Heuristic Approach for Risk Assessment Modeling: EPCCM Application; Engineer Procure Construct Contract Management

Ayda Nayer A. Rawash¹, Khaled El Hagla² and Ali Bakr³

Various risk factors influence construction projects cost and schedule performance from project conception to completion. In the context of project management, contract assessment helps allocate integrated risks. The aim of this thesis is to investigate standard conditions of contract, namely FIDIC, Turnkey EPC, (Engineer, Procure, Construct) Conditions of Contract as a standard contract format. Implications of the contract clauses for the risk management strategy to be adopted by Contractors are analyzed through predefined risk assessment plan RMP. Relevant conditions will be scrutinized in terms of induced risk events. The basis for defining major risk categories and events are described through RBS (Risk Breakdown Structure) schemes, as well as, proposed actions and mitigation plans.

Finally, EPCCM; modeling system is created to assist contract administrators, to diminish time, effort, wading back and forth between construction cases and developed projects. The result is a more efficient and proactive contract management environment by providing database for lessons learned in addition to tracking ongoing projects contractual risks, and consequently for issuing relevant decisions and activity plans.

Field of Research: Construction Projects, Contract Management, Risk Modeling Application

1. Introduction:

Currently, In Project Management research topics, Risk is considered to be the cumulative effect of the chances of uncertain occurrences adversely affecting project objectives, identifying the degree of exposure to negative events, and their probable consequences impacting on project objectives, as expressed in terms of scope, quality, time and cost.

In practice, project participants tend to be indifferent to risks outside of their control or believe that measures such as forms of contracts and insurance adequately allocate risks between the various parties. Consequently, risk management is a set of techniques for controlling the uncertainty in a project. Depending on the type of disruption occurring to contractual terms in EPC Contracts, that concerns Both Parties Employer and Contractor (Guy M. et al., 2004).

Furthermore, many owners and contractors are unaware of the full range of these risks, and few have demonstrated the expertise and knowledge to manage them effectively (Walweski, 2005).

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However, in construction contract environment there is a gap between the existing risk management techniques and their application and use by contractors and owners. Complexity of the situation and the extensive resource commitment necessary to perform good risk management as well as that there is no easy-to-use management tool available that can identify and assess the risks specific to construction conditions of contracts.

The research is demonstrating a computerized tool overcoming the risk factors that are inherent to organizations as parties of contracts, such as risks related to the political, cultural, economic, and operational environments of the project’s location. While investigating contract terms the research reports deduces the probability of occurrence of the encountered risk outcomes.

As a result, a descriptive analysis is provided in order to explain and verify the procedures and results of the designed model, EPCCM (Engineer Procure Construct Contract Management) Risk Model to help owners and contractors improve the performance of turnkey construction projects.

2. Literature Review:

2.1. Uncertainty, Opportunity and Risk

In the context of project management, project risk is defined as follows: Project risk is the cumulative effect of the chances of uncertain occurrences adversely affecting project objectives. In other words, it is the degree of exposure to negative events, and their probable consequences impacting on project objectives, as expressed in terms of scope, quality, time and cost. The constant goal of project risk management should be to move uncertainty away from risk and towards opportunity. Consequently, when assessing overall impacts of uncertainty on a project, it is the net project risk which should be determined, i.e., the cumulative net effect of the chances of both adverse and favorable consequences affecting project objectives (Wideman R.M., 1992).

Risks encountered throughout project life cycles and impact severity to parties involved have been demonstrated in previous researches, (Gibson G. et al. 2003; E. Zavadskas, et al., 2010), the risk factor in construction business is very high.

2.2. The EPC Contract Environment

FIDIC Silver Book 1999 edition standard form of condition of contract EPC/Turnkey Projects, for works designed by the Contractor, the framework consists of two-party arrangement, generally with an Employer’s Representative. According to Wang and Chou (2003), to make risk management more efficient and effective, all parties must understand risk responsibilities, risk event conditions, risk preference, and risk management capabilities. It can be concluded that the Owner has a greater tendency to allocate certain risk to the Contractor if the risk is easier to change the probability or effects of its happening.

Furthermore, if the probability of a certain risk event condition is uncontrollable, the Contractor’s tendency of risk handling changes from actively transferring the risk to
passively retaining the risk (figure 1). On the other hand, if a risk is controllable and certainly allocated to the Contractor, the Contractor tends to take the initiative to reduce the impact caused by the risk event rather than retain the risk.

