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Risk Assessment For The Construction Of Airports' Projects In Egypt Using BIM

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الملخص:

يؤدي تعقيد مشاريع البناء في المطارات جنبًا إلى جنب مع مشاركة العديد من الأطراف في إثارة مخاطر متعددة يجب إدارتها بشكل فعال طوال المراحل المختلفة من المشروع للنجاح في تحقيق أهداف المشروع. أظهرت إمكانات نمذجة معلومات البناء (BIM) مثل النمذجة ثلاثية الأبعاد والجدولة والتخطيط رباعي الأبعاد وتقدير التكلفة 5D إمكانات واعدة في تحسين عمليات إدارة المخاطر من خلال المراحل المختلفة لدورة حياة المشروع.

ناقش باحثون متعددون الإمكانيات التي تقدمها BIM في إدارة المخاطر بشكل عام دون دراسة حالة لمناقشة التحسينات التي تقدمها بشكل واضح على طول عمليات إدارة المخاطر. وبناءً على ذلك ، يهدف هذا البحث إلى تحديد أهم عوامل الخطر المتعلقة ببناء مشاريع المطارات في مصر أثناء استخدام BIM ، ومناقشة مدى تأثير BIM على عوامل الخطر ، وتحديد درجة استخدام BIM في مصر والعقبات التي تعترض استخدامه .

للوصول إلى الأهداف المذكورة أعلاه ، تم عقد اجتماعات للخبراء لجمع البيانات الخاصة بعوامل الخطر جنبًا إلى جنب مع استبيان الذي ساعد في إجراء التحليل النوعي للمخاطر. تمت مقارنة تحليل المخاطر هذا مع التحليلات السابقة التي أجريت قبل استخدامBIM .

Abstract:

The complexity of Airports' construction projects together with the involvement of many parties results in the arousal of multiple risks that should be managed effectively throughout the different phases of the project to succeed in achieving project objectives. Building information modelling (BIM)'s capabilities like 3D modelling, 4D scheduling and planning, and 5D cost estimation showed a promising potentials in improving risk management processes through the different phases of the project lifecycle.

Multiple researchers discussed the possibilities BIM is offering in Risk Management in a general way without a case study to clearly discuss the improvements it offers along risk management processes. Accordingly. This paper aims to identify the most significant risk

factors related to the construction of airport projects in Egypt while using BIM. It is discuss the extent to which BIM affects risk factors, determine the degree to which BIM is used in Egypt, and the obstacles to its usage. To reach the above objectives, experts' meetings were conducted to gather data for the risk factors together with a questionnaire survey that assisted in performing qualitative risk analysis. This risk analysis was compared with previous analyses that were conducted before using BIM.

Keywords:

Airports construction; Risk management; BIM

1. Introduction and background

Construction industry has proven with no doubts that it's the main key for economic developments in any country. Infrastructure projects have a big share in the latest developments as it is considered the most important factor for countries' evolution among which airport projects. According to world Bank in 2012(World Bank (2012): Cairo's Airport Expansion: a Gateway to Growth, June 4 2012), 80% of tourists enters Egypt through airports providing 2.5 million jobs directly and indirectly.

Conventional risk management, that is dependent on the experience /intuition of individuals, isn't enough anymore with technology capabilities appearing around us. Many studies were conducted on BIM capabilities that can be effectively used in managing risks. As airport projects construction are more complex and the consequences of not managing their risks are more critical, it has become a must to take advantage of the technologies surrounding us like BIM.

1.1 Airports

The Air Transport Industry (ATI) is one of the most important infrastructure development area to the evolution of countries economically wise from under-developed to well developed. ATI is essential for global trading, business & tourism which makes it vital for economic growth for any country welling to develop (century to develop from an agrarian to industrial economy with infrastructure development leading the way. The United States took approximately a hundred years beginning in the mid 19 n.d.). The quality, availability, adequacy & reliability of infrastructure system of a country are vital to survive and compete globally (Alnasseri, Osborne, and Steel 2013).

Alnasseri et al. (Alnasseri, Osborne, and Steel 2013) stated that Airport construction projects are very complex in nature with unique characteristics. A number of a significant and diverse activities are performed in airports, whether related to airside, terminal or landside areas. A lot of parties, tools & techniques are included in airport construction activities. this requires management, communication & the application of effective management techniques & tools to ensure project success.

