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RISK MANAGEMENT IN THE CONSTRUCTION PROJECTS FROM THE CONCEPTUAL DESIGN AND LIFE CYCLE PERSPECTIVE

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Abstract: *Every day thousands of building projects are realized all over the world that each phase of the construction projects are required to have good decisions in order to take a step further towards the success of the project. The purpose of risk managements to predict, reduce and avoid the risks and their consequences. Risks can also be transferred to other parts of the project in order to achieve the best final results in each area of the project. A building project is a process where each activity and phase includes different risks that should be handled by the project participants. Nowadays, the building market is developing very fast and it is important to deliver the project to the client on time and within the budget, each decision made in the conceptual design phase can have an impact on other phases and bring consequences that could be negative for the building project in each phase of a building project, such as conceptual, preliminary, design development and construction execution has to be performed by a project participant according to his role, can also be referred to a project or a project task, because it contains the parts that the project teams work on within a company. The risks related to critical events in the project tasks are managed by the project participants according to their responsibilities defined in the contract documents. The risks managed in the project tasks are an integral part of the risk existing in the building projects. To understand the concept of risks in building projects, it is worth to study how a typical building project is organized and how it works in practice. A good knowledge about the forms of building projects would help to identify the risks in all the phases of the construction projects. The structure of a building project, depending on its scope, varies with the number of project teams, and form of management. Also the form of contract plays an important role regarding that, what kind of risk that should be taken into consideration and how to handle it. The aim of this paper is to identify the decisive risk approaches to manage the risk at every phase of the construction from conceptual design to close out to complete the project on time and within the budget.*

Key words: *Predict, Conceptual, Preliminary, Design Development, Construction Execution, Pre-Design stage, Building projects, Risk Management.*

II. LITERATURE REVIEW

Substantive research has been done in the field of risk management for construction projects, a significant outcome of which is the identification of many risks that

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may influence the construction project delivery from conceptual design point of view. Chen et al. (2004) proposed risks concerned with project design, cost and divided them into three groups: resources factors, management factors and parent factors. Through a case study on the building construction projects in Kuwait, Associate and Chief Structural Engineer, Gulf Consult, Mr.Mansoor Rao found that the many factors such asthe "Client requirements, tight project schedule , budgets ,architectural views, site conditions, soil and wind studies ,availability of the materials and experienced professionals in the market and price escalation of materials" are pertaining to resource factorsof Risk in the building projects from conceptual design as well life cycle perspectives, further "inaccurate cost budget" and "supplier or subcontractors' default" pertaining also to risk management factors, and "excessive interface on project management" pertaining to parent factors are the most significant risks in the construction projects. Summarizing other researchers' work, identified the main factors affecting safety performance including "poor safety awareness of top management", "lack of training", "poor safety awareness of project managers", "reluctance to input resources to safety" and "reckless operation". While the above research studied the diverse risks influencing the project objectives in terms of cost, time and safety, other research examined the risks or risk management in different phases of a project. Uher and Toakley (1999) investigated various structural and cultural factors concerned with the implementation of risk management in the conceptual phase of a project life cycle and found that while most industry practitioners were familiar with risk management, its application in the conceptual phase was relatively low; qualitative rather than quantitative analysis methods were generally used; widespread adoption of risk management was impeded by a low knowledge and skill base, resulting from a lack of commitment to training and professional development. Chapman (2001) translated the risks described within the Central Computer and Telecommunications Agency Publication "Management of Project Risk" into the design risks which included but were not limited to "difficulty in capturing and specifying the user requirements", "difficulty of estimating the time and resources required to complete the design", "difficulty of measuring progress during the development of the design". Chapman also stated that the design team's in-depth knowledge of the sources of risk can greatly influence the identification of risks in the design phase of a project. Abdou (1996) classified construction risks into three groups, i.e. construction finance, construction time and construction design, and addressed these risks in detail in light of the different contractual relationships existing among the functional entities involved in the design, development and construction of a project. Risk classification is a significant step in the risk management process, as it attempts to structure the diverse risks affecting a construction project. In order to manage risks effectively, many approaches have been suggested in the literature for classifying risks. Perry and Hayes (1985) presented a list of factors extracted from several sources which were divided in terms of risks retainable by contractors, consultants and clients. Chapman (2001) grouped risks into four subsets: environment, industry, client and project. Of the 58 identified risks associated with Sino-Foreign construction joint ventures, Shen (2001) categorized them into six groups in accordance with the nature of the risks, i.e. financial, legal, management, market, policy and political, as well as technical risks. In a word, many ways can be used to classify the risks associated with construction projects and the rationale for choosing a method must service the purpose of the research. In this paper, the researcher aims to seek to study the risk management in the construction projects from the conceptual design perspectives.