**Figure 1: The Eight Key Business Levers in Contract**

![Diagram showing Content of the Project and Assurance for both sides]

Thus, project participants do not have a shared understanding of the risks that threaten a project. Consequently they are unable to implement effective early warning measures and mitigating strategies to adequately deal with project risks (Tah and Carr, 2001).

The contract should then go on to consider the obligations and rights of every party. In determining the risk allocation and therefore contract strategy, it is important to apply risk analysis and management techniques to ensure that the worst-case scenario has been anticipated and provision has been made to deal with risk events as and when they occur.

Baloi and Price (2003) states that the principal guideline in determining whether a risk should be transferred is whether the receiving party has both the competence to fairly assess the risk and the expertise necessary to control or minimize it.

**2.3. Holistic Definition of Risk Management Evolving Techniques:**

According to the established risk management standards (PMBOK Guide, 2004), (Practice Standards, 2009), any risk management typically includes a series of the following tasks: (1) identification, (2) assessment, (3) treatment planning, (4) treatment, (5) monitoring, and (6) documentation as per the following figure 2.
Risk treatment followed in this work to be consisted of two parts; proactive and reactive treatment, figure 2 shows the two cycles of proactive and reactive risk management. Proactive treatment is the traditional known type within risk management in which only anticipated high probability/impact risks, according to the agreed thresholds, are treated by executing the planned treatment strategies (R. J. Scherer, W. Sharmak, 2008).

Several researches highlighted RM Processes such as (Han et al., 2008; Rutkauskas 2008; Zayed et al. 2008).

2.4. General review of the risk assessment modeling:

Although risk assessment is probably the most difficult component of the Risk Management process, it is potentially the most useful. A critical review of the literature reviews the existing literature on construction risk modeling and assessment has revealed significant results, (Taroun A., et al., 2011).

Architectural and construction risks, as the means of conceptualizing and modeling domain knowledge, architectural and engineering notions are modeled in the form of concept hierarchies, interrelationships between concepts, and rules that specify the definitions of concepts and relations and constraints on their behavior and interpretation.(N. El Gohary et al., 2011). Risk management in construction is a tedious task as the objective functions tend to change during the object life cycle (Dikmen et al. 2008). Tseng et al. (2009) presented a study of ontology based risk management framework of construction projects through project life cycle variance – covariance Isaac and Navon (2009) described models of building projects as a basis for change control. Risk management processes of construction project describe the work of all project life cycle. The risk assessment problem is analyzed by many authors (Shevchenko et al. 2008; Zavadskas et al. 2008a; Zavadskas et al. 2010; Schieg , 2009; Šarka et al. 2008).

3. Methodology:

3.1. EPCCM Risk Assessment a Pro-active Approach:

Different approaches could be adopted to help assess data related to contractual risks. Contract conditions are interpreted by both parties to help enhance project aspects especially quality and time and diminishing pre-expected obstacles to reduce arising difficulties or claims. Choose the terms of contract logically, depending upon the nature of the work, its certainty, its urgency, the motivation of all parties and other factors such as the relationship between conditions implied and manageable events.

The following figure 3, presents EPCCM Implemented Methodology including Risk Information assessment in terms of contract conditions and Contractual Risks confronted To Assist In building Knowledge Based Identification within the framework of Turnkey Projects.

**Figure 3: EPCCM Main Modeling Structure**

Source: Author

3.1.1. Risk as Basis for Initiating FIDIC Contracts:

Main Objective is to implement solutions for pre-identified risks as well as those occurring within the project execution, putting in consideration FIDIC EPC clauses implication upon parties involved in the contract (Employer / Contractor). Risk allocation among events of predefined Risk Break Down Structure EPCCM RBS in alliance with clauses implication including responsible cause and actor for response mitigation plans, potential qualitative measurement are then assigned and update according to the confirmed Risk Management Plan.

3.1.2. Risk allocation by Contract Clauses:

Before the contract is awarded, owners already allocate project risks through contract clauses in projects. Contractors are typically unable to influence the contract conditions and clauses. For this reason, it is indispensable for the Contractors to understand which risks they should undertake (Ergun Usta, 2005).
In figure 4, five major categories are stated to organize the types of risks, to discuss how these risks are managed by the Contractors in each risk category and how risk allocation between Owner and Contractor are handled by contract clauses. However, there are often different interpretations of risk allocation between Owners and Contractors. According to Wang and Chou (2003), disagreements may result from the absence of related contract clauses, unclear stipulations, or queries about the fairness of risk allocation.

