ISSN 2278-3091
Volume 9, No.5, September - October 2020
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse36952020.pdf
https://doi.org/10.30534/ijatcse/2020/36952020

# Appraisal for the Evolution of Risk in Construction Industry

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## ABSTRACT

The construction industry plays a crucial role in any country's economy, especially in the developing countries where there exist quite a number of opportunities for construction projects. Nevertheless, the construction industry, here and there, is exposed to different types of risks that limit the chances of successful completion of projects. This study presents an investigation of the most critical risk factors that are tackling the construction projects in Egypt for the past five years. As well, the study monitors the differences in perception of risk criticality between the key participants of the construction projects, customers, engineering consultants, and contractors. Statistical analysis is conducted to identify and categorize the criticality of each risk factor. Results revealed that the most critical risks are proportionately stem from internal and external sources of the organization. Critical internal sources include financial issues, technical deficiencies and ineffective project management while external sources include changes of the economic and political circumstances as well as the continuous changes of customer requirements.

**Key words:** Construction Industry, Risk Management, Risk Perception.

## 1. INTRODUCTION

The construction industry is widely known as one of the recorded important sectors in economic growth, particularly in developing countries that assign considerable interest to infrastructure, transportation and residential projects [1]. This industry survival is not only attainable, by the number of work opportunities, but also by the percentage of successful projects. Most of construction projects include several parties with different levels or experiences and expectations that generate a dynamic and complex setting [2], [3]. Such characteristics of work environment generate different sources of risk which have a positive or negative impact on the work progress and on the achievement of the project's objectives [4]. Effective risk management helps the project parties in identifying and controlling the risks, and successfully achieving the project objectives [5]. Recently, construction projects in Egypt have confronted different sources of risks which need proper assessment to find out the most effective measures for controlling such risks [6], [7], [8]. This paper presents a study of the risks that encounter the Egyptian construction projects for the past five years (from 2014 to 2019). This period represents a new era in the Egyptian Market, characterized by political stability and beginning of many construction projects such as Suez Canal Extension, New Administrative Capital, Roads and bridges, Residential buildings…etc. This study is performed based on a comprehensive review of the literature of risks in construction projects, in addition to an examination of the current practices of risk management. The findings of this study contribute to the researches and practices of risk identification in construction field locally and internationally either for projects which have comparable circumstances or for engineering service providers which seek for construction opportunities in Egypt.

This paper is composed of four sections; first section is to introduce the concepts of risks in construction projects; second section presents how this study is deployed, third section displays results and discussions, and the last section provides conclusion for this study.

## 2. RISK MANAGEMENT IN CONSTRUCTION PROJECTS

Several definitions have been introduced for explaining the term "risk". Most of researchers adopt a definition which based on two main characteristics; probability of having an event, and the consequences of this event which may be positive or negative outcome. One of main features of the risk is the "Uncertainty" which may be built-in either in the probability of event occurrence or in its consequences [9]. Specific researchers adopt proactive definition for the risk where highlighting the need for any system to anticipate and manage the uncertainty, threats or opportunities for protecting the assets and values besides achieving the objectives [10]. Focusing on risks of construction projects, they were traditionally limited to the nonconformity with a certain pre-defined plan, which are supposed to fulfill all project

objectives during its preparation [11]. Afterwards, the perception of "risk" is developed to include any uncertain event that can impact the achievement of one or more of the project objectives [12]. The basic criteria which shape the project objectives are identified as, scope, time, cost, quality [13]. Over the time, Construction industry has become more complex. The identification of project objectives itself turns to vagueness in many projects [14], [15]. Additionally, construction projects started to include several parties with different levels of expectation and experience [16]. Such dynamic and complex work environment leads some researchers to adopt a holistic thinking for risk definition and analysis which supports the needs of professional life [17].

Risk management is an iterative process where its scope is extended form identifying, analyzing and evaluating the risks of the project, to proposing, executing and monitoring treatment measures, which applied to reduce the level of risk level [18]. Risk identification is a key factor in the risk management process, particularly for construction projects. Risk breakdown structure is a technique adopted by certain researches to classify the risks in categories for better management [10], [17], [19], [20].

Construction projects include several risks which influence project's progress in terms of its basic criteria; time, cost and quality. Although risk is theoretically defined as an event generates positive or negative consequences in case it is occurred [12], most of practitioners are considering the negative side only of the risk when managing their projects.

