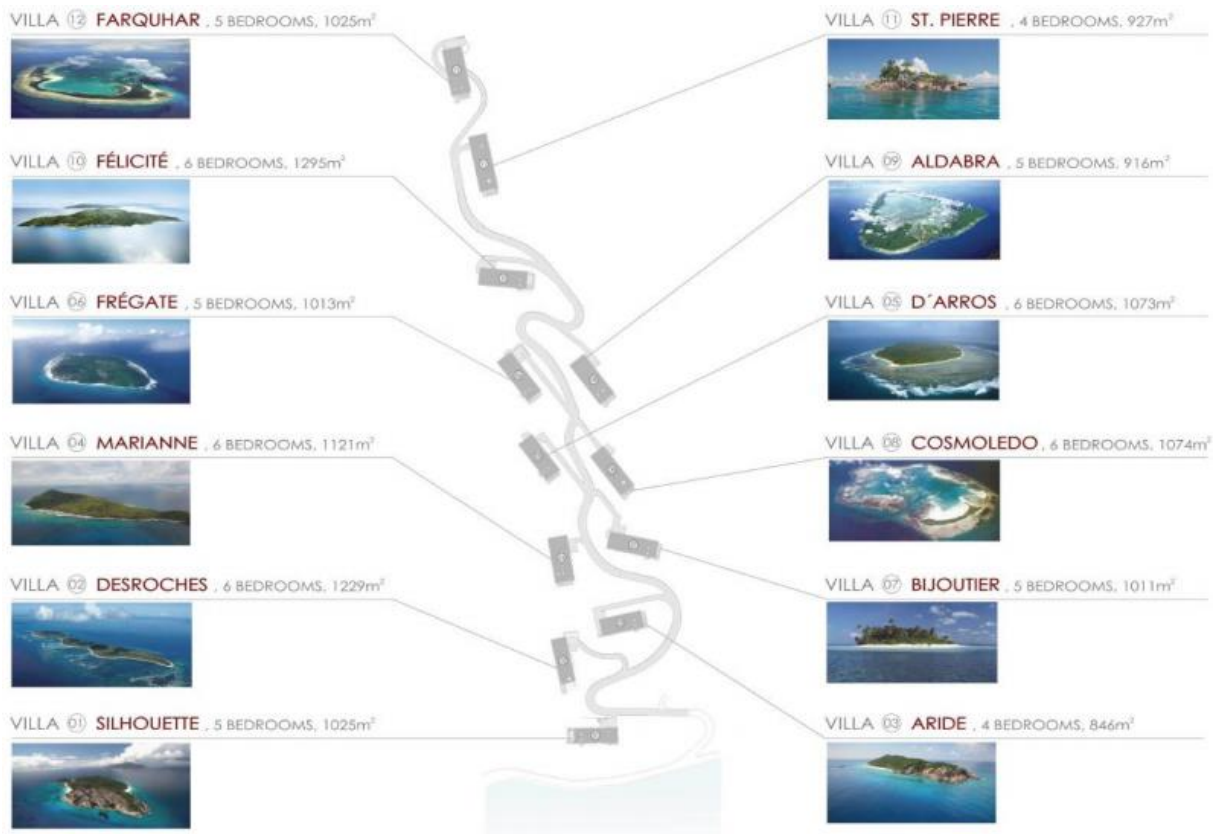


Figure 2 Project visualization (Hubicka, 2015)

1.3 Considerations

Selecting the project delivery system is one of the most fundamental spheres where the owner can influence efficiency, productivity and profitability. The ability to affect the construction cost of the project is highest in the initial phases of the project (Sanvido & Konchar, 1999).

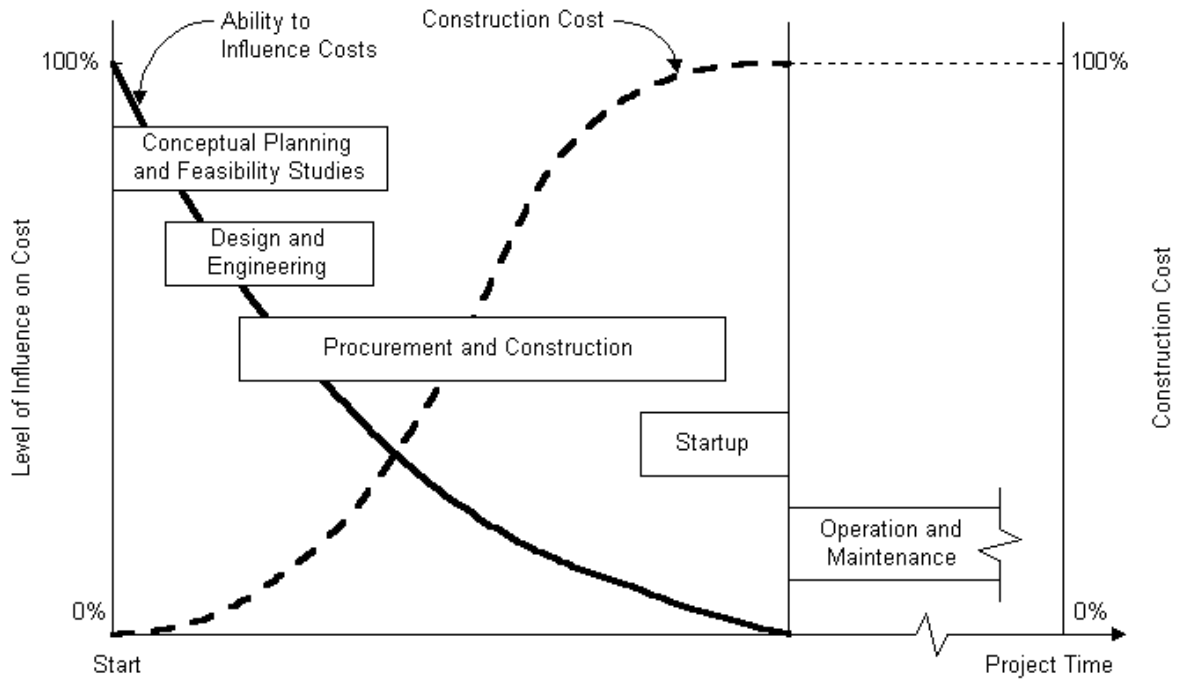


Figure 3 Ability to influence construction costs of the project (Oberlender, 1993)

An owner has various areas of concern when initiating with a construction project and these values vary even more from the perspective of the architect or the contractor (Oberlender, 1993). It is necessary to properly select the body and create the core of the project by selecting a project delivery system in order to effectively and efficiently manage the project. The key considerations that will influence the selection of the delivery strategy are owner's responsibility to control budget, schedule, quality, risk assessment and relationships (Urban Land Institute; PwC, 2014).

The owner is the essential participant of the construction, the driving element in the construction industry. It is natural that his commitment to the business will be on the highest level of all the participants.

The necessary control and supervision is required in all the phases of construction beginning with control of design details, project outcome, knowledge of all the prime contractors, desire to innovations and new project solutions, up to design excellence (CMAA, 2012).

1.3.1 Control of Budget

Owner's primary need is to determine a realistic budget. Knowing the required budget is imperative for the evaluation of the profitability and further optimal usage of the available funds. This needs to occur even before designing in order to be able to create and later evaluate any feasibility studies, to secure financing, to assess risks or to select the suitable design. These outcomes and evaluations will also serve as a background knowledge and tool which will be used for selection of the project delivery method. Once the budget is determined it carries important information about the cost of the project, which shall be near this estimate. The owner also needs to establish what risk level of exceeding this cost is acceptable and later on distribute these risks reasonably.

1.3.2 Control of Quality

One of the foremost important factors is that the desired facility quality and function complies with users and owners needs and priorities. Therefore, not only the design team needs to be well qualified in the type of facility being designed, but all the project participants need to have clear requirements on the quality of works (Gaba, 2013). The team communication must be excellent. This goes for both the owner's visions and demands, which must be clearly conveyed to the design team and for the designers to create complete, clear and apposite documentation. Same needs to be implemented with the contractor where the requirements must be emphasized equally. The level of the control is owner's responsibility and can be modified according to the current necessity. Many different professionals can be used in order to do so starting with professional supervisors and ending with regular quality inspectors.

1.3.3 Control of Schedule

The owner has the need to control the timeline of the project. The most important information lies with set deadlines for any works that the owner finds important. These can be dates of completion of design, shell&core, whole construction or preparedness of the facility to be fully operated. Therefore, a realistic schedule of project duration and assessment of sequences shall be prepared in the initial phases of the project. It is then necessary to appropriately monitor the progress and update the schedule correspondingly. It is up to the owner how important the actual duration of the project is. Last but not least, the importance of

precise timekeeping is reflected in all kinds of payments and especially in desire to avoid delays due to disputes and claims.

1.3.4 Control of Risk Assessment

Any yield is equivalent to the risk that was undertaken by the participant in the project. In construction, issue of risk is tied to the status of the budget, schedule and local construction market. To fully assess any potential risk that the project holds it is necessary to create a risk allocation matrix, which is a modern tool for the risks prevention, evaluation and their correction. The owner is responsible for the allocation of the risks among other participants. When it comes to risk allocation, the owner, in order to fully understand the threats, should assign risks to those participants who can most effectively deal with that particular risk. The biggest responsibility the owner holds is the liability for the success or failure of whole project (KPMG, 2015).

When it comes to fair risks allocation, there are many important rules which shall be abided in order to maximize the risk control. Among these are principles, that risk allocation should create a winning situation for all parties, each party needs to understand their risks before accepting the terms, and no party should accept responsibility for risks beyond their control or for problems created by other parties. Last but not least, risks and rewards should be proportional for all parties.

There are seven major roles that must be filled.

Owner decision maker – The entity with the authority to make project decisions on behalf of the owner.

Project Management – The guidance of project and project related activities from beginning to end through the application of knowledge, skills, tools and processes in order to meet or exceed stakeholder's expectations from the project.

Design – The solution to the owner's project needs in the form of contract documents from which cost estimates can be obtained and the project constructed.

Contracting – The arranging for or holding of the contracts with performing trade contractors.

Construction – The hands-on work of the performing trade contractors who actually build the project with their own workforces.

Construction Coordination – Directing of the performing contractors during construction.

Construction Contract Administration – The servicing of construction contracts during construction.

Next figure shows the distribution of responsibilities for each project delivery system.

Project Delivery System	Project Delivery Roles						
	Owner Decision Maker	Project Management	Design	Contracting	Construction	Construction Coordination	Construction Contract Administration
DBB	O	O	AE	O	GC/TC	GC	GC
DB	O	DBE	DBE	DBE	DBE/TC	DBE	DBE/O
CMAR	O	AE	AE	O	TC	CM	AE/CM
MPC	O	AE	AE	O	TC	O	O
IPD	O	IPT	AE	IPT	TC	IPT	IPT

AE (Architect/Engineer), CM (Construction Manager), DBE (Design-Build Entity), GC (General Contractor), IPT (Integrated Project Team), O (Owner), TC (Trade Contractor)

Figure 4 Project Delivery Role Responsibilities (KPMG, 2015)

1.3.5 Control of Relationships

In order to enhance project coordination it is vital for the owner to invest in relationships with all project participants. The willingness to create an efficient professional environment is an important factor of the project process. The cooperation with architects, designers, contractors, manager and all kinds of experts is fundamental for any project and is a key variable for a successful project.

To summarize the information above, the owner needs to revise wide range of information, prioritize their value and correspondingly create list of preferences. Starting with length of time for the building to be constructed, through complexity of the building, compliance with regulations, time available for the expertise of the project, budget constraints, up to how much risk he is willing to assume in the processes.

1.4 Statement of Research Problem

Project delivery is an extensive process that includes planning, design and construction. These acts are required to be executed and completed so that the facility or any kind of project is completed.

Choosing a project delivery method is one fundamental decision owners make while developing their acquisition strategy. Besides the selection of the project delivery systems, the other crucial tasks the owner needs to solve are selection of the procurement procedures and finally select a payment provision method (Dorsey, 1997).

Selection of the Project Delivery System	Selection of the Procurement Method	Selection of the Contract Format
Design-Bid-Build (DBB) Design-Build (DB) Construction Management at Risk (CMAR) Multiple Prime Contractors (MPC) Integrated Project Delivery (IPD)	Low Bid Best Value Qualification-Based Average Bid Cost Plus Time	Fixed Price Cost Reimbursable Guaranteed Maximum Price

Figure 5 Key decisions of the Project

It is important for the owner to consider all three of these areas. The primer focus needs to be on the selection of the project delivery system. Determining this fact will influence whole project. Each delivery method establishes the time when the parties engage into the project, it predestines the choices of contractual relationships and affects the matter of ownership, responsibilities and cost modification (Vesay, 1991).

Minimum three parties are always included; these are owner, designer and contractor (Bartholomew, 2002). It is important to assess responsibilities and tasks to all the participants

accordingly to their abilities and use the abilities of the parties to find the best solution for meeting the specific needs of every project.

The task of this Thesis is to review and fully describe and understand all the availabilities in the current market, evaluate them and come with a solution which will, as mentioned above, fulfill the unique requirements of the given project (CMAA, 2012).

1.4.1 Project Delivery System Matrix

The selection approach shown below, encompassing two main stages: First stage reviewing project characteristics, setting project goals and identifying project constraints, Second stage with creation of key decisions of the project based on first stage knowledge following with the selection of the system or development of a different suitable one.

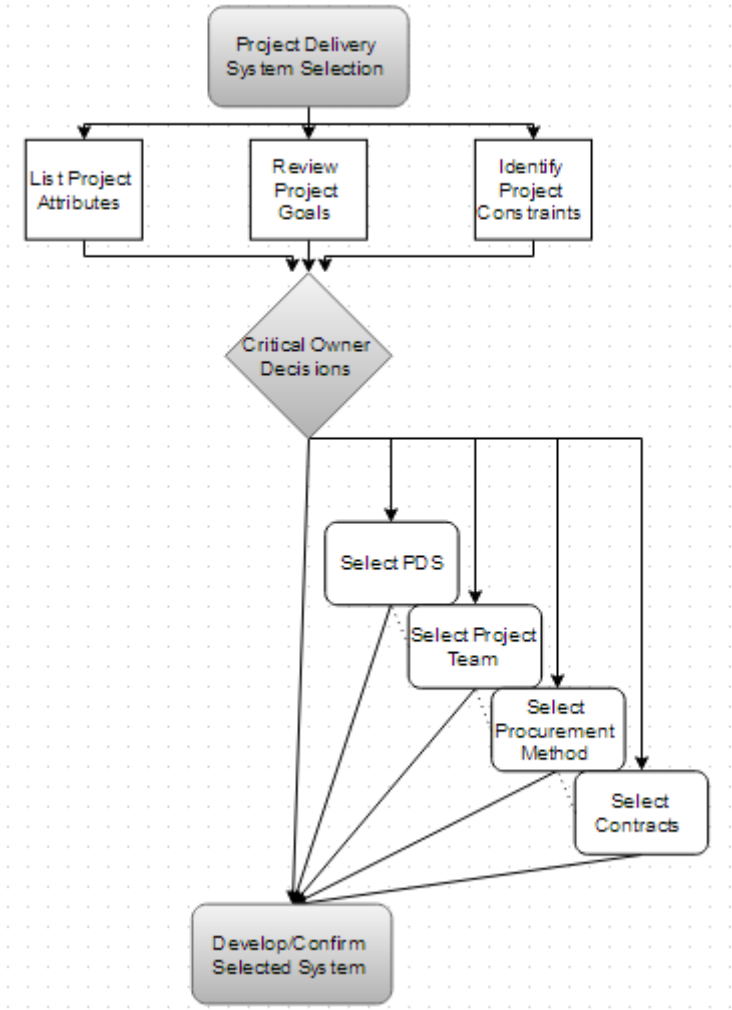


Figure 6 Project Delivery System Selection Matrix

1.5 Project Delivery Methods

A project delivery method is a system design to achieve an effective completion of a construction project (CMAA, 2012).

