Risk Decision Support System for Public Private Partnership projects in Egypt

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Abstract— Public Private Partnerships (PPP) started to be used in Egypt and there are several projects under study for future implementation. The two key success factors for PPP projects are a proper risk allocation and a suitable contract so that the risks are adequately covered and are properly assigned to the party who is the best at managing them. In this paper, the top 59 risk factors that affect PPP projects are identified from the Literature Review and from interviewing experts. These risk factors are grouped into several critical risk groups and included in a questionnaire which is distributed among a number of experts (25 experts) who work internationally and in the Egyptian Market. The results of the survey showed that the top 26 risks are from the following groups: financial and macroeconomic risk group, commercial risk group, legal risk group, political risk group, regulatory risk group, government maturity risk group, technical risk group, production risk group and unforeseen risk group. In addition, a prototype for Risk Decision Support System for the top ranked risks in the survey was developed using Crystal Ball software in order to determine the overall severity and the overall contingency percentage of the project. Finally the top risks are compared to the critical risks obtained from previous studies conducted in China, India and Singapore. The similarity in these top risks with other developing markets is assessed.

Index Terms—Contingency, Egypt, Public Private Partnership, Risk, Risk Allocation, Risk Decision Support System, Severity.

I. INTRODUCTION

Public Private Partnerships (PPPs) came into existence as a result of continuous challenges facing the public (governmental) sector in its attempts to improve services, facilities and infrastructure that demand challenging economic resources. Accordingly, the public sector resorted to the partnership with the private sector in order to deliver projects or public services that benefit from the private sector's experience, financial ability, management and technical skills. Consequently, PPP is used in various sectors all over the world especially in the infrastructure sector where it is considered as a "catalyst for economic growth" [1]. PPP scheme is believed to be able to deliver better value for money especially for infrastructure projects [2]. It has been noticed that there is an increasing attention towards the PPP scheme in developing countries [3]. In order to ensure the success of the partnership between the public and the private sectors, many aspects have to be taken into consideration to get the best

outcomes out of such collaboration. The long term nature of PPP contracts require to identify the key concepts present in the relationship between the public partner and the private partner such as the management of risks, quality of service required, value for money, how to handle disputes and how to deal with changes that may occur during the project's lifetime. One of the most important factors that should be thoroughly analyzed is *the proper and appropriate risk management*. The first step towards a good application of risk management is conducting sound risk identification and risk allocation between the private sector and the public sector in a way that each party bears the risks that it can best manage [2]. The main goal of this paper is to identify the critical risk factors associated with PPP projects in Egypt, a country facing challenging economic and political conditions after the January 2011 revolution. Many efforts have been deployed by the Egyptian government to standardize the process of partnerships between the private and public sector. This was done through the issuance of laws and through the establishment of the PPP Central Unit affiliated to the Ministry of Finance. Hence, the need for a proper methodology of drafting contracts and for risk analysis of PPP projects is crucial in order to get the best outcomes of these projects.

II. LITERATURE REVIEW

PPP is described as a venture between the government from one side and one or more private companies from the other side in which responsibilities, risks and rewards are shared for the aim of delivering a clearly defined and agreed upon scope. PPP is an output-oriented long term relationship between the public and the private party [5]. Fig.1 shows the amount of PPP investment (US $ billions) in the domain of infrastructure between 1990 and 2007 in developing countries [3].

The investment amount in PPP projects has been increasing since 1990 and till 2006 when it reached more than Sixty (60) US$ Billions. This obvious increase shows an expanding interest in the Private Sector involvement to meet the funding gap that faces the Public Sector especially in infrastructure projects.