Several approaches were adopted to classify the risks in construction projects. Reference [21], classified the risks into engineering and non-engineering risks. Engineering risks expressed the technical and project management activities such as identifying customer requirements, design/execution phases, and contracting process and managing the resources, while non-Engineering risks includes all other activities such as political issues, country's legalizations, environmental and geological risks, and natural hazard [21].

In Egypt few studies were performed for risk identification in construction projects. Some of these studies focused on the risks from the impact perspective, particularly risks which leads to delay in project completion or to cost overrun [6]. Where risk classification process based on identification of the risk responsibility; "Employer", "Contractor", or both. Alternatively, some studies concentrated on specific construction sector in several researches [4], [22], [23]. As for residential projects, a study was performed to identify and classify 46 risks showed that most of top critical risks are related to external financial issues particularly, inflation and changes in material prices and labor cost [4]. Highway construction projects which considered a vital axe has been studied on 2016. The study showed that the overall risk assessment to this type of projects is medium, however this kind of projects encountered several high risks, basically related to crush project duration, delay in payments and incompliance with safety and quality regulation [23]. Moreover, in one of the most important sectors in construction industry, which is offshore oil and gas projects showed that risk of adverse weather conditions is one of the top risks in such sector, although it is considered as negligible risk in Egyptian construction environment [22]. Finding of these researches reveals that, although most of risk sources are common in the construction industry, the rank of the top risks may vary according to the project sector. Further researches studies the risks during certain periods. For example, a study was performed to identify critical risks in construction field during one of the most critical periods in the Egyptian history; (from 2011 to 2013), [7]. Obviously, from the study of previous literature, risk identification and classification can be diversified according to the research objectives [24], [25].

## 3. STUDY DEPLOYMENT

The study of this research starts by reviewing the methods of risk classifications and categorization in the field of construction projects in the local and international studies. Afterwards, a list of risk factors is prepared and verified through interviews with five experts (Two academics and three professionals). Further, a questionnaire is developed to measure in which degree these risks influence the construction projects in Egypt. Likert scale, five points; is adopted as a measurement instrument for the responses. Such measurement scale has been chosen to allow the variety of the construction workforces expressing their perception of risk in a descriptive manner. Hence, the adopted scale assign numbers to express the importance of the risk in this way "1 to very low", "2 for low", "3 for moderate", "4 for high", and "5 for extreme". Data were collected from various practitioners in the Egyptian construction industry with ample amount of experience. After that, the data was analyzed with Statistical Package for Social Studies (SPSS) software.

### 3.1 Risk Classification

Based on reviewing the literature, a preliminary list of risks is prepared and categorized according to a hierarchy of three levels. First level grouping risks, according to its source into two main groups; "External Risks" for the risks which are generated from sources beyond organization's control, and "Internal Risks" for those which are related to the internal system of the organization. The second level of the risk classification hierarchy, categorizes the risks, according to the nature of its group. The group of "External Risks", includes only two categories; "Customer (Cst.)" and "Economic and Political circumstances (Eco.)", while the "Internal Risks" group includes four categories; "Financial risks/problems (Fin.)", "Management (Mgm.)", "Technical risks (Tech.)" and "Project Management (PM)". The third level itemized/classified risks of each category into classes. The three levels of risk classification supported with code for each risk factor are illustrated in Figure (1).

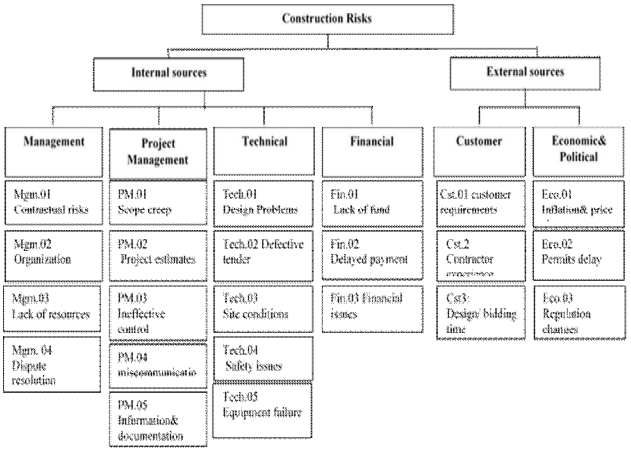


**Figure 1:** Classification of risks in construction projects

### 3.2 Questionnaire Design and Structure

The questionnaire is composed of two sections. The first part of the questionnaire was designed to collect general information about the respondents and the organization in which they worked for. For this purpose, four demographic variables are identified:

1. Respondent experience in terms of years, which is divided into four groups; (0-5), (5-10), (10-20), and (More than 20)
2. Company characteristics, labelled to four categories (Engineering Consultant, Contractor, Developer, and Others).
3. Work category, which represents the dominant type of projects in the company and where the respondent chooses from four groups (Residential, Industrial, Infrastructure, and Others).
4. Workload presented by the number of projects in which the respondent works in at the same time. This variable is measured by one of three sets; (One project), (2-4 projects), and (more than 4 projects. The variety of respondents, contributes in collecting different perspectives about the risk in the construction industry.