III. RESEARCH METHODOLOGY

In this paper, at the outset, general focus has been made on the general concepts of Risk Management in the construction projects from the Conceptual Design and life cycle perspectives;hence questionnaire has been developed by going through literature on construction and conceptual design risk management. A discussion has also been made with the design professionals in Gulf Consult, Kuwait to define, frameand pact the risk, which have been associated in the various phases of design as well construction of the building projects for different types of contracts.

IV. PROJECT'S LIFE CYCLE

The best way to present how a typical building project is structured is by help of the project life cycle. A typical project life cycle is divided into phases, each with a predetermined purpose and therefore an identifiable scope of work. The project begins with an idea, and then it is developed in many steps and at the end closed and terminated. Every project has its design phase, construction phase and closing-termination phase, which are partly overlapped from phase to phase. The phases can be defined in different ways. Below an example of how a typical building project can be divided into several phases is presented in Figure 1.

CONCEPTUAL DESIGN PHASE; The conceptual design phase is the initial phase of the building project. Most important decisions about the planing, design and type of contract take place in this stage. The initial ideas about the project turn out in various concepts. The alternatives are evaluated and the final conceptual solution is chosen.

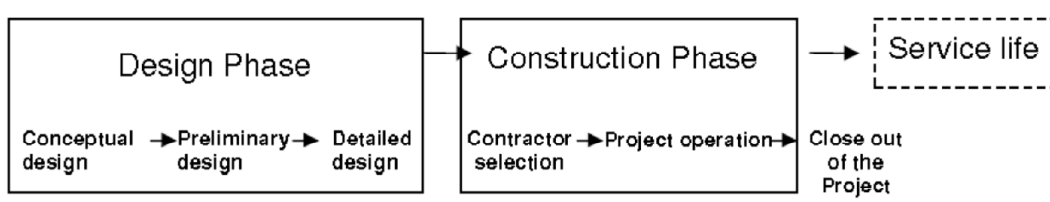

Figure 1: Project's Life Cycle

The design stage is, prior to the construction phase, a main part of the whole project time, where the conceptual design stage plays an important role for further development. It is essential to understand that the conceptual design phase has a great influence for the further stages of the project and bad decisions can have decisive impact on the work in the future. That is why good management is needed when the alternatives are discussed, and the final solution is selected. Also important aspects of the project and good stated and answered questions of what can be expected and unexpected in the project should be considered.

NEED AND VISION; Firstly, the need of a certain building should be identified. A clear vision and objectives of the project should be stated to clarify what the task is, so the participants know their responsibilities and roles in the process. The task statement is the consequence of the need, but it does not represent the vision of the product itself. Forcing ready solutions or technical parameters at this stage is a mistake, since this can cause unnecessary problems in future creation of alternatives.

When the need has been identified, the idea should become a real issue so the purpose is considered first, and then design requirements are checked to analyses it from the technical point of view. Important questions about the structural behavior and the reliability should be stated and discussed in detail by professional participants in the project, who have been practicing and having good experience and knowledge in the construction projects. Sometimes it is essential to engage a specialist, if some issues are doubtful and require further expertise.

Very often during the concept development, old examples and experience are used without any space for creativity and improvements. This might result in less innovative ideas in the project and less quality for the client. Creative thinking with proper usage of experience feedback makes the project better and gives the possibility that more efficient and valuable alternative is presented.

BLACK BOX; the creation of possible alternatives is the next step of the conceptual design stage. According to Niemeyer (2003), the black box principle can be used for this purpose. The black box contains many ideas of the project concept that can be taken into consideration, but only those alternatives that meet the project objectives and are possible to realize should be selected. First the inputs on which possible alternatives are going to be stated and known should be completed, and then outputs to which the inputs are going to be transformed are stated. At the beginning of the conceptual design phase there is always meeting room for innovations and creativity.

CONSTRAINTS**;** when the set of alternatives are going to be created all constraints should be identified to know the boundaries of possible solutions and to assess the solution space. There will always be some limitations that reduce the solution space (see Figure 2), so the task is to maximize the solution space taking

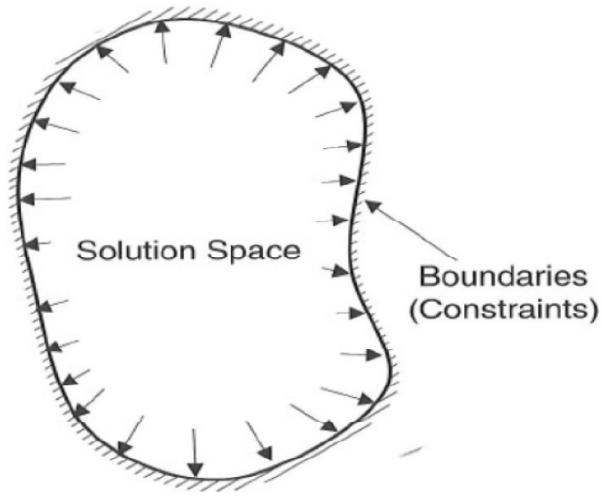

Figure 2: Schema of solution space bounded by constraints

into considerations all important restrictions that show up at the beginning and during the need analysis.