There is no standardized nomenclature used for describing PPP projects. However, there is a scale for Public Private Partnerships which is defined by the degree of the Private sector involvement which ranges from the Design Build (DB)

where the private sector only designs and builds the project up to the privatization (Private Divestiture) by giving the private sector not only full control over the investment, operation and maintenance but also a permanent ownership of the facility's assets. In this case, the government only plays a regulatory role ensuring the protection of the customer from monopoly in addition to requiring some minor maintenance and/or investment in some cases. Privatization is done either by selling the facility's assets to investor(s), by performing a management buyout or by selling the facility's shares in the national stock market. The private divestiture can either be complete or partial where the government can still have a certain level of control over the facility by owning a certain percentage of the company's assets [8]. Fig.2 is developed by the PPP Central Unit in Egypt to describe the various levels of private sector participation in projects. They range from the Works and Services Contracts to the Concessions Contracts and finally full Privatization.
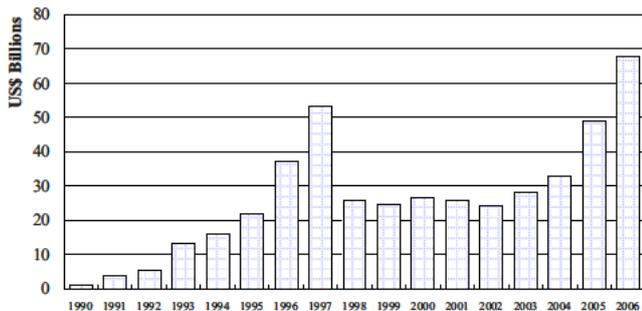

Fig. 1: PPP investment in infrastructure projects in developing countries [3]

Reference [7] shows that the Chinese economy has been recently prospering and growing at a fast rate. Between 2006 and 2010; 2,400 infrastructure projects were developed with a total budget of RMB 470 billion where some form of PPP was implemented. The Bird's Nest (National Stadium) in Beijing and Beijing Metro Line 4 (BJL4) are two major examples of PPP projects in China. The top 10 risks affecting PPP projects are: government intervention, poor public decision making process, government corruption, financing risk, inadequate law supervision system, public credit, subjective project evaluation method, interest rate fluctuation, conflicting or imperfect contract and change in market demand.
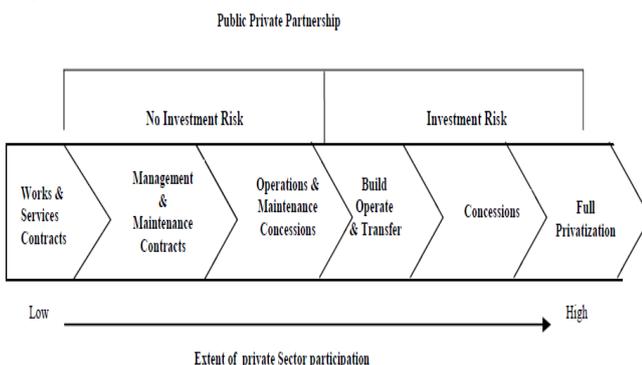

Fig. 2: Degree of private sector Participation in PPP projects according to the PPP Central Unit in Egypt [8]

These risks were obtained through an extensive literature review and a-two round Delphi survey which helped in identifying those risks. Then, data analysis was performed through statistical and analytical tools in order to rank the previously identified risks [7].

Reference [4] shows that the necessary financing for infrastructure projects in India for the next five years is approximately $ 448 billion in the water, ports, roads and airports projects. However, this cannot be achieved in India without the intervention of the private sector. Public Private Partnership is considered as a solution to enhance and improve India's infrastructure. According to this study, the major risks affecting PPP projects in India are: 1-Preinvestment risks: The project may be prone to cancellation or inadequate bid preparation. 2-Delay in financial closure: The private party may not have enough financial ability to execute the project. 3- Resettlement and rehabilitation operations: These may be necessary for habitants due to the new project, such as in the case of road projects requiring the displacement of habitants to allow the work to take place. 4-Delay in land acquisition: This may be due to political opposition or delays in permits. 5- Permit/approval risks: This may be due to the government corruption, poor documentation or poor coordination among the public sector parties. 6- Technology risks: Sometimes, the technology adopted may not be beneficial or suitable for the project. 7-Design and Latent Defect Risk: These risks may occur due to poor geological studies or deficiency in design. 8-Cost Overrun risks: This risk occurs when the project cannot be completed within the specified budget. This can be due to a certain party's fault or may be due to reasons beyond the party's control such as inflation or interest rate fluctuation. 9-Schedule risk: This risk occurs if the project cannot be completed within the expected time. 10- Direct political risks: This may be due to changes in law, nationalization or problems in getting the necessary approvals for the project.