Every project is a result of converting an initial concept into a final output that satisfies owner's needs & hopes. The presence of risk & uncertainty means a path that can never be forecasted with absolute certainty (Flouris and Lock 2009).Due to the high complexity and the previous factors attributing to the construction of airports projects the level of uncertainty is considerably high.

1.2 Risk Management

Risk is defined as the possibility for problems and complications that could hinder the completion of the project and achieving projects' objectives (Rezakhani 2012).

The assessment and evaluation of the uncertainties related to events is the concept of risk as proposed by Kangari (Kangari 1988)

While Risk Management is defined as a systematic method to identify, analyze and respond to risk factors to achieve project's objective (Bahamid and Doh 2017).

Risk management is the process of minimization of the probability and impact of negative risks that could harm projects' objectives and maximization of the probability and impact of positive risks (Iqbal et al. 2015).The high dependence of the process on the experience of individuals decrease its effectiveness .

1.3 BIM and risk Management

BIM is believed to have the ability to transform the construction industry (Doan et al. 2019). BIM is now considered not only as a technology but as a process that is changing design, communication & project delivery (Zou, Kiviniemi, and Jones 2017) as shown in Figure 1.

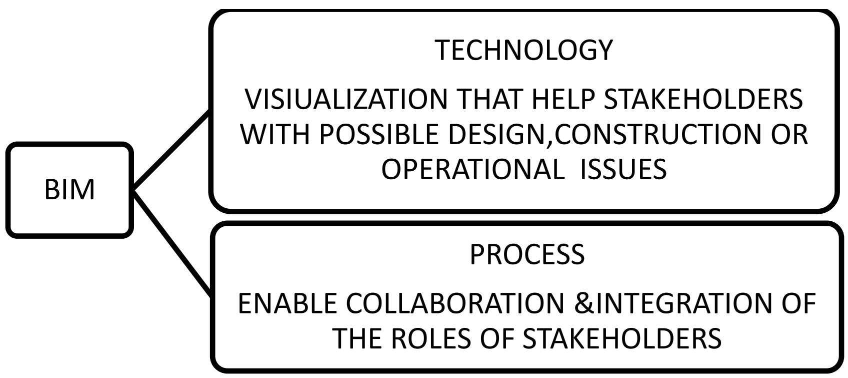

Figure 12: BIM Definition

To overcome the challenges facing conventional risk management, several attempts to establish a link between risk management and BIM have been conducted.

Ganbat et al summarized the risks that BIM can assist in, risks that BIM can't assist in and the obstacles to BIM usage into Figure 2 (Ganbat et al. 2018) .

Figure 13: Summarized Capabilities and hinders

Many researchers studied and summarized BIM capabilities such as Zou et al.(Zou, Kiviniemi, and Jones 2017) like 3D modelling, 4D scheduling, Clash detection,…etc. that can effectively assist in risk management processes.

2. Methodology

The first step in this research is risk identification, which is the source of input data needed. A list of risk factors, which could affect the airport construction projects while using BIM, was identified through extensive literature review and structured questionnaire survey. Participants were asked to provide the probability and impact for each risk factor according to their point of view. Then the data collected is analyzed statistically using Statistical Package for the Social Sciences (SPSS) and is compared with results from previous studies on risks in airport construction projects without using BIM.

2.1 Questionnaire survey

A questionnaire survey was conducted on 76 participants while allowing the diversity of this sample from background, years of experience and company role point of view to accurately represent the total population in airport construction industry in Egypt. The questionnaire was in a Google Form to simplify the process and they were given Assessment criteria was provided as the probability and impact scale tables below along with what each number presents to simplify the analysis process.

Table 4: Probability scale table

Probability	Score	Description
Very low	0.1	Highly unlike to occur
Low	0.3	Unlikely to occur
medium	0.5	Likely to occur
high	0.7	Very likely to occur
Very high	0.9	Highly likely to occur

Table 5: Impact scale table

Impact	Score	Description
Very low	1	Insignificant impact on the project
Low	3	Minor impact on the project
medium	5	Measurable impact on the project
high	7	Significant impact on the project
Very high	9	Major impact on the project

Risk factors are presented under their main categories. Participants can add risk factors they believe weren't available in the questionnaire and provide the probability and impact for each risk according to the assessment criteria provided.