Kroll *at al.* (2001) propose to classify of such limitations into two groups, explicit and implicit constraints, so the solution can be more exact according to stated boundaries. Table 1 presents short characteristics of constraints depending on their class and the correlations to other issues in the project life cycle.

Table 1
Explicit and implicit constraints kroll (2001)

Explicit Constraints	*Implicit Constraints*
• Come from task statement	• Based on studies of life cycle environment
• Easy to Identify	• Generated on need analysis.
• Approved by the client if changed	• Possibility of causing problem should be studied
	• Re-Examination and revision necessary if not fitted to requirements.

Explicit constraints are easy to identify because they come from the statements that are known at the beginning of the conceptual design stage. These come from stated "wishes" from the client, obvious constants (gained for example from knowledge and experiences) that are listed first, thus easy to identify. However, every change in the boundaries should be approved by the client. It is connected with economical risks (e.g. different solutions, different funds) that have to be discussed by all project participants. Otherwise it might cause misunderstandings in the future.

Implicit constraints are not known at the beginning of the project. They are the result of later studies in the project life cycle, and calculations in progress of need analysis. As a result, they can limit the solution space later on than explicit constraints. However if there is a probability of causing problems, the engineer should revise and re-examine the implicit constraints again.

DESIGN REQUIREMENTS AND KEY PARAMETERS

The design requirements form the basis that every design engineer should determine before he/she makes next step towards the key parameters identification. Design requirements are a set of criteria that every solution must satisfy. The design requirements are the connection of need analysis result with constraints of the solution space. They should be defined as precisely as possible to minimize the risk of conflicts and misunderstandings between participants. The requirements should not be too general, because it disturbs selection of design alternatives.

The choice of proper alternatives is made by using a set of key parameters, which decide if acertain alternative is worth to go further to the next step. To clarify the parameters, boundaries of the project should be known. It allows reducing the critical events and risks in design and construction phase of the project.

However, proper parameter identification is essential. The task should be simplified by clearly pointed objectives and needs, which make identification easier in conceptual design. The parameter could be a factor, issue, information or concept, but not a dimension or property. A set of well-chosen parameters requires good knowledge experience and innovative thinking, which help to develop new ideas and solutions for stated questions and problems. The point is not to act in a schematic way, because the new project could turn out to be different from the ones that are known from the experience. On the other hand, some successful methods already known from experience in realization of activities in projects, would streamline the process of finding a final solution.

Five-step methodology, adopted from Engstrom and Lierud (2006) Figure 3, the process starts with a task definition, which is a result of need analysis. It is a very important step to begin with, and a good task statement minimizes the risk of potential mistakes in the further development. The task definition is not a simple activity but a closed loop where the final alternative is chosen and if the result is not sufficient then the process of finding a new solution is repeated until the final required outcome is found. A clear vision, creativity and proper design requirements are essential for good key parameters identification. Afterwards the concept is configured and evaluated. If the evaluation of the final solution is adequate then the chosen concept is further developed in a building project. A good sequence and plan of work from the beginning ensure the fluency of work in the conceptual design phase of building projects; make the identification and analysis of critical events more efficient where the needs, boundaries and requirements are known.

To sum up, the methodology of choosing the alternatives can be presented as below: As an example of key parameters, the influence of a construction site on conceptual design is discussed below, a visual inspection of the construction site can often provide useful information not only for the construction planner but also for design engineers who should know the conditions where the new structure is going to be implemented. This kind of analysis shows which critical events and risks can be expected from different points of view when the construction work is planned.