The questionnaire was distributed to 100 practitioners that work in the construction projects. The number of collected Responses reached 81 respondents, which represent 81% responding rate. Table (1) represents the distribution of respondents according to the four demographic variables.

Second part of the questionnaire is composed of 50 closed questions to identify the risk factors previously prepared in list of risks and verified from experts in Egyptian construction projects. Further, the questionnaire includes one open question for allowing the respondent for adding any missing risks. The results of this single question are used as an extra verification for the list of identifying risk factors.

Each risk factor is addressed in the 50 closed questions where the respondent is requested to express risk importance level according to Likert five-point scale, from 1 to 5; very low, low, medium, high, and extreme. Then relative importance index (RII) is calculated for each risk factor [25].

$$RII = \frac{\sum_{i=1}^{A} wi*ni}{AN} \quad (1)$$

$$0 \leq RII \leq 1$$

Where: $w_i$ is the weighting given to each factor by respondent, ranges from 1 to 5;

$n_i$ is a variable expresses $i^{th}$ response

A is the highest weight

N is the total number of respondents for a given factor

**Table 1:** Distribution of the Demographic Variables

| | Frequency | Percent % |
|---|---|---|
| **Company Role** | | |
| Engineering Consultant | 25 | 30.9 |
| Contractor | 36 | 44.4 |
| Developer | 9 | 11.1 |
| Others | 11 | 13.6 |
| **Work Category (Dominant type of projects)** | | |
| Residential | 38 | 46.9 |
| Industrial | 14 | 17.3 |
| Infrastructure | 23 | 28.4 |
| Miscellaneous | 6 | 7.4 |
| **Respondent experience (years)** | | |
| (0-5) | 12 | 14.8 |
| (5-10) | 17 | 21.0 |
| (10-20) | 32 | 39.5 |
| More than 20 | 20 | 24.7 |
| **Work Load (Number of working projects)** | | |
| One project | 22 | 27.2 |
| (2-4) projects | 41 | 50.6 |
| More than 4 projects | 18 | 22.2 |

## 4. RESEARCH OUTCOME

Data were collected from respondents for 50 questions (closed type) representing their evaluation for the listed risk factors of construction projects. Analysis is performed for the risk factors as well for the risk categories and risk groups. Two sorts of analysis were performed; first one aims to have a holistic vision of the risk evaluation in the Egyptian construction projects regardless the respondent background, the second analysis targeted studying the differences in risk perception between construction practitioners based on the changes of their demographic data.

### 4.1 Risks in Egyptian construction projects

The first objective of this research is to identify and assess the most critical risks in Egyptian construction industry. The relative importance index (RII) is calculated for each risk factor as well as for each group of risks and presented in Table (2).

