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Identifying the Risk Impact on Cost and Time of the Egyptian Non-Residential Buildings Projects

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ABSTRACT

Construction projects in Egypt were typically influenced by multiple risk factors which have various impacts on both cost and time objectives that lead to project cost overruns and time delays. This paper presents the results of an investigation study concerns with the identification and assessment of risks associated with the Egyptian Non-Residential Buildings Projects (ENRBP). The study explores risk factors probability of occurrence and their effects on cost and time of these projects. A field survey was conducted with professionals in the construction projects in EGYPT for a purpose of collecting the required data of the risk factors characteristics. Based on results analysis, several risk factors were identified and categorized into fifteen risk groups as well as they were prioritized based on their effects on cost and time. A high agreement for ranking risk factors among contractors, consultants and owners was acquired. The list of the major risks included many factors such as: dramatic changes in the materials prices and Adopting direct attribution system rather than tendering and bidding systems. The most expected average increase of the cost overruns and time delays was more than 20% of the project planned budget and schedule. Finally, the analysis and findings showed that risk factors were very close in their impacts on both cost and time of ENRBP.

Keywords: Risk analysis, Non-Residential Buildings, Cost Overruns, Time Delays, Egypt.

I. INTRODUCTION

Non-residential buildings comprise buildings other than dwellings, including fixtures, facilities and equipment that are integral parts of the structures and costs of site clearance and preparation. Examples include warehouse and industrial, commercial public entertainment buildings as well as hotels, restaurants, educational and health buildings. Recent researches were conducted concern assessment the non-residential buildings characteristics. Based on field surveys, Jeong et al. [1] introduced a reference building from database based on the building design trends for non-residential buildings. Rezaie et al. [2] evaluated non-residential buildings regarding the environmental impact, renewable energy indices using two different renewable energy technologies and one hybrid system. Panopoulos and Papadopoulos [3] assessed the facade building technology, in order to investigate the possibility of future retrofits achieving nearly 'Zero-Energy Building' in existing non-residential buildings. Bode et al. [4] discussed a proposal to use the flexibility of installed non-residential buildings systems. They investigated a method to identify and utilize the potential for flexible use of building energy systems and applied it to non-residential buildings. Trachte [5] studied solar renovation of non-residential buildings to widen the vision of designers and building owners to other environmental and health issues related to advanced renovation of non- residential buildings. Droutsa et al. [6] exploited data from energy performance certificates to derive relevant benchmarks for non-residential buildings. Different refurbishment concepts for non-residential public building stocks have been analyzed, modeled and evaluated regarding their energy saving potential, usability as well as ecology by Kierdorf et al. [7]. Solla et al. [8] explored various tools of green building rating system to Non-Residential Green Building. In this research, non-residential buildings are studied against the risks that can affect their construction and use, as well as, their construction duration and cost within the Egyptian construction industry.

Risk can be defined in many different ways. Gray and Larson [9] defined risk as “the chance that an undesirable event will occur and the consequences of all its possible outcomes”. Risk is not always easy to be evaluated, since the probability of occurrence and the consequence of occurrence are usually not directly measurable parameters and must be estimated by statistical or other procedures [10]. The risk is expressed as the function of likelihood and impact. The Egyptian Construction Projects (ECP) became of great importance, as construction projects are considered the backbone of development and investments.

The construction industry, perhaps more than others, has been plagued by various risks often resulting in poor performance with increasing costs and time delays, even project failure [11]. Cost overruns and time delays in the construction projects are strongly related to risks and are considered the most important project objectives that affected by risks. Construction industry in developing countries suffers from lack of the previous documented data for the probability of occurrence and the impacts of the expected risks that may affect the project objectives.

ENRBP were subject to high risk levels due to their complex and dynamic environments. Consequently, projects were deteriorated in their objectives such as cost, time and quality. As a developing country, the main problem encountered by the parties of construction projects in Egypt is the lack of detailed documented previous data regarding risk factors associated with the construction projects. In addition, lack of expertise in risk analysis and management makes the problem more complicated. Due to these reasons, efforts have been concentrated on overcome the shortage of data availability for risk effects on ENRBP.