A statistical analysis was used to calculate the mean, mode, standard deviation, standard error of mean and confidence interval. SPSS was used to aid on these calculations.

Mean: for ungrouped data, the mean is computed by summation of the data values and divided by the number of values as shown in the following equation (Ali and Ibrahim 2009)

$$X = \frac{1}{n} . \Sigma \, f \, (X_n) \qquad (1)$$

Where;

X = Average mean.

Xn = (Scoring scale which is the multiply of probability and impact).

f = Frequency of each observation of each factor.

n = Number of observation for each factor.

While Risk score is calculated by multiplying the average of probability and the average of impact for every risk factor. Thus, the risk score for each risk is represented by the following equation (Shen & George 2001) (Ali and Ibrahim 2009):

$$Rs_i = \frac{\Sigma (P_r)_{ij}}{n} . \frac{\Sigma I_{ij}}{n} \qquad (2)$$

Where:-

RSi = Risk score for risk (i).

(Pr) ij = Probability of occurrence of risk (i) assessed by participant (j).

Σ (PS) ij / n = Average probability of occurrence of risk (i) that was calculated by statistical program "SPSS".

(I) ij = Degree of impact of risk (i), assessed by participant (j).

Σ (I) ij / n = Average degree of impact of risk (i) that was calculated by statistical program "SPSS".

n = Number of respondents.

2.2 Results

Participants provided the probability and impact of every risk factor. Risk scores were then calculated using SPSS then compared with results from previous studies. The figure below represents the percentage of difference of risk scores from previous studies in the same field before using BIM. Risk factors were given a codes to facilitate the process.43 Risk factors were the ones focused upon in this research and presented in Figure 3.

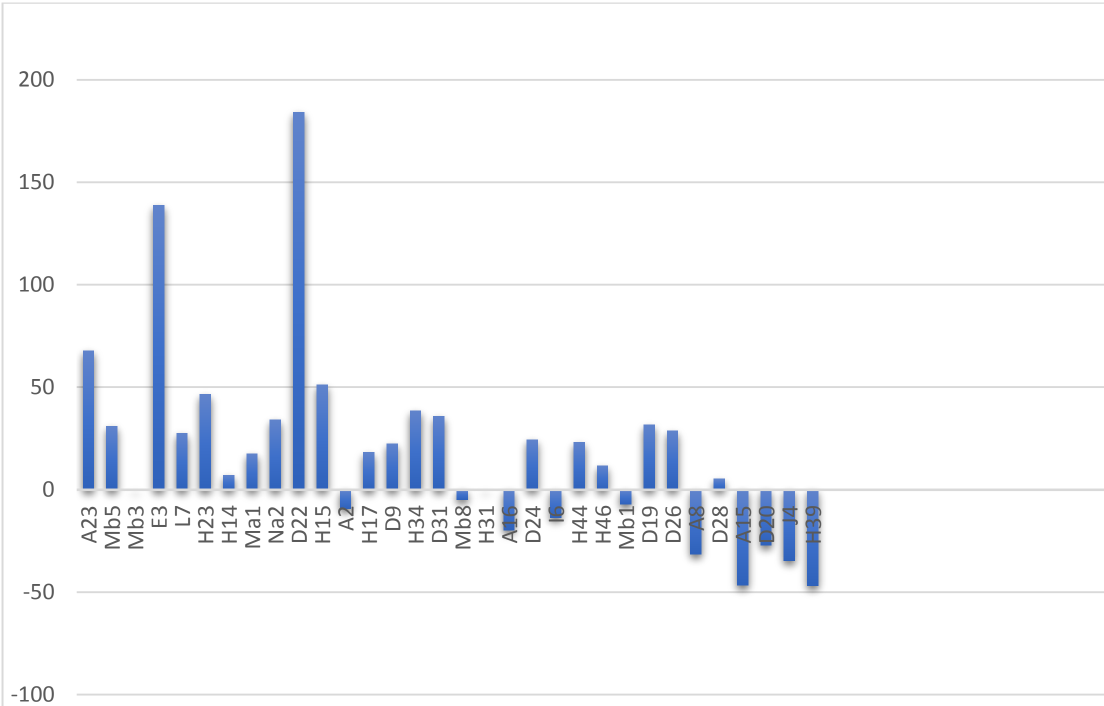

Figure 14: Comparison with previous studies

Not all risk scores showed improvement comparing to previous studies. This is because of several factors among which that previous studies in similar topic were in 2009 before the revolution and inflation besides the current increase in the complexity of construction projects. In addition to an important factor which is that BIM capabilities aren't fully used in Egypt.

