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Appraisal of Risk Factors which Influence the Construction of the School Buildings in Northern Iraq

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A B S T R A C T

Construction projects have a unique nature which takes the high risk due to many interrelated parameters. This study aims to investigate and assess the influence of the risk factors that occurred during the lifecycle of a school project which comprises the design phases, implementation and operation and maintenance. In addition to examining the effects of the internal and external risk factors that contributed by the school's construction, in order to avoid the risk occurrence during the lifecycle of the projects. A questionnaire was prepared and distributed to a number of engineers in the Governmental Sectors (School buildings sector, Kirkuk Governorate sector, and Municipal sector in Kirkuk Government and Buildings sector in Erbil Governorate) in northern Iraq. The collected data which were analyzed using the relative importance index (RII) and matrix analysis to prioritize the project risks. The analysis results were revealed that the most significant risk factors in the school's project lifecycle and construction were providing a proper water supply and storage system to maintain a continuous good quality of water, incompetent contractors and sub-contractors for completing school buildings, using proper construction materials to avoid cracks in the building, lack of safety in project site, keep the toilets clean to avoid diseases, and providing an emergency exits were considered the most significant risk factors in construction of school buildings.

DOI:

تقييم عوامل المخاطرالمؤثرة في تشييد الابنية المدرسية في شمال العراق

الخلاصة

مشاريع البناء لها طبيعة فريدة من نوعها والتي تأخذ مخاطر عالية بسبب العديد من المعايير المترابطة. تهدف هذه الدراسة إلى التحري وتقييم تاثيرعوامل المخاطر التي تحدث أثناء دورة حياة المشروع المدرسي والتي تشمل مراحل التصميم ، التنفيذ والتشغيل والصيانة. بالإضافة الى اختبار تأثير عوامل المخاطر الداخلية والخارجية التي تشارك في تشييد المدارس. تم اعداد وتوزيع استبيان على عدد من المهندسين في القطاعات الحكومية (دائرة الابنية المدرسية، دائرة محافظة كركوك ودائرة البلدية في محافظة كركوك ودائرة الابنية في محافظة اربيل) في شمال العراق.ثم تم تحليل البيانات المجمعة باستخدام مؤشر الأهمية النسبية (RII) وتحليل المصفوفة لتحديد أولويات مخاطر المشروع. تحليل النتائج كشف ان عوامل المخاطر الأكثر أهمية في دورة حياة وتشييد المشروع المدرسي هو توفير نظام ملائم لتوفير المياه والتخزين للحفاظ المستمر على نوعية جيدة للمياه، عدم كفاءة المقاولين والمقاولين الثانويين لإكمال بناء المدرسة، استخدام مواد خاصة ومثالية لتجنب التشققات في المبنى ، قلة عوامل السلامة في موقع المشروع، والحفاظ على نظافة المرافق الصحية لتجنب الامراض، توفير مخارج الطوارئ الذي يعد من اهم عوامل المخاطرالمؤثرة في تشييد الابنية المدرسية.

الكلمات الدالة: تقييم ، دورة حياة ، عوامل المخاطر ، ابنية المدرسية.

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1. INTRODUCTION

Project risk management consists of the processes of guiding risk management planning, identification, analysis, response planning, response implementation, and project monitoring risk. The aims of managing the risk in any project are to raise the likelihood and influence of the positive risks and to reduce the likelihood and influence of the negative risks, with the purpose of enhancing the probabilities of the project success [1].

Project risk could be defined as an unexpected events or circumstances. Happening of project risk may have damage or a progressive effects on one of the following project objective, such as golden triangle constraint (time, cost, and quality), safety, and sustainability. On the other hand, risks are dangers for the projects accomplishment [2].

Andersen, Garvey [3] defined the risk as a conception that related to the human expectancy. It indicates a probable negative influence on an ability that may grow from known processes in improvement or known future events. In the common language, the risk is frequently used as a synonym for the likelihood of a lack of a threat or risk.