II. OBJECTIVES

The main purpose of this research is to identify and explore the various components of risk factors that affect the cost and time in ENRBP and to prioritize and highlight the major of these risk factors. Other objectives introduced in this research can be summarized as follows:

a- To test the hypotheses that there is a high agreement among the contractors, consultants and owners to the assessment of the risk factors probabilities and impacts on both cost and time in ENRBP.

b- To present a general overview for the risk factors probabilities and their impacts on the cost and time for the ENRBP to highlight the most critical of these factors. It is necessary to create awareness of these factors, their probability of occurrence, and study the extent to which of them has high impacts on the project objectives.

c- To study and compare the impacts of the risk groups on the cost and time in the ENRBP, so that efforts can be conducted to control these causes, share practical solutions and examine their relative importance.

III. HIERARCHICAL RISK BREAK DOWN STRUCTURE

The process of risk management is generally divided into three phases: risk identification, risk analysis and risk response. From these three phases, the concept of risk identification appears to be the most known and practiced. The aim of risk identification is to identify comprehensively all significant sources of risk within a project, as well as the causes of those risks. Chapman, Ward [12] stated that the risk identification is both important and difficult, and that it calls for some creativity and imagination. Tummala, Burchett [13] mentioned that the Work Breakdown Structure (WBS) assists in the identification of risk factors by simplifying the project structure into smaller units, for estimating the project cost more accurately and analyzing correlations that may exist between any two cost cores. In addition, the work breakdown structure was used to identify potential risk factors by checklists. The Hierarchical Risk Breakdown Structure (HRBS) is similar to the WBS and can provide a number of benefits, by decomposing potential sources of risk into layers of increasing detail.

IV. RISKS AFFECTING EGYPTIAN NON-RESIDENTIAL BUILDINGS PROJECTS (ENRBP)

Structural problems of construction industry in developing countries are more fundamental, more serious, more complex, and, overall, much more pressing than those confronting their counterparts elsewhere [14]. Egypt as a developing country faces many risks in its construction industry especially in non-residential buildings projects. The Egyptian government gives non-residential buildings more attention due to the large investments that are still being made in this industry recently. In addition, these projects are considered one of the largest projects in Egypt.

Moreover, many researchers attempted to study risks in Egyptian construction projects in recent years. Khodeir and El Ghandour [15] examined the role of value management in controlling cost overrun, with special reference to residential projects in Egypt. Khodeir and Nabawy, [16] identified key threats arising from the internal and external environment of stakeholder's organization during construction of infrastructure projects. Issa and Ahmed [17] identified thirty-one risk factors affecting driven precast reinforced concrete piles activities through execution stage. Marzouk and El-Rasas [18] analyzed causes of construction delays in Egypt. Sharaf and Abdelwahab [19] identified the most significant risk factors affecting highway construction project in Egypt to decrease the likelihood and impact of those risks. Issa [20] developed and applied a fuzzy model for assessing risks affecting the quality in the Egyptian construction industry. Another fuzzy model for time overrun quantification in construction projects was proposed based on risk evaluation and applied on industrial projects in Egypt [21].

This study tackled risk identification by investigating the most significant risks related to the ENRBP with the same basic form of WBS for various levels. A hierarchical risk breakdown structure has been developed, and the structure provides the basic classification of risks and the development of a nomenclature for describing projects risks. The HRBS developed in this research is open, flexible, and easily updateable. It allows all types of risks to be classified and categorized and its hierarchical basis enables risk grouping for better probability and impacts determination. The proposed classification displayed in Fig.1, categorizes risks to four levels (macro risks, projects risks, managerial risks and indirect impact risks). The total identified risk factors were eighty-one and grouped into fifteen groups in order to suit the ENRBP context.

V. FIELD SURVEY DESIGN

Due to the lack of organized information related to the probability of occurrence and impacts on project objectives in the ENRBP, a questionnaire was designed based upon literature to obtain information on the probability and impacts of the risk factors known to professionals in ENRBP. The approach of the questionnaire is well-recognized and widely used in general management and project management research [22,23,24]. Several techniques were employed to deliver the questionnaires to potential respondents. Direct (face-to-face) delivery was used in most of the questionnaire filling to motivate respondents and to ensure the accuracy of answers and improve response rate as stated by Long et al. [25].