Table I: Areas of concern in PPP papers from 1998 to 2003 [3]

Topic	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	%
Risk management	2	2	5	0	2	5	1	4	5	2	7	35	20.6
Integration research	4	3	0	0	6	1	2	5	6	4	3	34	20.0
Governance issue	0	1	1	3	0	7	1	1	6	4	7	31	18.2
Investment environment	0	1	2	2	0	5	2	1	4	2	2	21	12.4
Procurement	2	1	0	1	2	0	3	2	2	5	1	19	11.2
Economics viability	0	3	1	0	2	1	2	3	3	2	2	19	11.2
Financial package	1	0	0	2	0	4	0	1	2	1	0	11	6.5

In the period from 1998 to 2003, the papers published and tackling PPP scheme were initially studying 3 major aspects in PPP which are the risks associated with PPPs, procurement method in PPP and financial issue in PPP. Among these 3 major points of interest, papers published about risk management for PPPs account for approximately 21 % of the total number of papers published and concerning PPPs. Table I shows the major points of interest of PPP papers from 1998 to 2008. Accordingly, it is noticed that risks associated with PPP along with their management techniques occupy a considerable percentage and is considered as an area of

concern among the various topics and issues related to PPP [3].

III. RESEARCH METHODOLOGY

The adopted research methodology consists of four major steps; namely, A. Risk identification, B. Data collection, C. Data analysis and processing, and D. Data validation and verification as shown in Fig. 3.

A. Identifying risk factors

The first step in the methodology consists of identifying the risk factors. This is done through the Literature Review and by using customized interviews of risks' professional experts. The final grouping of risk factors with all the different risks under each group is shown in Table II.

Table II: Grouping of Risk Factors

#	Risk Factor
Factor 1: Macroeconomic and Financial Risks	
1	Interest Rate Fluctuation
2	Inflation
3	Foreign exchange fluctuation
4	Price Change
5	Operation cost overrun
6	Revenue Risk
7	Inability of concessionaire
8	Subjective Project evaluation method
9	Insufficient project finance supervision
Factor 2: Commercial and Market Environmental Risks	
10	Market competition
11	Supply and demand
12	Change in Market demand
13	Public Credit
Factor 3: Legal Risks	
14	Performance Security Risk
15	Permits Risks
16	Delay in project approvals/permits
17	Legislation changes
18	Dispute resolution
19	Change in tax regulation
20	Government policy
Factor 4: Political Risks	
21	Political/Public opposition
22	Swings in Public Opinion
23	Political Risk
24	Nationalization/expropriation
Factor 5: Regulatory Risks	
25	Regulatory/Contractual Risk
26	Government Intervention
Factor 6: Government Maturity Risks	
27	Poor public decision making process
28	Government corruption
29	Inadequate law and supervision system
Factor 7: Technical Risks	
30	Imperfect contract documents
31	Deficiency of design
32	Quality Assurance
33	Quality Control
34	Latent Defect Risk
35	Lack of supporting infrastructure
Factor 8: Construction and Operational Risks	
36	Project/operation changes
37	Inability of concessionaire
38	Provision of transformers, substations or backup power
39	Construction Risk
40	Organization risk
41	Coordination risks
42	Land acquisition
43	Physical Obstacles that cannot be avoided
44	Maintenance Risks
45	Access and delivery of site
46	Connection of Public utilities to boundaries of site
47	Connection to boundary of Site of telephone lines and natural gas provision
Factor 9: Resources Risks	
48	Labor unavailability
49	Material shortage
Factor 10: Production Risks	
50	Third party delay/violation
51	Planning risks
52	Supervision, organization and control for inspection of Construction works
53	Technological Risks
54	Completion risk
Factor 11: Environmental Risks	
55	Sustainability Risk
56	Antiquities Risks
Factor 12: Unforeseen Risks	