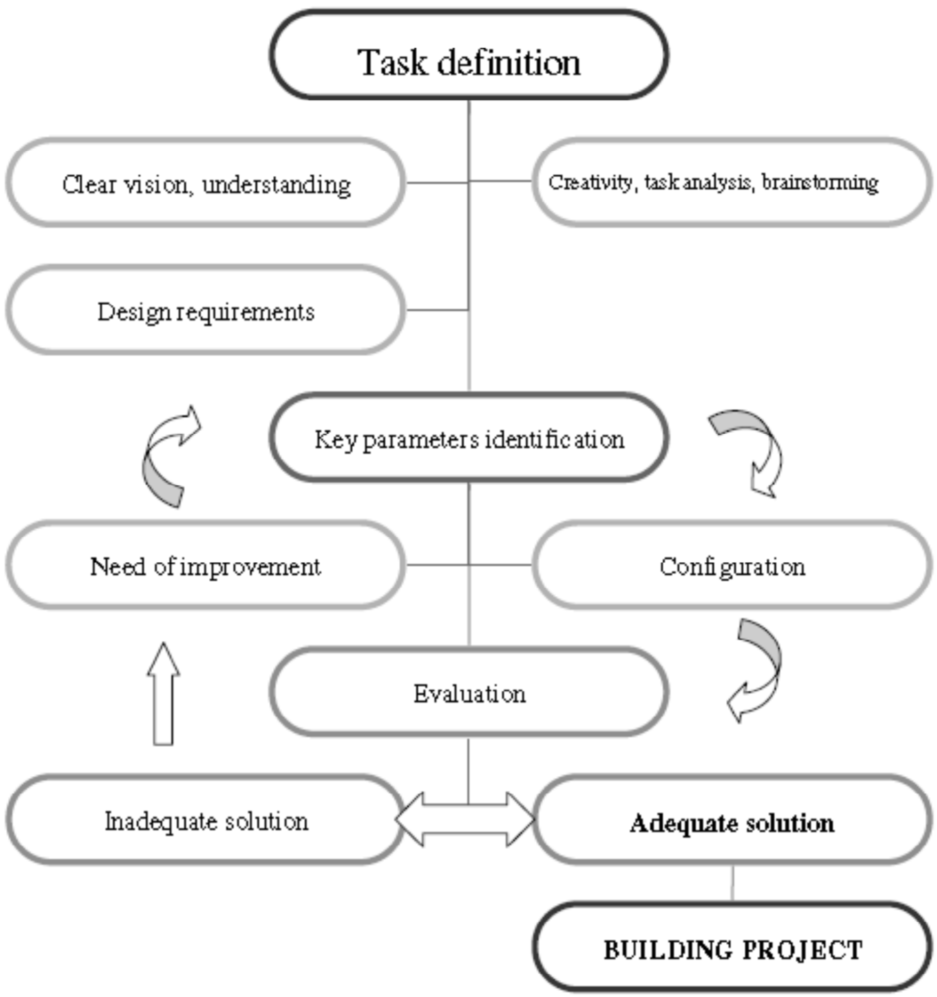

Figure 3: Five-Step methodology, adopted from Engstrom and Lierud (2006)

Below in Table 2 some examples of parameters for a site investigation are presented which could be considered in the evaluation of alternative concepts:

In building projects key identification parameters can differ, but each of them is related to critical events and risks which have to be identified and handled in further stages of the project.

In conceptual design many aspects have a great impact on the successful run of this phase not only in time but also in efficiency. This part of a building project is also a process where different problems should be solved, and good decision making should take place. The experience, risk awareness, good management, communication between participants, environment of work and adequate knowledge build up the system of efficient thinking. It is important not to be stuck in old solutions, but try to search for new ideas and possibilities, which can turn out be better than the ones from the previous projects and have influence on continuous improvement of the design process, which is important in form and development of quality of the company. These issues allow reduction the risk in the conceptual design phase, or improve the ability to identify critical events at the beginning of building project.

It can be said that the conceptual design phase, its purpose and role, is a gate to the project development, and most important decisions, and risk identifications are done in this phase. This is why risk analysis in the conceptual design stage is going to be further developed in this paper to show the great importance and influence of risk management on other steps of building projects.

Table 2
Example of key parameters on the construction site in alternative selection process Illingworth (2001)

Access	*Boundary Conditions*	*Noise*	*Surface and Ground conditions*
Media (Electricity, Water supply, Road…etc.)	Adjacent height of buildings and trees.	Nearby Hospitals, Schools, Offices.	Weather conditions
Ground level obstructions	Adjacent public areas (schools, playground…. etc)	Restrictions on night work or weekends	Examination of bore holes.
Underground obstructions	Safety of the public		Lie of the land and flow of watercourses
Buildings and trees	Adjacent mains and sewers		
Watercourses	Adjacent watercourses		

PRELIMINARY DESIGN

After the conceptual design phase, where one concept is chosen, this is further analyzed, taking into consideration technical requirements. More details are considered, a project brief is developed, and preliminary cost estimation is prepared in order to assess the economy of the project and of the chosen solution. The concept is not a ready project in this phase; still detailed studies are going to be done to identify potential risks, plan for a proper organization and prepare a sufficient space for changes.