In order to present the questionnaire in a systematic way, a comprehensive multiple-choice questionnaire was developed and tested prior to being administered. The questionnaire was divided into three sections (A, B and C). Section A contains general questions related to the respondents' information such as position and experiences. Section B represents the main part of data collection to obtain information on the probability of occurrence for each risk factor and its impact on the cost and the time of the ENRBP from the reality of participant experience. The proposed eighty-one risk factors were included as introduced in the Hierarchical Risk Breakdown Structure as illustrated in Fig.1. Finally, Section C sought information on the ENRBP cost overruns and time delays of these projects which the respondents have been involved in.

VI. QUESTIONNAIRE DISTRIBUTION AND SUMMARY OF REPLIES

After designing the questionnaire, it was necessary to be examined by experts in the field of ENRBP to ensure its intelligibility and the understanding of the questions, and to give comments on the design of the questionnaire. This is an essential issue in order to allow any modification before the real study is conducted. Four professionals having average experience of 25 years in the field of ENRBP were involved in the pre-test using semi structured interviews. Test professionals included 2 owners, 1 consultant and 1 contractor. Their comments were used to find out the shortcoming and ambiguities in the first draft of the questionnaire. Their suggestions with respect to the contents, structure, format and sequencing of the questions were incorporated in the final questionnaire.

Following examining the questionnaire, the final version of the questionnaire was developed and which comprises the three sections explained before. To get quick results, the questionnaire was either distributed personally and collected by hand, or sent via internet. However, direct (face-to-face) delivery was preferred to motivate respondents and to ensure the accuracy of answers and improve response rate. This method was effective as there will be direct communication between the researcher and respondent. (70) Questionnaires were distributed and (40) responses out of them were collected with average response rate of 57%. The collected questionnaires were then analyzed as shown in Table1. The response rates from the different groups were 53% from contractors, 67 % from consultants, and 48 % from owners. Fig.2 illustrates the percent of respondents in the questionnaire.

Risk Identification

Macro risks

Political Stability Risk (PSR)

1- Project stop or delay due to war, revolution, and riot
2- Modified or changed laws and regulations related to construction industry
3- Political problems and instability within countries of suppliers, owners, and contractors
4- Change of the state general policy towards this kind of construction projects

Financial and Economic Stability Risk (FER)

5- Local or foreign currency exchange limitations and rate fluctuation
6- Increase of inflation rates
7- Unstable local economic conditions
8- Change of financial allocations for these kind of construction projects
9- High taxation and Taxes rate changes

Market Conditions Risk (MCR)

10- Fluctuations in market demand for this kind of construction projects
11- Lack of clear fare procedures in tendering process and contractor choice
12- Adopting direct attribution system rather than tendering and bidding systems
13- Market suitability and acceptability for advanced technology
14- Difficulties face transportations and communications
15- Poor quality of available local materials

Natural forces Unforeseen Risk (NUR)

16- Sudden attack of natural disasters such as (Floods, Earthquakes, Fire, wind damage, lightning, soil conditions and landslide)
17- Severe weather conditions

Project risks

Design Stage Risk (DSR)

18- Scope changes and unclear project scope definition
19- Lack in using new technologies in design
20- Miscommunication and coordination between designers, engineers and site work
21- Design codes changes
22- Inadequate specifications and shortage of design data as well as architectural program
23- Design errors and omissions
24- Design changes during project execution
25- Delay in design and regulatory approval
26- Ignoring the building users` needs in design process
27- Lack of project context circumstances study and treatments integration into design
28- Variations of actual quantities of work compared with quantities in bidding documents

Project Financing Risk (PFR)

29- Lack of project suitable fund
30- Fluctuation of project cash flow such as (Delay in payment by client)
31- Mishandling of project finance due to bank policy change problems
32- Inadequacy of project insurance (during construction)

Site Work Risk (SWR)