57	Unforeseen Weather conditions
58	Unforeseen geotechnical conditions
59	Force majeure
Factor 13: Other Risk(s) (Please Specify)	
60	

B. Questionnaire/Survey

The respondents for this survey are from the private Egyptian sector, public Egyptian sector and academic sector as well. All the respondents have worked in the domain of Construction Engineering in Egypt and abroad. All of them have worked in Egypt while some of them have, in addition to the Egyptian based experience, worked abroad whether in the Gulf, Africa, Australia, the United States and Canada. The guidelines of the questionnaire set by the researcher are to answer the questionnaire based on the Egyptian Construction market.
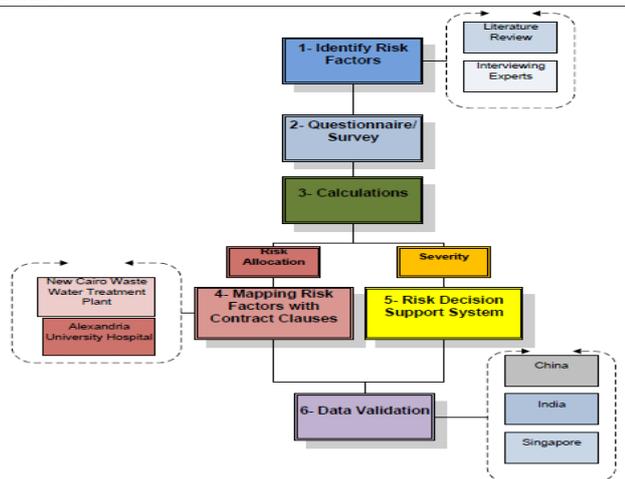
Fig. 3: Research Methodology

All of the respondents have been involved in PPP projects in Egypt. Respondents should have been involved in different types of PPP projects: educational, water and waste water, residential and transportation projects. The sample size for this questionnaire is 25 respondents. The majority of the respondents have more than ten years of experience in the domain of Construction and more than two years (up to six years of experience) in PPP projects.

In order to fill the survey, the respondent should specify the probability (likelihood of occurrence) and the impact of each risk on the project based on the respondent's experience and point of view. The probability and impact are both chosen on the Likert's scale raging form 1 to 5. Moreover, the respondent should specify whether this specific risk will be borne by/allocated to the private party, the public party or whether it will be shared by both parties. Also, the respondent has the right to add any risk factor which was not before included within the aforementioned risks. Definitions are provided in the questionnaire for all the risk factors presented in the survey in order to get a unified point of view from all the respondents about each risk factor.

Table III: Risk Ranking according to their normalized severity

#	Risk Factor	Average Severity	Normalized Value
1	Foreign exchange fluctuation	16.92	1.00
2	Political Risk	16.71	0.98
3	Inflation	15.24	0.87
4	Poor public decision making process	15.16	0.86
5	Government policy	14.72	0.83
6	Political/Public opposition	14.28	0.79
7	Lack of supporting infrastructure	14.24	0.79
8	Change in tax regulation	13.4	0.73
9	Government corruption	13.16	0.71
10	Legislation changes	12.88	0.69
11	Public Credit	12.48	0.65
12	Swings in Public Opinion	12.44	0.65
13	Dispute resolution	12.17	0.63
14	Nationalization/expropriation	11.88	0.61
15	Force majeure	10.92	0.53
16	Inadequate law and supervision system	10.6	0.51
17	Interest Rate Fluctuation	10.4	0.49
18	Regulatory/Contractual Risk	10.26	0.48
19	Delay in project approvals/permits	10.16	0.47
20	Price Change	10.04	0.46
21	Revenue Risk	10	0.46
22	Completion risk	9.95	0.46
23	Government Intervention	9.74	0.44
24	Permits Risks	9.63	0.43
25	Operation cost overrun	9.58	0.43
26	Supply and demand	9.17	0.40

