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Analysis of Construction KPIS Risk for Sustainable Buildings

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Abstract : Recently, a rising number of green buildings have been constructed across the globe in response to increased attention and promotion from scientists, as well as conventional structures, and that the development of green buildings confronts various risks. It is the goal of this research to identify and simulate the performance of Intelligent Buildings (IBs). Engineers, clients, producers, and end-users can use Key Performance Indicators KPIs developed by the authors to better understand and promote the value of risk design by looking at a variety of building types. Components are included in the tools that deal with sustainability issues related to the environment, culture, and economy. Intelligent buildings' value is evaluated in relation to their design for different uses and their ability to meet a variety of needs, including the needs of occupants and users, as well as their ability to meet sustainability, whole life value, health, and emotional needs of occupants and users. Experts provide risk-mitigation risks. A thorough investigation was undertaken, as well as a questionnaire. The survey's findings revealed that the complicated processes for gaining permissions, the high initial cost that is neglected, the owners' imprecise needs, and the lack of and availability of information are all factors that need to be considered. The use of green materials and equipment is one of the top five priorities. The survey's risks revealed that green building construction projects are more perilous than standard structures. This study suggested 13 risk mitigation measures to address risks in green building construction projects, and (35) groups were categorized Main, the structured interview technique was adopted to obtain opinions from 100 construction specialists for different construction projects.Through this paper, the risks and performance rates were studied to know the effect on time and cost of green buildings and compared to traditional buildings, and a mathematical model was designed to be used through a computer or phone to reach the extent of the impact of the results of this research on the time and time of the project.

KEYWORDS: Project risk management, Risk assessment, Framework

Introduction

Green buildings are structures that are designed and built to be sustainable, based on international standards developed by competent institutions to assess the building's environmental compatibility. It is an environmentally responsible method that promotes resource efficiency across the building's life cycle, including design, construction, upkeep, renovation, and demolition. The buildings that were constructed today differ greatly from the buildings that were constructed 100 years ago, and energy consumption in buildings increases with improved standards of living and population growth (Zhao et al. 2015), and it is expected that energy consumption in the world will increase by 33percent from 2010 to 2030. (Abdul-Aziz et al 2011). Due to the detrimental effect on the environment caused by the extraction, processing, transportation of raw materials, the building construction and operation sector uses around 40% of global resources and generates roughly 25% of worldwide garbage (Elms et al. 2007 Ding 2008).As a result of renovations, reduced energy consumption and improved indoor climate issues can result in additional benefits such as reduced government subsidies, improved health due to less air pollution in the workplace and better worker productivity. This is the essence of evaluating a renovation project's sustainability. Key Performance Indicators (KPIs) have become one of the most widely used and valuable tools for measuring the level of sustainability of construction projects in recorded literature. This demonstrates the significance of the building materials themselves. Although Egypt's construction industry has grown rapidly in recent years, the industry is still plagued by rework, which no construction project can avoid. Non-conformity features are restored to an acceptable condition, including fixed aspects that contradict the initial standards (Aiyana, 2013), via rework. Due to fast globalization and industrialization in developed and developing nations, societies have been forced to adapt and embrace new methods. The construction sector contributes to numerous sustainability concerns as a result of these difficulties (Oke and Aigbavboa 2017).

2.Literature review

2.1Green buildings and Traditional buildings in the Middle East countries

Green buildings have witnessed tremendous expansion as a result of current environmental challenges (Azeem et al., 2017), yet there is a research gap when it comes to applying PRM in this situation (Hwang et al., 2017). There's a resemblance to traditional constructions. As a result of the introduction of sustainable components in building projects, there has been an increase in green dangers (Yang and Zhou, 2014).

Green buildings are distinct from regular buildings in terms of risks. The knowledge of hazards in green buildings has grown as a result of limited research on risk identification linked to design methods. To begin, a database search was performed utilizing (the Scopus database) and the search code (TITLE-ABS-KEY) to find contracts relating to each of the green buildings.(Samuel 1996) mentions that risks are an inevitable necessity that cannot be avoided in building and construction projects, while (Rodger and Joson 1999) defines risks as the possibilities of loss or profit resulting from a state of uncertainty or certainty and the most critical risk factors for minimizing the cost implications of LEED-certified projects when contractors and subcontractors disagree on criteria within their fields of knowledge and competence . According to(Zhao et al. fuzzy 2014) synthetic assessment approach (Zhao's method), the highest risk factors were high certification costs, lack of expertise in new products, materials, and technologies, inadequate identification of the project's contractual obligations, and an incorrect cost estimate. It is possible to reduce project costs and hazards by using green project management principles

Through these studies alone, we reached 35 sources of risk that green projects may be exposed to, whether through previous research or through interviews with experts in the Middle East countries that were studied.