**Table 2:** Evaluation of Risk Factors in Construction Projects

| Code | Risk Factor | RII | Rank | Category | Group |
|---|---|---|---|---|---|
| Fin. 01 | Lack of funding throughout the project | 0.825 | 1 | Internal | Financial |
| Cst. 01 | Multiple changes of customer requirements | 0.822 | 2 | External | Customer |
| Fin. 02 | Delay in invoice payment | 0.817 | 3 | Internal | Financial |
| Tech. 02 | Inconsistency of project tender documents | 0.813 | 4 | Internal | Technical |
| Eco. 01 | Inflation and price changes | 0.810 | 5 | External | Economic& Political |
| PM. 04 | Miscommunication between project team | 0.807 | 6 | Internal | Project Management |
| PM. 01 | Misunderstanding of project scope | 0.805 | 7 | Internal | Project Management |
| Cst. 02 | Using unexperienced contractor | 0.793 | 8 | External | Customer |
| Cst. 03 | Crushing the process of design review before tendering | 0.790 | 9 | External | Customer |
| Tech. 04 | Site hazards | 0.788 | 10 | Internal | Technical |
| Mgm. 04 | Ineffective methods for coordination and issues resolving | 0.783 | 11 | Internal | Management |
| PM. 02 | Financial problems | 0.783 | 11 | Internal | Financial |
| PM02 | Project estimation is based only on experience | 0.783 | 11 | External | Project Management |
| Tech. 01 | Defective design and specification | 0.780 | 12 | Internal | Technical |
| PM. 03 | Loose control on project parameters | 0.773 | 13 | Internal | Project Management |
| PM. 05 | Insufficient/ inaccurate studies for the project | 0.770 | 14 | Internal | Project Management |
| Mgm. 03 | Unpredictable absence of team members | 0.760 | 15 | Internal | Management |
| Mgm. 04 | Disputes between sub- contractors | 0.748 | 16 | Internal | Management |
| PM. 05 | Unavailability of information for previous similar projects | 0.743 | 17 | Internal | Project Management |
| PM. 04 | Poor coordination between sub- contractors | 0.740 | 18 | Internal | Project Management |
| Tech. 05 | Repetition of equipment failure | 0.740 | 18 | Internal | Technical |
| Mgm. 02 | Unawareness of project risks | 0.738 | 19 | Internal | Management |
| Eco. 02 | Delay in obtaining permits and licensees | 0.733 | 20 | External | Economic& Political |
| PM. 03 | Misunderstanding of project nature and characteristics | 0.723 | 21 | Internal | Project Management |
| PM. 01 | Availability of proper technology | 0.722 | 22 | Internal | Project Management |
| Tech. 04 | Incompliance with safety regulations | 0.721 | 23 | Internal | Technical |
| PM. 05 | Ineffective documentation system for the project | 0.719 | 24 | Internal | Project Management |
| PM. 02 | Errors in offers estimation | 0.710 | 25 | Internal | Project Management |
| Mgm. 02 | Ineffective purchasing procedure | 0.704 | 26 | Internal | Management |
| Eco. 03 | Changes in rules and local regulations | 0.696 | 27 | External | Economic& Political |
| Tech. 02 | Incomplete design documents | 0.696 | 27 | Internal | Technical |
| Mgm. 02 | Improper procedures for risk avoidance | 0.689 | 28 | Internal | Management |
| PM. 05 | Ineffective information distribution system | 0.679 | 29 | Internal | Project Management |
| Tech. 03 | Unawareness of site conditions | 0.672 | 30 | Internal | Technical |
| Mgm. 02 | Changes in organization chart | 0.659 | 31 | Internal | Management |
| Mgm. 02 | Inconsistent evaluation system for supplier | 0.659 | 31 | Internal | Management |
| Tech. 04 | Repetitive accidents in the site | 0.649 | 32 | Internal | Technical |
| Mgm. 02 | Absence of risk policy | 0.637 | 33 | Internal | Management |
| Mgm. 02 | Changes of risk policies according to project manager | 0.628 | 34 | Internal | Management |
| Mgm. 03 | Unqualified team for the project | 0.622 | 35 | Internal | Management |
| PM. 02 | Inaccurate estimation for project budget | 0.620 | 36 | Internal | Project Management |
| Mgm. 02 | Delay of project manager involvement | 0.617 | 37 | Internal | Management |
| Mgm. 02 | Absence of strategy for handling risks | 0.615 | 38 | Internal | Management |
| Fin. 03 | Cash shortage | 0.610 | 39 | Internal | Financial |
| Mgm. 02 | Risk management process is centralized | 0.608 | 40 | Internal | Management |
| PM. 04 | Delays and defects from suppliers/ subcontractor | 0.587 | 41 | Internal | Project Management |
| PM. 03 | Poor- coordination between project stakeholders | 0.587 | 41 | Internal | Project Management |
| Mgm. 03 | Lack of training | 0.568 | 42 | Internal | Management |
| Mgm. 02 | Accepting of different type of projects | 0.548 | 43 | Internal | Management |
| Mgm. 01 | Improper contingencies | 0.544 | 44 | Internal | Management |