3.1.3. Risk Allocation by Risk events Triggered:

Furthermore, the previously mentioned RBS, Table 1, is used in the research as Typical Identified risks a project contract should consider when exposed under FIDIC EPC Contract Conditions as Reference for Project Team as a starting point for risk identification and analysis. For example, a labor shortage would be a risk issue, with a potential effect or consequence of project delay. Since project delay is an effect that can result from one or more risk issues, it does not appear in the risk issue hierarchy. For example, labor shortage is dependent not only on the uniqueness of the project, but on the general economic situation in the region where the project is being built, (Sanjaya De Z., 2003).

3.2. Potential Contract Risk Analytical Description:

3.2.1. EPCCM Risk Break Down Structure

The user selects factors related to a given project from the list. Each of the general factors is further divided into sub-elements which provide the user with added detail. After identifying the uncertainty factors, the expert system goes on to ask questions about risk policy, and so on. EPCCM_RBS in table 1 presents the breakdown structure of an expert system inference net leveled for construction risk management.

3.2.2. EPC Contract Risk Management Plan (EPCCM- RMP)

EPCCM management performance and project success, and normally includes the preparation of a specific project contract - risk management plan. The RMP describes how risk management will be structured and performed on the project Contract clauses. It becomes a subset of the Contract management plan.

Reference is made for inductive risk assessment methods as previously described in item 22.3, to determine the appropriate level of detailed risk analysis to be performed on the project. The RMP comprises four main sections of risk assessment:

1. Risk Identification;
2. Risk Response Strategy;
3. Risk Analysis (Qualitative);
4. Risk Monitoring and Control.
Table 1: EPC Contract Assessment Break down Structure of Identified Risks Output formatted as per EPCCM MODEL Report

<table>
<thead>
<tr>
<th>Risk Breakdown Structure (RBS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Report Description:</strong></td>
</tr>
<tr>
<td>EPCCM</td>
</tr>
<tr>
<td>ECONOMICAL - POLITICAL - CONSTRUCTION - Contractual - MANAGEMENT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Engineer</th>
<th>Economical Risk</th>
<th>Inflation</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Labour</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Energy Shortage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Financial Uncertainty</td>
<td>Owner</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Contractor</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Designer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Currency Fluctuation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROCUR</th>
<th>Political Risk</th>
<th>Environmental</th>
<th>Air</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Noise</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Public Disorder</td>
<td>Demonstration</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>War</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Government Acts &amp; Regs</td>
<td>Tax Rate Changes</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Permits</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONSTRUCT</th>
<th>Construction Risk</th>
<th>Uncertainty In Labor</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Skills</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uncertainty In Equipment</td>
<td>Breakdown</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Availability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Uncertainty In Material</td>
<td>Storage</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Availability</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delay Site Access</td>
<td>Titles</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permits</td>
<td></td>
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<tr>
<td></td>
<td>Quantity Variation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Defective Construction</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contract</th>
<th>Contractual Risk</th>
<th>Failure Of Payment</th>
<th>Owner</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Contractor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delay Disputes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Coordinating Failure</td>
<td>Owner</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Contractor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Change Orders</td>
<td>Delay</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design Changes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Labor Disputes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MANAGEMENT</th>
<th>Management Risk</th>
<th>Productivity</th>
<th>Labour</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Equipment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quality Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safety</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mistakes</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Management Competence</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Variation in Quality</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

Analysis for potential risks a project is exposed to under FIDIC EPC Contract Conditions. Reference for Project Team as a starting point for risk identification and analysis.
EPCCM Application Modeling:

The EPCCM - RMP serves as a Contract Risk measurement tool where the nominated user assigned to each risk reports periodically to the project manager on the effectiveness of the plan, any unanticipated effects, and any mid-course correction that the Project Team must take to mitigate the risk. This helps monitoring and updating status for residual risks relevant to different projects phases.

Modeling enhances quality because it enhances communication. Through modeling, communication becomes efficient and effective. This is so because modeling raises abstraction to a level where only the core essentials matter. The resultant advantage is twofold: easier understanding of the reality that exists and efficient creation of a new reality (Unhelkar, 1999).

3.2.3. EPCCM Standard tools:

Application is created under the environment of Microsoft windows XP, Vista, 7 or higher, by the use of the following tools:

a. Basic Tool consistent on data base management tool created using Microsoft SQL server 2008 or higher in addition to Dot Net frame work version 3.0 or higher.
b. Crystal report runtime 2008, for the purpose of generating editable data reports and updates.
c. In addition to the above types of projects, UML is being used providing integration between application modules

The great value of Data retrieval and updates as well as their complexity justify the effort towards the automation of utilizing logical induction and set theory approaches for the generation of risk mitigation plans per event triggered at any stage of project life cycle.