2.2. Green Building Construction Projects' Risks

Construction projects for environmentally friendly residential buildings are still largely unstudied when it comes to potential risks. However, research into generic green building construction has grown in recent years, supposing that similar risks apply to projects for environmentally friendly residential construction. So in order to come up with a comprehensive list, the dangers associated with general green building construction projects are thoroughly investigated in this section.

There have been a number of recent studies looking at the various dangers involved with green building construction. Ranaweera and Crawford state that eco-friendly building projects are more expensive to complete and hence more likely to have budget overruns than traditional construction projects. LEED certified construction projects.Dewlaney et al. found a 36% increase in laceration, sprain, and strain injuries among those working on LEED projects compared to those not involved in LEED. Green building construction was said to be vulnerable to errors and omissions by design professionals and contractors as well as subcontractors. Also, they claimed that owners of green building construction projects risk being sued by their tenants or residents, losing tax advantages, and losing preferential financing or loans if they don't meet the required level of green certification.

(Zou and Couani, 2012)compiled a list of 38 dangers related to green building development and performed a study. Financial risk, timetable delay risk, building goods and materials risk, design guodeline availability risk, and energy saving uncertainty were the top five hazards identified in their study. (Yang and Zhou and Wang , 2016) used the Social Network Analysis (SNA) technique to establish stakeholder-associated risk models to investigate the dangers of green building construction projects. Ethical and reputational concerns were detected by a wide spectrum of stakeholders, although technical risks were not as big as previously imagined, according to the research. It was found that 20 possible risks in green retrofit projects have been studied by (Hwang et al.2017) They were Prior to retrofit tenant collaboration, legislation, market demand, project funding, stakeholder cooperation (including availability and accessibility of materials), and building quality were the eight most critical hazards that they looked at in-depth at this time.

(Qin, Mo, and Jing , 2016) performed an online questionnaire poll in China in order to determinethe most crucial hazards connected with Chinese green building construction projects.Bureaucracy in the approval process, a lack of competence in designing and managing green buildings, and an erroneous aim set by the owner/developer ranked as the top five most important dangers.(Zhao, Hwang, and Gao , 2016) established a green building risk paradigm that categorizes risk indicators into seven groups. A fuzzy model was developed by (Zhao, Hwang, and Gao , 2016) investigated these risks, and the findings revealed that erroneous cost forecast was the most significant risk element in green building construction projects, and cost overrun was the top critical risk category. Risks in green building construction projects may now be identified thanks to an in-depth research described above. As shown in Table 1, a preliminary list of 35 threats is provided, together with information on their sources and countries of origin.

2.3. Measures for Reducing Risk in Green Building Construction Projects

The presence of dangers is accompanied with advice on how to lessen the impact of those dangers. New risk-mitigation strategies for green building construction have recently emerged. Using the decision-making method described by Ranaweera and Crawford (2010), for example, it is possible to lessen the financial risks associated with sustainable design by incorporating environmental practices into building projects. According to (Tollin,2016) minimized by investing more in research and development and hiring experts.

For a green educational building construction project in the Middle East, (Yang and Zou's,2014) found that a SNA-based risk management model helped contractors better interact and communicate, which they applied to the project. Measures have been put in place by (Hwang, Zhao, See, and Zhong , 2015) to limit the dangers of green retrofitting. In addition to making green building more accessible to the general public, the "Design & Build" delivery method also helped stakeholders better understand each other's concerns about the project's environmental impact. This study also compiled a list of 13 risk-mitigation measures for green residential building construction. Information about the analysis and discussion of data can be found in the section of data analysis and discussion.

3. The aim of the research study

To identify Key Performance Indicators (KPIs) by finding out what the risks to green facilities are and what actions can be taken to mitigate those risks, as well as how risk mitigation can be measured in relation to green building project development.

4. Research Methodology and Data Presentation

This research presents the risks facing green facilities, as an investigation was conducted in the literature to determine the factors that affect green facilities during the construction process and identify Key Performance Indicators (KPIs). Interviews and discussions were held with experts about the design of green facilities and how to reduce the risks facing green facilities during design. And we made a questionnaire form to assess the risks that affect the time and cost of the project, where the risk scale ranges from (1-5). Through the questionnaire, statistical indicators were used to analyze the answers of the participants in the questionnaire, and through these answers, these factors were classified using indicators that illustrate the impact of risks on green facilities. And this information was collected on an application (Android) used on phones to know the risks to green facilities. The government recommends making facilities when accessing search results that reduce the risks facing green facilities.