Because of financial, time and organizational constraints, many project delivery methods evolved in various shapes. These are design to fit unique needs, because every construction project is an original. The most common delivery methods nowadays are Design-Bid-Build, Design-Build, Construction Manager at Risk, Multiple Prime Contractors and Integrated Project Delivery. These systems are the typical methods of delivering the construction project.

Each of these project delivery methods carries a different level of risk for the owner. Generally speaking there be assumed a correlation between the level of risk and level of control (Oberlender, 1993). As seen on the chart below, this fact provides us with a view as where we can arrange these options.



Figure 7 Project Delivery Methods Risks (CMAA, 2012)

Integrated project delivery system does not really fit the arrangement above, but what the figure describes is the shared risk and equal control among all the parties of IPD.

A brief introduction of these delivery systems follows in the following paragraphs.

1.5.1 Design-Bid-Build

The Design-Bid-Build system is the most frequently used project delivery system for construction projects (Oberlender, 1993). Using this method, the owner engages an

architect/designer to prepare the initial design of the project later on followed with all the required construction drawings and specifications. The designer may also be providing some additional services such as environmental investigation, communication with local authorities, permitting, right-of-way purchase documents or submissions for project funding. This cooperation is the first stage of the whole system.

Once the design stage is completed, the whole package of documents is presented to potentially interested contractors who prepare their bids for the works and submit the bids to the owner. The owner then selects a contractor based on various criteria. The selected general contractor then executes the contract either with his own labor force or subcontractors to construct specialty items. The contractor bears the responsibility for the construction as it needs to comply with all the construction documents and agreements. There are usually two supervisors involved, one for the owner who performs quality control and the other one for the designer who maintains limited oversight over the works and checks the compliance with the design specifications for the owner.

1.5.2 Design-Build

The Design-Build project delivery system has in recent decade grown in popularity and is often taken for a solution solving delivery method when it comes to addressing the limitations of other systems (Lahdenperä, 2001). The primary benefit for the owner is the simplicity of having only one party which is responsible for all the phases of the construction, i.e. both design and construction of the project.

Using this system, the owner creates a relationship with a DB team, which can be a joint venture of a contractor or a designer, a contractor and a designer as a consultant, a designer-led team with a contractor as a subcontracted identity, or a single company capable of performing both phases design and construction. The primal concern is to create the project team that will organize and supervise the project delivery. However created, the project team performs the complete design of the facility. At some point during the process the team initiates the construction process and is then responsible for all coordination of the project for both design and construction.

1.5.3 Construction Manager at Risk

Construction Management at Risk method is similar to the Design-Bid Build method in many ways, because the CMR acts as a general contractor during construction (Dashöfer,

2010). That means he holds the risks of construction performance and also guarantees completion of the project in an agreed scope and negotiated price.

The difference in this scenario is that the CMR provides advisory services and assists the owner before the initiation of construction works. Prior to construction the CMR is consulting the design phases and offered solutions and constructability advices of the structure, is also offering schedule management and controls the budget. The owner then communicates with a hybrid construction manager/general contractor.

Among the biggest benefits of the early involvement of the Construction Management at Risk is the opportunity to begin construction prior to completion of the design (McGraw Hill Construction, 2014). The subcontractors can be also bid earlier and the required works can be set into packages and bid separately at any time.

1.5.4 Multiple Prime Contractors

Multiple Prime Contract system is an important variation of Design-Bid-Build (American Institute of Architects, 2011). In this method the owner holds separate prime contracts with various contractors of different work disciplines, such as earthworks, structural, electrical or mechanical. In this system, the owner, or his construction manager, manages the overall budget and schedule.

Prime contracting gained favor in part as another method of fast tracking the construction. Every part of construction works is bid separately, which allows control over the bid process and flexibility of awarding the contracts as soon as the respective aspect is designed (Stutzman, 2010). This aspect is highly desirable when the critical aspect of the construction process is time.

1.5.5 Integrated Project Delivery

This project delivery method (IPD) is a newly evolved project delivery method which has been capturing attention in past few years. This system promoted more intense integration of the parties instead of lack of cooperation and wastage of productivity (American Institute of Architects, 2007).

This newcomer provides new solutions for inefficiency, coordination problems, cost overruns or general errors caused by poor information integration.

“Integrated Project Delivery is a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insight of all project participants to optimize project results, increase value to the owner, reduces waste and maximize efficiency through all phases of design, fabrication and construction.” (American Institute of Architects California Council, 2007).

1.6 Procurement Procedures

Every owner needs to understand and set preferences for different kinds of selection methods available before any entering the contract since it prefigures future environment (CMAA, 2012).

According to the project attributes, constraints and goals, procurement can be performed through different techniques. Currently, many various procurement procedures exist and have been used successfully in the construction industry. There is no optimal procurement approach for a residential project and the options listed below are both the most commonly used in the market and a few newcomers that are growing the popularity nowadays.

1.6.1 Low Bid

Competitive bid system where the selection system is based solely on the price presented to the owner (Bartholomew, 2002). This method presents a traditional approach and is commonly used with traditional delivery systems where the design documents are completed for the bid phase. The owner requests a price proposal from multiple contractors. The submitted bids are based on complete project specifications. The owner then compares the bids and the offer with the lowest price which meets all the requirements is then awarded with the contract.

Many projects can use low bid as long as the received proposals completely meet the specifications and design of the project. The limitations appear in bigger or more complicated projects where the contractors estimate may not completely involve all hidden or unpredictable complications. The contract may be also subjected to many change orders if the price is inaccurate and that leads to an increase in price.

1.6.2 Best Value

As the price has been traditionally the only factor of consideration, best value method allows encompassing other factors such as schedule, quality, qualification and performance-based criteria (Office of Construction and Innovative Contracting, 2012). The purpose of this method is to match the best qualified contractor to the project in order to minimize impacts and to enhance the long-term performance and value of construction. Best value can be used in a variety of ways using various algorithms such as fixed budget, adjusted score or weighted criteria.

It is efficient to use the best value method in projects that are complex or large in size and that require additional considerations and qualifications besides the price of the project. Best value allows the procurement of works that are not yet completely designed, therefore is often used with DB system, but can definitely also be used with DBB. The limitations mainly occur as a result of state restrictions.

1.6.3 Qualification Based

Qualification based method is a procurement system that focuses on qualitative criteria such as experience, qualifications and past performance (Sandquist, 2007). Price is not a concern of the selection process. This method requires input from the contractor during the design phase.

The contractor is asked to provide a proposal for the project without the price for the project. The procurement is based on qualification criteria such as past performance, structure of the contracting organizations and others. The price becomes an issue as soon as the qualified firm is selected and negotiations begin at this very moment.

It can also be used as a prequalification for the contractors, where the owner can evaluate their qualification or references for example.

1.6.4 Average Bid

Behind the average bid method lies a hypothesis, that when using the traditional low bid system, the ultimate savings that were negotiated with the contractor in the process, are then passed on to the subcontractors, that are unable to both deliver the project of good quality and make a reasonable profit at the same time (Ioannou, 1993).

In general, the winner based on the average bid method is the contractor whose bid is in a certain relationship with the average of all the bids obtained.

The advantage of this system is that it protects the owner of signing a contract with for an unrealistic low price. Very low bids often lead to excessive claims a disputes with increased delays as a result of the negotiations. There are many mathematical models that support this method over the traditional ones.

1.6.5 Cost plus Time

Cost + Time, also commonly referred to as A+B, is a selection method used in procuring construction services where the “A” or cost portion is the bid amount and the “B” or time portion is the proposed project duration for the work. The “B” value is multiplied by a set value per day and the contractor with the lowest sum of these two factors is awarded with a contract (CMAA, 2012).

The project is estimated to be completed in shorter period of time when using this method, which allows savings in price. This procurement strategy encourages bidders to consider the time of the construction and involve innovative methods in order to decrease this time.

It is often used with projects that are related to reconstruction or rehabilitation or projects that impact local business or life. The limitations associated with this method are obviously project delays caused by change order or by unforeseen complications.

1.7 Payment Provisions

A construction contract is an agreement that describes the method of execution of a construction project and specifies the amount of compensation for the performed job under fulfilled conditions (Stark, 2012). Moreover, a construction contract is negotiated specifically for the construction of an asset or a group of interrelated assets. There are several types of construction contracts used in the industry, which can be divided into two major groups that are fixed-price contracts and cost-reimbursable contracts (CMAA, 2012).

When using a fixed-price contract the owner pays the fixed price which is incorporated in the contract regardless of the actual costs that the contractor has to cover. This fixed price is usually paid in a set of payments, normally on a monthly basis with the actual progress of scope of works or on an agreed payment schedule.

A cost-reimbursable contract is almost entirely based on the owner's funds. The amount of payment is directly dependent on performed services and these are reimbursed directly to the owner on an agreed schedule, usually monthly.

1.7.1 Fixed-price contract

Often called lump sum or firm-price contract. The idea behind this contract is that the provider of the services will be paid a certain agreed fixed price for providing contractually stipulated services. There is no relation between the actual costs incurred by the provider and the amount of payment received from the owner.

1.7.2 Cost Plus Percentage Fee Contract

The simplest form of cost-reimbursable terms is CPPF and is widely used in smaller construction contracts. The owner agrees to reimburse the costs incurred by the provider of the services with an agreed fee, usually a fixed percentage of incurred costs. There is obviously a big handicap of this method for the owners as the more money contractor spent the more money he earned.

1.7.3 Cost Plus Fixed Fee Contract

This form of contract evolved as the CPPF showed a potential for abuse. It is used for projects where for some reasons it is not possible to accurately permit firm pricing. In these contractual terms, the owner reimburses all of the service provider's costs and pays a fee that is fixed in the beginning of the contract. The estimation of the costs is assessed in order to create the fees. This fee will only change with a change of scope.

1.7.4 Cost Plus Incentive Fee Contract

Also called target estimate contract. Prior to entering the contract an estimate is made as the most probable cost of providing the services. A fee as payment for the services is also agreed to according to the amount of the target estimate. The agreement also includes the clause that any benefits or penalties will be shared between the parties.

1.7.5 Guaranteed Maximum Price Contract

The GMP arrangement is similar to the target estimate form because the parties agree on an initial estimate for the cost along with a fee for the provider based on the estimated cost. These estimates are then put together to create the guaranteed maximum price which will be the maximum financial exposure for the services for the owner. In case that the GMP is reached the owner has no legal responsibility for any further expenses and the provider has to cover all the costs to fulfill the agreed scope of services. These terms are very popular in the residential and commercial segment.

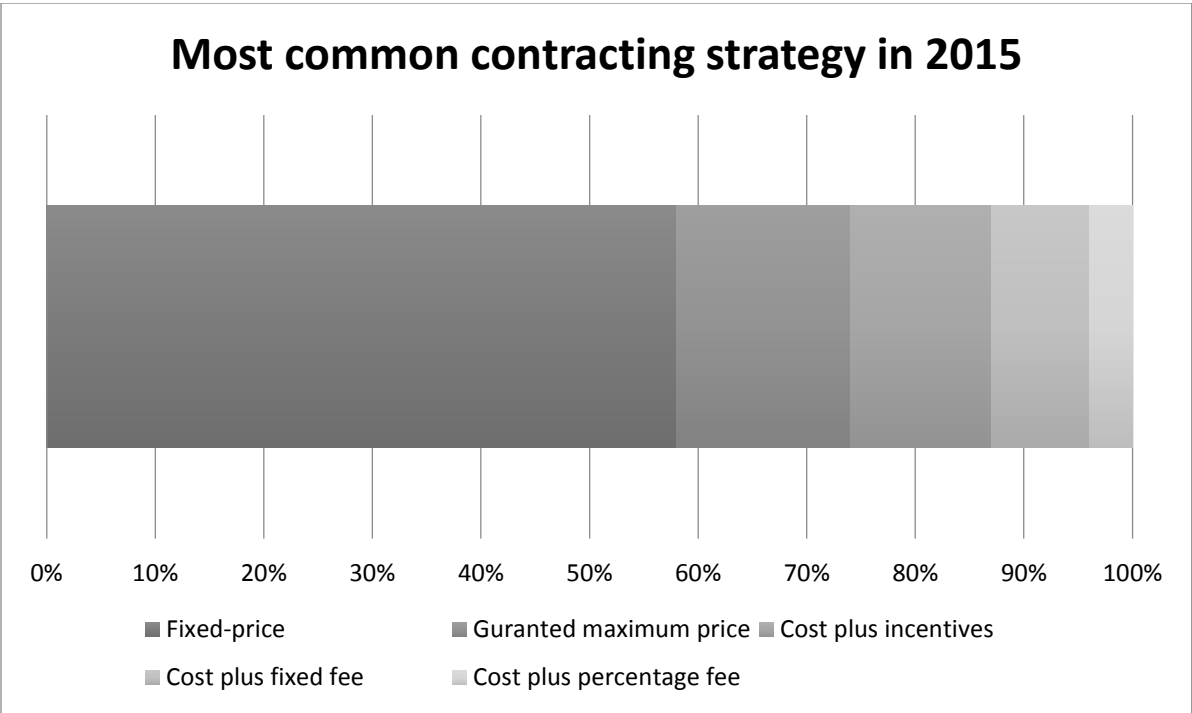


Figure 8 Most common contracting strategies worldwide in 2015 (KMPG, 2015)

1.8 Research Questions

It is beneficial not only the owner but for all project participants not to rely only on the traditional project delivery systems. In current construction environment the benefits of innovative approaches outweigh the struggles with additional activities that need to be performed in order to access all contemporary opportunities.

Q1: According to the uniqueness of the given project it is suitable to use the Construction Manager at Risk method. The benefits of the early involvement of a construction manager exceed the initial increase of funds required.

Q2: Due to the complexity and sophistication of the project along with its remoteness, it is possible to state, that the Multiple Prime Contracting is a method that will be the least appropriate.

1.9 Significance of the Study

The theory of project delivery systems is a phenomenon that plays a critical role in owner's control of the project progress. The amount of lost both financial and non-financial resources that are caused by inappropriate organization of the project is continually rising on the modern construction environment. In order to avoid these losses and to set an efficient management approach it is a major concern to consider the variations that are available for the owner. It is the owner's desire to achieve a successful project that will maximize all kinds of invested resources.

This study shall serve as a background source of information for the investor who will have to determine project variables and for the owner's ultimate decision making. The study will also provide a complex recommendation for project organization.