C. Risk analysis and development of Decision Support System

After the probability and impact of each risk was determined through the survey results, the severity of each risk is calculated by multiplying the probability of the risk by the risk impact.

$$Risk\ Severity = Risk\ Probability \times Risk\ Impact \quad (1)$$

An average severity and standard deviation are obtained for each risk factor. These results are the ones used in the future calculations. The obtained values are normalized. The objective of the normalization procedure is to unify and adjust the data to a common scale so it can be better interpreted and analyzed. In order to get the normalized value for each risk, the following formula is applied:

$$Normalized\ Value = \frac{(Average\ Actual\ Value - Average\ Minimum\ Value)}{(Average\ Mximum\ Value - Average\ Minimum\ Value)} \quad (2)$$

After the normalization is performed, the risks are ranked according to their severity from highest to lowest. The top 50% of the risks with normalized values equal to or greater than 0.4 are highlighted in their descending order in Table III. The risks with severity values equal or greater than 0.4 are used later in a quantitative analysis (using a commercial software) to develop a Decision Support System (DSS). In the Decision Support System, there are two concepts: the first one is the "Experts Opinion" which is the opinion that was obtained through the analysis of the 25 surveys. The second

one is the "End user's opinion" which is the opinion of the user who is going to use the Decision Support System. This end user can be from the public sector or from the private sector. The idea of the Decision Support System is based on the fact that the end user has the flexibility of combining his opinion to the collective opinion of the experts. If the end user has a considerable background about risk management and about investment in PPP projects, then, he/she can assign a large weight to his/her opinions. On the other hand, if the end user does not have an experience about risk management or cannot determine the probability and the impacts of the risks, therefore, he/she should depend more on the experts' opinion. The inputs that the end user is required to provide are: the probability of each risk and the impact of each risk. The Decision Support System's output is the following: the average risk level based on the experts opinion, the average normalized risk level based on the experts opinion, the average risk level based on the end user's opinion, the average normalized risk level based on the end user's opinion, the overall risk level for the whole project, the overall normalized risk level for the whole project and the Contingency percentage for the whole project based on the most critical risks included in the questionnaire and based on the severity obtained. Based on the severity of the project and based on the contingency percentage associated with the risks in this specific project, the end user can decide whether this specific project should be accepted or not. The Decision Support system's calculations are based on the actual value contingency cost in a current PPP project performed in Egypt. Table IV is an extract from the Decision Support System (RDSS-PPP) showing the different deliverables of the Decision Support System after running the simulation:

D. Validation of top ranked risks

In order to check for the validity of the identified top ranked risks in this study, a comparison is performed against the top risks found in the literature for China, India, and Singapore.

1- Comparison with the top ranked risks in China

The survey results in China identified 17 critical risk factors with a normalized severity equal to or greater than 0.5[6], [7]. Those critical risk factors are compared to the critical risk factors identified in this study for Egypt. The similar risks in both countries are highlighted in Table V. When comparing the top 17 risks in Egypt to the top 17 risks in China, 7 risks are found to be on the same list but in different order. From the top 5 risks in China three risks are included in the top 17 risks of Egypt. The most critical risk in Egypt, the foreign exchange fluctuation risk is taking the twelfth rank in China. On the other hand, the government intervention risk which is the most critical risk in China occupies the twenty third positions in Egypt.

Table IV: Extract from the Decision Support System (RDSS-PPP)

3- Click "Start"				
Average Risk Level (Experts Opinion)	11.78		**Average Risk Level (Previous End User(s) Opinion)**	11.85
Average Normalized Risk Level (Experts Opinion)	0.41		**Average Normalized Risk Level (End User's Opinion)**	0.45
Maximum Severity	16.32		**Maximum Severity**	25.00
Minimum Severity	8.59		**Minimum Severity**	1.00
Overall Risk Level		11.84		
Normalized Overall Risk Level		0.45		
% of Contingency Cost in current Project		3		
Severity/Contingency (Slope of the Line) for current Project		0.15		
Contingency % for the New Project		3.00		

