Facilitate Risk Management in Construction Process by Using Hierarchical Risk Breakdown Structure

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Abstract- Risk management is an important part of the decision-making process in construction project management, particularly regarding the project's integration, scope, time, cost, quality, human resources, communications and procurement. Risk management improves the future prospects of a project as it identifies uncertainties and probabilities. However, A lot of analysts and experts have been struggling to define risks by using many analysis and methods where have been applied to define these uncertainties and risks. But eventually, these methods have showed up a weak and sometimes a fatal data missing which may lead to affect directly on the risk management and success of project. In this research paper highlights on one of the most useful and practical method Hierarchal Risk Breakdown Structure which may facilitate to identify and quantify all risks to which the project is exposed so that a conscious decision can be taken on how to manage the risk.

Index Terms- Risk Management, Risk and Uncertainty, Hierarchical Risk Breakdown Structure

I. INTRODUCTION

Risk management is a form of decision making within project management and it is an important part of the project management plan; it describes the types, sources and impacts of potential risks in the project. Furthermore, the objective of Risk Management process is to indentify risks, predict, assess their probability and impact, in addition to which, tools and techniques will be used in risk identification, classification and assessment.

II. LITERATURE REVIEW

Risk is defined as a threat that has an impact on the success of a project [3]. On the other hand, uncertainty is defined as the chance occurrence of an event where the probability is unknown [15]. Put simply, uncertainty describes a situation being considered by decision makers that has no previous data with which to identify the probability of its occurrence [6].

Risk and uncertainty change the actual outcome of an activity from the planned outcome if it is negative. Both have two directions, either a positive or negative deviation on the time frame or the budget of the construction project. Risk and uncertainty are attached to every construction activity and to the construction parties, such as clients, consultants, contractors, sub-contractors and suppliers [15].

Some researchers prefer to differentiate between risk and uncertainty, while others believe that the words are synonymous [6]. All projects are subject to risk and uncertainty, and they could have a positive or negative impact on a project's success. Risk factors could be initiated internally or externally during a project's lifecycle, and to succeed and meet the project's objectives and aims it is necessary to identify potential risks and have a plan to manage them [14].

III. RISK MANAGEMENT PROCESS

The vast majority of construction projects expense and/or schedule overwhelming. An investigation of breaking down cost was completed on open works project in the entire world. The study brought about event and the seriousness of cost overwhelms was fundamentally significant [2].

The idea of risk management is totally distinctive to that of risk evaluation, though some can utilize the expression risk management to portray a danger evaluation method [8,9]. According to Westland [23], risk management is identified as "identify, quantify and manage the risk in the project by following organized process".

In the arranging and construction phase, different danger sorts can begin to be recognized, analysed and surveyed by utilizing the likelihood hypothesis or the relative significance file hypothesis with a specific end goal to assess the risks and manage their impact on the project of construction [13].

This exploration will receive the more broad and expansive meanings of risk management as exhibited by Larson and Gray [10] and Westland [23] where management risk is the procedure by which risk toward the project are basically defined, measured (quantify) and controlled (responses).

1) Risk Identification

Zou et al [25] state that the risk identification, indeed, is the initial phase in the risk evaluation process, which the possibility of risk factors (RF) connected with construction projects are defined and ordered. According to William [24], the system for defining, controlling and designating risks ought to be shaped in the earlier phases of the lifecycle of construction project. It is helpful to estimate the potential inside and outer risks to the client, contractors, and project group, from the perspective of diverse contractors, reckoning sources for cases or debates. On the phase of risk identification it is imperative to distinguish the risk impact and its source [20].

It is useful to seek an answer to the three essential questions in the risk identification phase which are; what could go wrong? How likely is it? (Probability), and how it will affect the project? (Impact). Project manager and the team could use the experience and lessons learnt from the past, use a simulation model to present possible risks in addition to brainstorming in order to recognize the potential risk factors.

2) Risk Classification

According to Flanagan [6] and Chapman [4]that the manageable risks are associated with risk classification by the control and impact of the leaders and experts. Non controllable risks are associated with the leaders have no control or impact along of them, additionally; they more often than not originate from outer sources. Besides that, one of the viable apparatuses is the work breakdown structure (WBS) for identifying potential risk which lessens the shot of missing risk factors [2,7], where the work breakdown structure (WBS) alludes to recognizing exercises required to convey the outline expected to build the project, furthermore, the assets will be expected to do the job [14] as shown in figure 01.

The main classification of risk in the project of construction is partitioned into two big portion internal risk and external. Different groupings are more itemized and comprise of more particular classifications, for example, financial, market, political, social and safety of risk [5, 16].