4.1. Data Collection and Presentation

This research used a questionnaire to identify and assess hazards, as well as related studies to develop risk mitigation strategies for green construction projects. The results revealed 35 risks and 13 risk reduction strategies. Experts were urged to complete the new risk assessments and analyze their severity based on their real-world experience. For the final questionnaire, respondents and their linked businesses are asked to identify themselves as well as to assess how each risk affects green and conventional building projects, in addition to evaluate the effectiveness of risk mitigation measures. The questionnaire also inquired about new dangers and ways to mitigate them, as well as the suggested inquiries. Based on significant research and analysis of relevant literature and green assessment, this study presented 38 risk categories based on four views on economic, social, environmental, and management sustainability and the construction of a risk assessment system using sustainability viewpoints. A panel of experts who have already worked on green construction projects is used to assess the level of relevance and severity of project dangers. These hazards were used to identify the risk factors to which green building projects are subject to, assess the findings, and propose some solutions for controlling the risks of green building projects, which were presented to a group of 100 engineers with project management expertise.

Table 1.Respondents and their companies Backgrounds:

Peofile	Frequency	Percentage
Company		
Type		
Consultsncy	13	13.1%
Developer	5	5.1%
Contractor	17	17.2%
Architecture firm	11	11.1%
Job title		
Project manager	6	6.1%
Architect	6	6.1%
Engineer	7	7.1%
Quantity surveyor	28	28.3%
Consultant	3	3.0%
experienceyears in traditional residential building projects		
less than one years	18	6.50%
From 1 to 2	20	18.30%
From 3 to 4	41	37.60%
From 5 to 10	25	22.90%
more than 10	5	4.60%
experienceyears in green residential building projects		
less than 1 year	14	14.30%
From 1 to 2	17	17.30%
From 3 to 4	33	33.70%
From 5 to 10	26	26.50%
more than ten	8	8%

4.2. Indices of Risk Criticality

Respondents were asked to rate the probability and extent of each risk's effect during the survey.

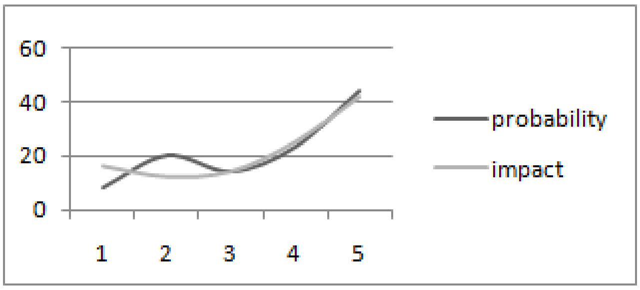

Fig 1. Critical risks inside green residential building construction projects: probability and effect curve

5. Analysis of Data and Discussion

5.1 Data collection

A questionnaire was made and presented to 100 respondents, and the respondents were classified into three categories according to the type of job, experiences and projects that concern them. 19 respondents (16.5%), the number of developers responded (0.9%), the number of contractors was 24 responsive and represented (20.9%), the number of respondents for the architecture company was 9 respondents and represented (7.8%), which is a low percentage for developers and a good percentage for consultants because most cases represent consultants and contractors, and most of the jobs participating in the questionnaire are: The number of respondents for the project manager is 4 respondents, representing (3.5%), the number of respondents for the architect is 6 respondents, which represents (5.2%), the number of respondents for the engineer is 6 respondents, representing (5.2%). the number of respondents to the site engineer is 42, representing (36.5%), there are no respondents for the consultant, and it represents (0%). The years of experience in green building projects participating in the questionnaire are: The number of respondents for years of experience less than 18 years old, representing (15.70%), the number of respondents for years of experience from (1-2) years 20 respondents, represent (17.40%), the number of respondents for years of experience (1-2) years, representing (17.40%). Respondents for years of experience from (3-4) 41 respondents, represent (35.70%), the number of respondents for years of experience from (5-10) years 36 respondent, representing (31.30%), there are no respondents for years of experience more than ten years and representing (0%).

The reliability and extent of the data were verified using Cronbach's alpha reliability test (α) as a measure of internal consistency (2019:Rachid et al 2011:Tavakol and Dennick),where it was 0.976, 0.981, (α)= 0.981, and this result was more From (0.7) as a specific cut-off value, it shows a strength in the internal consistency of the data (Shen and Rong, 2007, Tavakul and Denek, 2011, Jamil and Abdel Rahman, 2018) and the program (SPSS V22) was used to measure the alpha coefficient of the frequency of occurrence of risks that affect the time and cost Green building project. Number of respondents / percent.