33- Lack of accurate determination of site boundaries
34- Delay in possession of site due to any reason such as land expropriation
35- Limited working hours and difficulties in accessing the site
36- Inadequate of Existing facilities and utilities
37- Improper site stores management such as storage and protection of material
38- Poor site safety regulations
39- Unforeseen site conditions such as soil conditions, groundwater and archeology findings

Environmental Impact Risk (EIR)

40- Environmental protection due to project pollutions (noise, smoke, and wastes caused by project)
41- Environmental negative impact due to project activities

Construction work and New technology Risks (CNR)

42- Unsuitability of the project design for the ordinary methods of construction
43- Problems in technology implementation and feasibility of construction methods
44- Defective workmanship
45- Lack of work professional experience that complies with Project complexity
46- Poor productivity of manpower or equipment
47- Shortage of required equipment

Supplies and Procurement Risk (SPR)

48- Lack of equipment and raw material for long periods
49- Delay in high quality materials delivering
50- Dramatic changes in the materials

Managerial risks

Project Contract Risk (PCR)

51- Contract dispute raised from disagreement over some conditions in contracts
52- Breach of contract
53- Contract termination

Project Working Team Risk (PWR)

54- Inadequate project organization structure
55- Lack of appropriate professional skills for the team work
56- Poor Communication, coordination and different opinions among team members
57- problems among project team members
58- Changes in the project core technical and admin team
59- Inadequate Motivation for workers
60- Improper accommodations for workers

Project Stakeholders Risk (PSR)

61- Lack of Client's experience and understanding of their own needs
62- Client's representative problems
63- Bankruptcy of a project partner
64- Poor communication and coordination among the project team work and other partners (Client, consultant, users ...)
65- Third party delay
66- Cultural differences
67- Language barrier
68- Delayed dispute resolution

Project Construction Management Risk (PMR)

69- Scheduling errors and underestimation of cost
70- Inadequate project management budget
71- Inadequate site management staffing
72- Inadequate definition of authority and responsibility for any partner
73- Poor quality, performance control, and supervision
74- Inadequate and slow decision-making mechanism
75- Variation order control
76- Delay of regulatory reporting
77- Problems resulted in contradictions among different subcontractors
78- Fluctuation work rate of Subcontractors

Indirect impact risks

Pro-Occupation Risk (POR)

79- Poor client`s satisfaction with project construction quality
80- Poor project design compliance with its function
81- Lack of maintenance plan

Figure 1 Risk Breakdown Structure (RBS) for ENRBP

Table 1 Questionnaire return rate

Respondents	Contractors	Consultants	Owners	Total
Questionnaires distributed	15	30	25	70
Responses received	8	20	12	40
Response rate (%)	53%	67%	48%	57%

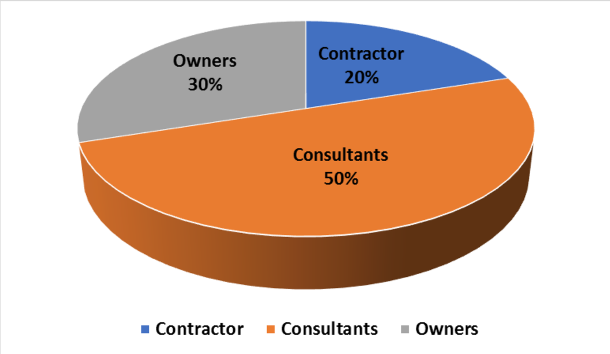

Figure 2 Percent of respondents in the questionnaire

VII. ANALYSIS OF THE COLLECTED DATA

Data collected from the survey was analyzed using descriptive statistical techniques. An advanced and accurate analysis method was needed to process the large body of data in a systematic, fast and reliable way. For this purpose, the Statistical Package for Social Science (SPSS) and Ms. Excel spread sheets were chosen as the best option available for data analysis.

A. Project Sizes

Four main categories of the project sizes were identified in the questionnaire and respondents were asked to select one or more that they have dealt with as explained in the previous section. In terms of the four major categories (very large, large, medium and small size projects), it can be clearly seen from Fig.3 that most of respondents (34%) have been dealing with the medium size projects. However, respondent who have been dealing with large, very large and small size were found to be 33%, 19% and 14% respectively. The total number of projects that respondents have been involved in were (186) projects with different sizes.