Results show that the top ten risks are distributed between the two risk categories; external and internal risks with nearly equal proportion; six risks from internal sources and the other four from external sources. The most critical risk has been chosen by the participants was due to internal sources, particularly "financial" group. This is the risk of "the lack of fund throughout the project" with value of RII 0.825. The second top risk is "Multiple changes of customer requirements" with value of RII 0.822, generated from "customer" group, which considered external source. This result signals, the consequences of the financial difficulties which confronts the construction projects in Egypt during this period, as well as the need for establishing clear identification of the customer requirements before going through the project to avoid unnecessary expenses. The following risks were "delay in invoice payment" and "inconsistency of project tender documents" with RII values of 0.817 and 0.813 respectively. The risk of "inflation and price changes" appeared in the fifth rank with RII value of 0.81. This was expected due to the unexpected changes in currency rates that accompanied the economic reforms in this period. Remaining risks of the top 10 reveals the lack of experience among the project participants. This was observed either from the risks of "Customer" group which are "using unexperienced contractor" and "the crushing the process of design review before tendering", or from those related to "Project Management" group which are "Miscommunication between project team" and "Misunderstanding of project scope". It is also noted that the risk of "Site hazard" is included in the most important risks with RII value of 0.788, which raise a question about to what extent the regulation of health and safety is followed and applied in such important sector. The risk factors which have least impact were related to "Management" group, which are "Accepting of different type of projects", and "Improper contingencies" with RII values of 0.548 and 0.544.

For better visualization, the distribution of RII for risk groups is illustrated in Figure (2). The group of risks which are raised from the "Customer" is the most significant one with RII value of 0.82 followed by the group of "Financial" risks with RII 0.756. The "Management" group which comprises the risks of the company recorded the least value of RII 0.656. The three other groups "Economic& Political", "Technical" and "Project Management", have convergent values of RII which are 0.738, 0.734, and 0.718 respectively

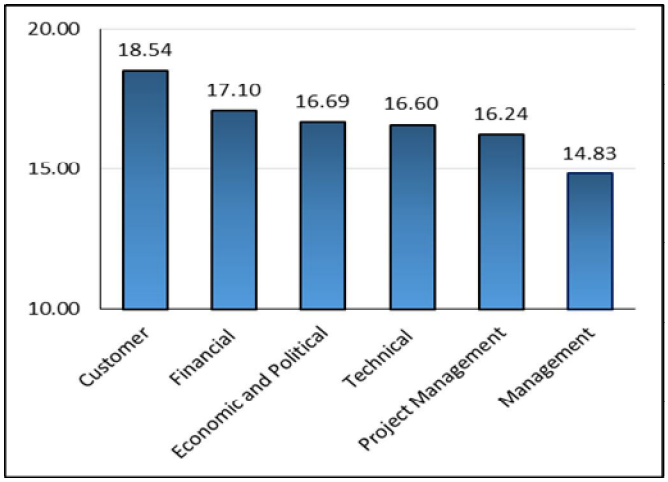


**Figure 2:** Distribution of the Weight of Risk Groups

### *4.2 Risk Perception*

The secondary objective of this research is to study the differences in risk perception between the different actors of construction projects. Four independent variables were selected for that purpose; two of them are related to the respondents themselves and the other two variables are related to the company in which the respondent works for. Respondent's variables are identified to measure the difference in risk perception based on changes in "respondent experience" and on the "work load" of the respondent. The other two variables of the company are, the "Company characteristics" which depends on the role which the company takes in the project, and the work category which represents the dominant type of projects in which the company perform.

Radar plot is used to illustrate the results in Figures (3) and (4).