3.2.4. Analogy For EPCCM Model Guidance

EPCCM System for risk management Application constructed in order to evaluate and assess risks emerging throughout Turnkey projects life cycle. Inductive logical Procedures, as shown in figure 4, the 3 main steps utilized for utilizing logical induction support system in assessing Contractual risk.

3.2.5. Master Data Modules:

Contract risk assessment guides the project team in reviewing the project work plan (and any other project plan elements) to determine the probability and impact of potential adverse events on project.

This Modeling System Provide the user in reference to his integrity (owner / Contractor) a detailed risk assessment for contractual clauses throughout project life cycle regarding considered event impact and equivalent mitigation responses as well as a qualitative overview updated status, figure 5.
Figure 4: Procedural Steps to Produce Status Reports

- **Risk Originator**
  - Raise Risk
    - Risk Break down Structure
  - Risk Category /level
  - Description cause
    - Is Risk Triggered
      - Yes
        - Risk owner actions
          - Impact
            - Yes
              - Risk mitigation per contract
            - No
              - Actor response actions
                - Yes
                  - Modifications
                    - Add
                      - Qualitative / status analysis
                        - Risk Status Review
                      - No
                        - No
                          - Yes
                            - Risk Matrix RQP
  - No

- **Risk Break down Structure**
  - Analysis per contract clauses implication
  - Assignment Risk Response Actions
  - Conditions Contract Review
  - Risk response Analysis
  - Risk Status Update
### Figure 5: Risk Allocation Processes

<table>
<thead>
<tr>
<th>RBS data Level</th>
<th>Risk Identification</th>
<th>Risk Categories</th>
<th>Risk Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPC Contract Clauses</td>
<td>Contract Conditions</td>
<td>Description</td>
<td>Implications</td>
</tr>
<tr>
<td>Risk Owner</td>
<td>Risk Exposure Analysis</td>
<td>Employer / Contractor</td>
<td>Risk Trigger (Cause)</td>
</tr>
<tr>
<td>Impact Actor</td>
<td>Risk Response</td>
<td>Employer / Contractor</td>
<td>Actions to be taken</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mitigation by contract</td>
</tr>
<tr>
<td>Tracing and Update</td>
<td>Risk Events</td>
<td>Admin/User</td>
<td>Status Updates /reports</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quality Assessment</td>
</tr>
</tbody>
</table>
3.2.6. Model Graph Dependencies:

While advances have been made in defining the information that should be contained within a risk register, and in implementing a register as a computer tool, the development of a richer set of attributes that can be modeled in the risk Data adapters, and the incorporation of search and navigation technologies and reporting mechanisms that can make the contents of the register more accessible can also be considered as desirable improvements (Figure 6).

**EPCCM Internal Dependencies:**

As the project progresses the project team would update the register with response measures that were adopted, the risks that were realized during the project and their impact on project performance measures, additional risks that might have been identified and so forth. At the end of the project, the information in the register would serve as a means to augment the organization’s risk issue library knowledge base.

**EPCCM External Dependencies:**

The project risk reports for implemented Contract Risk Plans prove to be the most tangible part of the system, where actual data is extracted from previously analyzed events. Output for the risk assessment function, providing information on risks, their time windows, methods of incorporating risks into the further analysis, and appropriate response measures including details for Crystal Reports Engine integrated within the application modules and allowing for producing updated reports.

3.2.7. Quality of EPCCM Activity Diagrams:

Activity diagrams have their origins in the state chart diagrams, consequently in UML as per the following scheme Data view 2.0 they are considered quite independent of their origins (Fowler, 2003).

As seen in the procedural activity diagram in figure 7, showing the flow of activities, making them ideal to EPCCM Schematic Modeling processes.
Projects Module contains classes to allow for multi projects storing initial data such as title and duration datum for closure date as well as other required data to be stored and reported in report A.

Project Assessment: contains data retrieved per each event triggered to be stored as per ProjectassessmentID class level identified to provide further integration to events captured and required actions to be monitored and updated.

ProjectRisk: Include classes for assigned data per each triggered event such as RiskID related to triggered risk categories and events, data required to allow for assigning action response filtered in event tracing module.