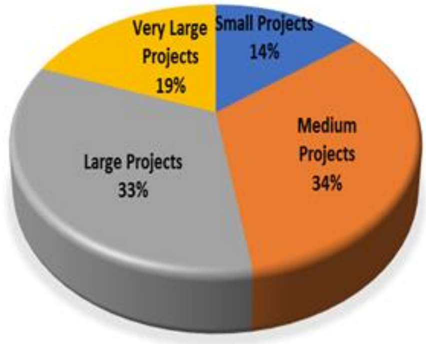

Figure 3 The Percentage of respondents regarding to the size of projects they have participated in

B. Analysis of Risk Factors

The collected data from section (B) concerned with evaluating the identified risk factors in the form of five risk levels (very high, high, medium, low and very low). They were analyzed through three indices namely; 1) Probability Index (PI), 2) Impact Index for Cost (IIC), 3) Impact Index for Time (IIT). These indices were used to assess or rank risk factors based on their probability of occurrence, impact on the project cost and impact on the project time as identified by the participants. Description of these indices can be explored through the following equations:

$$PI = \frac{\sum_{i=1}^{5} Pi * Ni}{\sum_{i=1}^{5} Ni} \quad IIC = \frac{\sum_{i=1}^{5} Ici * Ni}{\sum_{i=1}^{5} Ni} \quad IIT = \frac{\sum_{i=1}^{5} Iti * Ni}{\sum_{i=1}^{5} Ni}$$

Where:

PI is the probability index for a certain risk factor
Pi is the probability weight
Ni is the number of participants who responded to option i
IIC is the impact index for cost
Ici is the impact weight for cost
IIT is the impact index for time
Iti is the impact weight for time

Pi , *Iic* and *Iit* are constants expressing the weight given to the *i*th response:
i=1, 2, 3, 4, 5
Ni is a factor expressing the frequency of the (i) response
N1=frequency of 'very low' response
N2=frequency of 'low' response
N3=frequency of 'medium' response
N4=frequency of 'high' response
N5=frequency of 'very high' response

These equations were used to calculate the probability index (PI), the impact index for cost (IIC), and the impact index for time (IIT) for all risk factors. The weights were ranked for contractors, consultants and owners.

C. Agreement Analysis

A correlation test was used in this research to ensure the high agreement among the respondents' groups for the ranking of the risk factors, and then a full analysis for the risk factors and risk groups can be introduced based on the outcome from all respondents. The Spearman's Rank Correlation Coefficient is a non-parametric measure of correlation and is used to discover the strength of a link between two sets of data. Altman [26], Finkelstein and Levin [27] described the spearman rank-order correlation coefficient as a measure of linear relationship between two sets of ranked data, that it measures how tightly the ranked data clusters around a straight line.

The Spearman test was applied for the three pairs of groups (contractors, consultants and owners) to ensure the strong agreements on the ranking based on probability of occurrence and the impacts of the risk factors on both; the cost and the time of the ENRBP. The Spearman's correlation coefficients for ranking due to the probability index of the risk factors between contractors and owners were somewhat high values and these values were 0.736, 0.772 and 0.712 for the ranking due to PI, IIC, and IIT respectively. Similarly, the Spearman's correlation coefficients for ranking risk factors between contractors and consultants, and owners and consultants were somewhat high but lower than between the contractors and owners. Therefore, further attempt to analyze the problems faced by the different groups of respondents is not necessary, and all the results are positive which indicate good agreements among the different groups.

D. Assessment of Risk Factors

Based on the high degree of agreement between the three groups on ranking, the analysis in this research for ranking the risk factors was presented regarding to the total number of respondents. Therefore, the tables provided will illustrate these links which will be discussed as it seems useful and relevant to the objectives of the research. The full rankings due to the probability of occurrence and the impact on the cost and time of all risk factors rated by the different respondent groups (contractors, consultants and owners) are available from the author on request.