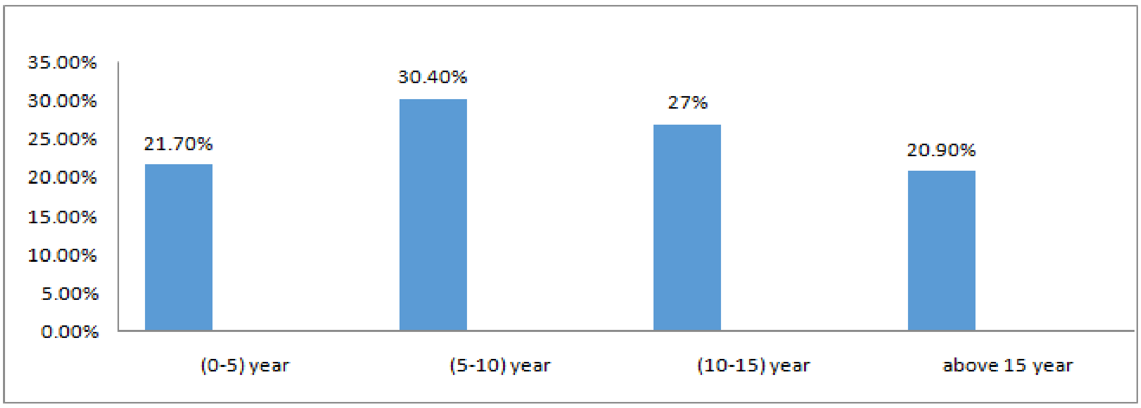

Fig2. Participants and experience years for the surveyed project

Table 2,3show number Explanation of the results of the slides on which the questionnaire was conducted

Kind of your organization	Number of Respondents	per %
Client	0	0.00%
Consultant	66	57.40%
Contractor	49	42.60%
Position within your organization	**Number of Respondents**	**per %**
Construction Manager	14	12.20%
Project Manager	41	35.70%
Cost Control	30	26.10%
Quantity Surveyor	2	1.70%
Site Engineer	26	22.60%
Other	2	1.70%
Type of projects within your organization's scop	**Number of Respondents**	**per %**
Residential Projects	27	48.70%
Highway Construction Projects	12	10.40%
Commercial Buildings	12	10.40%
Service Buildings (e.gschool,hospitals, etc.)	6	5.20%
Others	2	1.70%
All of the above	56	48.70%

Table 3. Description of the sample size projects . The percentage of respondents for housing projects is (56) out of the total (100) and represents (48.7%) since the current trend in housing projects.

Table2. Shows the type of institution, job and projects to which it belongs, and shows the following:

1. Customers (0%)
2. Consultants (57.40%)
3.Contractors (42.60%)

It is a low percentage for clients and a good percentage for consultants because most cases represent clients and consultants.

Most of the jobs participating in the survey are

1. Construction Manager (12.2%)
2. Cost Control (26.1%)
3. Quantity Surveyor (1.7%)
4. Site Engineer (22.6%)

The reliability and extent of the data were verified using the Cronbach alpha (α) documentary test as a measure of internal consistency (2019: Rachid et al .: 2011: Tavakol and Dennick)

Where it was (α)= 0.976, 0.981, 0.981, and this result was more than (0.7) as a specified limit value showing strength in the internal consistency of the data (Shin and Rong, 2007, Tavakol and Dennick, 2011, Jamil and Abdul Rahman, 2018)

The program (SPSS V22) was used to measure the alpha coefficient of the frequency of risks that affect time and cost of the green building project.

5.2 Data Analysis

Preliminary testing for data dependability and internal consistency using Cronbach's alpha was performed. The alpha of a scale should be at least 0.7, according to Nunnally et al. [43]. According to the alpha values of 0.956 and 0.957, the questionnaire data collected for this study's green residential building construction projects was accurate.