When budget and request forecasts are combined, for instance in the cost-benefit analyses that are normally used to explain a great transport substructure investments, the outcome is impropriety to the second degree. Benefit-cost ratios are often incorrect, not simply by a little percentage but for several reasons [4].

A risk register is essential to organize in combination with the first published cost and schedule estimation of the task. After that, full analysis and apprise of the risk register should be carried out at the beginning of each subsequent phase of the project. The project risk management process is simply suggestiong a structured approach to consider the risk and how we can deal with it [5].

Nieto-Morote and Ruz-Vila [6] Showed that a big scope, change orders and complexity of building projects have added risks to the project during the execution stage. With the need for an improved performance in the construction project and increasing obligations, the requirement of an effective risk management approach has never been more necessary.

Safety in the construction industry are influenced by several aspects such as project kind, building ways, safety controlling processes, weather, and position circumstance and so on. Among them is the quality of scheme and plan relative to safety. Since many design assessments may be effected by the safety of structure projects at the building stage, cautious consideration of safety is necessary for the design step. Consultants do not think how safety the designed element could be created and in what way effect the designed element which would be taken for the construction safety [7].

Constructing a risk analysis, particularly at the initial stages of the plan, is a complicater task because the nature of risks which are usually effected by several influences or impacts including the human and documents mistake and the availablity of material. In various situations, it may be very problematic to evaluate the risk that threatening the project due to the excessive involved uncertainties [8].

Effective risks management must involving four-phase process. They are risks identification, assessment, response monitoring and reviewing. The random and illogical risk management could cause danger to the achievement of the project, since most of the risks are dynamics throughout the project life. Risk management processes are considered in order to support designers and managers in detecting major risks early to develop events to report them and their magnitudes. Risk management is directed towards confirming more encouraging and trustworthy results are achieved regarding the suitability, cost, and quality of the project and the provided facilities [9].

The risk in building project has been cared since the moment of completing the activities of the project, quality, and budget overruns that reversed for the structure projects. To highlight the main target of this study (risk managing action), risks have been definite as the possibility of happening of various unclear, non-expectable and even undesired occasions that may converst the success view on a specified contract [10].

The risk field valuation is a complicated issue that covered uncertainty and ambiguity. The unclear terms are inevitable, since project managers measure risks in qualitative linguistic terms which it is easer. The relations between risk factors, risks, and their impacts could be represented through a cause and effect diagrams [11].

It seems that there is less conducted study for evaluating the risks in the school constructions. Therefore, the main objective of this study is to identify and assess the most risk factors in internal and external dimensions that involved in the lifecycle development of the school building. PMBOK, matrix risk analysis was used to classify risk factors into three (high/medium/low) zones that by determining their likelihood and impact by a relative important index, allowing risks to be ranked to monitor and reduce the critical risk factors.

2. LITERATURE REVIEW

Waweru [12] investigated factors that influencing compliance with a disaster of risk reduction guidelines in public primary schools in Kiambaa Division, Kiambu County, Kenya. The research included a clear study plan of survey, data collection from the questionnaire. In fact, the respondents confirmed that there was overcrowding in their schools which posed the trial to submission to disaster risk reduction strategies. Professionals like architects, quantity assessors, suppliers, Ministry of Public works and Ministry of Health were not involved in the construction and preservation of school physical structure as recommended in the Safety and Standards Manual for Schools (2008) by the Ministry of Education in Kenya. The study concluded that school size, lack of financial resources and poor school-community association are a risk for the children's safety in schools.

Abdulla, Najib [13] presented a survey covered 50 primary schools in Erbil city out of 242 schools covered the educational year 2010-2011. The informations were collected using a survey made by the scholars who included general evidence, the area nearby the school, school environment. The results showed that most of the schools were placed close to the public street, approximately all (98%) the streets leading to the schools were paved. In contrast, thirty-one (62%) schools had been exposed to a pollution source, largely noise (54.84%) and litter (45.16%) pollution.