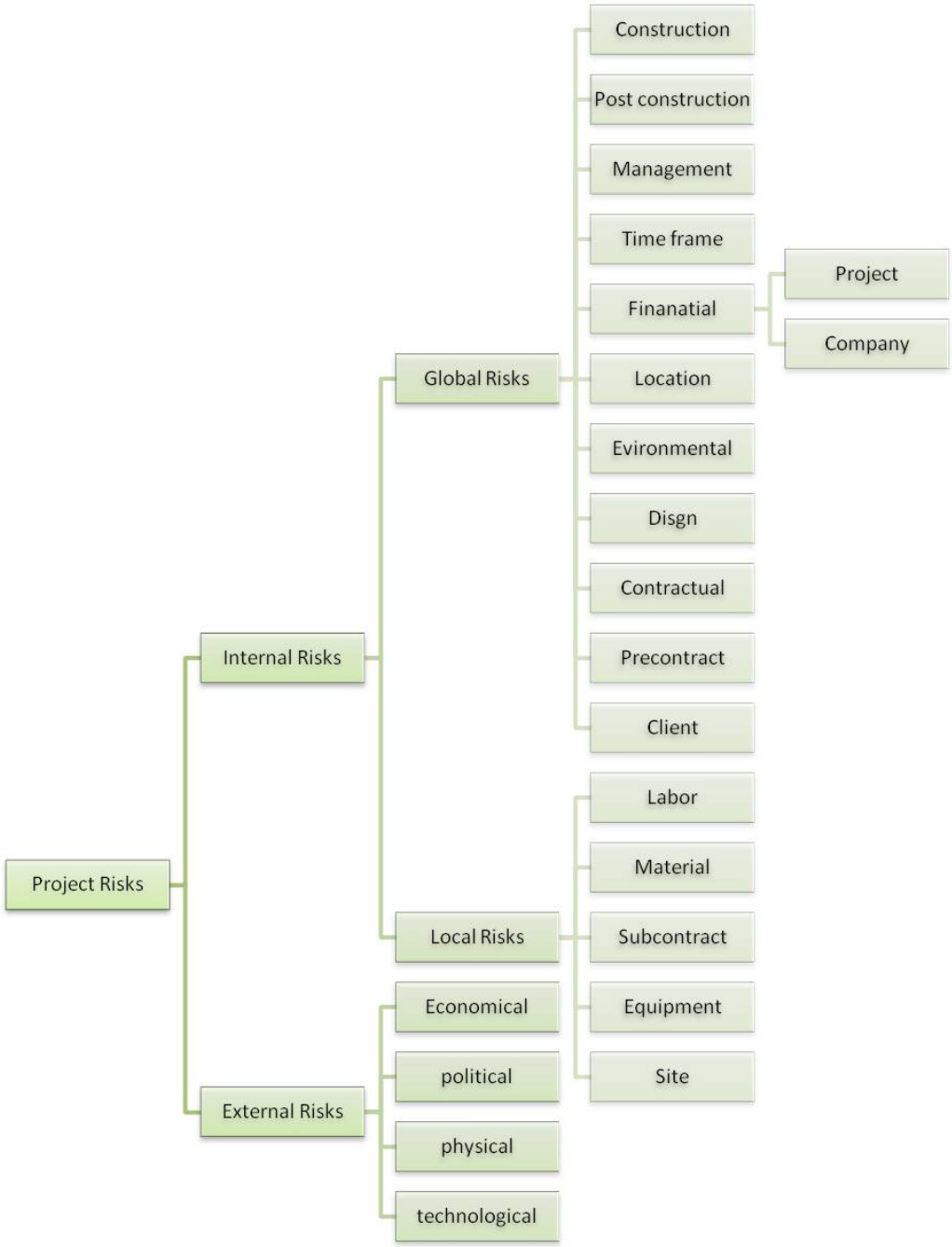

Figure 01: Hierarchical Risk Breakdown Structure (HRBS)
Source: Tah *et al,* [17]

3) Risk Analysis

Oztas and Okmen [12] state that the risk analysis is the middle procedure between risk identification and risk reaction. As well as risk analysis strategies are classified into two methods quantitative and qualitative [11]. The degrees of risks are analyzed utilizing either quantitative or qualitative method or both of them to assess their potential effects [25].

4) Risk Response

This phase of the procedure includes the plan of management reactions to the primary risks/opportunities. Risk management may begin start amid the review, examination and analysis stage as the need to react to risks can be earnest and the solution genuinely self-evident. Emphasis between the risk review and risk response stages is additionally likely [1]. Project risk/opportunity management identified and evaluates the organized risks that essentially influence the completion of the project. Methods are then defined and applied to address the risks, and particularly to influence those risks which introduce opportunities and successfully decrease the potential effect of drawback risks [18, 22]. When risks have been evaluated and organized it is conceivable to build up the risk mitigation measures expected to manage them. Basic activities are:

(1) Eliminate, (2) Reduce, (3) Transfer, or (4) Accept; every risk can have one or a greater of the choices accessible. Consideration ought to be taken in the assessment with a specific end goal to enhance the measures so as to give the best value to the moves to be made. The in general objective of this phase is to guarantee that:

• Clients get their item/benefit inside of their details (quality, cost, and time).