All 100 respondents' data collected were analyzed using four main statistical indicators (frequency - severity). In order to identify the most important factors those have a high frequency and a significant impact on the project time and cost in the equations. Frequency index can be calculated by using the following equation to determine the frequency with which respondents identify hazards to green buildings (Assaet al. 2006, 2015 Bekr et al.)

$$\text{Freqency index (F .I) (\%)} = \sum a(n/N) * (100/5) \quad \text{eq (1)}$$

Where (a) is a constant reflecting the weight assigned to each response (ranging from 1 (very low) to 5 (extremely high)), (n) is the response frequency, and (N) is the total number of replies. According to the respondents, the severity index is a formula for measuring the influence of risk on the project's cost and time, and it may be computed using the following equation. (Neutral 2016, Baker and others, 2015, Assaf and others 2006)

$$\text{Severity Index (S.I)(\%)} = \sum a(n/N) * (100/5) \quad eq(2)$$

Where (a) is a constant that represents how much weight each answer is given (ranging from 1 (very low) to 5 (extremely high)) when compared to standard residential building construction projects, (N) is the total number of replies and (n) is the frequency of response. In the context of typical residential building construction projects, the (SI percent) (FI percent) risk was also required in this research. Middle East tuberculosis, the values of (FI %) and (SI %) of the participants were calculated, assessing (35) risks in standard home construction projects and comparing them to Green GB projects as shown in the table

Table 4. Description of the results of the risk analysis.

Group	Q.Group	code	Questions	TB		GB		DIFF. F.I%	DIF F.S. I%	p-Value T.B	p-Value G.B	Difference p-Value
				F.I %	S.I %	F.I %	S.I %					
G1	construction	R2	Delay in schedule risk	74	75	75	80	1	5	0.001	0.009	0.008
		R4	Design guodeline availability	74	76	74	79	0	3	0.000	0.007	0.007
		R10	Design risk	75	79	74	79	1	0	0.017	0.003	0.014
		R12	incomplete drawings & spaces	76	77	75	78	1	1	0.02	0.002	0.018
		R22	unlear design details and specificatins	77	78	74	78	3	0	0.006	0.006	0.000
		R30	poor design	79	77	74	78	5	1	0.019	0.008	0.001
		R31	unfamiliarity with construction process	76	76	74	78	2	2	0.000	0.004	0.004
G2	financial	R1	financial risk	73	71	74	79	1	8	0.035	0.006	0.029
		R14	fluctuation in exchange rates/	78	78	75	77	3	1	0.02	0.01	0.01
		R18	shortage of funds	79	75	74	78	5	3	0.026	0.004	0.019
		R24	a scarcity of skilled designers with the necessary skills	77	76	74	78	3	2	0.000	0.01	0.01
G3	Suppliers , sub contractors	R7	Team performance risk	76	77	75	79	1	2	0.000	0.003	0.003
		R21	loose control over subcontractors	78	75	75	79	3	4	0.020	0.007	0.013
		R29	unskilled workers	75	79	74	76	1	3	0.016	0.012	0.004
		R32	fluctuations in labor / material rates	77	78	74	78	3	0	0.014	0.005	0.009

G4	*Resources*	***R9***	***regulatory / legislative risk***	***77***	***78***	***74***	***78***	***3***	***0***	***0.019***	***0.002***	***0.017***
		R11	***Lack of communications***	***79***	***77***	***74***	***78***	***5***	***1***	***0.027***	***0.002***	***0.025***
		R23	***poor communication among projects stakeholders***	***78***	***76***	***74***	***78***	***4***	***2***	***0.010***	***0.010***	***0.000***
		R27	***lack of experience***	***77***	***77***	***72***	***76***	***5***	***1***	***0.001***	***0.009***	***0.008***
		R25	***technical issues***	***77***	***73***	***73***	***77***	***4***	***4***	***0.020***	***0.004***	***0.016***
G5	*Contract general conditions*	***R6***	***Green building certification results***	***76***	***77***	***75***	***80***	***1***	***3***	***0.000***	***0.005***	***0.005***
		R13	***lack of contract***	***76***	***75***	***73***	***78***	***3***	***3***	***0.020***	***0.007***	***0.013***
		R15	***complex procedures to obtain approvals***	***77***	***74***	***73***	***78***	***4***	***4***	***0.026***	***0.008***	***0.018***
		R16	***import / export rrestrictions***	***76***	***77***	***74***	***79***	***2***	***2***	***0.000***	***0.009***	***0.009***
		R28	***setting expectations too high***	***75***	***77***	***74***	***76***	***1***	***1***	***0.013***	***0.006***	***0.007***
		R33	***high target for green mark ratting***	***77***	***78***	***75***	***78***	***2***	***0***	***0.000***	***0.000***	***0.000***
		R34	***If the facility is commercial, then the community must include green facilities***	***75***	***77***	***74***	***77***	***1***	***0***	***0.019***	***0.003***	***0.013***
G6	*Technical*	***R2***	***Building products and materials***	***72***	***79***	***74***	***79***	***2***	***0***	***0.029***	***0.006***	***0.023***
		R26	***unfamiliarity with green materials and construction technologies***	***75***	***78***	***75***	***78***	***0***	***0***	***0.024***	***0.006***	***0.018***
G7	*Main contractor*	***R8***	***client is goal uncertainty***	***77***	***77***	***75***	***79***	***2***	***2***	***0.002***	***0.005***	***0.003***
		R17	***unclear allocation of roles and responsibilities***	***75***	***72***	***74***	***77***	***1***	***5***	***0.007***	***0.005***	***0.002***
		R19	***unclear requirements of owners***	***77***	***75***	***76***	***79***	***1***	***4***	***0.009***	***0.01***	***0.001***
		R20	***inappropriate interventions of clients***	***79***	***74***	***76***	***79***	***3***	***5***	***0.019***	***0.006***	***0.013***