2- Comparison with the top ranked risks in India

17 critical risks are identified for India through interviews, literature review and case studies [4]. The top risks in both countries are highlighted in Table VI. When comparing the top 17 risks in Egypt to the top 17 risks in India, 5 risks are found to be on the same list but in different order. From the top 5 risks in India no risk are included in the top 17 risks of Egypt. The most critical risk in Egypt, the foreign exchange fluctuation risk is not appearing in the ranking of India. On the other hand, the pre-investment risk which is the most critical risk in India does not appear in Egypt's risks. When comparing the Egyptian model to the Indian model for PPP projects, it is noticed that the risk grouping according to the Indian study is different from that of the Egyptian study. For instance, according to the Indian study, the political risk is divided into direct political risks and indirect political risks. The direct political risks being the risks associated with expropriation, changes in law and the indirect political risks being the risks of war, riots or terrorism.

Table V: Comparison between top risks in Egypt and China

Risk #	Egypt (2013)	China (2012)
1	Foreign exchange fluctuation	Government Intervention
2	Political Risk	Poor public decision making process
3	Inflation	Government corruption
4	Poor public decision making process	Financing risk
5	Government policy	Inadequate law and supervision system
6	Political/Public opposition	Public credit
7	Lack of supporting infrastructure	Subjective project evaluation method
8	Change in tax regulation	Interest rate fluctuation
9	Government corruption	Conflicting or imperfect contract
10	Legislation changes	Change in Market demand
11	Public Credit	Insufficient Project Finance Supervision
12	Swings in Public Opinion	Operation Cost Overrun
13	Dispute resolution	Foreign exchange fluctuation
14	Nationalization/expropriation	Inflation
15	Force majeure	Project/Operation changes
16	Inadequate law and supervision system	Completion risks
17	Interest Rate Fluctuation	Price Change

Table VI: Comparison between top risks in Egypt and India

Risk #	Egypt (2013)	India (2010)
1	Foreign exchange fluctuation	Preinvestment risks
2	Political Risk	Delay in Financial Closure
3	Inflation	Resettlement and Rehabilitation
4	Poor public decision making process	Delay in Land acquisition
5	Government policy	Permit/Approval risk
6	Political/Public opposition	Technology risk
7	Lack of supporting infrastructure	Design and latent defect risk
8	Change in tax regulation	Cost Overrun risk
9	Government corruption	Schedule risk
10	Legislation changes	Direct political risk
11	Public Credit	Indirect political risk
12	Swings in Public Opinion	Legal risk
13	Dispute resolution	Financial risk
14	Nationalization/expropriation	Nonpolitical force majeure risk
15	Force majeure	Partnering risk
16	Inadequate law and supervision system	Environmental risk
17	Interest Rate Fluctuation	Physical risk

According to the Egyptian study, the division of risks is different where the political risks are not divided as in the Indian case and the nationalization/expropriation risk is identified as a separate risk factor. The delay in land acquisition, which is the fourth ranked risk in India is taking the forty second rank in Egypt. Also, some risks have a different nomenclature in both countries such as the interest rate fluctuation risk in Egypt which is taking the seventeenth position is already covered under the financial risk in India. Also, due to the difference in the conditions between both countries, India identified a separate risk factor named "nonpolitical force majeure" which is related to the natural disasters such as floods and earthquakes. This risk is not likely to occur in Egypt. For instance, the unforeseen weather conditions risk in Egypt is taking the last position in the 59 identified risks in the questionnaire. The latent defect risk which has a low severity according to the Egyptian study is taking the sixth position in India.