• Contractors deliver the project without spending and time overwhelms while making a great benefit and keeping the clients fulfilled.

• All other stakeholders' worries are looked into or manage inside appropriate lines of correspondence.

5) Risk Monitoring and Control

After risk lessening exercises have been actualized, the stakeholders and different partners will audit what risk management exercises have been actualized and how viable they have been. Assessment is basic to responsibility and in addition in guaranteeing the judicious utilization of rare assets. The instruments utilized for assessment should be as adaptable and differing as the risk lessening activities themselves. Associations may change the essential steps also, supporting projects most suited to accomplishing basic comprehension and actualizing reliable, proficient, and powerful risk management. Regardless, the accompanying steps are basically taken [18, 22]. Every stride is clarified later:

- Manage the concurred risk moderation and mitigation
- Assess the adequacy of the procedure and its application
- Revise the risk management plan periodically

6) Manage the Agreed Risk Mitigation

In this phase the mangers and senior administrators ought to ensure that the mitigation arrangement for each critical danger is connected and managed legitimately. Toward the end of this stage the danger register rundown ought to be upgraded and any new risks or residual dangers ought to be changed. The proprietor of every danger ought to be dependable to the task manager to monitor his or her hazard, and to either make fitting move to keep it from proceeding with or to take recovery activity if the issue occurs[18, 22].

IV. PROJECT OVERVIEW

The project selected to be reviewed as a case verification for application of fuzzy logic inrisk management of project is Construction of 39 units double story shop office consist of 4 units three story shop office (KP3), 18 units two story shop office (kp3) and 4 units three story shop office (kp2) which it started on 15/6/2015 and it is planned to be done on 14/12/2016. Its location is on zone 1, Puncak Bestari,Mukim Ijok,Daerah Kuala Selangor .

1. *Risk Identification*

To support establishing the Collecting data to identify all risk factors, several semi structure interviews were then conducted with experts. The risk factors register went through several revisions to enhance the capabilities of the data.

Based on risk identification process, it has been elicited 95 risk factors in the project distributed on 13 categories (Environmental & Location, Design, Contractual, Financial, Legal, Construction, management, Material, Labor & Equipment, Subcontractor, Client, and exterior); and all risk factors was divided based on the expert views.

2. *Risk Classification*

Risk classification is an important step preceding the risk assessment process after identified all risk factors, as it helps to structure the various risks that may affect a project. There are a number of different methods for classification suggested in the literature. In current research based on RBS (risk breakdown structure), all risk factors have been classified considering to their origin and the location of their impact on the project. Moreover, the following categories can be used as a basis considering all the types of risks included. This chart can serve the group and management team as a checklist to make sure that all areas are considered, and should be updated from time to time. More illustration has been clarified in figure 02

- Internal Risks
    a. Local
    b. Global
- External Risks
    a) Legal
    b) Political
    c) Exterior

The next tables explain the risk factors which has been deduced from the project and classified by categories

Table 01: the extracted risk factors from the project

Category	ID		Risk factors
Environmental and location	R1	E1	Nature factors (floods, earthquakes… and so on)
	R2	E2	Difficulty and trouble to access the site (settlements)
	R3	E3	Adverse weather conditions
	R4	E4	Distance
	R5	E5	Ground Conditions
	R6	E6	Adjacent/Existing Structures
Design	R7	D1	Design-team experience.
	R8	D2	Complexity of project design.
	R9	D3	Confusing requirements.
	R10	D4	Design Modifications.
	R11	D5	Data collection and survey before design.
	R12	D6	Complete documents and drawings of projects.
	R13	D7	Producing design modification documents.
	R14	D8	Clarity of details in drawings.
	R15	D9	Excessive change order.
Contractual	R16	C1	Not available workers, materials and equipment
	R17	C2	Unclear scope of working (extent)
	R18	C3	Exrtemely competition in tenders
	R19	C4	Inaccurate the different dimension of project program
	R20	C5	Poor communications between the consultant team and field workplaces (contractor side).
Financial	R21	F1	Financial difficulties payment of completed work
	R22	F2	Delay in progress payments
	R23	F3	Difficulties in financing project by contractor/clients.
	R24	F4	Timing of availability funds does not match cash flow forecast
	R25	F5	Labor cost is higher than predicted
	R26	F6	Incomplete cost plan.
	R27	F7	Inflation.
	R28	F8	Delay payments of completed work.
	R29	F9	Slow payment by owners due to dispute.
	R30	F10	Financial problems due to errors in estimating.
	R31	F11	Loss due to default of contractor, sub-contractor, supplier or owner.
	R32	F12	Material cost is higher than predicted.
Legal	R33	L1	Difficulty to get licenses.
	R34	L2	Vagueness about work legislations.
	R35	L3	Legal disputes with the involved parties during the construction process
	R36	L4	postpone solving the legal disputes
	R37	L5	No specific arbitrators to settle quickly.
Construction	R38	CS1	Rush bidding.
	R39	CS2	The constraints between the Implementation and the particulars because of misconception of drawings and details
	R40	CS3	Complexity
	R41	CS4	No-registered change requests.
	R42	CS5	The time limitations with lower labors quality.
	R43	CS6	Genuine amounts differ from the agreement amounts
Political	R44	P1	New governmental acts or legislations ‘exp GST “.
	R45	P2	Unstable security circumstances.
	R46	P3	Closure.
	R47	P4	Change of Government.
Management	R48	M1	Poor communication and coordination between parties (Clients, Consultants, and Contractors).
	R49	M2	Information unavailability (include uncertainty).
	R50	M3	Unclear responsibility.
	R51	M4	Availability of capable representatives.
	R52	M5	Postponement of work (Held Orders).
	R53	M6	Issuance of instruction.