The remainder of the thesis is organized as followed. In chapter two, a literature overview is assessed to determine the issue of project delivery systems, their brief history, specifications and benefits provided for the owner. Chapter three focuses on a detailed evaluation of considerable project delivery systems along with results presentation. Chapter four presents a Checklist together with a Project Manual that will serve the investor in decision making. Chapter five presents a conclusion of this study and focuses on the states hypotheses.

2 Project Delivery Systems

Project delivery system is the process used to execute a construction project for the purpose of assigning responsibilities and risks to the project team (Oberlender, 1993). Common delivery systems include Design-Bid-Build, Design-Build, Construction Management at Risk, Multiple Prime Contractors and Integrated Project Delivery. Commonly used management method is also Construction Management Agenda, which is not a pure project delivery system. It is a way of gaining advisory services from a third party and can be used with any project delivery system.

Because of the fact that every delivery method is different, there shall be developed a unique delivery system that would respect all the individual requirements of the given project (Dorsey, 1997). The entity that typically chooses the delivery system that will be used is the owner, but it is advised to rely on professional recommendations of designers and/or contractor specialists because of their ability to determine which project delivery system will best suit the project.

Selection of a delivery system is usually dependent on how the given organization operates level of knowledge, available resources, funding requirements and anticipated schedule for delivery (Design-Build Institute of America, 2015).

The common delivery methods are overviewed bellow.

2.1 Design-Bid-Build

Design-Bid-Build (DBB) method is also known as a design/tender or general contractor method and is presented as a traditional method by most people in the construction industry. There have been many various alternatives in the history but this method has started being used about 100 - 150 years ago and is still preferred by many owners until now. Many organizations mainly in the private sector are oriented primary to this method (Sanvido & Konchar, 1999).

The figure below shows a timeline of project progress. The design stage is clearly divided form the construction phase.

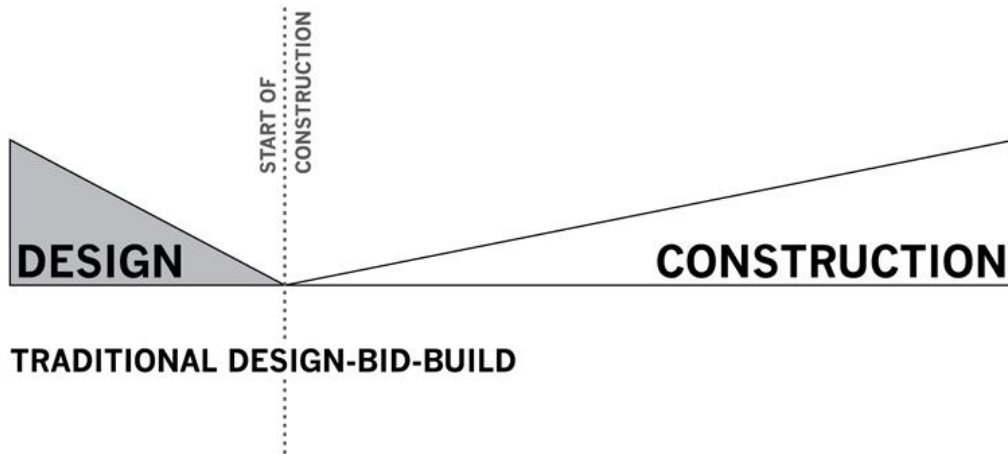


Figure 9 DBB Timeline

2.1.1 Management Structure

As seen in the relationships structure the owner is forming two arrangements in the DBB system. The core of this delivery system is that the owner contracts separately with a designer and a constructor (Construction Management Association of America, 2015).

The owner can also use advices from a construction manager agent which is not holding any responsibilities in the project. Scope of his work only covers advisory professional help and consults for the owner's decisions and is not legally connected to neither to architect nor to contractor.

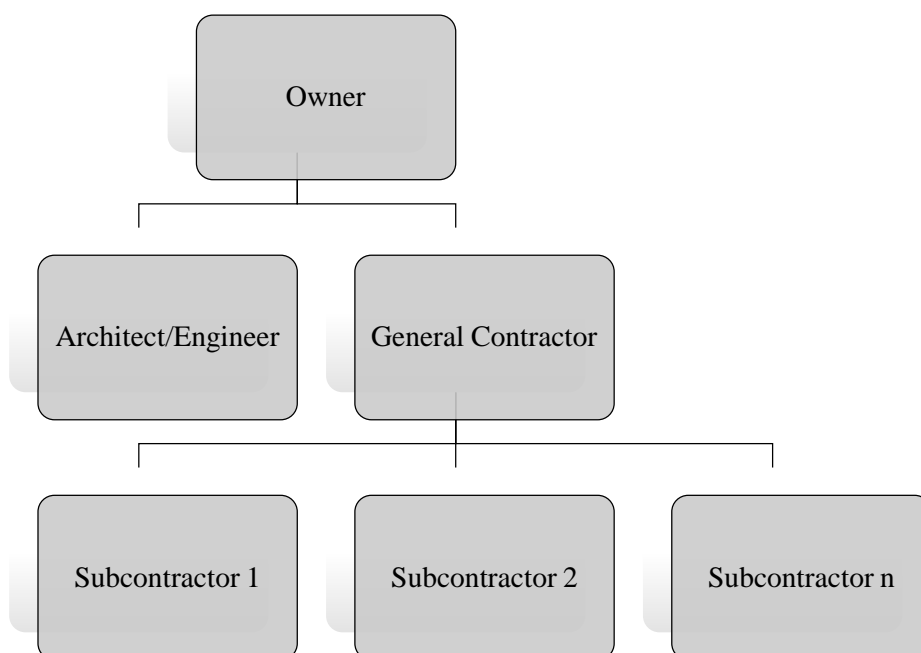


Figure 10 DBB Relationships Structure

2.1.2 Design-Bid-Build Processes

This method has a logical chronology of procedures (Construction Management Association of America, 2015). The owner contracts with a designer to provide complete design documents along with all required drawings and specifications. These documents are then used by the owner or their agent for the selection of the contractor. A general contractor is selected based on proposed bids and this entity initiates the construction phase (Trauner Consulting Services, 2007).

A graphic representation of all consequent phases according to the division of phases is presented below.

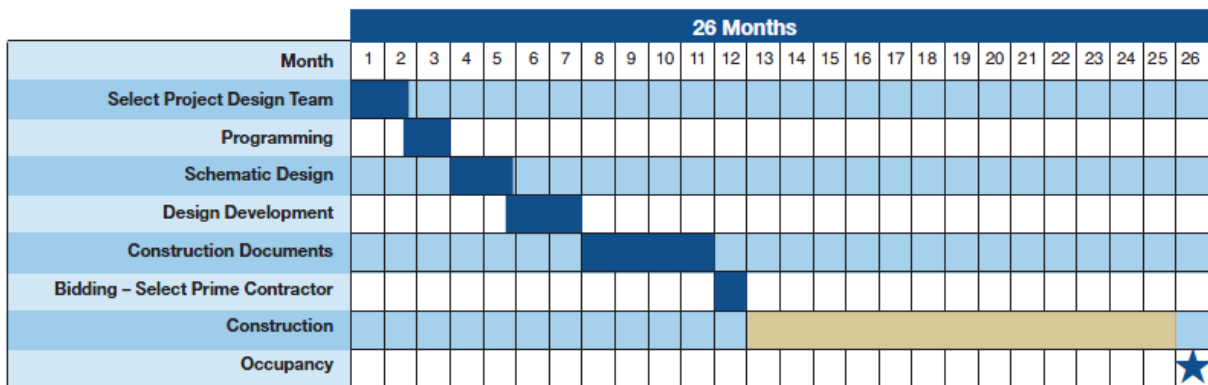


Figure 11 DBB General Sequence of Activities

These phases are linearly dependent on completion of the preceding phase as seen above. Let's more closely focus on the three procedures of the process.

Pre-design phase – The phase when the owner is selecting the architectural company to design the project. This includes selection of the project design team, programming and creation of schematic designs. The owner is making final decisions and specifying requirements along with scope of works for the designer, investigating suitability of the project and potential legal constraints, preparing a project schedule for all the key activities, developing estimated project budget for all hard and soft costs. Along with all the above the owner is most likely evaluating proposed design suggestion offered by interested architectural studios.

Design phase – The architectural company is preparing the design documents in this phase on which the bidders will turn in the bid to construct the project which is represented by design development and construction documents. The architect is working together with the owner on identifying owners requirements and composing these needs into the design. As soon as the early design is developed the architectural studio can proceed to creation of the mechanical, electrical, plumbing or fire protection documents. During this phase it is also required for the owner to continuously perform the cost analyses. The finished documents are used to create the documents package that is used a tender documentation for the interested general contractors.

Bid phase – The owner/architect/consultant is soliciting bids in order to select the general contractor. The documentations are provided to interested contractors who are later submitting bids based on that documentation. Once the bids are collected the evaluation is performed. There is a space for negotiations as there can be many rounds if any questions or discrepancies arise. The owner is not obligated to select any bid if the bidders do not meet his demands. In the case when a contractor is selected, the procurement method is negotiated and the agreement is signed, the construction phase begins.

Construction phase – The phase when the successful bidder is constructing the given project. The awarded contractor is required to deliver the project in agreed scope, time and quality and in compliance with the legal authorities' restrictions which is under owners and designer's detailed control.

The owner takes over the project after the completion of the construction.

2.1.3 Advantages of Design-Bid-Build

According to professional agencies such as CMAA, DBIA or AIA one must take in consideration the advantages of this project delivery system which are following:

- Most common approach
- Widely applicable method for many projects
- Well established easily understood system

- Clearly defined roles for all participants
- Designer's proposal are created in favor of the owner
- Possibility to control project before the tender phase
- Provides the lowest initial price that the bidders can offer
- The possibility of revealing of discrepancies in the bidding process
- The possibility of comparison of estimated and bid prices
- Well established legal precedents
- No legal barriers in in procurement and licensing
- Guarantees equal starting position for the contractors
- Well defined insurance and bonding
- Owner's significant control of the project

2.1.4 Disadvantages of Design-Bid-Build

It is also necessary to consider disadvantages and barriers that compromise this project delivery system:

- Tends to yield the base level quality
- Great potential for time/cost growth
- Owner's responsibility for the design
- Higher level of inspection is needed due to least-cost approach
- Initial low bid might now result in ultimate lowest cost or final best value
- Designers may have limited knowledge of the actual costs or scheduling
- Creating a competitive environment rather than cooperative atmosphere
- Not enough space for contractor's comments and offerings
- Agency bears design adequacy risk
- Possible claims and disputes due to propensity to adversarial positions
- Threat that discrepancies might be revealed in the construction phase

2.2 Design-Build

Design-Build (DB) is an old method of construction. The master builders of old started operating as an integrated service providers as to design and construction about four millennia ago.

The recent century was however dominated by other delivery systems as the owners emphasized competitive approach to the construction projects (Dorsey, 1997).

The situation has been recently changing and the popularity of the oldest delivery method rising again. This change is due to ongoing change of attitude and trying to involve cooperation of all the professionals for more effective delivery of given projects. Simple selection of contractors based on price offers is no longer considered as a sufficient approach.

To better understand strengths of this delivery system the figure below represents the simultaneousness of both design and construction phases (Lahdenperä, 2001).

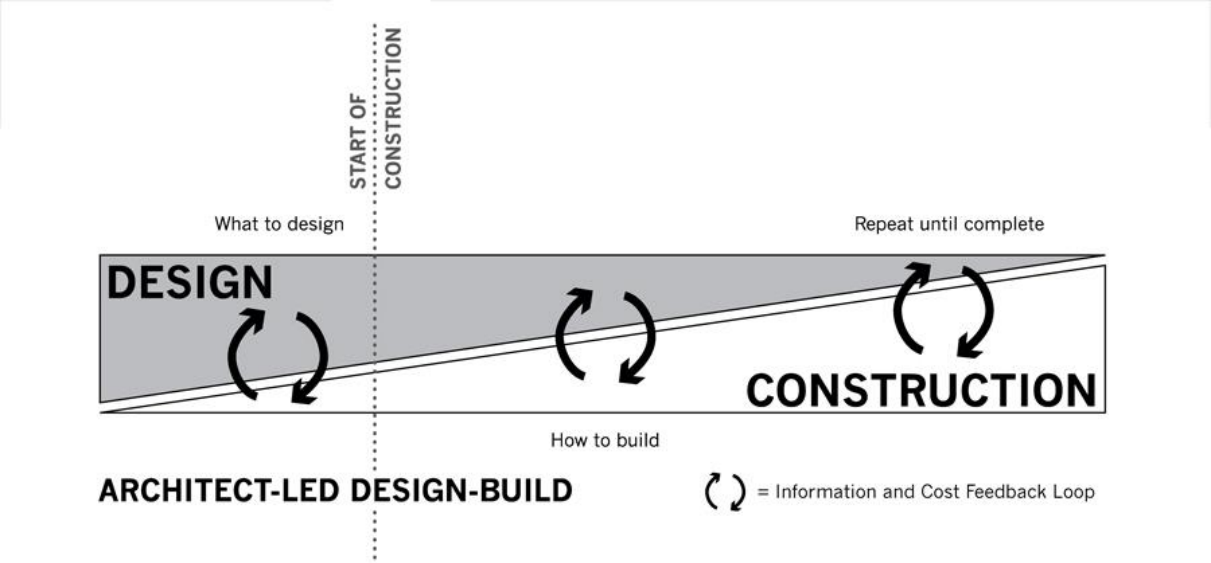


Figure 12 DB Timeline

2.2.1 Management Structure

Design-build is a project delivery system that involves only a single contract between the project owner and a design-build entity which covers both phases design and construction of the project (Lahdenperä, 2001). The design-build contractor performs design, construction engineering, construction and all other required works that are necessary for a successful completion of the project. Design-build method reduces the number of involved parties compared to other delivery systems and makes many key factors easily solvable for the owner as there is only one party that is fully responsible of the project (Design-Build Institute of America, 2015).

The owner can also use advisory services of a construction manager, but in this case it is only to make sure that the requirements will be fully and comprehensibly transferred to the contractor since the contractor is fully responsible for the execution.

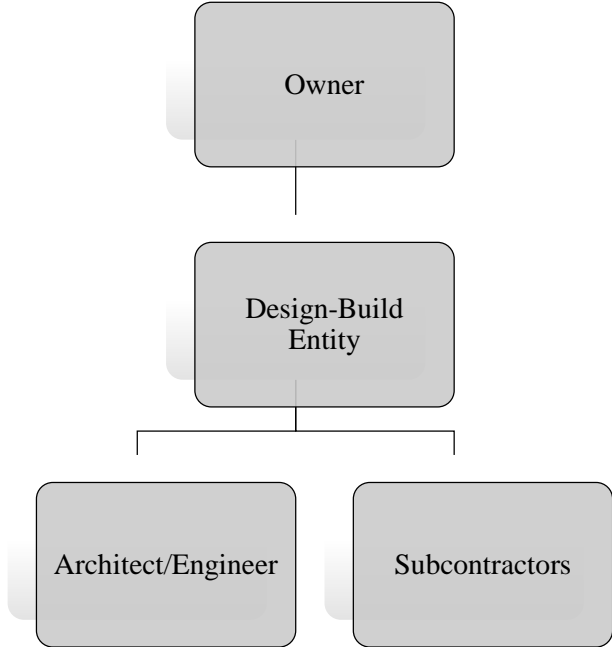


Figure 13 DB Relationships Structure

2.2.2 Design-Build Processes

Design-build as a system of a single contractor is supposed to ultimately save time and cost of the project but this may be achieved only with thorough responsibilities assessment and great control of organization of the contractor. In order to achieve a smooth delivery the owner’s needs need to be described precisely, in other words the owner needs to have a clear idea of what he wants (Construction Management Association of America, 2015).