G1.Constructions

The design phase of any building project can be characterized by a number of errors and changes that can affect green facilities, as the largest value of (S.I %) = 80% indicates the severity of the risks facing and the lowest value of (S.I%) = 78%.

G2. Financial

Financial matters must be taken into account when implementing green facilities in terms of changing the prices of raw materials from time to time, where the largest value (S.I%) = 79% indicates the severity of the risks faced and the lowest value of (S.I%) = 77%., as the largest value of (S.I%) = 79% indicates the severity of the risks facing and the lowest value of (S.I%) = 77%.

G4. Resources

G3.G7 Suppliers,sub-contractorsand Main contractor

The subcontractor must have experience in implementing green facilities and have good workers, where the largest percentage is (S.I%) = 79% and the minimum values is (76%),Subcontractors must have prior experience working on green facility projects according to the guidelines provided by the experts.

The contractor must provide the materials needed to implement green facilities in terms of equipment and materials, which, according to the questionnaire, more than 100 engineers where the largest value was (S.I%)= 78% and minimum (S.I%)= 76%, which indicates these Risks and risks that we must take care to avoid in green building projects

G5. Contract general conditions

Ignoring the general conditions of the contract leads to risks faced by green facilities during the implementation procedures. This group includes 7 factors that affect green facilities where the largest value was (S.I%)= 80% and minimum (S.I%)= 76%

G6. Technical

There are two factors that affect the technology of implementing green facilities, which are building materials products and new technical processes, where the highest risk value was (S.I%) =79% and the lowest risk value faced green facilities (S.I%) = 78%

5.3Comparing risk factors with previous studies.

Using average values, this section summarizes the risk categories for green facilities in Egypt and compares them to 24 previous studies, which shows the contribution rates for groups of risk factors facing green facilities based on their frequency in recent research studies. It was determined that the Egyptian construction industry's five most influential groups were compared to a similar group in previous studies as follows: An average of 38.40 percent of all risk factors were classified as external factors, which accounted for 11.94 percent of all risk groups in this study, and had an average value of 23. This finding differs from previous research, which placed the ninth risk group (against a total of 6.07 percent), in the previous ranking. Because of the economic changes that have affected Saba's performance on the Egypt construction project over the past three years, external factors related to this occupy an advanced rank. In order to minimize their occurrence and impact, and thus improve project performance, the client in Egypt was the second most influential group among the related factors. According to previous research, it was the third most popular choice for paraphrase, with 12.71 percent of participants. Construction-related factors came in third on the list of influential factors. This study ranks fifth, which is consistent with the previous one. Rework groups in total are therefore required to plan for the construction process adequately by all stakeholders involved in projects, for example to establish a realistic project schedule and implement. In terms of design-related factors, Egypt appeared to be concerned, as they occupied the top spot and all groups re-worked, but the fourth group is important. Participants in Egyptian construction projects have a disinterest in the design process, as evidenced by the above-mentioned end result. Finally, the fourth most important factor was the relationship between the contractor and subcontractor. To be consistent with previous studies, which also placed this category in the top four, contractors with extensive training and experience should pay closer attention to its occurrence. To ensure a successful project and minimize rework, the method should be tailored to the specifics of the

Table5. Comparing risk factors.

Groups	**GB**		**Rank**	
	Mean	**Mean other**	**Rank1**	**Rank other**
External related factors	23	38.40	1	1
Client related factors	23	36.56	1	2
Construction related factors	23	33.49	1	3
Design related factors	23	32.76	1	4
Contractor and subcontractor related design	23	32.75	1	4
Labour related factors	22.8	29.33	1	5
Materials and equipment related factors	23	29.33	1	6
Site related factors	23	27.98	1	7
Contract related factors	23	27.55	1	8