Subcontractor Client Equipment and Material Labour	R54	M7	Availability of project management team members (experience).
	R55	M8	Information dissemination.
	R56	M9	Site mobilization and delay in site handover.
	R57	M10	Contractors' experiences.
	R58	M11	Availability of competent subcontractors / suppliers.
	R59	M12	Rework due to errors during construction.
	R60	M13	Availability of Disputes and Claims- comprehensive dispute resolution.
	R61	M14	Conflicts in sub-contractors schedule in execution of project.
	R62	M15	Delays in sub-contractor's work.
	R63	M16	Unsatisfactory work of contractor.
	R64	M17	Delay in approving major changes in the scope of the work.
	R65	M18	Long waiting for approval of tests and inspection.
	R66	M19	Quality assurance/control.
	R67	M20	Excessive use of contractors / subcontractors.
	R68	M21	Unreasonable risk allocation.
	R69	M22	Frequent change of sub-contractors because of their inefficient work.
	R70	M23	Revising/approving design documents, shop drawings and sample materials.
	R71	MT1	Quality of Materials (Below standards).
	R72	MT2	Availability of construction materials in market.
	R73	MT3	Change in material types and specifications during construction.
	R74	MT4	Material delivery.
	R75	MT5	Manufacturing special building materials.
	R76	MT6	Materials Supplier's Problem.
	R77	MT7	Material wastes handling.
	R78	MT8	Compliance of material to specifications.
	R79	LE1	Labor performance/productivity.
	R80	LE2	Equipment availability.
	R81	LE3	Productivity and efficiency of equipment.
	R82	LE4	Labors and management relations.
	R83	LE5	Scarcity of skills.
	R84	LE6	Labor strikes and disputes.
	R85	CL1	Selection criteria as communication.
	R86	CL2	Experience.
	R87	CL3	Financial stability.
	R88	SC1	Type of Contract.
	R89	SC2	Contract Content.
	R90	SC3	Risk Allocation.
Exterior	R91	EX1	Site's topography is changed after design.
	R92	EX2	Civil disturbances.
	R93	EX3	Problems with neighbours.
	R94	EX4	Government permits.
	R95	EX5	Changes in regulations.

Figure 02: Hierarchal Risk Breakdown Structure for the Project

After successfully classified all 95 risks of project on their categories, we can easily quantify and prioritize all risks of the project following the rest of risk management process by using quantitative or qualitative analysis method. Moreover, project managers and experts can finalize and deduce perfectly the decision making about all risks in the project and in similar projects. The identification and classification the risk by using HRBS, risk analysis is barely sure accomplished. The dangers are put in appropriate point of view within the hierarchical risk breakdown structure by sorting the dangers in the different levels and categories. The analysis of risk includes the utilization of systems for evaluation of risks, defining the likelihood of the danger, and figuring the effect of the danger. At no time ought to the manager of project or risk supervisor choose that the aggregate number of classified risks have the reason of delay or abortion of the project.

V. CONCLUSION

The effective risk management in construction can bring a lot of profits and enhance the success of the project through follow the different steps of risk management in any project starting from risk identification, risk classification and going through risk analysis and risk control until reach risk agree and mitigation as the last step of risk management. In this paper explained the priceless value of hierarchical risk breakdown structure as a major and core step in risk classification practically as well as in risk management generally, and how can risk analysis affect and ease the next process of risk management. The Hierarchal Risk Breakdown Structure method have been proved its ability to identify, classify and easily quantify all risks in project which may affect positively on risk management, project process and success.

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