3- Comparison with the top ranked risks in Singapore

Table VII: Comparison between top risks in Egypt and Singapore

Risk #	Egypt (2013)		Singapore (2012)	
	Risk Factor	Allocation	Risk Factor	Allocation
1	Foreign exchange fluctuation	Both	Lack of support from Government	Public
2	Political Risk	Both	Availability of finance	Private
3	Inflation	Both	Construction time delay	Private
4	Poor public decision making process	Project Dependent	Inadequate experience in PPP	Both
5	Government policy	Both	Unstable government	Public
6	Political/Public opposition	Both	Lack of legal/regulatory framework	Public
7	Lack of supporting infrastructure	Both	Site Safety and Security	Private
8	Change in tax regulation	Project Dependent	Construction cost overrun	Private
9	Government corruption	Private	Organizational and communication risk	Private
10	Legislation changes	Project Dependent	Strong political interference	Public
11	Public Credit	Both	Inflation	Both
12	Swings in Public Opinion	Both	Interest rate	Both
13	Dispute resolution	Both	Corruption and bribery	Both
14	Nationalization/expropriation	Private	Inadequate distribution of responsibilities	Both
15	Force majeure	Both	Delay in approval and permits	Project Dependent
16	Inadequate law and supervision system	Project Dependent	Inconsistent Legal/regulatory framework	Public
17	Interest Rate Fluctuation	Both	Inadequate distribution of authority	Both
18	Regulatory/Contractual Risk	Project Dependent	Lack of commitment between parties	Both
19	Delay in project approvals/permits	Both	Poor financial market	Private
20	Price Change	Both	Differences in working method	Both
21	Revenue Risk	Project Dependent	Excessive contract variation	Project Dependent
22	Completion risk	Private	Financial attraction of project to investors	Private
23	Government Intervention	Project Dependent	Level of demand for project	Private
24	Permits Risks	Both	Operation Cost overrun	Private
25	Operation cost overrun	Private	Material availability	Private
26	Supply and demand	Both	Low operation productivity	Private

A third comparison is presented in this research which is the comparison with Singapore where the top ranked risks are identified along with the proposed risk allocation for each risk [2]. The risk ranking and the risk allocation of the top 26 ranked risks in Singapore are compared with the top 26 ranked risks in Egypt in table VII. When comparing the top 26 risks, 8 risks are found to be on the same list but in different order. The top ranked risk in Singapore is the lack of support from the government differs from Egypt where the top ranked risk is the foreign exchange fluctuation risk

IV. CONCLUSION

Risk management is a crucial step that ensures the success of PPP projects especially in Egypt, a country that faced challenging economic conditions since the 2011 revolution. In this research, 59 risk factors were identified through the Literature Review and through interviewing experts. The identified risks were included in a questionnaire distributed among 25 experts who assessed the probability, impact and severity of each risk factor in addition to the risk allocation. According to the survey results, the most severe risk groups affecting PPP projects in Egypt are: financial and macroeconomic, commercial, legal, political, regulatory, government maturity, technical, production and unforeseen risk groups. The Risk Decision Support System for the top ranked risks is developed in order to determine the overall risk level (overall normalized severity) and the overall contingency percentage that should be assigned to the PPP project. In order to overcome the current Decision Support System limitations and in order to increase the accuracy of the results, future work is suggested such as increasing the relatively small sample size of the survey respondents. This small sample size is due to the unfamiliarity of many experts in the domain of Construction Engineering with the nature and with the risks associated with PPP projects. Also, repeating the questionnaire in case of any update in the conditions of the country in order to assess how this change is affecting the domain of PPP can be a beneficial step. In case more projects are executed under the PPP scheme, an addition can be done to the Decision Support System which is including a summary for the data obtained from previous projects. This summary will include the severity ranges and the corresponding contingency percentage that are allocated for each severity range. In this case, after the end user assigns the weight of his opinion in addition to the probability and impact of each risk, the end user will insert the estimated project cost. Based on the severity obtained from the model, the Decision Support System will help the user knowing the range in which his project falls and accordingly it will calculate the additional project cost caused by the contingency. In this case, the Decision Support System develop will not only be a tool for estimating the contingency percentage associated with the project, but also will deliver a quantified forecast about such project. Such forecast can help

both the private and public sector in taking their decision regarding any given PPP project.

From the validation step, which is comparing the top ranked risks in Egypt to the top ranked risks in China, India and Singapore, it can be concluded that Singapore, China and India are respectively close to Egypt in terms of the risk affecting PPP projects.

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