Figure 7: Epccm Schematic Activity Processes Relational Diagram

3.2.8. EPCCM Package Graphical User Interface:

Application tool developed to support Risk Assessment for EPC Contracts, Consists of a multi console graphical User Interface GUI, to support the pre-described model and cover different aspects of the processes involved. GUI is Integrated with data base system and allowing for a back and forth interaction in order to display multi project data presentations.

System Admin is allowed seamlessly to access all master data modules as well as editing parameters and criteria introducing flexibility to model design, and customizing data per each project under study.

3.2.8.1. Main Data modules security access:

The Administrator for EPCCM Package has the authority to either start new project or proceed with update, review and edit previously available projects, Used for EPPCM Users to review available Projects and related reports as per stated in
3.2.8.2. Risk Event Manager Interface:

This interface showed on figure 8, provides the integral view of different modules of EPCCM allowing interaction and swift access for other modules related to Master Data Standard Review in figure 10, Each Module Interface is allowed to be viewed, edited, and printed separately through File Drop down Menu for any new updated fields.

4. Discussion and Case Study:

Through the EPCCM Administrative interface for creating new project "Major Construction Project _ MCP 500"A set of triggered events and respectively action plans to fulfill required actions on timely manner, in order to mitigate impact on project delayed start, as per site conditions and required documentation.

Filtration for Required Risk Categories to be tracked, as per figure 9, is used to clarify any required response to be initiated by the Contractor CM Construction Manager, or considered from CA Contract Administrator, point of view to be fulfilled by Owner, the other active Contract party.
4.1. Demonstration:

Thus, the aim of this research is to examine how risk factors are shared between different parties in EPC conditions contract, investigate how the risk management strategy of Contractor change with respect to different contract conditions.

Finally, throughout the project and during project closure, EPCCM Application risk-related lessons are reviewed in order to contribute to organizational learning and support continuous improvement of Project Contract Risk Management practice. Minimize project site condition risk exposure,

Assure project completion with no delays, Secure Project budget. With respect to entries on the project risk register side, related exposure to contractor risks managed by Construction Manager CM, Considered as User to keep close eye on actual Project risks. Contract Administrator CA, Considered as system administrator in research case; additional Data will be provided by Project team.

4.1.1. First Step - Project Creation:

Save Project Data DATUM For Risk Management Protocol, corresponding to specific project

Figure 9: Creating New Project Related ID, Name and Datum Further Imported To Report A.
4.1.2. Second Step- Risk Events Criteria:

In research case study most influencing risk events have been selected to check and validate system modules where integrity of each caused event will have direct influence on total project completion and quality for execution, further reports and contingency plans of actions could be considered. At start of Project, mainly concerning contractual arrangements, Site access, Advance payments and performance security, Start Adding Risk Events Relevant to Contract Conditions, displayed from

- Master Data Review clauses/risk events in accordance with the coordinated assessment respectively.
- Risk Identification: Risk Category / Risk Events; In relevance with EPCCM Risk Breakdown Structure analysis
- Contract Condition Assessment; Reference is made to clauses / description / Implication/ included in master plan
- Risk Exposure Analysis: Risk Owner (Employer/Contractor/or both) / Risk events triggered per clauses interpretation
- Risk Response: Action / Actor (Employer/Contractor/or both) tracing relevant in risk event

Shifting between projects IDs allow to add new risk events or update existing risk parameters such as actual status, probability of occurrence, degree of severity impact, in order to allow for Updating and / or reviewing existing project data assessment

Figure 10: Interface For Assessing Contract Clauses in Term of Analyzing Risk: Exposure, Identification & Response.
4.1.3. Proactive Data Handling:

Step 1- Analyzed implications related to project terms of contract are prescribed in order to extract respective responsibilities between contract parties (Employer/Owner), accordingly the cause for risk event triggered is highlighted through a definite risk exposure versus response actions to eliminate, mitigate impacts figure 11.

Step 2- Risk events preview where Data is filtered by selecting field and relevant events category to be analyzed, this filter application allows for tracking preventive actions and checking for suitable mitigation clauses.

By double click on four columns we can find filter tool to apply by one or more of these four fields (Category – Event – Owner - Actor); Resulting Events triggered are displayed by the Risk Event Preview Interface allowing for further analysis by selecting filtered data according to parameters selected by risk owner or response actors in relation to category of risk events allocated, racing details for actions required as response mitigation plan is permissible by selecting event in figure 12. Extracted data exported to excel format as per the following risk register demonstrating related triggered events and relevant responses required to mitigate such impact levels, as part of the risk management plan RMP Suggested Contents of Risk Issue RBS and Project Contractual Risk Register.