DETAILED DESIGN

The detailed design is the next task to solve after the final concept has been chosen and the preliminary design has determined the initial cost and 'constructability' of the project. The designers use information from the final concept evaluation in order to prepare final drawings, select materials, determine component sizes, determine methods of construction, in order to make the project cleared and ready to implement and construct. The technical specification and requirements together with drawings are the set of documents for potential contractor who would be selected in the contractor selection phase.

CONSTRUCTION PHASE

The selection of a contractor is the initial part of this phase. Depending on the form of the project roles and responsibilities of the contractor are prescribed.

After the contractor has been selected, the necessary agreements, licenses and insurances must be secured. The critical events and risks in this point depend on the type of construction. If this is a highway or a road for example, then the accessibility of private properties where the road is planned should be checked in the conceptual design stage, and if the owner will not agree to project development on his/her ground, then other solutions should be proposed.

The construction phase should be carefully planned and placed in time and duration of the project. Each delay is connected with money, hence if any delay in project then the contractor has to pay to the client as a penalty as per contractual terms and conditions.

CLOSURE OF THE PROJECT

The closure is the final phase of a building project. According to Bennet (2003) inspections and maintenance should be scheduled before the object is taken into operation. During this phase a pre-final inspection of the building is made by the designer, the client and the contractor. Depending on the project it takes one or few days in order to check or test the individual components or parts of the structure. If some defects are found or need of improvements is identified the contractor has time to make corrections until the final inspection takes place.

In this phase, the final payment to the contractor and cost control completion take place and the certificates of the guarantee are given to the client. It is valuable that the contractor makes feedback visits to the building/structure after some time from the closure of the project, to hear the opinion from the owner about the usage of the owned structure. Such kind of activity gives the possibility to keep the contact between the project participants and may result in further cooperation concerning new projects in the future.

SERVICE LIFE

The service life period is the time when the constructed structure is operated and should be durable and maintained after the building project has been closed and the structure delivered to the client. Service life design prepared in a good way ensures that the durability and intended functions as load-bearing capacity of the structure will last the period as it was assumed in the design phase. The service life design might have a large influence on the economy of the building after the project's completion. Sometimes it is a matter of discussion between the client and the designer whether to use more expensive solutions in the project to ensure a better quality during the service life. The client considers the risk in making such decisions, taking into account the costs of the project and the service life cost in the future.

V. PARTICIPANTS

Depending on the form of building projects, see Section 6, the number of participants can differ, and might have different responsibilities

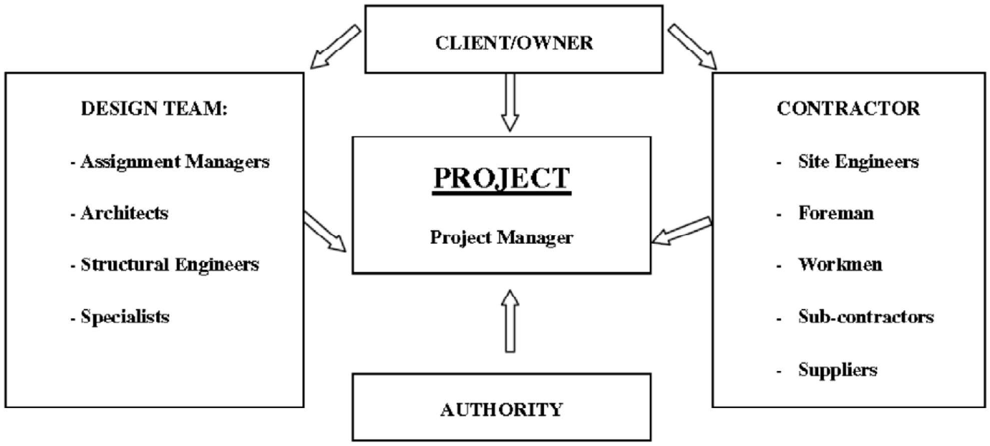

Figure 4: Examples of project participants

THE PROJECT MANAGER is a person who coordinates the work on a new building project from the initial phase to the end. The project manager motivates discussions with the client about the objectives of the project, needs and requirements. He/she also gives advice to the client about important technical solutions, costs, schedules, safety, construction process etc.

THE CLIENT is the person / company who owns the property and orders the project for realization. It is very important to discuss in detail the needs with the client at the pre-project phase, to learn what the owner expects from the new construction. The client should participate during the whole process of design and construction to be informed about the work progress and economy and to inform about the needs and priorities of the project.