Table 3 presents the risk factors that haven't shown any improvement as perceived per the above chart.

Table 3: Risk Factors

RISK CODE	RISK FACTOR	RISK CODE	RISK FACTOR
G5	The project effect on environment (dust, noise, diseases…) the environmental effect on the place and surrounding areas	D26	Inconstructable designs
D22	Insufficient information for site investigation (include site access definitions of site boundaries) which leads to extra work.	D24	Conflict and miscoordination in design due to more than one consultant in project

E3	Poor traffic flow& conditions: resulting in difficulties with transportation of material, labor, or equipment.	Ma4	Low productivity of labors
H38	Bad planning for enabling works.	H44	Submittals approval from many parties and their notes is a must
A23	Improper risks and contingency budgeting, underestimating budget which leads to cost overruns	D9	Defective design: decrease the accuracy of tender price
E4	Restrictive site conditions: Such as the intensive security, or working restriction	H17	Defective works
H15	Low construction productivity: inadequate supervision and /or deteriorated equipment	Ma1	Labor skill level: competency level of labor is low.
H33	A lot of design changes during construction	Nb9	If the client is related to an authority/government
H23	Change of key staffing throughout the project.	H46	Inadequate work sequence and construction methodology
Nb4	Claims: owner refuses compensating the contractor for any submitted claim	Mc7	Poor major equipment plan
H34	Constructability reviews (use of unsuitable construction methods)	H14	Adequacy of construction schedule depicting durations, sequencing
D31	Conflict and ambiguity between contract documents	D28	Bad location (electromagnetic waves, military waves…).
Na2	Poor coordination between subcontractors	D26	Inconstructable designs
D19	Interfacing between engineering and procurement (in design process).	D24	Conflict and miscoordination in design due to more than one consultant in project
Mb5	Increase of material price		

While Figure 4 below represents the improvement in risk factors as per provided data.

Figure 15 : Improved Risk Factors

According to the previous chart, the improvement in the risk scores of the above-mentioned factors from 2009 to 2020 is from 46.8% to 0.43%. Not all improvements are related to BIM like revolution and exchange rate variations, which are in fact due to the stability after the previous storm. The improvements in design, coordination, scheduling and budgeting are the ones directly related to BIM. BIM is expected to have such improvements on risk factors due to the capabilities it's offering but in fact there are many other capabilities that are wasted and not taken enough advantage of. BIM is limited in usage in Egypt in the criteria of design, clash detection and sometimes scheduling and budgeting. While the usage of BIM in risk management, safety, quality, site management, etc. is totally neglected. Such capabilities could have saved money, effort and time the factors that can transform any country to a well-developed one. What hinders BIM full usage in Egypt is the question that must be answered to fully recognize the situation and develop actions that can help in improving the usage thus improving the outcomes. This question was given at the end of the questionnaire. Figure 5 below represents their answers.

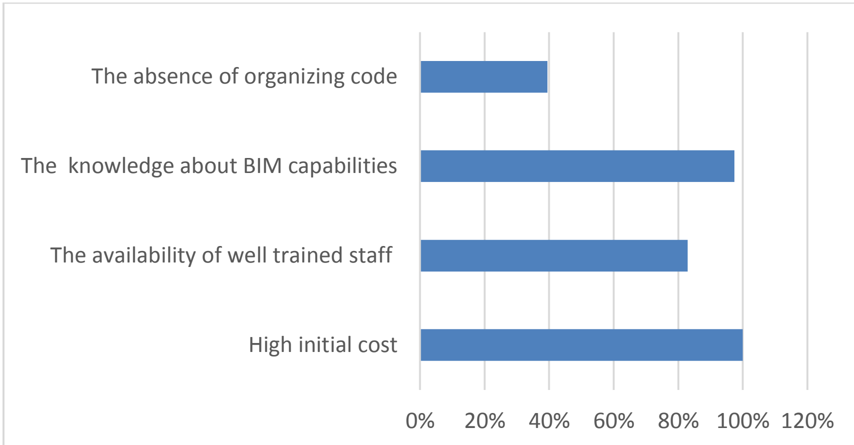

Figure 16:Obstacles Facing BIM in Egypt

As shown above there are multiple reasons from participants' point of view,100% of the participants mentioned the high cost of BIM software programs. The majority blamed the availability of adequate trained staff to work on such applications and the actual knowledge about the capabilities of BIM and the potentials it offers. About 40% of the participants perceive the absence of organizing code as an obstacle toward BIM widely usage.