Figure 11: Risk Exposure Analysis, Risk Response.
4.2. Tracking and monitoring:

Project participants most suited to manage the risk identifies the party or parties who are best able to control the risk. For our Soil investigation example, one could take the position that no party is able to control the risk, and it simply has to be passed on to the Owner, Fully documented. Finally, the opportunity exists to include previous experience that has been particularly effective in identifying, and judging and managing the risk issue. EPCCM Generates, reports cited in the following table 2.

**Table 2: EPCCM Generated Output Reports.**

<table>
<thead>
<tr>
<th>Report A</th>
<th>Project Risk Optimized Datum</th>
<th>PROD</th>
<th>Datum for project initiation and risk management strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report B</td>
<td>Contract Condition Risk Analysis</td>
<td>CCRA</td>
<td>Risk Management Plan and Responsible actors</td>
</tr>
<tr>
<td>Report C</td>
<td>Risk Events Report</td>
<td>RER</td>
<td>Cumulative analysis for risk categories/events</td>
</tr>
<tr>
<td>Report D</td>
<td>Risk Response Summary</td>
<td>RRS</td>
<td>Trace required response action as part of mitigation plan</td>
</tr>
<tr>
<td>Report E</td>
<td>Risk Status Monitoring</td>
<td>RSM</td>
<td>Qualitative-risk analysis for probability and impact</td>
</tr>
</tbody>
</table>

4.2.1. Examples for reports:

Mostly used figure representing report c demonstrating summary for events occurring, allowing for tracing and updating confronted risks in contractual project environment changes fundamentally the basis of managing in addition to lessons learned impact this could have upon the future development of the organization
works. It is important then to reassess the project and relatively study its allocation of risk defined under EPC standard forms of contract, decisions will be taken in reference to stored data and updated reports for risk management as per referenced reports in figure 13.

**Figure 13: Report C, Derived analysis for risks Categories occurrence and Impact.**

![Figure 13: Report C](image1.png)

**Figure 14: Report D Details for Risk Events Identified With Relative Action Response**

![Figure 14: Report D](image2.png)
4.2.2. Qualitative Risk Analysis:

Conducting a combined qualitative-risk analysis to determine if the allocated risks to the project start. EPCCM includes methods for prioritizing the identified risks for further action, such as Quantitative Risk Analysis or Risk Response Planning. Qualitative Risk Analysis assesses the priority of risks by using their probability of occurrence, corresponding impact on project objectives if the risks do occur, as well as other factors such as the time frame and risk tolerance of the project constraints of scope, schedule, budget, and quality, result presented in following figure 15a and 15b.

Figure 15- A: Qualitative Risk Analysis Defining Severity and Occurrence Impact.

Figure 15- B: Detailed Qualitative Risk Analysis Defining Project Event Analysis in Addition To Mitigation Responsive Actions.
4.3. EPCCM System Validation and Verification:

In order to allow for System Verification a Project Prototype is created to demonstrate different modules efficiency and relational outputs. Steps are described in parallel to analysis for selected events under study.

In performing risk analysis of a project, we are interested in predicting the consequences of a risk issue on project performance, and where it is significant, on developing risk mitigation measures. Risk mitigation deals with how best to manage a risk using strategies such as redesign, alternative processes (procurement, construction, etc.), insurance, contingency allowances, contractual language, and so forth. By linking risk issues through to project performance measures, including consideration of the project context, it is possible to assess the importance of a risk issue, and judge the efficacy of various risk mitigation measures.

5. Conclusion:

Major Risk issues related to contract administration environment is explained as well as the risks allocated to contracting parties through contract conditions. Necessary steps to successfully manage the contractual elements of a construction contract. Types of contracts and relationships between contracting parties are explored. The case study model is produced with general information about the FIDIC and Egyptian Design and Build Contracts are given, followed by risk allocation schemes in contracts are explored so that risks can be managed successfully as per reports analysis.

This research discussion points are limited on a certain scale of projects, further application should be initiated within the definition of risk management standards for larger risk items. In addition further development could be recommended to allow for comparing research results with other simulation tools, this step could be required for proof of verification of similar results. Hence justification for system selected EPCCM, In terms of achieving an Explicit Approach for Contract Risk Management, the presented research allows project participants to prioritize their response and develop mitigation strategies that will enhance overall project performance. Therefore, projects that use the structured risk assessment process will have a better chance of meeting financial, schedule, and other stakeholder expectations.

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