THE DESIGN TEAM is a board consisting of a group of consultants such as assignment managers, architects, structural engineers and specialists. The design group takes responsibility for development of ideas of the owner to the completed set of drawings and calculations, which then are going to be introduced into the implementation phase of the project. The design team may be divided into smaller teams working in the same business area in the company. The designers shall be involved during construction in quality control inspections, and as advisers in case of some problems with the construction realization according to the project prepared by the consultant company.

THE GENERAL CONTRACTOR is a company which in the selection process / tender process is chosen to execute the construction of a building project. The general contractor is responsible for entire work on site and cooperation with sub-contractors (a company which is responsible for a specialized part of the construction work (foundation, ventilation, electricity etc.) and suppliers of materials and equipment. The general contractor cooperates with the project manager and the design team to ensure proper development of the building project and in case of some problems or doubts, the questions is explained on common meetings.

The relation between Participants of building projects is widely described in the literature on the construction management process [Boyd (2006), Bennett (2003)]. The reason is that the good communication between the client, PM/CM, designers and contractors participation in the process would play a key role to understand the project's objectives. The open dialog has influence on work fluency and potential better identification of critical events and risk reduction, because in this point sharing of experience and knowledge between participants are essential.

VI. FORMS OF BUILDING PROJECTS

Depending on the form of a building project, the relation between participants and their roles and responsibilities can differ. The three most popular forms of contracts are described below.

THE DESIGN-TENDER (BID)-BUILD Contract is known as the traditional form, where design and construction parts are provided separately. The responsibility for each part of the project is also divided between designers and a contractor. Another characteristic is that the construction part will not start until the tender process is successfully finished, which sometimes makes the whole project duration time consuming.

Some advantages with this kind of contract have been described by Gould and Joyce (2002) and are presented below:

- Contractual rules are known and understood by owners, designers and contractors
- Approved by many professionals, reduces level of risk and uncertainty-well defined relationship
- The allocation of risk for the construction performance depends completely on contractor and the sub-contractors, which is an advantage for the client.
- The cost is known from the beginning of construction, and the risk of cost overrun is borne by the contractor

This type of contract has also disadvantages:

- The contractor is not a participant of design process, so it is not possible to share information with designers and assess constructability of the structure.
- Design of structures that could be built in a more economical way or more effectively often results in higher costs by using more expensive technology or materials.

- The risk of higher costs depends on the accuracy and completeness of contract documents. If they are unclear or badly prepared, it raises the unexpected costs drastically.
- It is difficult to reduce the time required for design and construction because realization of both fields in parallel is impossible.

THE DESIGN-BUIL form of contract is also known as Design-Construct. Once the Design andsupervision consultant has chosen by the owner, and takes responsibility to provide the concept design, guide line and contract documents to construct the project, then the client appointed consultant wouldchose the general contractor to take the design and build responsibilities, thus the general contractor should chose the design consultant to perform the detailed architectural, structural, infrastructural and electro-mechanical design and drawings based on the project concept design and contract guide linesconsequently the owner's appointed consultant would approve the detailed design and contract documents prior to the construction activities on site, in addition to the above responsibilities the owner's appointedconsultant would take the site supervision and project control responsibilities to le the project team to complete the project the client intended. Design and construction on this form contract would overlapVery often due to tight project schedule, so the design phase has not to be finished before the implementation stage starts. Lawrence Bennett (2003) noticed that in this type of contract there is seldom

A lack of integration between these parties compared to the traditional design-tender-buildmethod.

Some advantages of design-build form of the building project in comparison with the design-tender-build contract can be noticed:

- First of all a singular responsibility takes place, so the contractor takes care of the schedule, design, structure, methods, technology ….etc.
- Time saving due to overlapping of design and construction phases and elimination of time for a second tender process
- The organization of a design/build team which is responsible for the whole project, can manage more of the risks than the owner in design-tender-build. The factors like costs, schedule and quality are clearly defined
- Potential risks and problems can be identified and solved quicker in the same environment, due to the ability to use available experienced engineers, and better communication between the participants .

Some disadvantages in organization and system of work can also occur in design-build contract forms:

- The owner has less control over both project parts than in the traditional contract form, because both of them act simultaneously and participating in design and construction at the same time is difficult.

- From the economical point of view the real price for a contract cannot be estimated by the client at the beginning. For this purpose a preliminary budget is used without the guarantee that the price will not be higher.
- If the price is fixed by the owner, then there is a risk of sacrificing quality to fit in thedesired price.
- Also the division of work and price could be more difficult for the contractor.
- A poor identification of the owner's needs and requirements and also a project brief understood in the wrong way by the project team, can cause main problems during the project realization.