Wainaina [14] examined and evaluated the implementation of safety measures in secondary schools within Kikuyu District of Kiambu County. He used the questionnaire in his research and found the principals had a positive influence on the application of the safety methods in schools and his study concluded that safety policies improve implementation of safety measures. The researcher recommended that principals must establish priorities for dealing with these issues and take into account health and safety. Secondly, secondary schools should have tools, creativities and appropriate planning that is needed to be in place for safety, convenience, and mobility to be enhanced. Lastly, the government and other stakeholders should provide adequate funding since the implementation of safety policies involves extensive modification of the existing buildings, the purchase of expensive safety equipment and fittings and capacity development at all levels.

Janice [15] Examined the disaster preparedness policies in schools; to assess risks among the school community participants; to recognize the risk; to found actions in place to improve disaster preparedness, and to come up with appliances on how to develop disaster preparation. The objective population was all the 28 public secondary schools in Githunguri district. The used tools for data gathering were questionnaires. The researcher found that 66.7 percent of the schools had risk management plans which turned out to be ineffective, recognized that the most (41.7 percent) common disasters faced in schools were fire. It was also recognized that 80 percent of the schools had adequate security lighting and first aid kits accessible by all. Regarding disaster management facilities and equipment, it was established that 86.7 percent of schools had fire extinguishers and fire alarms. However, it arisen that 61.7 percent of the tools were hardly altered over time, were in a bad state and not fixed thus making them unusable in times of emergency. The study recognized that 75 percent of the schools had well ventilated and set on fire corridors as well as open (unobstructed) escape routes, therefore making evacuation easy in the trouble times.

Omolo and Simatwa [16] carried out a study of the population consisted of two axis Quality Assurance and Standards Officers (QASOs) and 54 head teachers from 54 public secondary schools in Kisumu East and West Districts. The used mechanisms for data collection included surveys, meeting programs, and outlook design. In findings of this study showed that the implementation of some safety policies was implemented to a large extent as supported by the followings: Accommodation for teachers was provided in 76.67% of the schools. Halls in 70% of the schools had emergency doors, 17 out of 30 schools had halls with doors opening outwards, and 28 out of 30 schools had protected fences and gates while 96.67% of the schools took first aid kits. The study also identified that there was a lessening trend in guiding fire drills; fire extinguishers were found in only 26.67% of the schools, there was mass in 70% of the schools and 93.33% of the schools did not have enough toilets.

Radwan, Yousef [17] conducted a study purposed an analyze of real situations of elementary education buildings (primary schools) in Yemen cities (Almukalla as a case study) to explore their architectural problems and resolve methods. The researchers have used the 'survey' as a field study and the ' Questionnaire.' focused on users (pupils, teachers, and administrative staff) in addition to the architecture meeting of the investigators as a study case and as actualities source of database studies for identifying the problems and different types of actions that are important to achieve the educational requirements and social objectives in Yemen cities.

The risk matrix assists relocation of a separate risk category to every combination of impact and probability, i.e. it provides a drawing or mapping of likelihood and consequence to risk. This mapping may be particular and is not bound by formal restraints, although it is usual to confirm that the representing function is monotonically increasing, a rise in impacts (where probability remains the same) or a rise in probability (where impact remains the same) may not lead to a reduction of the assigned risk [18].

3. RESEARCH METHODOLOGY

The questionnaire design and preparion are based on the objectives of this study. The questionnaire was prepared by taking into consideration the idea of engineers with various experiences and responsibilities and in different departments and their experience in the construction projects. These help us to conclude in this survey all the required data for performing an effective survey. The questionnaire survey was prepared with a detailed understandable question in order to create an easily answered survey for the respondents.

The questionnaire survey was prepared and distributed to engineers who have dealt actually with the construction of school buildings. The survey was distributed to 50 engineers with different professions from which 100 % distributed to the civil engineers of different profiles and different years of experience in four departments in Kirkuk and Erbil Governorate in Northern Iraq. Out of the 50 surveys, 45 questionnaires were completed only.