Table 2 Ranking of the top 20 risk factors affecting Cost and Time of ENRBP

Risk No	Risk Fcator	Rank due to		
		PI	*IIC*	*IIT*
50	Dramatic changes in the materials prices	1	3	8
12	Adopting direct attribution system rather than tendering and bidding systems	2	10	68
29	Lack of project suitable fund	3	11	2
1	Project stop or delay due to war, revolution, and riot	4	1	1
5	Local or forign currency exchange limitations and rate fluctuation	5	2	10
6	Increase of inflation rates	6	17	43
7	Unstable local economical conditions	7	5	18
15	Poor quality of available local materials	8	9	32
30	Fluctuation of project cash flow such as (Delay in payment by client)	9	37	7
70	Inadequate project management budget	10	7	3
8	Change of financial allocations for these kind of construction projects	11	4	5
49	Delay in high quality materials delivering	12	30	14
59	Inadequate Motivation for workers	13	69	61
78	Fluctuation work rate of Subcontractors	14	16	12
81	Lack of maintnance plan	15	59	79
9	High taxation and Taxes rate changes	16	8	25
11	Lack of clear fare procedures in tendering process and contractor choice	17	22	63
34	Delay in possession of site due to any reason such as land expropriation	18	72	27
45	Lack of work professinal experience that complies with Project complexity	19	29	19
46	Poor productivity of manpower or equipments	20	13	13

Table 2 shows the ranking of the top 20 risk factors due to their PI. It also shows the ranks due to their impact indices (IIC and IIT). From these rankings, many factors had high ranks and appear in first 10th of ranking for both their degrees of probabilities and their impact on cost and time such as dramatic changes in material prices and project stop or delay due to revolution and riots. The ranking results make sense as material prices were dramatically rise as a result of the economic reform actions adopted by the government after revolution.

E. Analysis Based on Risk Groups

The fifteen identified risk groups were analyzed and compared to highlight the significance of group's effect. The risk groups were evaluated based on the Average Weight (AW) for both the probability of occurrence and impact. The average weights were determined as the average of the three indices (PI, IIC, and IIT) of all risk factors that came under a group. However, analyzing the AW of factors of a specific group is useful for determining the average weight of the group, and to compare more than one group but does not take into account the number of factors listed in the group. In other words, the design stage risk group (DSR) includes 11 individual risk factors, while both; the natural forces unforeseen risk (NUR) group and the environmental impact risk (EIR) group include just two factors each. So that the AW of NUR or EIR groups may be higher than the AW of DSR risk group, although there are eleven factors in it. In order to overcome this argument, another method was introduced in order to take into account the number of factors under the group in order to accurately rank them. The method depends on multiplying the AW of the group by the modulus of number for the factors in a risk group. This was calculated as (MAW = AW * m); where m is number of factors included into the group\total number of all factors and MAW is called the modified average weight.

It is essential to refer that, the MAW which is used in this research means the average weight of a group taking into account the number of the factors in the group and does not refer to the average weight of all factors listed in that group. It helps to realize the entire importance of the group among the other groups, and therefore its rank. It can be used as a reference to assess the risk groups. Fig.4 shows the modified average weight (MAW) for the fifteen groups based on their probability of occurrence, while Fig.5 shows a comparison between the MAW based on the risk factors impacts on cost and time. In terms of the probability of occurrence across the groups, it can be clearly seen that both; design stage risk group (DSR) that includes (11 factors) and project construction management risk group (PCM) that includes (10 factors) achieved the highest rank among groups. However, the natural forces unforeseen risk group (NUR) that includes only (2 factors) achieved the lowest rank in probability of occurrence. It can be spotted from Fig.5 that DSR and PCM risk groups also stayed in the highest rank in terms of their impact on cost and time of the project, while the environmental impact risk group (EIR) achieved the lowest impact on both objectives due to its limited number of factors (two risk factors only). The impact of the two highest groups (DSR and PCM) on time is higher than their impact on cost. This situation was found in other groups except in the financial and economical stability risk group (FER), the market condition risk group (MCR) and the pro-occupation risk group (POR) as they achieved higher impact on cost of the project rather than their impact on time. The remaining risk groups are found to be almost equal in their MAW in terms of their impacts on cost and time.