5.4Suggested Mitigation Measures

In the efficacy study, the Risk Mitigation Scale (RMM1) Allowing Emergency Financing was assessed on the first value (mean=23). This risk reduction strategy was stressed since the intricate nature of green residential construction projects makes it difficult to accurately predict the project costs. and certain reserve money must be set aside to take on some unforeseen but possible risks. In reality, emergency money was also used. Risk management is well-known in conventional building projects, and it came in second in terms of risk reduction (RMM6) The most effective measure with an evaluation (Mean = 23) to guarantee the success of the project to construct a green residential building is to improve communication and coordination between the contracting parties due to the necessity for a heterogeneous workforce in green residential building projects, the contracting parties change more often than in regular residential building construction projects. Project delays and cost overruns are likely to occur if more thorough professional training programs are not put into place to deal with the complex and unique technology used in these projects. Following Huang and Tan's advice, a value of (Mean = 23) was achieved in the Middle East by understanding the owner's goal from green mark criteria, as well as following their advice on effective project team communication. In order to be eligible for the green label, a company must meet specific requirements. Construction cannot begin until all parties are clear on the owner's Green Mark Standard goal for the building. It is possible that a project may fail to obtain the necessary green certificate if the owner's green mark intention is misunderstood. A green building project's success hinges on its team's ability to effectively communicate its green building objectives, as they both concluded. Training programs for front-line workers are needed to ensure that they are familiar with the new processes and materials used in green construction projects, which necessitate ensuring that they are well-trained. It is being taught to local construction professionals so that they can better understand the green technology that they will be using in their projects, which are extremely popular in the area. We were able to get our hands on the scale for assessing risk. Using the prior guidelines for residential developments, the fifth position (RMM2) was achieved. Green is the most successful and has the lowest value (Mean = 22.8).

Refer to successful initiatives from the past as a risk mitigation strategy for future construction projects. After 2011's announcement of the green building badge for residential projects, the Middle East has gained a lot of experience developing green residential constructions. These lessons may be used to future green building construction projects in a variety of ways.

This finding was similar to that of (Zou and Couani, 2012), who indicated that gathering experiences was an essential method for reducing risks in the green building supply chain.

Table6. Suggested Mitigation**.**

CODE	Measure of Risk mitigation	Mean	Rank
RMM1	emergency contingency funds	23	1
RMM3	Investing in the search for green building materials and processes	23	1
RMM4	Create team member incentive programs.	23	1
RMM5	A well-organized framework for handling design modifications	23	1
RMM6	Increasing stakeholder communication and collaboration	23	1
RMM7	Recognize the objectives of clients in a green building project.	23	1
RMM8	Construction designs and specifications are subjected to a quality control process.	23	1
RMM9	Take advantage of the integrated design process	23	1

RMM10	Buy insurance when allocating risks	23	1
RMM11	Incentives and financial measures from the government	23	1
RMM12	Advertisements and programs to increase community awareness of the importance of green facilities	23	1
RMM13	Tempting the use of green buildings	23	1
RMM2	Use previous green projects as a reference	22.8	1

5.5 Application

This application is used through the mechanism of determining performance indicators and to clarify the risks that green projects are exposed to as well as traditional projects and the extent of their impact on the time and basic cost of the project and gives a mechanism to the user to avoid the occurrence of some of the risks to which the project is exposed. And some of the suggestions how much it gives the user information to know the probability of the occurrence of risks and the extent of their impact and the relationship between them to him and also allows the user to adjust the rates and prices according to the variables that the user sees. It also gives general information on green facilities and educational examples. This application is used in English and Arabic reports are given to all of the above and can reprint. This application stores all user data so that we can follow up and use this data in other research

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5.5.1 Importance of the application

Fig 2start creating green projects.

The risks facing green facilities and the consequences of these risks. It is also used to spread the culture of building green primary security and educate the user to start creating green projects as shown in Figure (2)

Fig 3. Explanation of the application

Explanation of the application Through this application, the information is displayed quickly when entering the building type, area and country, and the user can make a decision about green facilities through this application. as shown fig(3)