PARTNERING is one of the newest forms of contract. Both the design and construction teams are involved in the project from the beginning, because the tender process for contractor is done at the beginning of the project before the detail design phase. The cooperation between the project participants is essential and a continuous dialog is held during the whole project process. Overall, separate companies or individual form a project team that works together to deliver a project of good quality. This type of contract allows each member of the project team from a subcontractor to the client, to read and understand the project easily. Additional advantages are ability to exchange the experience between the members, and possibility to make decisions together. This way of working helps to clarify the objectives of the project and avoid misunderstandings and conflicts, which can have great influence on risk potential as it is mentioned in section 4.

VI. PROJECT COST CONTROL

The planning and control of capital costs is a key requirement of good governance and should be a priority for all capital works projects, the primary aim of implementing cost planning and cost control procedures in the management of capital projects is to ensure that the cost certainty and value for money are achieved, by adopting best practice procedures in the management of capital expenditure through the use of cost planning and cost control, the Project Coordinator can minimize the financial risks involved in undertaking capital works projects.

COST PLANNING or capital costs as it is more commonly known can be defined as a system of integrating cost-based intelligence into the design process to maximize its value, cost planning should be based on a series of cost holding categories appropriate for a particular project design. Each cost holding category should be allocated a value (a target cost) that represents a reasonable proportion of the budget and also represents value for money. The aggregate value of the target costs should not exceed the overall approved budget for the project. Once an Outline Cost Plan is established, the cost holding categories should be continually assessed to ensure that the integrity of the project budget continues to hold true.

COST CONTROL can be defined as the management of the costs associated with the design process (in each cost holding category) to achieve a predefined approved capital budget. Continuous assessment of the cost holding categories during the Planning Developed stage (including preparation of tender documentation) will test the robustness of the costs in these categories that make up the approved budget. Cost control is dependent on two key factors: information and action. In order to have successful cost control, it is essential to have the necessary information and to take appropriate action based on that information. If the relevant information is not available or if the required action is inefficiently executed, then the risk to cost control on a project is raised considerably.

CAPITAL WORKS MANAGEMENT FRAMEWORK (CWMF) is a structure that has been developed to deliver the objectives in relation to construction procurement reform. It consists of a suite of best practice guidance, standard contracts and generic template documents that form four pillars that support the Framework; the pillars are:

1. A suite of standard forms of construction contracts and associated model forms, dispute resolution rules, model invitations to tender, forms of tender and schedules;
2. The standard conditions of engagement for consultants, dispute resolution rules, model invitations to tender, forms of tender and schedules;
3. Standard templates to record cost planning and control information; and for suitability assessment;
4. Extensive guidance notes covering the various activities in a project delivery process.

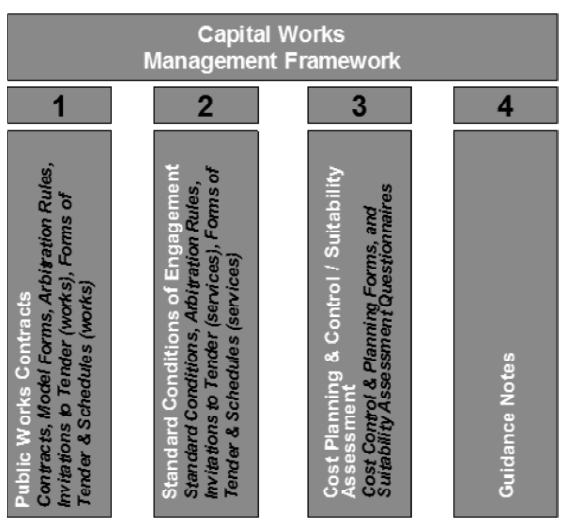

Figure 5: Capital Works Management Frame.

VII. BUILDING INFORMATION MODELING (BIM)

Construction is full of risk and the need to make assumptions. It's hard to be right all the time – especially during a design phase when information on the existing may be limited. Design Managers must rely on previous experience and knowledge, as well as the right technology – like Building Information Modeling **(BIM)** – to manage the risk and overcome any potentially flawed assumptions. BIM is a sophisticated and dynamic tool that can uncover conflicts in a project's design to flag constructability issues before they become too costly and time consuming to fix. What is BIM? BIM is a layered, 3-dimensional, electronic model by the software like Revit ,TEKLA that represents exactly how the real building will be built in the field, – with Structural, Architectural, Plumbing, Electrical, and **HVAC** components laid out in precise detail. One of the major benefits of creating the building electronically first is clash detection. Each subcontractor creates a single electronic model for his particular layout. Then, the individual models are "federated," or laid on top of each other, to create a consolidated model of the building. When that is done, the coordinator can run a clash detection to see if there are any problem areas. For example, if the plumbing subcontractor has laid out piping in the same space as the electrician's wiring, the clash detection will catch that interference and allow for a fix to the plans before the clash becomes a problem in the field. The ultimate goal of BIM is to create a model that's so accurate and reliable, there are no field RFIs during the project because the model eliminated all of the issues beforehand.