Design-build is primary designed to save time due to the fact that the construction is occurring simultaneously with design phases and the total duration of the project can be reduced by up to 25% according to recent researches (CMAA, 2012).

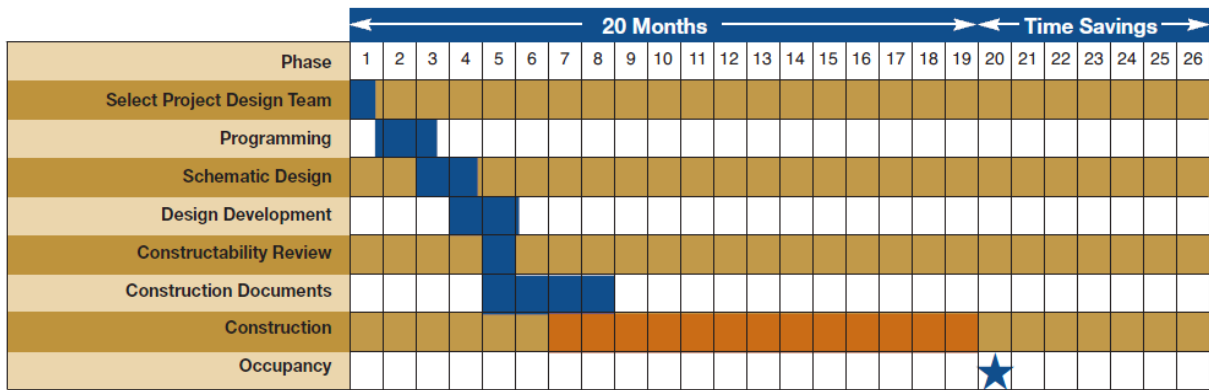


Figure 14 DB General Sequence of Activities

The figure above shows the sequences of the project delivery and it clearly indicated in which phase of the project the actual time savings occur.

Let's focus on the stages where the owner's decision influences the whole process by distributing the responsibilities.

Pre-design phase – The key consideration of this delivery system is a selection of a project design team. As this system is from owner's point of view described as a contract between only two entities the main consideration is how the design-builder will be organized. The approaches differ in two ways as the entity can be led by an architect or a contractor (Design-Build Institute of America, 2015).

In architect-led design-build projects, the architect works directly with the owner (the client), acts as the designer and builder, coordinating a team of consultants, subcontractors and materials suppliers throughout the project lifecycle. The architectural studio can lead the project in several ways which are that the contractor is working as a subcontractor for the studio or that the studio is in a joint venture together cooperating on the project.

On contractor-led design-build projects, management is structured so that the owner works directly with a contractor who, in turn, coordinates subcontractors. Architects contribute to contractor-led design-build projects in one of several ways, with varying degrees of responsibility. The architect can be a legal part of the contractor entity, can be working as a subcontractor or the both sides can be working together a joint venture.

There are many types of procurement of this entity as described in chapter 1.6. The most common ones are qualification-based, best value or a hybrid bridging-type selection where the contractors are presented with a preliminary design and are expected to review, modify and complete it. Owner's intention should be involving the contractor as early as possible so that

all his requirements are well understood and incorporated in the early stages. Besides the requirements identification, this phase includes creation of the budget and schedule and general negotiations with the contractor.

Design-build phase - After the design-builder selection the process automatically proceeds in continuous cooperative manner and the development of design and construction solutions to meet owner's expectations.

This phase includes all phases that follow the selection of project design team. These are programming, schematic design creation, design development, constructability review, creation of construction documents and the construction itself. The actual performance is contractor's responsibility but shall and must be under control of the owner so that his needs and expectations are met.

2.2.3 Advantages of Design-Build

To be able to evaluate this method I provide the list of advantages based on reports from professionals such as CMAA, DBIA or AIA:

- One single responsible entity for design and construction
- Accelerated delivery
- Risk allocation in owner's favor
- Undemanding on owner's management skills
- Close coordination between designer and contractor
- Early contractor involvement
- Minimal owner exposure to design errors
- Fewer disputes or litigations between architect and contractor
- Earlier cost and schedule certainty
- Space for innovations and improvements
- Flexibility in selection of materials, design or construction methods
- Higher quality outcome
- Less administrative burden

2.2.4 Disadvantages of Design-Build

In order to be able to understand the delivery system these are the limitations and constraints of this delivery system:

- Reduced opportunities for local smaller companies
- Fewer competitors
- Clear formulation of needs and expectations necessary
- Risk of higher initial cost
- Elimination of traditional checks and balances
- Loss of a designer who usually defends investors interests
- Quality may be reduced by cost or schedule considerations
- Less owner's control over final design
- Threat of contractor's false decisions
- Higher procurement costs
- More complicated funding may require accelerated cash flow
- Variations in different states

2.3 Construction Management at Risk

Construction Management at Risk (CMAR) is a new project delivery method that has been developed to serve investors and owners in the matter of organization and management in the construction industry.

With increasing industrialization and specialization in the construction industry it is very difficult to master all professional branches. The investors have often different concerns than to understand the construction schemes, plans or documents. The demand for professionals and specialists arises with rising complexity and complicated requirements from the owners (Strang, 2002).

We are also no longer talking about an environment where bidding serves all the best quality, cost and schedule. Since all the works can be effectively subcontracted, the winning method is to have a skilled manager with effective organization of procurement and management of subcontracts.

2.3.1 Management Structure

CMAR projects are characterized by a contract agreement between an owner and an construction manager who will be responsible for the final cost and time of construction, i.e. he will be at risk. The owner makes an agreement with a designer too and the design phases are also under CM’s control (3D/International, 2014).

The original idea is to provide professional management of all phases of project’s life as the owner’s representative because the owner may not have the capabilities internally. The CMAR contract involves two agreements. The first one for coordination and management of the design stage, and the second one for the construction.

The CMAR agreements usually contain a set GMP with a provision for the manager. There is frequently a clause in the contract that describes how the potential savings will be divided between the owner and the construction manager.

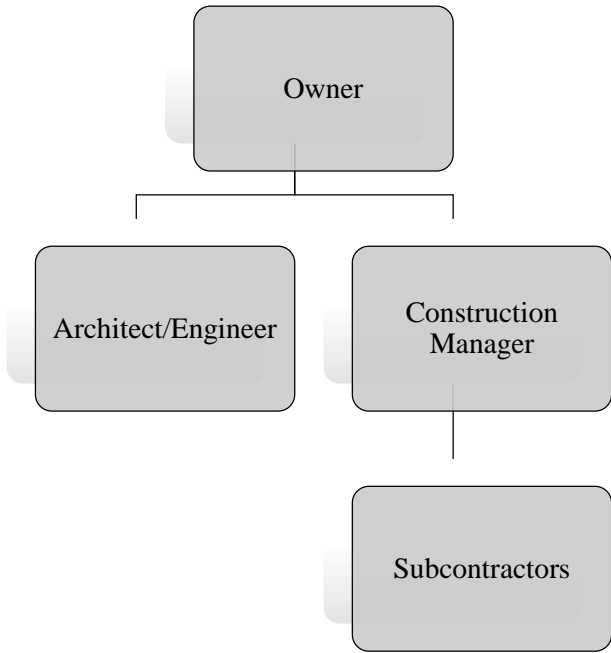


Figure 15 CMAR Relationships Structure

2.3.2 Construction Management at Risk Processes

Owner’s prime objective shall be selection of the best construction manager at a fair and reasonable price, which usually consists of a fee. The earlier the involvement of the CM is the better added value can be expected.

Among the essential things that the owner usually needs to know about the construction manager are corporate information (company history, size of the company, staff, general experience), personnel information (organization chart, key leaders, project team and their resumes), system approach (project management control tools, management plan) and references (similar project to the given one) (Construction Management Association of America, 2015).

A figure of processes is presented below with clear representation of involvement of individual parties which are owner (dark blue), architect (light blue) and construction manager (orange).

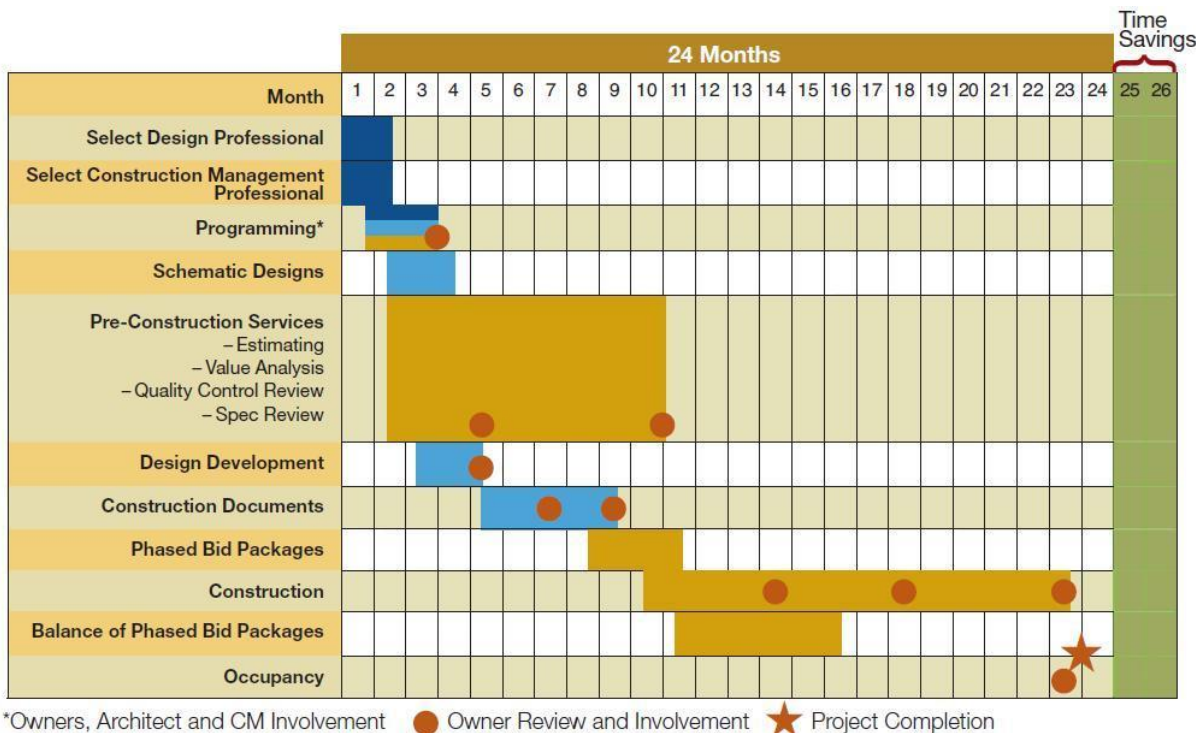


Figure 16 CMAR General Sequence of Processes

The selection method of the designer is classical with specification of requirements, selection of suitable architectural studios and then selection of the designer who meets the best the expectations (American Institute of Architects, 2011). Let’s focus on the processes regarding the issue of construction management.

Pre-design phase – The selection of the construction manager is based on various criteria such as price, quality of services, reputation, past relationship with client or liability to comply with legal constraints. The CM’s fee is usually negotiated along with all the other

contract variables. The fee is a great consideration and its value should not be the prime concern, i.e. the lowest fee does not mean the best services.

The selection of the construction manager is ideally in the earliest phase of the project as seen in the figure above.

Preconstruction phase – Since the construction manager becomes a member of the project team, he is the driving force of the project and is working in compliance with owner's interests. The responsibilities include cost estimating, scheduling, budgeting, constructability reviews and value engineering studies and these are performed during schematic design phase, design development and construction document phase. The construction manager is also responsible for the bidding so with drawings being partly finished the works are being divided into appropriate scopes of work for bidding and then the contractors are prequalified for the bidding phase. At a mutually agreed upon point during the design process, the owner and construction manager negotiate the GMP. This is usually based on partly completed design along with estimates for the unfinished part, construction contingency and CM's fee. This contingency can be used in many ways and this varies with the level of agreement between these two parties. Unused contingency is meant to be returned to the owner.

Construction phase – As soon as the agreement is set, the CM can begin the construction process which allows fast-tracking (overlapping design and construction phases) and accelerating the schedule. This phase is organized by the construction manager who behaves as a general contractor.

2.3.3 Advantages of CMR

The list of advantages of this project delivery method according to agencies like CMAA, DBIA or AIA is below:

- Pre-construction services are provided by professional managers
- Potential for fast-tracking which reduces project schedule
- CM holds the contracts along with the risks
- Allows innovations and recommendations on constructability
- Earlier project costs estimates
- Reduced requirements for owner's management skills

- Working with GMP and fixed fee motivates the CM
- Professional CM expertise
- Quick transfer of request to the contractors
- Active solution of project problems
- Possibility to implement changes in later phases
- Opportunity to use local vendors and suppliers or subcontractors

2.3.4 Disadvantages of CMR

The disadvantages are following:

- Efficient with large projects only
- Possibility of quality/cost/schedule arguments with CM as a general contractor
- Disputes about project changes due to GMP
- Owner retains design liability
- CM input may not be included by designer
- GMP approach may lead to a large contingency
- CM holds all subcontracts
- Reduced owner's control of the project
- Expensive design changes during the construction

2.4 Multiple Prime Contractors (Separate Prime Contracts)

Multiple Prime Contracting (MPC) is a form of procurement similar to design-bid-build where the owner is utilizing multiple direct contracts with contractors thus avoiding the traditional general prime contractor segment (Sweeney, 1998).

With projects becoming more and more complex and specialized in architecture/engineering/structural branches, the demand for professionals in these segments has been rising correspondingly. Many clients prefer longer lasting relationship with a contractor with quality references and therefor tend to commit an agreement with a contractor who they have been working with in past projects.

It may seem as a great reduce of cost for the owner but on the other hand it requires a high level involvement and professional skills of the owner.

2.4.1 Management Structure

As the owner displaces the general contractor he enters into agreement with multiple contractors and specialists that are only responsible for their own work. The management structure then naturally needs a party to coordinate all the trade contractors (Dorsey, 1997).

If the owner is an experienced client and a sophisticated manager then then it can coordinate the overall project itself. The responsibilities and risk assessment needs to be transferred clearly and all the project works and segment must be coordinated properly by the prime contractors. For the less experienced owners it is better to assign a delegate manager or a construction manager to advice with all the procedures. Construction manager agency would be an optimal solution since it is a professional advisory service able to manage and designate project scope. It is necessary to precisely formulate the contract with the consultant assigning relationships and responsibilities (Stutzman, 2010).