3. Conclusions

The main objectives of this research were to identify the most significant risk factors facing Airports' construction in Egypt, study the effect of using BIM on these risk factors, identify to what degree Egypt is using BIM on current projects and what renders its application in the industry. A 236 risk factors were identified, coded and categorized where 43 risk factors were focused upon in our study. Comparing their risk scores to the latest study in the same field that took place in 2009 showed that not all of the 43 risk scores improved over the years. While the improvement percentage was found to be between 46.8% and 0.43%. Not all the improvements are because of BIM clearly as there are multiple risk factors that can't be related to it. Analyzing these risk factors emphasized that the usage of BIM in Egypt is limited to 3D modeling, scheduling and sometimes budgeting. Accordingly, the improvement in the design, coordination, scheduling, budgeting and controlling was found to be between 31.449 % to 0.43%.

Many BIM capabilities are wasted and not fully incorporated in the industry due to many factors that were mentioned by the participants in the questionnaire like the high cost of BIM programs, which 100% of the participants agreed upon. While the majority (80 to 100 %) of the participants added the knowledge of BIM capabilities and the lack of trained staff to the factors hindering BIM usage and about 40% blamed the absence of an organizing code that clearly identifies roles and responsibilities while using BIM.

3.1 Recommendation for future work

A research on risk factors under BIM usage can be done on other mega infrastructure projects like roads, bridges, ….etc

4. References:

Ali, Eng, and Mohsen Ibrahim. 2009. “Risk Management in Airport Construction Projects in Egypt By Risk Management in Airport Construction Projects in Egypt.”

Alnasseri, Nasser, Allan Osborne, and Glenn Steel. 2013. “Managing and Controlling Airport Construction Projects: A Strategic Management Framework for Operators.” *Journal of Advanced Management Science* 1(3): 317–20.

Bahamid, R. A., and S. I. Doh. 2017. “A Review of Risk Management Process in Construction Projects of Developing Countries.” *IOP Conference Series: Materials Science and Engineering* 271(1).

“Century to Develop from an Agrarian to Industrial Economy with Infrastructure Development Leading the Way. The United States Took Approximately a Hundred Years Beginning in the Mid 19.”

Doan, Dat Tien et al. 2019. “What Is BIM? A Need for A Unique BIM Definition.” *MATEC Web of Conferences* 266(January): 05005.

Flouris, T. G. and, and D. Lock. 2009. *Managing Aviation Projects from Concept to Completion*. Farnham, Surrey, England: Farnham, Surrey, England ; Burlington, VT : Ashgate.

Ganbat, Tsenguun, Heap Yih Chong, Pin Chao Liao, and You Di Wu. 2018. “A Bibliometric Review on Risk Management and Building Information Modeling for International Construction.” *Advances in Civil Engineering* 2018.

Iqbal, Shahid et al. 2015. “Risk Management in Construction Projects.” *Technological and Economic Development of Economy* 21(1): 65–78.

Kangari, Roozbeh. 1988. “Construction Risk Management.” *Civil Engineering Systems* 5(3): 114–20.

Rezakhani, Pejman. 2012. “Classifying Key Risk Factors in Construction Projects.” *The Bulletin of the Polytechnic Institute of Jassy, Construction and Architecture Section* 62(2): 27–38. http://www.ce.tuiasi.ro/~bipcons/Archive/292.pdf.

“World Bank (2012): Cairo’s Airport Expansion: A Gateway to Growth, June 4.” 2012.

Zou, Yang, Arto Kiviniemi, and Stephen W. Jones. 2017. “A Review of Risk Management through BIM and BIM-Related Technologies.” *Safety Science* 97(May 2016): 88–98.

http://dx.doi.org/10.1016/j.ssci.2015.12.027.