A rank procedure is used for the risk's impact which are classified into 5 categories starting from one which indicating a negligible impact up to the five which is the extreme risk impact. Otherwise, the probability that classified from one as not expected up to five indicating the expected probability as shown in Figs.1 and 2**.**

1	Not Expected
2	Low
3	Moderate
4	High
5	Expected

Fig.1. Probability Scaling

1	Negligible
2	Low
3	Moderate
4	High
5	Exterme

Fig. 2. Impact Scaling

The respondents were practitioners in construction sectors mostly involved in the construction of school buildings and from the following sectors:
1- School buildings department in Kirkuk Government.
2- Kirkuk Governorate department.
3- Municipal department in Kirkuk Government.
4- Building department in Erbil Governorate.

The classification of respondents' positions are shown in Fig.3, which indicates that most of the respondents are senior engineers and site engineers represent 44% and 38% respectively.

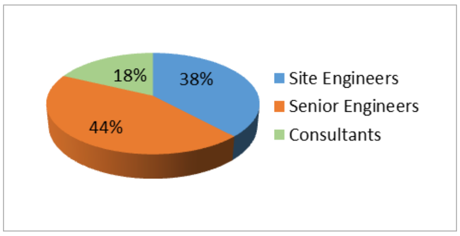

Fig. 3. Respondent's Position

Experience of the respondents that participated in this study is shown in Fig. 4 which indicates that 64% of the respondents have worked more than 10 years in the construction sector, while only 10% of the respondents have between 1 to 4 years' experience.

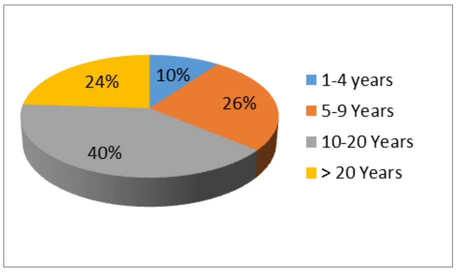

Fig. 4. Respondent's Years of Experience

4. DATA ANALYSIS

For analyzing of the survey questionnaire the Relative importance index, the method will use the following Eq. (1): [2]

Relative importance index,

$$RII=\frac{\sum_{i=1}^{n} SiXi}{\sum_{i=1}^{n} Xi} \quad ......(1)$$

where Si: significant index assigned to ith response;
for i = 1, 2,3,4 and 5, respectively,
Xi: frequency of the ith response,
i: response category index = 1, 2,3,4 and 5
The higher value of RII presents an overall risk significance in the project parameters.
Example of analysis results were obtained using RII (R1 for example). For impact and probability
1. for impact
$\sum_{i=1}^{5} SiXi$= 1*0+ 2*5+ 3*7+ 4*13+ 5*20=183$\sum_{i=1}^{5} Xi$ =0 +5 +7 +13 +20=45 RII= $\frac{183}{45}$ =4.07 ≈ 4.00
2. for probability
$\sum_{i=1}^{5} SiXi$ = 1*3+ 2*15+ 3*11+ 4*7+ 5*9=139$\sum_{i=1}^{5} Xi$ = 3+15 +11 +7 +9=45, RII= $\frac{139}{45}$ =3.09 ≈ 3.00

5. RESULTS AND DISCUSSION

On the bases on analysing the performed survey questionnaire using the relative importance index method RII which had been used for 45 risk factors in the school as given and illustrated in Table 1.

Risk assessment matrix is a common tool that used to conduct a quantitative risk assessment. The risk matrix and its representative variations are broadly applied in several situations. Risk matrix only needs two input variables to create a risk matrix. The output risk is determined by the impact of the factor and its probability. The matrix creation is based on values of the impact and the likelihood after rounding to the nearest quarter which comprised 45 risk factors in the construction of the school buildings.

According to the analysis result of the matrix for the risk factors in the school construction seems to be a significant risk in school is providing a proper water supply and storage system to maintain the continuous good quality of water with a risk value of 20.25 in the high zone.

Followed by the second risk factor incompetent contractor and subcontractors for completing school building with risk value equal to 18.06 in the high zone. The third risk factors are using a special and a perfect materials to avoid cracks in the building, lack of safety in the project site, and keep the toilets clean to avoid disease with risk value equal to 17 in the high zone.