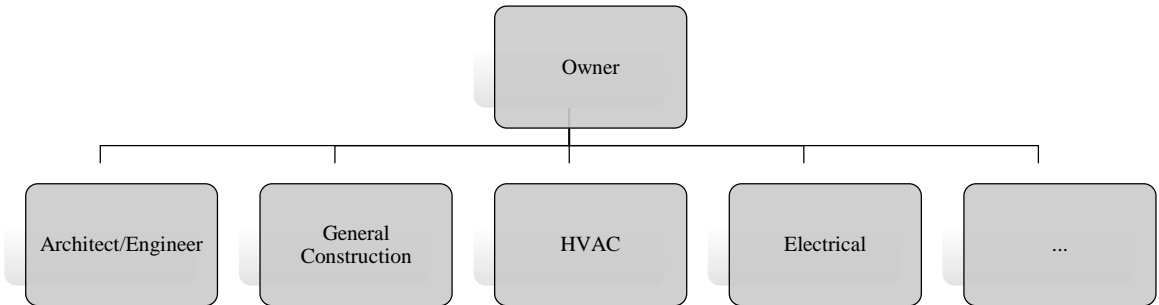


Figure 17 MPC Relationships Structure

2.4.2 Multiple Prime Contract Processes

Multiple contracting works in the same way is the design-bid-build method with the exception that the procurement and contracting of trade contractors is not under general contractor’s management responsibilities (Construction Management Association of America, 2015).

Since the design does not need to be completed for all the professions to start bidding, once a design is completed for a portion of the project it can be procured.

The simultaneousness creation of construction documents and procurement of construction works is represented in the figure below.

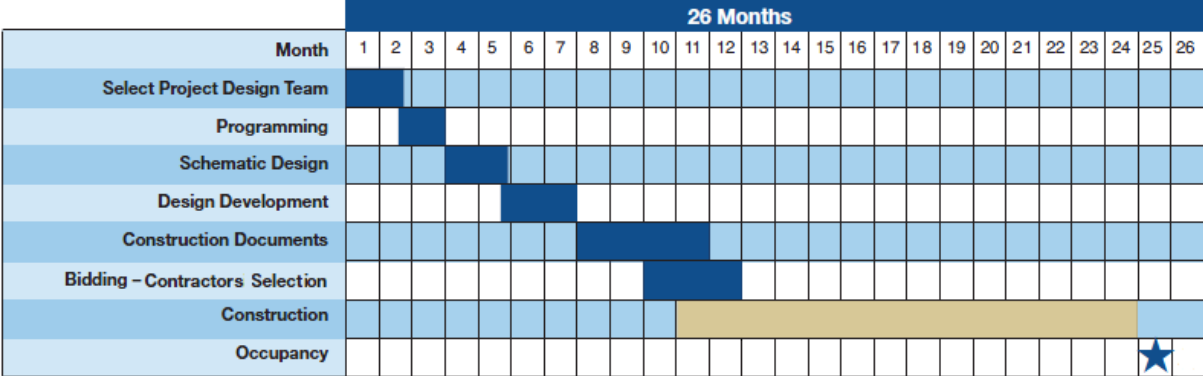


Figure 18 MPC General Sequence of Processes

Pre-design phase – During this phase the owner is selecting the architectural company to design the project. This main considerations are selection of the project design team and schematic designs creation. The owner is formulating expectations and specifying requirements along with scope of works for the designer, investigating suitability of the project and potential legal constraints, preparing a project schedule for all the key activities, developing estimated project budget for all hard and soft costs. Along with all the above the owner is most likely evaluating proposed design suggestion offered by interested architectural studios.

Design phase – Design phase is occurring similarly as in the DBB. The architect is working together with the owner on identifying owners requirements and composing these needs into the design. The architectural studio is preparing the design documents for the owner. As soon as the early design is developed the architectural studio can proceed to creation of the mechanical, electrical, plumbing or fire protection documents which are separately being use as a tender documentation for trade contractors. The owner must continuously manage and control the design studio as he bears the responsibility for the whole procurement phase.

Bid phase – The owner or other hired professional is organizing the tender as soon as the corresponding parts of the project are completed (Stutzman, 2010). Since the owner is about to enter the contractual relationship with many contractors it is highly necessary that the coordination must be precise, well timed and well managed. The construction documents are provided to interested contractors who are later on submitting their proposals. The usual chain of events start with selection of the contractor for earthworks followed by superstructure works and finally followed by all the other professions. Once the bids are collected the evaluation is performed. There is a space for negotiations as there can be many rounds if any questions or discrepancies arise. When the contractor for given works is selected, the agreement is signed and all the necessary obligations are performed, the construction phase may begin.

Construction phase – The most significant hazard of the execution is the actual coordination of construction works. The absence of the general contractor automatically requires a skilled approach to the organization of works. The owner obviously holds the duty to coordinate that work. With that duty comes the liability for failure to coordinate and the additional costs that failure generates among the trade contractors. With this liability comes the responsibility to create continuous flow of works, precise timeline, exact schedule or prevent poor performance form contractors.

2.4.3 Advantages of Multiple Prime Contractors

The advantages of multiple prime contracting according to professionals from CMAA, DBIA or AIA are listed below:

- Lower price due to elimination of general contractor's mark-up
- Owner holds all subcontracts
- Segregated work areas
- Direct communication with contractors
- Potential for earlier involvement of contractors
- Contractor selection based on their performance
- Increased opportunity for local vendors and subcontractors
- Possibility of fast-tracking

2.4.4 Disadvantages of Multiple Prime Contractors

The limitations of this project delivery system are following:

- Increased necessity of coordination
- Possibility of works being duplicated or omitted
- Increased administration requirements
- Final cost not known until procurement of the ultimate contractor
- Lack of authority
- Contractor delays lead to delays of sequential contractors
- Potential for numerous claims between contractors
- Higher cost and more change orders
- Poor quality

2.5 Integrated Project Delivery

Integrated Project Delivery (IPD) is the modern project delivery approach. The traditional delivery systems segregate the project teams into three entities: owner, designer and contractor. As these participants enter the construction at different time with different preferences this may lead to disagreements which will ultimately cost all the participants time and money.

It has been primary the matter of cooperation which has been evolving in past decades. Project alliancing is the brand new model for a project delivery method and this has been rising in popularity mainly in the USA. IPD is an approach to capital project delivery that emphasizes a higher level of collaboration among project participants (American Institute of Architects, 2007).

Among other applications, IPD has been effectively facilitating the use of building information modeling (BIM) for construction projects. BIM is the development and use of an intelligent computer software that digitally represents the facility and simulates design, construction and following operation of the building.

2.5.1 Management Structure

Organizationally, the IPD project share one thing in common and it is an early involvement of construction managers and key trade contractors with the owner and designer. These contractors and thus selected based on their qualification and not on price.

Bringing the key contractors all together with the designer team and owner from the early stages of the project allows the entities to develop a much better understanding of the project. This is beneficial for the project itself in many ways.

IPD is an attempt to contractually reflect the relationships and efforts that are possible when a project team is cooperating as an integrated unit in order to complete design and construction of the project (Thomsen, Darrington, Dunne, & Lichtig, 2009).

The entire project team is equally (or similarly) motivated to achieve the same goals, which they have been agreeing to in the start of the project. It is required from the owner to assemble the major roles to the parties in the earliest stages of the project, ideally at the project feasibility (CMAA, 2012). This early creation of an agreement results in earlier engagement of all the entities.

The figure below represents the similar involvement of all the players.

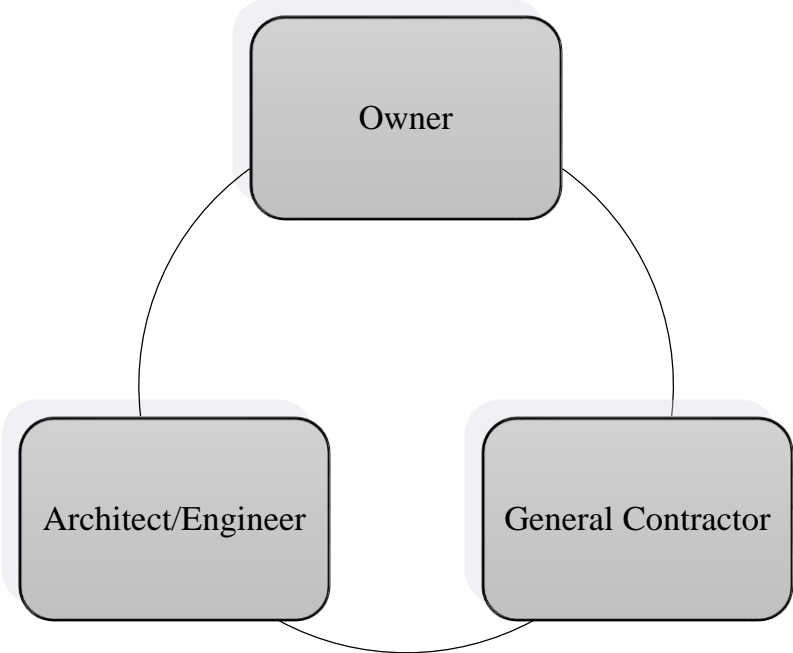


Figure 19 IPD Relationships Structure

2.5.2 Integrated Project Delivery Processes

Integrated project delivery represents a change in the industry which is represented by breaking down the responsibility dividing. Instead of this the close cooperation among all participants is expected and required. All entities involved in the project share same goals and are aligning to reach project success.

The IPD strategically and effectively redefines participant roles and using each entity’s knowledge and best talents in the right time, this method creates a great environment for a successful project (American Institute of Architects, 2007).

This approach which is abolishing the traditional methods obviously needs more attention in management and proper intuition or skills when it comes to the integration of processes. Let’s focus on the issues that occur during all the project phases and identify the main issues that arise when setting up a project for integrated delivery (Construction Management Association of America, 2015).

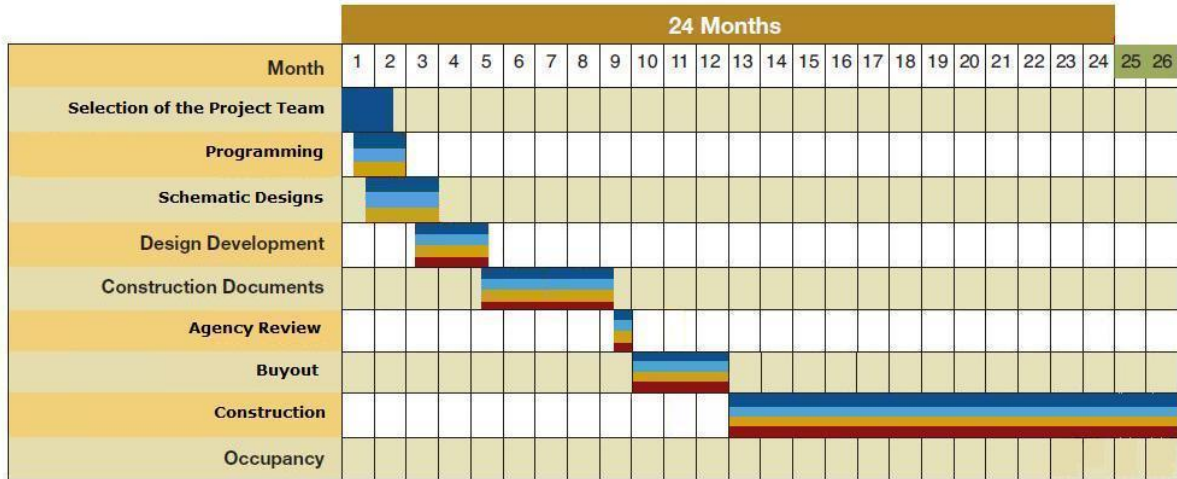


Figure 20 IPD General Sequence of Processes

Owner (dark blue), designer (light blue), contractor consultants (orange), trade contractors (red)

The figure above indicates the early environment of participants and the cooperative nature of this method.

Selection of the Project Team – The key for a successful project is assembling a team of professionals that is responsible and committed to the integrated project delivery . The owner

identifies the participant roles, pre-qualifies team members, define project goals and interests, identify management structure, develop project agreements and provisions, allocate risks and ensure proper collaboration.

Project execution – This sections consists of all parts regarding programming, design preparations, procurement of trade contractors and construction of the project. Beginning with specification like what shall be built and how shall it be built, continuing with evaluation and testing of the options. On the figure below is seen how IPD changes the possibility to influence an ongoing project in time.

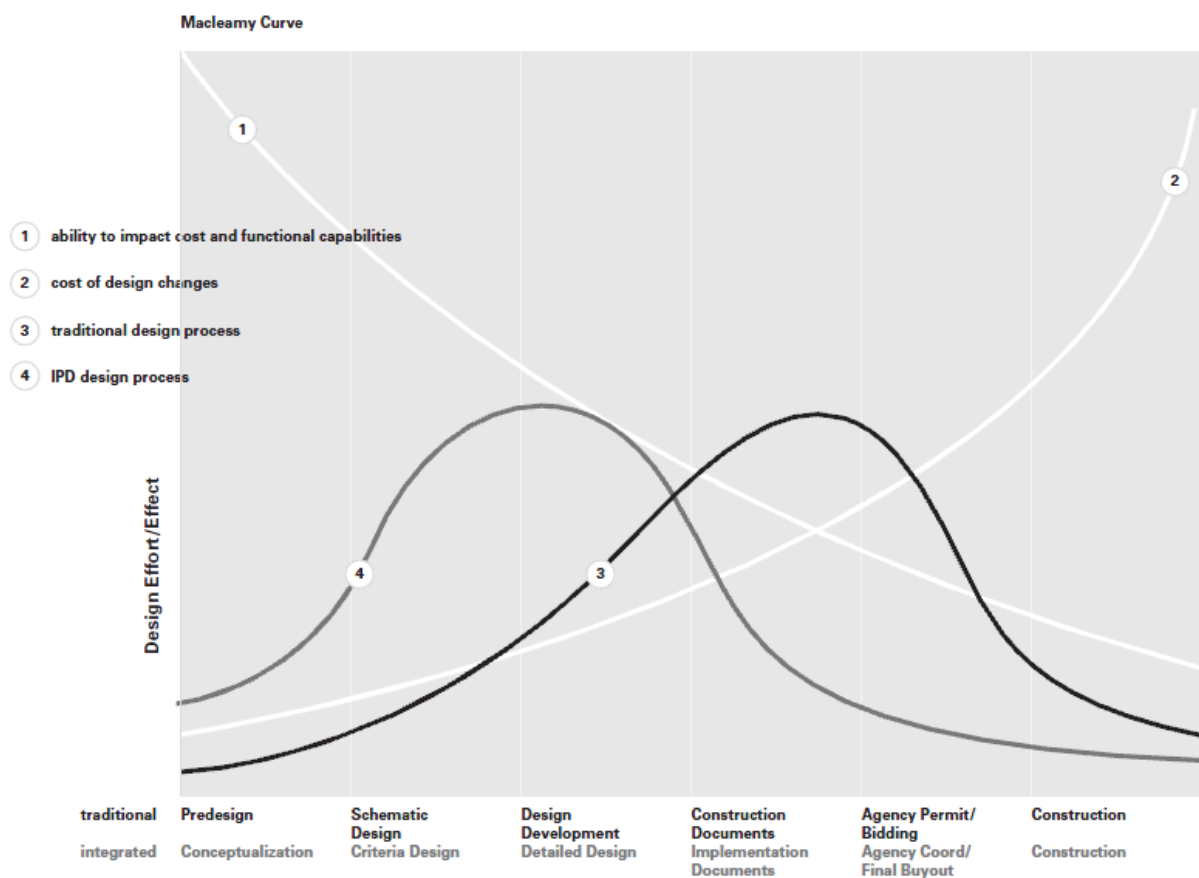


Figure 21 Project impressibility using the IPD

After the key factors of the project are set, the design development phase takes place. During this phase, all key design decisions are finalized. The building is well defined and the cost is established to a high level of precision. During the construction documents creation the owner is checking the finalized specifications, set construction methods, approving the

construction schedule and is ultimately reviewing the design using modern technologies like BIM.