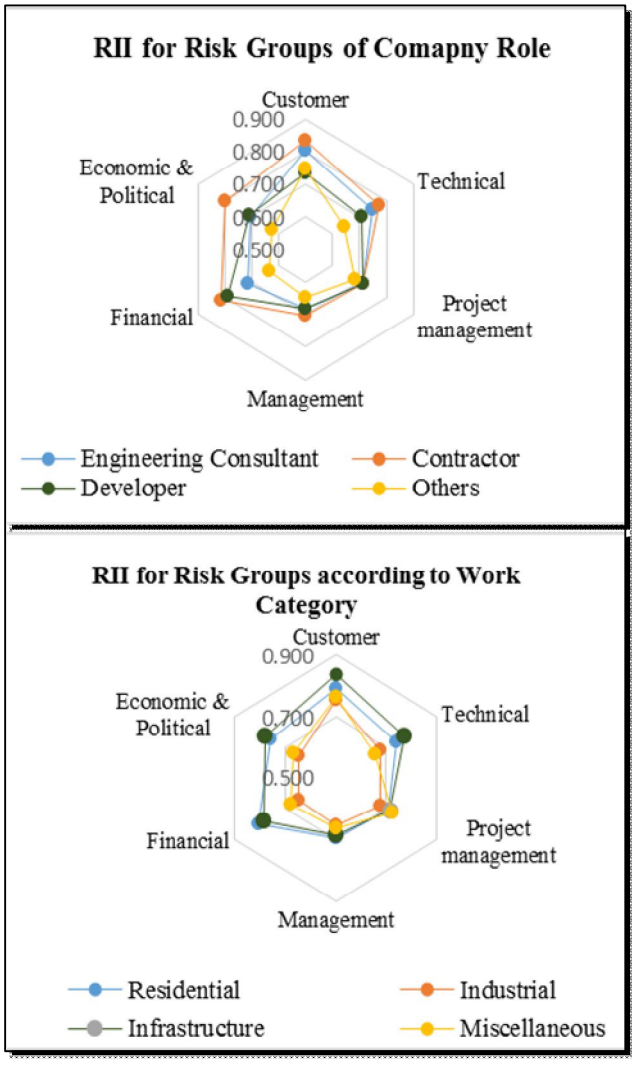


**Figure 3:** Criticality of Risk Groups/ Company's Demographic Variables

Findings reveal that, with respect to the "Company characteristics" as per Figure (3), the "Contractors" have higher concerns for project risks since they give highest values of RII which varying from 0.834 for "Customer" risk group to 0.702 for "Management", followed by "Engineering consultant" in most of risk groups. The lowest values of RII have been offered by "Others" which represent companies support construction projects but they are not a key player in industry.

For the other company's variable "Work category" related to the type of projects, the results have shown that risks of "Infrastructure" and "Residential" projects are more serious than those of the "Industrial" and "miscellaneous" projects. This finding meets with the expectation of the researcher, since these two types of projects "Infrastructure" and "Residential" are the most dominant projects in the Egyptian market as they acquire the largest part of the capital in construction field.

Results show that there is no significant change in the rank of risk groups based on the difference of the independent variables. The highest RII values are for the two groups "Customer" and "Financial", and the lowest RII value is for the group "Management".

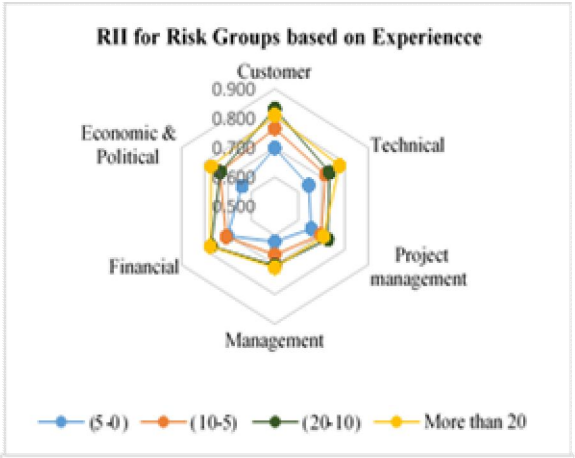



**Figure 4:** Criticality of Risk Groups/ Respondent's Demographic Variables

Additionally, results indicate the work load has negligible impact on the risk perception. However other categories included variance in the value of RII which corresponds to the independent variable "Respondent experience". For example, the analysis of the importance of risk, shows that the professionals of lowest experience (0-5) has lowest RII values for all risk groups (ranged from "Management" RII value of 0.622 to RII value of 0.704 for "Financial"). Inversely, more experienced respondents give greater values of RII for the same risk groups. This indicates that the more experienced the professional the more understanding and perceiving the risk in construction projects.

## 5. CONCLUSION

The construction industry, like all other industries, confronts inevitable risks, especially in developing countries. However, Identification of these risks in early stages of the project can eliminate them or at least reduce its negative impact. This study presented the risks encounter the construction projects in Egypt during the past five years. The study showed a convergence in the perception and evaluation of construction risks, between the main project parties; Customer, Engineering Consultant, and Contractor. The study concluded that financial risks such as the lack of necessary funding for the project, along with the delay in the payment, are among the most important risks which tackle the construction projects. Also, the study showed that customers constitute one of the important sources of risks that threaten this industry. Customer risks include lack of clear vision when determining their requirements, setting a limited time for the design stage, and selecting incompetent contractors. Such risks have negative impact on the work progress as well as the quality level of project outcomes. The list of risks that have been evaluated by the respondents contained technical problems such as a lack of quality and integrity of designs and tender documents, in addition to problems related to project management such as giving wrong estimates of project parameters or losing control of it. The least important risks were those related to the management of the company itself.

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