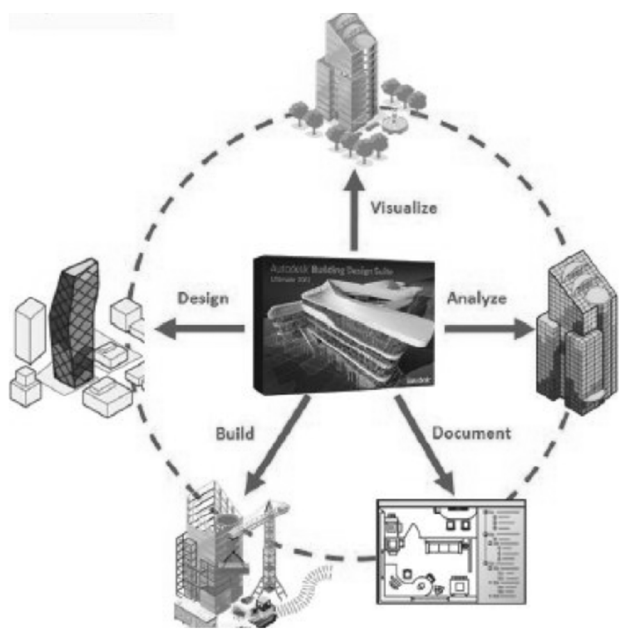

Figure 6: Illiustration of the Building Information Modeling.

VIII. VALUE ENGINEERING (VE)

Virtually all projects have opportunities for improved value, and the **VE** process has the objective of identifying those opportunities. Value is proportional to the ratio of function over cost, where a project's function is defined as what it is expected to do.

Figure 7: Illustrations of Value Engineering Objectives

Value = Function/Cost

Value is achieved by improving function and *maintaining* cost; by *maintaining* function while reducing cost; or by improving function while reducing cost. VE can be defined as an analysis of a project's functions directed at improving performance, reliability, quality, safety, and life-cycle cost.

VE studies identify project issues and provide opportunities to optimize the design in progress while validating project scope, budget, and costs. Activities undertaken during VE studies include:

- Understanding project criteria.
- Identifying appropriate project scope.
- Validating project initial cost, budget and time.
- Ascertaining best value alternatives.
- Evaluating life cycle costs.
- Identifying and evaluating risk.
- Assessing the schedule.
- Reviewing constructability.
- Evaluating contract/procurement options.
- Minimizing change orders during construction.

IX. CONCLUSIONS

- A building project is having complex process, where each phase should be carefully planned and discussed to meet the project objectives. In first place a good understanding of the project objectives, good relations and vital communication between the involvedparticipantsand effective coordination between the trades would be maintained on each phase to complete the project on scheduled time and within the budget.

- Deciding early to use **B**uilding **I**nformation **M**odeling **(BIM)** for the construction projects from the early design, will serve to help create a smoother and more successful project at all the phases ,because the more you know before you mobilize for construction, the better the outcome will be, eventually risk could be identified ,managed in an early stage.
- The earlier a **V**alue **E**ngineering (**VE)** study is performed, the greater the potential benefits could be obtained in the project as well risk in the project also minimized. It has positive impact on a project when studies are performed during design for a standard design-bid-build scenario, and even more so for a design-build delivery as the design-builder becomes integral to the process.
- The client should avoid a *"Tight Project Schedule time",* which could bring the consequences risks to the project such as Bid price escalation, poor quality control, dispute between involved parties…..etc. Hence the client could fix the project schedule time as recommended by the Value Engineering consultant, further the client really wants to finish the project early than the project scheduled time then he would announce the bonus systems to the involved parties to complete the project as he wants with quality as intended in the design.
- Project management, Project planning, project Control and cost loading software would be used from very beginning of the project to monitor, handle and control the risks on time to meet the project goal on time and within the budget.
- Identification and handling of potential risks in the building project could be real issues, which should be monitored, recorded, handled, controlled and transferred carefully during the project life cycle, however ,the decisive point to analyze and minimize the impact of risk could be a core issue in the construction projects, this could be handled to meet the project objectives only by assigning the well experienced professionals in the projects, who have been practicing and having solid experience in the construction from the conceptual design to the closeout of the project.

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