Since IPD assumes early involvement of key trade contractors, the procurement of them occurs in throughout the design phases. The rest of the contractors are procured before the initiation of the construction phase based on either their qualification or, when considering a low risk delivery, their price offer.

In the construction phase, the advantages of IPD are fully visible. Since the great majority of possible bugs, thanks to the integration systems, were already solved during the design phases, the construction phase mainly consists of cost monitoring and quality control (Delorey, 2010). The construction is much more efficient due to the efforts put into the project during design phases.

2.5.3 Advantages of Integrated Project Delivery

According to CMAA, DBIA or AIA the advantages of integrated project delivery system are:

- Early involvement of key participants
- Reduced requirements for owner's management skills
- Close coordination of all the participants
- Minimal owner exposure to design errors
- Construction services are provided by professionals
- Active solution of project problems
- Allows innovations and recommendations on constructability
- Possibility to implement changes in later phases
- Potential for fast-tracking which reduces project schedule
- Opportunity to use local vendors and suppliers or subcontractors
- Fewer disputes or litigations among the entities
- Earlier cost and schedule certainty
- Flexibility in selection of materials, design or construction methods
- Higher quality outcome

2.5.4 Disadvantages of Integrated Project Delivery

The disadvantages of integrated project delivery are listed below:

- Not well known system
- The agreement can be difficult to formulate
- Objective selection of the team is difficult
- Absence of precise cost estimates
- Possible confusion in the industry
- Lack of specialists
- Failure highly dependent on behavior of individuals
- Not certain if collaboration is more beneficial than competition
- The IPD contracts have not been court-tested

3 Methodology

Selection of a suitable project delivery method is an intricate decision making process. In order to achieve an effective project progress, it shall be selected as early as possible. Preferable is selection in the pre-design-phases such as project scoping phase and it definitely needs to be chosen before the final cost estimate phases (Almazroa, 2004). This is of course dependent on the final delivery method selection, but we can apply this requirement when speaking generally.

Since the decision is being made with limited information and many variables, it is vital for the owners to have decision-making materials as a support for their decisions. These documents shall be simple, objective and comprehensive and will be created as the output of this chapter.

Literature regarding the issue of project delivery systems, which is focused on decision-making process, provides mechanisms for given decision-making acts and serves as a default framework model serving for creation of checklists and also as a base for any further documents such as project manual. These frameworks range from basic flowchart methods throughout more complicated process methodologies such as multiple linear regressions or the Analytical Hierarchy Process (AHP) (Berkeley & Michael, 2010).

As mentioned in many publications (Touran et al., 2009), the important parameters can be divided into five major groups:

Project Related Parameters – Parameters which are directly connected with a particular project and affect its scope, budget and schedule. These are for instance estimated cost, quality level, complexity, estimated duration or risks assessment.

Agency Related Parameters – These consist of parameters that are related to the agency status, strategy of the agency and organization of the project. These are for example funding of the project, professional knowledge of the team, flexibility requirements in the construction process, level of preconstruction services and quality outcome expectations.

Legal Parameters – Legal parameters cover contracting and legal issues, for example market competition, management of construction permits or procurement issues.

Lifecycle Issues – These parameters deal with energy consumption matter, environmental effects of the project, maintenance expenses and decommissioning of the building.

It is vital to be able to delegate the parameters mentioned above to more project entities in order to achieve an effective risk allocation (McGraw Hill Construction, 2014). Since various project delivery systems have different mechanisms for risk distribution it is necessary to consider these issues in the early stages of the project.

Other parameters – Parameters that do not comply with groups mentioned above.

3.1 Analytical Delivery Decision Approach

Regarding the amount of information and many variations of project delivery evaluations I decided to put together the literature background which I summarized in previous chapters with a PDS approach called Analytical Delivery Decision Approach. This method provides a set manual for creation of decision making background with all necessary requirements (Touran et al., 2009).

Preliminary Description

As there is no universal delivery approach, all the possible variations must be thoroughly examined and evaluated separately.

Analytical Delivery Decision Approach (ADDA) provides a structured manual which will be further used and customized in order to perfectly fit the type of the given project.

This approach has the primal objectives which are:

- Present a structured framework for the companies to assist them in examining different areas and types of issues of the given project
- Determine whether there is a suitable dominant delivery system
- Assist in providing the outcome documents for the project delivery system decision

ADDA consists of six steps which are completed separately but which create a consistent set of data for decision making.

1 – Create Project Description

- 2 – Define Project Goals
- 3 – Review Go/No Go Systems
- 4 – Review of PDS Advantages and Disadvantages
- 5 – Selection of Most Suitable PDS
- 6 – Results Documentation

The objective of these steps is to create a valuable information source in order to describe investor’s situation and select most suitable PDS.

3.2 Case Study

The case study of this thesis is selection of a project delivery system in accordance with its individual needs and goals. There will be described whole evaluation process in following chapters.

3.2.1 Project Description

The first step is to summarize all project characteristics and conclude all information available to the agency at the time in which the project delivery method is determined. This step serves as a comprehensive project description and can be used as a source for communication with any interested stakeholders.

<i>Project Name</i>	<i>BOLV</i>
<i>Project Type</i>	<i>Residential Villas</i>
<i>Location</i>	<i>Mahé, Seychelles</i>
<i>Estimated Budget</i>	<i>USD78mil</i>
<i>Estimated Project Delivery Period</i>	<i>48 months</i>
<i>Required Delivery Date</i>	<i>December 2020</i>
<i>Source of Project Funding</i>	<i>Investor group, bank loan</i>
<i>Project Dimensions</i>	<i>12 villas</i>
<i>Project Net Floor Area</i>	<i>13780 m2</i>
<i>Major Features of Work</i>	<i>Road, villas</i>
<i>Major Project Milestones</i>	<i>24 months for brickworks and road completion, 12 months for interior and technology completion</i>
<i>Major Project Stakeholders</i>	<i>Private sector</i>
<i>Major Challenges</i>	<i>Profit maximization</i>

<i>Main Identified Sources of Risk</i>	<i>Coordination with GOVT, road construction, complex technology</i>
<i>Design and Construction Requirements</i>	<i>Professional designers, innovative contractor, high quality outcome</i>

Figure 22 Project Description

3.2.2 Project Goals

Probably the most important task in selecting the project delivery system is defining the project goals. These needs to be formulated clearly, aptly and its importance must be emphasized accordingly. The accurate formulation of project goals is the key factor to understand project complexity and is fundamental for precise assignment of importance of single goals. Furthermore it not only affects project delivery system but also methods of administration of the project and project procurement. The project will certainly have requirements for cost, quality, time, maintenance, sustainability and technical goals such as meeting design or safety standards must also be achieved.

In the beginning of the goals specification the responsible entity must select the so called preeminent factor. This will, generally speaking, be selected from the three most important project objectives which are cost, scope and schedule. In order to successfully achieve project success this factor will be preferred in comparison with other two. The outcome of this statement is, that if any given project must be without any delays delivered until a certain deadline, investor cannot be beforehand sure about delivered quality.

The act of defining project goals is not only a concern of the owner/investor, but shall be communicated with all major entities in the project to assure proper understanding of the goals. It is beneficial if all the entities such as designers, contractors and other agencies value set priorities the same as the owner and agree with presented decisions.

Project goals certainly come in three to four main areas which are cost, schedule, quality and sustainability. The table below shows the outcome from meeting with the investor where was performed both brainstorming in combination with their already presented goals.

<i>Cost</i>	Minimize project cost (especially road and reinforced concrete)
<i>Quality</i>	High quality technology (photovoltaic, water treatment, usage of own renewable water resources), high quality interior materials (wood, marbles)
<i>Sustainability</i>	Achieve EIA
<i>Sales</i>	Active pre-sell strategy

Figure 23 Project Goals

As seen above the meeting has given us many various goals which need to be evaluated and sorted according to their importance to the owner.

3.2.3 Go/No Go PDS

Before the PDS review it is appropriate to perform a Go/No Go evaluation where the agency is able to find out if any particular PDS is suitable for the particular project. The constraints can be divided into four major groups which are project schedule constraints; federal, local or state laws; third party agreements; labor union agreements. The agency shall review all four groups and decide whether there are any limitations and if so, if they are to such a great influence that it prevents the investor from choosing the given option.

The result will be the list of available delivery method to the owner for further evaluation.

Project Schedule Constraints

Project schedule is often a key factor when planning a construction project. Since it is the main reason because of which conservative agencies even consider any other delivery methods than DBB, one must know if the deadline is compatible with all PDS options. Generally speaking the DBB mentioned above is the most time demanding method because of linearity of its processes and the inability of fast tracking.

Other constraints may arise when the investor desires to start construction before completion of the design phase. This may occur as a result of necessity to speed up the project, to start construction phase in favorable weather or to differently manage company's expenditures.

“There are no life threatening deadlines and from this point of view every delivery method can be considered.” (Koreny, 2015)

Federal/State/Local Laws

There are several constraints on use of particular delivery methods when speaking worldwide. If it is the case, the agency shall eliminate that particular method. The history describes a few examples of situations when the agency described a particular delivery method as essential for the project and discussed the state approval with local authorities with successful outcome. Generally speaking the owner shall revise the environment ahead and make appropriate steps according to local findings, which often require dropping the PDS out of possible variations.

“There was performed a scan of local legal environment and there are no issues that would prohibit the use of any particular delivery system.” (Koreny, 2015)

Third-Party Agreements

Many big construction projects affect third parties and it may be possible that it is necessary to obtain a certain agreement in order to initiate the construction phase. It may require complete design documentation with all detailed drawings and this fact makes certain project delivery methods unusable.

“Current situation in the Seychelles does not show any necessity of creation of any third party agreements, the agency is in close contact with local authorities and was assured that the use of any project delivery method is not endangered.” (Koreny, 2015)

Labor Unions

Complications arise in countries where labor unions hold a dominant position. It primary affects public sector where public unions control design, maintenance or operation of a few types of buildings. In these cases the situation may eliminate for example the DB method.

“Labor unions do not hold any dominant position in the local environment.” (Koreny, 2015)

<i>Issue</i>	DBB	DB	CMAR	MP	IPD
<i>Project Schedule Constraints</i>	OK	OK	OK	OK	OK
<i>Federal/Local/State Laws</i>	OK	OK	OK	OK	OK
<i>Third-Party Agreements</i>	OK	OK	OK	OK	OK
<i>Labor Unions</i>	OK	OK	OK	OK	OK

Figure 24 Go/No Go Consideration Areas

As seen above, the situation In Seychelles does not limit the use of suggested delivery methods. All the methods presented as variations are applicable and will be submitted to further examination in the following chapter.

3.2.4 PDS Advantages and Disadvantages

The evaluation of all presented PDS's is the critical phase as it reveals all advantages and disadvantages in all considerable areas. The purpose of this evaluation is to determine how every PDS aligns with project type, its priorities, goals, characteristics, constrains and ideas.

In order to perform the evaluation a list of issues is going to be presented and the agency will evaluate its appropriateness according to individual needs of the project. Every issue will be presented with a summarizing list of advantages and disadvantages closely connected to the given issue to thoroughly analyze all given options.

As the outcome there will be created a summarizing table with assigned applicability with following options:

- Most appropriate
- Appropriate
- Least appropriate
- Not applicable

Project level issues are sorted as presented in the beginning of this chapter into four groups.

3.2.4.1 Project Size

Project size determines project difficulty and is represented mainly by physical dimensions and USD value. Both small and large construction projects are possible to manage via any

PDS but the table below will reveal advantages of certain methods according to the unique size of given project.

DBB	
Advantages	Disadvantages
DBB can be used on all project sizes	Necessity for larger groups of professionals in bigger projects

DB	
Advantages	Disadvantages
DB works with all project sizes but is beneficial in larger projects	When projects grow the owner needs bigger groups of professionals during particular project phases

CMAR	
Advantages	Disadvantages
Works well with all project sizes	Big project require CMR's high professional level

MPC	
Advantages	Disadvantages
Can be used in any project sizes	Demands great amount of professionals on big projects

IPD	
Advantages	Disadvantages
Especially useful in large complicated projects	Not big enough amount of project samples

Table 1 Evaluation Table 01 Project Size

DBB: Appropriate

DB: Appropriate

CMAR: Most Appropriate

MP: Least Appropriate

IPD: Appropriate

3.2.4.2 Cost

One of the first considerations is project cost which includes all cost related parameters such as cost estimation or cost control.

DBB	
Advantages	Disadvantages

Low bid procurement provides low costs, negotiable unit price bidding, known cost prior to construction, known quantities before bidding	Cost is not fixed until completion of design, no space for innovation or cost saving advisory from contractor, change order on regular basis increasing the cost
--	--

DB	
Advantages	Disadvantages
This method lowers the average final cost in comparison with other methods, early contractor's involvement can bring cost savings, earlier cost certainty	Risk of higher initial cost, additional fee for the DB entity, the necessity to agree on contingency level prior to signing the contract

CMAR	
Advantages	Disadvantages
Easier cost negotiations, earlier certainty in total price, early manager involvement can lead to cost savings, usage of GMP contracts	The total price grows when not managed correctly, possible problems with negotiations when GMP is used

MPC	
Advantages	Disadvantages
Low initial price due to not having a GC, opportunity to use cheaper local contractors	The ultimate cost can grow if multiple bid packages are used separately, final cost not known until the procurement is finished, threat of higher cost and change orders

IPD	
Advantages	Disadvantages
Early involvement of participants lower the expenses due to recommendations and innovations	Absence of precise cost estimates, unsure claim issue

Table 2 Evaluation Table 02 Cost

DBB: Appropriate

DB: Most Appropriate

CMAR: Most Appropriate

MP: Appropriate

IPD: Appropriate

3.2.4.3 Schedule

The schedule issue presents an insight covering the length of project duration and possibility to affect it.

DBB

Advantages	Disadvantages
None	PDS with the longest project delivery schedule, prone to length growth, inability to shorten the linear continuity

DB	
Advantages	Disadvantages
Single responsible entity for the schedule, flexibility in schedule compression, statistically faster than other PDSs	Fast schedule requires the owner to be able to quickly review the works,

CMAR	
Advantages	Disadvantages
Ability to fast track, generally faster than DBB but slower than DB	Threat of delays if not managed correctly, fast tracking requires prompt owner's reviews

MPC	
Advantages	Disadvantages
The possibility to use fast tracking, quick information transition	Requires highly skilled coordinator to prevent delays, prone to multiplying works which creates delays

IPD	
Advantages	Disadvantages
Fast tracking, earlier schedule certainty	Unsure if collaboration is more time saving than competition

Table 3 Evaluation Table 03 Schedule

DBB: Least Appropriate

DB: Most Appropriate

CMAR: Appropriate

MP: Appropriate

IPD: Appropriate

3.2.4.4 Risk Management

This issue analyses dealing with project uncertainties that threat every project delivery method.