F. Cost and Time of ENRBP

This section presents the results of analysing part C of the questionnaire. The participation of professionals in this survey is based on approximately 186 projects they have been involved in. However, the average number of projects for participants was 5 which mean in general that most respondents have a very good background about ENRBP, thus sharing their knowledge leads to accurate identification of the most important risk factors.

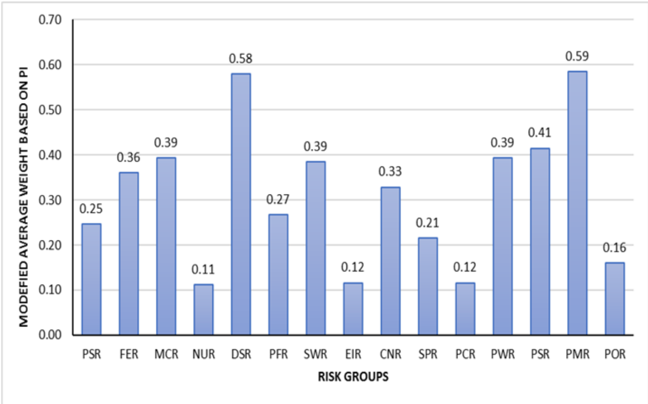

Figure 4 Modified average weight for the risk groups based on their probability of occurrence

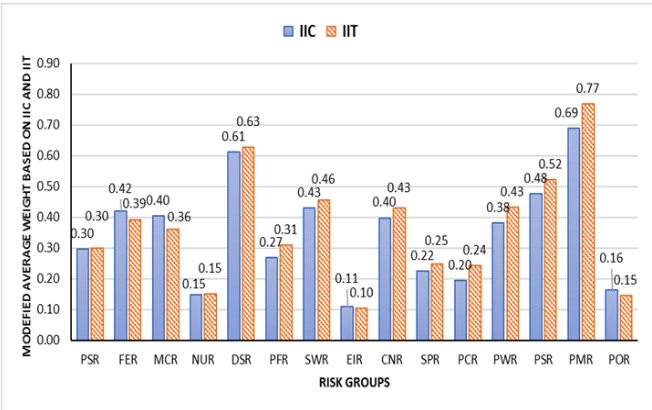

Figure 5 Modified average weight for the risk groups based on their impact on cost and time

1. Projects faced cost overruns and time delays

As shown in Fig.6, approximately 122 projects out of 186 faced cost overruns while 146 projects out of 186 were delayed. The number of projects faced cost overruns forms 65.6 % of the total projects and the number of delayed projects represents 78.5 % of the total projects. Those two high percent indicate that the ENRBP suffer from the cost overruns and time delays due to impact of many risks.

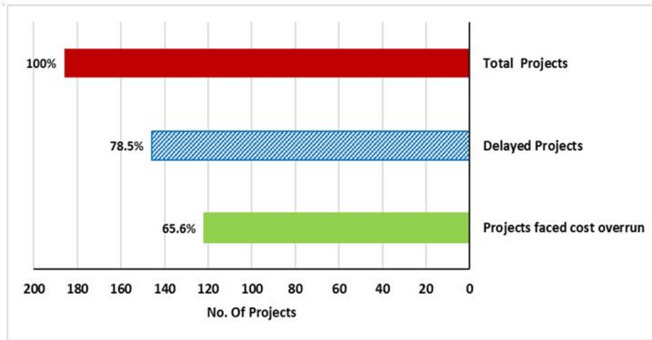

Figure 6 The percent of the projects faced cost overruns and time delays

2. Average increase in the cost and time of ENRBP

The cost overruns of these projects are classified into 5 categories, and respondents were asked to select one of these categories to indicate the average increase of the total cost for the projects faced cost overruns they were involved in. Fig.7 demonstrates that the highest average increase in the cost was greater than 20% of the project plan and represented by approximately (40%). The projects that had been faced cost overruns by range of 10% to 20% come as the second frequency by (30%). The projects faced cost overruns by range of 5% to 10% come in the third frequency by (20 %) and finally the lowest cost overruns percent was 10 % for cost overruns less than 5%.