6. Conclusion and Recommendations

Determining key performance indicators (KPIS) and knowing the risks that green facilities are exposed to and the actions that can be taken to mitigate these risks were among the main objectives of this research, as well as how to measure risk mitigation in relation to the development of the green building project. Green residential buildings have achieved rapid development in recent years, as the five most critical risk sing reecho using have been presented ,complex procedures for obtaining approvals, exceeding the high initial cost, unclear demands of the owners, labor restrictions. In spite of a detailed assessment of significant threats and risk reduction approaches in green residential building construction, this research has several shortcomings. It's possible that construction professionals in other nations may get a more comprehensive understanding of the dangers associated with green residential building projects, design a custom risk checklist, and come up with more innovative ways to address those dangers. Projects in the construction industry, in general, are related with risk and uncertainty because of their unique character and one of their most significant elements is the lengthy implementation phasethatleadstoshiftingcircumstancesanddifferentrisks,whilethestudy'sstatedgoalsareto identify the most significant sources of risk and assess the effect of those risks on the project's timeline and budget, as well as to compare the current findings to those of previous studies. Where a review has been prepared of the risks faced by building and construction projects in general,whichthecontractororownermaybeexposedto.Theremustbeaprofessionalteamin the construction firm that researches and identifies the many hazards each project may be subjected to, and the team takes on the responsibility of managing these risks. These projects were exposed to and the measures taken to overcome the impact of the risks. Original sentence thorough literature analysis initially identified 35 risks and 13 mitigation techniques, which were then incorporated in a questionnaire presented to 100 respondents. When it comes to green residential construction projects and their associated risks, a recent study found that the top five most important ones were complex approval procedures, overlooked high initial costs, unclear owner requirements employment constraint and lack of green materials and equipment Additionally 35 of the 39 identified hazards had considerably higher ratings in green residential building construction projects than in typical residential building construction projects, indicating that the former considers them to be of greater importance. 35 And the top five risk reduction techniques in green residential building construction projects were outlined in a recent study, and they were improving communication and coordination among contracting parties understanding owner's goal of the Green Mark Standard using past successful green residential projects as references developing training programs to upgrade workers skill and knowledge of new technologies and materials and allowing for contingency funds.

Appendix A. Questionnaire Used in This Study

Section 1: Background Information of Respondent

1. Please select the type of your company
   A. Consultancy
   B. Developer
   C. Contractor
   D. Architecture firm

2. Please define your job title
   A. A project Manager
   B. Architect
   C. Engineer
   D. Quantity Surveyor
   E. Consultant

3. Indicate how many years of experience you have with conventional home building projects.
   A. Less than one year
   B. 1 - 2 years
   C. 3 - 4 years
   D. 5 - 10 years
   E. More than ten years

4. Please indicate how many years of experience you have in the development of green residential buildings.
A.Less than 1 year
B. From 1 - 2 years
C. From 3 - 4 years
D. From 5 - 10 years
E. More than ten years

Section 2: Risk assessment for the construction of green residential buildings

Please use the following rating scales to evaluate the probability and effect of each risk below, based on your experience with green residential building construction projects:

Likelihood of occurrence: one–Very unlikely; Two–Unlikely; Three–Fairly likely; Four–Likely; Five–Very likely.

Magnitude of impact: one–Very insignificant; Two–Insignificant; Three–Fairly significant; Four–Significant;

Five–Very significan

Code	Magnitude of ImpactRisk									
	1	2	3	4	5	1	2	3	4	5

-financial risk
-Delay in schedule risk
-Building products and materials
-Design guideline availability
-Energy saving uncertainty
-green building certification results
-Team performance risk
-client is goal uncertainty
-regulatory / legislative risk
-Design risk
-Lack of communications
-ncomplete drawings & spaces
-lack of contract
-flucation in exchange rates
-complex procedures to obtain approvals
-import / export rrestrictions
-unclear allocation of roles and responsibilities
-shortage of funds
-unclear requirements of owners
-inappropriate interventions of clients
-loose control over subcontractors
-unlear design details and specificatins
-poor communication among projects stakeholders
-lack of qualified professionals with proper desigen expertise
-technical issues
-unfamiliarity with green materials and construction technologies
-lack of experience
-setting expectations too high
-unskilled workers
-poor design
-unfamiliarity with construction process
-fluctuations in labor/ material rates
-high target for green mark ratting
If the building is used for commercial purposes, the neighborhood must include

Section 3: Risk Assessment for Green Residential Building Construction Project
Using the accompanying grading scale, please evaluate the following risk mitigation methods based on your experience with green residential building construction projects:
one–Totally ineffective; Two–Ineffective; Three–Neutral; Four–Effective; Five–Very

ffective

Code Risk Mitigation measure	Effectiveness				
	1	2	3	4	5

1RMM1.Emergency contingency funds
2.Use previous green projects as a reference
3.Researching and developing environmentally friendly construction
4.Organize promotional activities for your team members.
5.A well-organized framework for handling design modifications

6.Improving communication and coordination among stakeholders

7.Recognize the objectives of your clients before embarking on a green construction project.

8.Construction drawings and specifications quality control

9.Take advantage of the integrated design process

10. Buy insurance when allocating risks

11.Incentives and financial measures from the government

12. Advertisements and programs to increase community awareness of the importance of green facilities

RMM13.Tempting the use of green buildings

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