DBB	
Advantages	Disadvantages

Well defined risk management processes and tools	The contractor cannot participate in risk management during design, low bid procurement constraints the contractor
--	--

DB	
Advantages	Disadvantages
Single entity responsible for risk management	The owner loses control over risk management processes

CMAR	
Advantages	Disadvantages
Usage of CMR's risk management knowledge during all project phases	Problems may arise with more complex projects and many separated contracts

MPC	
Advantages	Disadvantages
The owner is able to manage the risk management by its own	The owner is fully responsible for risk management which requires a skilled professional

IPD	
Advantages	Disadvantages
Early involvement of all participants provides risk management skills in early stages	Not well known system, may be difficult to formulate agreements

Table 4 Evaluation Table 04 Risk Management

DBB: Most Appropriate

DB: Appropriate

CMAR: Most Appropriate

MP: Least Appropriate

IPD: Appropriate

3.2.4.5 Risk Allocation

One of key issues in project management is an effective risk allocation. It is desired to distribute the risk appropriately and accordingly to the actual possibility to influence the given risk.

DBB	
Advantages	Disadvantages
Thanks to rich history of DBB a well understood and clear risk allocation is established	The contractor cannot participate in risk management during design, possible conflicts between design and construction contracts

DB	
Advantages	Disadvantages
Single entity deals with risk allocation	The ability to influence risk allocation is often out of the owner's reach

CMAR	
Advantages	Disadvantages
Construction manager responsible for risk allocation	Conflicts may arise between design contracts and construction contracts

MPC	
Advantages	Disadvantages
The ability to freely distribute risks	Owner fully responsible for risk allocation, requires skilled manager, possibly creating many disputes between many participants

IPD	
Advantages	Disadvantages
Effective risk allocation, the owner is not required to be a skilled risk distributor	Threat that collaboration fails, difficult to find objective agreements, the IPD contract have not ben court tested

Table 5 Evaluation Table 05 Risk Allocation

DBB: Most Appropriate

DB: Appropriate

CMAR: Most Appropriate

MP: Least Appropriate

IPD: Appropriate

3.2.4.6 Certification

Obtaining BREAM or LEED certification is nowadays very popular and each project delivery method involves different features and possibilities to obtain the given certificate.

DBB	
Advantages	Disadvantages
The certification can start being established in design phase	No opportunity for the contractor to affect the initial certification processes

DB	
Advantages	Disadvantages

Single entity responsible for certification	Owner not involved in all certification issues
---	--

CMAR	
Advantages	Disadvantages
Available expertise of construction manager during all phases o the project	None

MPC	
Advantages	Disadvantages
Owner can freely choose the entity for certification	Difficult coordination between all contractors

IPD	
Advantages	Disadvantages
The certification can start with project's first phase, available knowledge of all participant	None

Table 6 Evaluation Table 06 Certification

DBB: Appropriate

DB: Appropriate

CMAR: Most Appropriate

MP: Least Appropriate

IPD: Most Appropriate

3.2.4.7 Owner's Experience

Different delivery systems require different level of owner's staff experience and this fact strongly influences the final decision.

DBB	
Advantages	Disadvantages
The owners are most experienced in this method since it is used mostly	None

DB	
Advantages	Disadvantages
No high expertise required, design build entity holds the experience	Not vastly used method, not much experience with revisions of DB entities, required experience to deal with one contract

CMAR	
Advantages	Disadvantages

Experienced agencies, pretty common delivery method	More complicated negotiations, fast track methods may cause confusion, some pricing methods can be new
---	--

MPC	
Advantages	Disadvantages
None	Requires a lot of experience, organization, controls

IPD	
Advantages	Disadvantages
Many professionals available, no specialized staff knowledge requirements	New method, requires experience to manage and control the group of professionals

Table 7 Evaluation Table 07 Agency Experience

DBB: Most Appropriate

DB: Least Appropriate

CMAR: Appropriate

MP: Least Appropriate

IPD: Least Appropriate

3.2.4.8 Staffing Required

This issue evaluates the level of owner's involvement which is represented by both number of employees required is specific phases and their variation during project progress.

DBB	
Advantages	Disadvantages
Since the process is divided into two phases (design and construction), the variation of required personnel is low	DBB requires a strict owner's involvement, usually bigger than in other delivery systems

DB	
Advantages	Disadvantages
This method reduces the number of owner's experts	More experienced staff is needed, variation is bigger due to peak phases like revisions etc.

CMAR	
Advantages	Disadvantages
Only a few employees required if the CM overtakes the tasks	Necessary to delegate most of the tasks, important to control the CM and review his work

MPC	
-----	--

Advantages	Disadvantages
Stable number of people involved in the project	Most staff demanding PDS, high level of involvement, necessary to have experts on every position

IPD	
Advantages	Disadvantages
The least number of experts required	Necessary to overview the project team

Table 8 Evaluation Table 08 Staffing Required

DBB: Appropriate

DB: Most Appropriate

CMAR: Most Appropriate

MP: Least Appropriate

IPD: Most Appropriate

3.2.4.9 Staff Capability

The staff capability issue states how much capable staff is required for every possibility.

DBB	
Advantages	Disadvantages
DBB requires regular capable staff	Necessary experience grows with the growth of a project

DB	
Advantages	Disadvantages
Single staff responsible for all the phases	Necessary experienced staff in order to responsibly oversee the DB entity, special requirements in design review, unique procurement methods

CMAR	
Advantages	Disadvantages
The CMR covers the issues with his own staff	Necessary to have experienced staff in order to oversee the CMAR entity, owners may lack negotiation or managing skills

MPC	
Advantages	Disadvantages
No duties delegation, owner holds the responsibility	Staff demanding, necessary to have many experts and skilled staff

IPD	
-----	--

Advantages	Disadvantages
The IPD provides all the experts	Difficult objective team selection, lack of specialists, failure highly dependent on behavior of individuals

Table 9 Evaluation Table 09 Staff Capability

DBB: Appropriate

DB: Most Appropriate

CMAR: Appropriate

MP: Least Appropriate

IPD: Most Appropriate

3.2.4.10 Owner's Goals and Objectives

Project success is defined by set project goals. The ability to fulfill them has a significant impact on project delivery method selection. It is necessary to be able to have the ability to define them in order to comply with these goals.

DBB	
Advantages	Disadvantages
The goals are defined in the pre-design and design process	Difficult to comply with set goals in two separated phases

DB	
Advantages	Disadvantages
Suitable delivery method to achieve project goals, space for innovations	None

CMAR	
Advantages	Disadvantages
Possible to involve the CM in project goals, qualification based selection is suitable	The negotiations about GMP can create discrepancies between the entities

MPC	
Advantages	Disadvantages
The goals are usually defined before the design process	The development of goals is strictly up to the owner, difficult to achieve goals with many contractors

IPD	
Advantages	Disadvantages
Whole team available for the creation of goals	Doubtful collaboration issue, difficult to agree, many negotiations

Table 10 Evaluation Table 10 Agency Goals and Objectives

DBB: Most Appropriate

DB: Most Appropriate

CMAR: Most Appropriate

MP: Appropriate

IPD: Appropriate

3.2.4.11 Owner's Control of Project

This issue summarizes the ability to control single project phases such as project design or construction itself.

DBB	
Advantages	Disadvantages
The agency possesses the best ratio of control over the phases and responsibility, separate construction and design contracts	This method is prone to change orders in design conflicts, bigger control comes with more tasks for the staff

DB	
Advantages	Disadvantages
DB entity responsible for the design, no duties for the agency	Agency loses control over the design details

CMAR	
Advantages	Disadvantages
The agency benefits from both early manager involvement and control over the project	The owner is required to be skilled in order to control the CMR and multiple delivery packages

MPC	
Advantages	Disadvantages
Full control of the project, possibility to hire local vendors, direct communication with contractors	Requires full focus of the owner, skilled professionals, increased necessity of organization, threat of duplication of works

IPD	
Advantages	Disadvantages
Full control over the project if managed correctly, benefits from early involvement of other entities	Formulation of agreements

Table 11 Evaluation Table 11 Agency Control of Project

DBB: Most Appropriate

DB: Least Appropriate

CMAR: Most Appropriate

MP: Most Appropriate

IPD: Appropriate

3.2.4.12 Third-Party Agreements

The ability to potentially create third-party agreements (political entities etc.) can be an important issue in many kinds of projects.

DBB	
Advantages	Disadvantages
The agency is able to use complete documentation when negotiating with authorities	Required skilled personnel for this matter

DB	
Advantages	Disadvantages
Innovative methods of DB entities can be used while creating agreements	Extra costs are usually not covered in the contract

CMAR	
Advantages	Disadvantages
CM assistance in negotiations	Extra costs are usually not covered in the contract

MPC	
Advantages	Disadvantages
The agency is able to use complete documentation when negotiating with authorities	The tasks can get complicated to manage

IPD	
Advantages	Disadvantages
Team of skilled professionals available for the task	Not set responsibilities

Table 12 Evaluation Table 12 Third Party Agreements

DBB: Appropriate

DB: Most Appropriate

CMAR: Most Appropriate

MP: Appropriate

IPD: Appropriate

3.2.4.13 Competition

The level of competition is an important issue and each project delivery method influences the possibility to choose and involve entities differently.

DBB	
Advantages	Disadvantages
The construction market offers many potential entities since it is the most common delivery method	Delivery method often using low bid procurement, creating environment for change orders or claims

DB	
Advantages	Disadvantages
It is possible to address only highly skilled entities when qualification based criteria is used for the procurement	Project size may decrease number of participants, not many capable entities in general

CMAR	
Advantages	Disadvantages
It is possible to address only highly skilled CM when qualification based criteria is used for the procurement	Less competitive bidding possibilities

MPC	
Advantages	Disadvantages
Increased opportunity for local vendors and subcontractors, segregated work areas, contractor selection based on their performance	Lack of authority

IPD	
Advantages	Disadvantages
Possible to select only the most skilled professionals	Difficult team selection, lack of specialists

Table 13 Evaluation Table 13 Competition

DBB: Most Appropriate

DB: Least Appropriate

CMAR: Appropriate

MP: Most Appropriate

IPD: Least Appropriate

3.2.4.14 Federal/State/Local Laws

Some states require that the agency need to comply with legislative constraints and this fact should be further examined.

DBB	
Advantages	Disadvantages
All states are authorized to use DBB	None

DB	
Advantages	Disadvantages
More flexible legislation for DB in some states allowing flexible procurement	Not authorized in some states

CMAR	
Advantages	Disadvantages
More flexible legislation for CMR in some states allowing flexible procurement	Not authorized in some states

MPC	
Advantages	Disadvantages
MPC possible everywhere	None

IPD	
Advantages	Disadvantages
None	Not authorized in some states

Table 14 Evaluation Table 14 Laws

DBB: Appropriate

DB: Appropriate

CMAR: Appropriate

MP: Appropriate

IPD: Appropriate

3.2.4.15 Stakeholder/Community Input

This issue concerns the opportunity for stakeholders to involve in the project in each delivery method.

DBB	
Advantages	Disadvantages
The stakeholders are able to get involved before the construction phase is initiated.	Stakeholders changes can cause project delays, threat of change orders

DB	
Advantages	Disadvantages
DB inovativeness in involving community, the owner can use the DB entity for communication with community	Changes caused by community which are put after the RFP are extra cost

CMAR	
Advantages	Disadvantages
CM experience helps involving any input	Difficult to manage inputs after the GMP is set

MPC	
Advantages	Disadvantages
Stakeholders are able to involve really early	Threat of many discrepancies in late inputs

IPD	
Advantages	Disadvantages
Experience of professionals helps managing inputs from both community and stakeholders	Input that is made after the agreement is difficult to involve

Table 15 Evaluation Table Stakeholder/Community Input

DBB: Most Appropriate

DB: Appropriate

CMAR: Most Appropriate

MP: Appropriate

IPD: Appropriate

3.2.4.16 Lifecycle Costs

Lifecycle costs cover the issue of about how every delivery method is able to influence lifecycle costs.

DBB	
Advantages	Disadvantages
Cost control via completed design drawings and performance specifications	Minimal cotractor input in the issue

DB	
Advantages	Disadvantages
Possible to use performance specifications and use DB to comply with these criteria	The performance criteria need to be understood thoroughly and be incorporated in the agreement

CMAR	
Advantages	Disadvantages
The agency can control life cycle costs through completed design drawings and performance specifications, CM's professional insight	The performance criteria need to be understood thoroughly and be incorporated in the agreement

MPC	
Advantages	Disadvantages
The agency can control life cycle costs through completed design drawings and performance specifications	Limited input of all subcontractors, difficult to manage available inputs, organizationally demanding

IPD	
Advantages	Disadvantages
Usage of group of professionals input	None

Table 16 Evaluation Table 16 Lifecycle Costs

DBB: Appropriate

DB: Most Appropriate

CMAR: Appropriate

MP: Least Appropriate

IPD: Most Appropriate

3.2.4.17 Maintainability

The table below specifies the advantages and disadvantages of every PDS in the matter of the ability to specify and ease the maintainability of the given building.

DBB	
Advantages	Disadvantages
Maintainability can be managed after the design drawings are completed	Minimal contractor input in the issue

DB	
Advantages	Disadvantages
Possible to use performance specifications and use DB to comply with these criteria	The criteria need to be understood thoroughly and be incorporated in the agreement

CMAR	
Advantages	Disadvantages
Same benefits as DBB, the agency can profit from the CM involvement	The criteria need to be understood thoroughly and be incorporated in the agreement

MPC	
Advantages	Disadvantages
The agency can emphasise maintainability and project it in design drawings and performance specifications	Limited input of all subcontractors, difficult to manage available inputs, organizationally demanding

IPD	
Advantages	Disadvantages
Usage of group of professionals input	None

Table 17 Evaluation Table 17 Maintainability

DBB: Appropriate

DB: Most Appropriate

CMAR: Most Appropriate

MP: Least Appropriate

IPD: Most Appropriate

3.2.4.18 Sustainable Design Goals

Sustainable design issue deals with agency's ability to deal with tasks such as reduction of impact on the environment, comfort of building occupants, reduction of non-renewables resources, hence improving building performance (*Donald Horn, GSA*).

DBB	
Advantages	Disadvantages
Agencies cooperate with designers in order to involve this issue	Little to no opportunity for the contractors to get involved in the issue, can be cost ineffective

DB	
Advantages	Disadvantages
The agency is able to emphasise the design sustainability issue in the performance based procurement phase, better constructability probability	The criteria need to be understood thoroughly and be incorporated in the agreement

CMAR	
Advantages	Disadvantages

Same benefits as DBB plus the possibility to involve CM's experience	The criteria need to be understood thoroughly and be incorporated in the agreement
--	--

MPC	
Advantages	Disadvantages
None	Limited input of all subcontractors, difficult to manage available inputs, organizationally demanding

IPD	
Advantages	Disadvantages
The agency can use all project participants from the real beginning of the project in order to achieve sustainable design	None

Table 18 Evaluation Table 18 Sustainable Design Goals

DBB: Appropriate

DB: Most Appropriate

CMAR: Most Appropriate

MP: Least Appropriate

IPD: Most Appropriate

3.2.4.19 Sustainable Construction Goals

Sustainable construction must be considered along with sustainable design. This issue covers tasks such as building materials, energy efficiency or effective methods of construction.