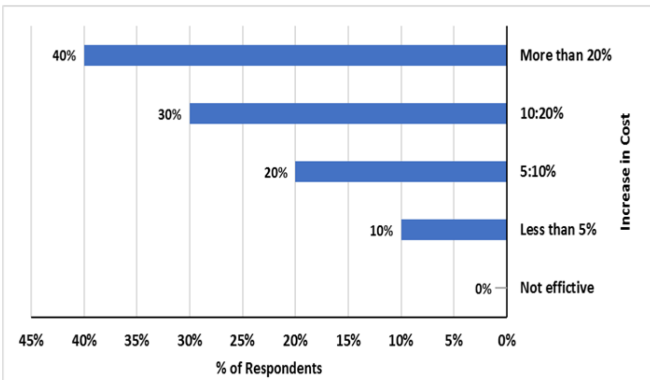

Figure 7 The Percent of cost increase for projects faced cost overruns

On the other hand, average time delays were classified into similar 5 categories and respondents were asked to select one of these categories to indicate the average time delay of whole delayed projects they were involved in. Fig.8 shows that the average time delay of delayed projects for half respondents (50 %) is more than 20% from the project normal time schedule. The percentage of time delay range from 10% to 20% were stated by (30%) of respondents. Finally, the lower frequency was for participants who experienced projects delayed by 5% to 10% and not effective delay with the same percent (10%).

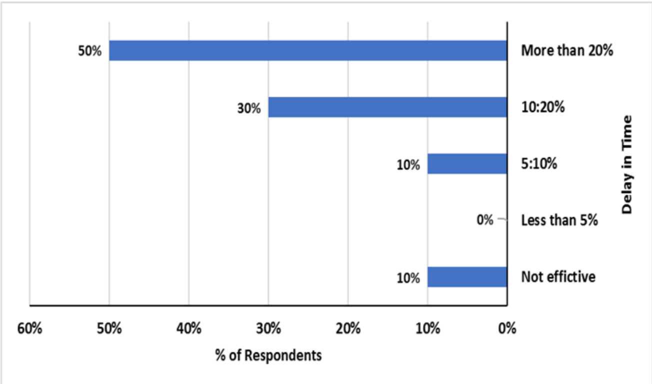

Figure 8 The Percent of time increase for projects faced time delays

VIII. CONCLUSION

As a result of urbanization and recent economic reform, construction of non-residential projects represents a large value of investments in Egypt. These projects involve various risk factors and the successful implementation of such projects depends on the accurate identification and assessment of these factors. With an assistance of a practical survey, this study identified and assessed several risks affecting the ENRBP. A new HRBS was introduced and classified numerous risk factors in many groups as the expected risk factors affecting ENRBP. Three risk indices were developed, providing an effective insight and clear picture of the risk profile involved in the ENRBP. An agreement test was conducted to examine the strength of associations among the rankings of the respondent groups. The results showed that there are high agreement percent among the contractors, consultants and owners to the most probable and severe risk factors ranking.

The study identified that dramatic changes in the materials prices, adopting direct attribution system rather than tendering and bidding systems and lack of project suitable fund were the top-ranked risk factors in terms of their probability of occurrence. However, project stop or delay due to revolution, and riot was the top-ranked risk factor affects the project cost and time. Meanwhile, local or foreign currency exchange limitations and rate fluctuation risk factor comes in the second order regarding its impact on cost. The second order in terms of impact on time was occupied by lack of project suitable fund risk factor. These results were found logical due to the recent actions within the economic reform governmental plan after two revolutions faced the country at the beginning of this decade.

The analysis and findings for the risk groups concluded that the design stage risk factors and construction management risk factors were the most influential in the ENRBP according to the probability of occurrence and the impact on the cost and time of the project. It was found that the percent of ENRBP faced cost overruns forms 33.10 % of the total ENRBP and the percent of delayed projects represents 65.6 % of the total ENRBP. The most expected average increase of the cost overruns and time delays for the ENRBP was more than 20% of the project time schedule plan according to the results of the field survey conducted in this research.

IX. REFERENCES

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