DBB	
Advantages	Disadvantages
None	Agency may be liable for prescribed construction methods

DB	
Advantages	Disadvantages
The integration of contractor entity in the design process may enhance sustainable construction, ability to emphasise sustainability in the criteria for the DB entity selection	The selection criteria need to be understood thoroughly and be incorporated in the agreement

CMAR	
Advantages	Disadvantages

The agency can benefit from the CM's experience	The integration of separate bid packages might not be managed correctly
---	---

MPC	
Advantages	Disadvantages
None	Limited input of all subcontractors, difficult to manage available inputs, organizationally demanding

IPD	
Advantages	Disadvantages
The agency benefits from the group of professionals	None

Table 19 Evaluation Table 19 Sustainable Construction Goals

DBB: Least Appropriate

DB: Most Appropriate

CMAR: Appropriate

MP: Least Appropriate

IPD: Most Appropriate

3.2.4.20 Construction Claims

The last issue shows how the agency is exposed to potential disputes that often lead to claims and conflicts.

DBB	
Advantages	Disadvantages
Well known legal processes in claim disputes	Very high probability of claim disputes, low bid procurement increases the threat

DB	
Advantages	Disadvantages
Single entity responsible for the project	Potential for claims if the scope definition is not understood correctly

CMAR	
Advantages	Disadvantages
The ability to lower the claim threat with use of CM's experience and innovative insight	Two contracts for design and construction means possibility of claims

MPC	
Advantages	Disadvantages

None	The worst method for the issue
------	--------------------------------

IPD	
Advantages	Disadvantages
The lowest threat of claims, minimal owner exposure to errors, active solution of project errors	Formulation of claim management is not court tested, complicated agreements

Table 20 Evaluation Table 20 Construction Claims

DBB: Appropriate

DB: Most Appropriate

CMAR: Most Appropriate

MP: Least Appropriate

IPD: Most Appropriate

3.2.5 Selection of the Most Suitable PDS

As seen on the table below, the results are pretty clear.

The formula used for the evaluation reflects the individual appropriateness of every single project delivery method in every single issue mentioned earlier in the Case Study. If any given PDS was evaluated as the “Most Appropriate” one, it has been awarded one point in overall ranking. If it was rated as the “Appropriate”, it was awarded zero points because it provides no major benefits neither significant drawbacks and in global picture seems as a neutral choice. In cases when the given PDS was rated as the “Least Appropriate”, thus was, for any matter, found inapplicable for the given issue, the delivery method was awarded a minus point in order to accurately influence the final sum.

Furthermore, after consultations with the investor entity, the most important issue called “2. Cost” was awarded double the amount of points to reflect the main goal of whole project.

	DBB	DB	CMAR	MPC	IPD
Project Level Issues					
1. Project Size	0	0	1	X	0
2. Cost	0	1	1	0	0
3. Schedule	X	1	0	0	0
4. Risk Management	1	0	1	X	0
5. Risk Allocation	1	0	1	X	0
6. Certification	0	0	1	X	1
Agency Level Issues					
7. Owner’s Experience	1	X	0	X	X

8. Staff Required	0	1	1	X	1
9. Staff Capability	0	1	0	X	1
10. Owner's Goals and Objectives	1	1	1	0	0
11. Owner's Control of Project	1	X	1	1	0
Public Policy Issues					
12. Third-Party Agreements	0	1	1	0	0
13. Competition	1	X	0	1	X
14. Federal/State/Local Laws	0	0	0	0	0
15. Stakeholder/Community Input	1	0	1	0	0
Lifecycle Issues					
16. Lifecycle Costs	0	1	0	X	1
17. Maintainability	0	1	1	X	1
18. Sustainable Design Goals	0	1	1	X	1
19. Sustainable Construction Goals	X	1	0	X	1
20. Construction Claims	0	1	1	X	1
	5	9	14	-10	6

Figure 25 PDS Evaluation

3.2.6 Results

Q1: As the CMAR project delivery method was evaluated as the “Most Appropriate” one 13 times, the contrast with the PDSs on 2nd and 3rd places is very significant. CMAR was elected as the most appropriate thanks to good performance in all issue groups, but especially in the main group “Project Level Issues”.

It seems to be the best choice in accordance with both size and cost of the given project. It also has excellent results due to its clear and suitable distribution of responsibilities. When it comes to agency level issues, the owner benefits for CMAR's experience which allows him to lower requirements for own both number of staff and staff experience. Same goes for the public policy issues when the owner can delegate responsibilities and profit from professional expertise. This PDS has not reached the highest ranks in lifecycle issues since the modern collaborative delivery methods provide better environment for these considerations.

Construction Manager at Risk method was selected as the most suitable project delivery system for the given project. This was achieved due to a combination of owner's project control and agency's manager experience which are the key concerns that affect the whole project. This balance provides an environment in which the owner and the manager collaborate together as one entity and this partnership enhances the level of project management, allows an effective project control, enables an effective project risk allocation, reduces project cost, shortens project schedule, lowers requirements for professional skills in owner's project team and ensures project sustainability.

In overall, 14 points is a very positive result and the recommendation of this Case Study is to use Construction Management at Risk PDS in order to effectively deliver given construction project.

Q2: Since the MPC received the most “Least Appropriate” points, it was evaluated overall as the least suitable method. The reasons for this fact are many, beginning with huge requirements for the owner’s staff in fields like management skills or professional experience, and finishing with complex sustainability management or owner’s complete responsibility.

Second place takes the DB method due to its potential benefits in nearly all issues. A conservative approach is necessary with this delivery method since the owner has no influence on project appearance which is not advisable in these types of projects.

Third place goes to the IPD since it seems to provide many benefits due to the early collaboration of involved entities. Despite this fact it is not very much clear how big is the real beneficiary, because it is considered a new innovative delivery system which has no wide portfolio of references.

Fourth place, pretty surprisingly, belongs to the traditional DBB and the reasons for this facts are numerous. The most important fact is, that other delivery methods are being developed in order to enhance current delivery systems and only time and use of these innovative systems will show how great are the benefits of collaboration, early involvement or software implementation.

4 Manual for Construction Manager at Risk Tender

This Manual describes all tender procedures that are necessary to follow in the selection of a Construction Manager at Risk process. It was created to define and describe procedures, duties and relationships during the tender.

Prime purpose of this manual is to provide background for preparation and organization of the tender and its smooth process.

4.1 Prequalification Form (PQF)

It is required to create a Long List of all potential candidates to examine the available market supply.

All potential CMARs must comply with owner's requirements and must agree to a non-disclosure agreement (NDA) between the owner and the construction manager (CM) entity. This NDA form ensures protection of any sensitive data, will be provided to all candidates and must be signed and sent back before any further tender progress. The candidates will be provided with brief project description, location, estimated project size and estimated project schedule.

PQF form serves as an opening survey among all the participants and is meant to gather information about the CM that is required for the decision, if the given CM is capable of sufficiently delivering the project. This information will consist of:

CM's General Information – Name of CM entity, full address, homepage, key contact for bidding, e-mail address

Organization of Business – Foundation date, name of parent company (if applicable), registration number, organization chart

Financial Information – Annual revenue for past three years, bank credit limit, bank guarantee limit, recent annual statements

License Information – Copy of all Licenses and Accreditations

Health and Safety Information – Number of accidents or injuries

Qualifications and Experience – List of references of similar projects both completed and ongoing

Technical Capabilities – List of disciplines that are managed in house and list of disciplines that have to be outsourced

Staffing and Resources – List of available personnel in various disciplines

Mandatory Contractual Requirements – Clarified issues such as payment terms, indemnification, intellectual properties or liability that need to be confirmed by the CM

Along with the issues mentioned above the candidates will present their Certificate of Incorporation, criminal records and statutory declarations.

Furthermore there will be developed a rating system. For qualification and general information there will be a Yes/No rule. For other issues there will be created a scoring system and when the candidate reaches certain amount of point he will be rated as suitable and will continue to next phase.

All candidates will be provided with a deadline for submission of required documents. If any fails to deliver the document until set date and time, the entity will be removed from the tender. All remaining participants will be thoroughly examined and compared if their references, capabilities and performance complies with set requirements and those who will reach sufficient results will proceed to the Short List and to the next stage of the tender.

4.2 Request for Information (RFI)

The participants that were short listed from the previous stage are automatically listed to participate in this stage.

The owner must have a clear detailed idea about the scope of works demanded. The candidates will be provided with detailed information and detailed specifications so that the CMs will be able to submit complete proposals.

Since only serious applicants are participating in this stage it may be necessary to set site inspections with individual candidates, thus provide all necessary information and possible limitations of the given project.

The RFI documents consist of:

Detailed Project Information - Project description, size, requirements

Scope of Services – Subject of Contract, detailed scope of required services

Project Time Schedule – Tender schedule, construction period for CM's development, deadlines

Bid Preparation – Requirements for bid submission, documentation, price breakdown, restrictions

Contract – Contract proposal for CM’s comments, service contract

Content of Proposal – Required documents, comments, proposals

Price and Payment Terms – Payment provisions type, invoices, payments, retention

General Requirements – Rights and obligations of participants

Insurance – Required level of insurance

Warranties – Required warranty periods

Project Communication – Methods, language requirements, reporting periodicity, site meetings

Proposal Form – Form to be submitted by the CM

All proposals will be sent by e-mail to given e-mail address. In case of any larger attachments, the participants will provide documents both on CD and paper form and deliver them to given address.

Tender participants can raise various questions during the RFI phase and owner’s agency will according to the nature of inquiries indicate the time required for the processing. Deadline for comments inquiry will be set in the provided schedule and a deadline for owner’s answer so that the compliance with core schedule is ensured. In any critical cases the project schedule can be adjusted.

The owner will develop a detailed comparison of bids. This will be elaborated via set scoreboard, where will be stated whether or not the given participant meets the mandatory criteria, following with issues such as completeness of required documents / correct documents form / agreement with proposed contract form (including submitted fundamental observations). Furthermore, the table will contain first pricing information – completeness as well as quality of inquired comments about the project and innovations. Simultaneously the table will reflect other terms of conditions such as guarantees for both the whole project and its individual parts.

Firstly, the companies that did not meet the mandatory conditions will not be included in the next phase, whatever the price or other parts of the proposal are.

Secondly, the candidates that met the mandatory conditions will be included in the next phase of this evaluation. The outcome will be a list of companies that will be addressed in the first round of the tender. Part of the RFI scoreboard will be variation percentage representing the difference from the minimal proposed price. Based on these comparisons there will be developed a commentary to every received bid.

Cogent contractual comments will be incorporated in the contract and will be confirmed in the first round of the tender.

4.3 1st Tender Round

The owner will ensure that the candidates will receive their proposals and will revise the bids in compliance with owner's requirements, which were modified in the RFI. Adjusted tender conditions will be processed by owner's team.

After receipt of updated bids for the tender, the selection process will continue with data procession and evaluation. This will be performed using the best value method with weighted criteria and according to criteria mentioned below.

Cost - All companies price offers will be compared in a single document and appropriately evaluated. The document will compare total price, rates for individual works and individual performance fees. Since the cost of the project is a significant issue it will be awarded a corresponding weighted factor.

Construction Deadlines – The evaluation will reflect the ability to meet set deadlines with an emphasis on the completion date and handover deadline.

Schedule – The final decision will mirror schedule constraints, such as general timeline, schedule quality, level of details in the schedule and will also involve suggestions for shortening single periods of both design and construction.

Guarantees – In terms of guarantees all participants are considered equal if they demonstrate required assurances. Bank guarantee on completion of the works will be agreed upon with the winner of the tender and will be handed over after all negotiations, which means with contract signing.

Payment Schedule – All competitors must comply with set payment conditions and owner's agency will be open to any positive proposals in this matter.

Consent to the Modified Contract – Mandatory for all participants, there will be the same version of contract made for all candidates and it is compulsory to agree on that.

Detailed Works Description – The level of detail in all involved documents will be evaluated separately. It is obligatory that the candidate thoroughly understands all project goals, constraints, variables and is required to raise question if he finds any discrepancies.

This round shall assure the owner that all his requirements are well understood and are met by the applicants. If any more questions arise in the process, the owner shall check on them and enable the clarification.

The owner can expect, that this round will select two to four candidates that will be subject of further negotiations in the next round. The final round can be skipped if one candidate excels over the others or if only one's capabilities are in compliance with owner's expectations.

4.4 2nd Tender Round

All candidates that were found suitable in the first round are capable of delivering the project in required quality. The subject of any further negotiations in the second round will be only the cost of the services. It may be required to convene various meetings in order to successfully and effectively select the most suitable CMAR.

4.5 Summary

The steps that are described above provide a detailed manual for the selection of a Construction Manager at Risk for the given project. If followed it will assure an effective progress of the tender beginning with wider selection of participants, narrowing the selection during the evaluation process and ultimately finishing with only one, most suitable, candidate.

5 Conclusion

This Thesis tends to deal with the Project Delivery System issue in construction management. Suitable delivery system selection is a key factor for an effective management of a project and its importance affects all project constraints from the earliest phases.

There are described five major delivery methods and these are further analyzed. First, the given PDS is described with its management structure, followed by description of related management processes and finishing with a general list of advantages and disadvantages as a support for the necessary decision making.

The Case Study of this Thesis presents the given construction project and deals with its individual project constraints according to previously overviewed issues.

The Analytical Decision Delivery Approach is used as a tool for the selection of the most suitable project delivery method. This technique sets general issues regarding any construction project, reviews its pros and cons according to a specific project type and then assigns a level of appropriateness for each major issue. These partly evaluations are then ultimately reviewed and assessed in the arranged table with a clear outcome.

Construction Manager at Risk method was selected as the most suitable project delivery system for the given project. This was achieved due to a combination of owner's project control and agency's manager experience which are the key concerns that affect the whole project. This balance provides an environment in which the owner and the manager collaborate together as one entity and this partnership enhances the level of project management, allows a thorough project control, enables an effective project risk allocation, reduces project cost, shortens project schedule, lowers requirements for professional skills in owner's project team and ensures project sustainability.

In the end the Manual for CMAR selection is presented and this documents serves as a tool for the owner and describes in detail all phases of given selection process.

6 Further Research

The project delivery system issue is globally well described and well known. In any future research I suggest to focus on new and young project delivery methods, especially the Integrated Project Delivery (IPD), that has impressive references worldwide and in my opinion also a great potential in local environment.

There are many scientific articles regarding this issue as well as technical literature, but since it is a young idea of delivering a construction project, there are not enough professionals capable of managing such a collaborative method for now.

I suggest review the possibility if implementing the Integrated Project Delivery system along with all suitable tools in this project in order to achieve greater results and benefit the owner in issues such as total cost and total time.

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