The fourth risk factors are considering emergency exit in case of fire for safe student's life; Smooth tiles should not be used to avoid slipping, the economic crisis in the country, and Government difficulties in financing the project causing a delay in finishing the school building with risk value equal to 15.93 in the high zone risks.

The fifth risk factors are Delay in completing the project in the specificed time causing transforming students to other schools, continual maintenance of faucet and pipes, and weak of monitoring system and unlegal commission with risk value equal to 15 in high zone followed by school's location should be far away from different pollution resources like places the wastes, school place should have a beautiful views, and green lands and without the easistance of high buildings around it with risk value equal to 14.87 and 14.06 respectively in high zone. Followed by R18, R29, R44, R20, R36, R15, R13, R38, R43, R27, R21, R31, R42, R34, R19, R16, R8, R10, R3, R25, R26, R32, R9, R12, R40 factors in high zone risks.

In the medium zone, the first critical factor is poor design and specifications with risk value equal to 12, followed by eight factors in this zone (R6, R2, R24, R35, R23, R5, R11, and R4). There are no risk factors in the low zone, as shown in Fig. 5.

Whereas the risk distribution in the sectorial basis during the lifecycle of the school project indicating that the highest risk is in the operation and maintenance of 15.27, and the external risk factors involved more risks than the internal risk factors of 13.3, 10.27 respectively, as presented in Fig. 6.

Table 1
Relative Importance Index (RII) & Risk level

Internal Risk Factors			
A- Design related risk factors		**RII**	**RISK**
R1 - Poor design and lack of specifications.	Impact	4.00	12.00
	probability	3.00	
R2- Lack of sunlight and proper ventilation.	Impact	3.50	10.5
	probability	3.00	
R3- Do not provide sufficient area for each student for easy movement in the classroom.	Impact	3.50	11.38
	probability	3.25	
R4- The floors of the school should not exceed 4 floors to make the movement on the stairs easy.	Impact	3.25	8.13
	probability	2.50	
R5- The windows should be had sufficient widths.	Impact	3.50	9.63
	probability	2.75	
R6 - The doors should wide and at least two students can pass through it.	Impact	3.25	9.75
	probability	3.00	
R7 - Considering emergency exit in case of fire for safe student's life.	Impact	4.25	15.94
	probability	3.75	
R8- Lack of sports, theaters halls and places for student's rest that not considered in the design stage.	Impact	3.25	10.56
	probability	3.25	
R9- Do not allocate areas for labs and library	Impact	3.75	12.19
	probability	3.25	
R10- Avoiding rigid design to facilitate for future expansion of the school to host more students.	Impact	3.25	10.56
	probability	3.25	
R11- Painting of the wall should be light and avoid glossy colors.	Impact	3.50	9.63
	probability	2.75	
R12- The height of schools furniture like seats and height of blackboards should suitable for student's length.	Impact	4.00	13.00
	probability	3.25	
R13- Provide a sufficient number of bathrooms comparing with students number.	Impact	3.75	13.13
	probability	3.5	
R14- Using durable, materials, and proper workmanship to avoid cracks in the building.	Impact	4.25	17.00
	probability	4.00	
R15- Sidewalk of the school should be at least 2 meters.	Impact	3.50	12.25
	probability	3.50	
R16- Lack of accurate design for drainage water causing flood during rain and causing school property damage.	Impact	4.00	14.00
	probability	3.50	
R17- Avoid using smooth floor tiles to avoid slipping.	Impact	4.25	15.94
	probability	3.75	
B- Construction related risk factors			
R18- Delay in completing the project at a specific time causing transform students into other schools causing overcrowded and uncomfortable for students.	Impact	4.00	15.00
	probability	3.75	
R19- Lack of supervision and regulation in the project during the construction stage.	Impact	4.00	14
	probability	3.50	
R20 - Lack of proper construction techniques consistent with the school building.	Impact	3.50	12.25
	probability	3.50	
R21- Lack of quality assurance and control.	Impact	4.00	14.00
	probability	3.50	
R22- Lack of safety on the project site.	Impact	4.25	17.00
	probability	4.00	
R23- Disapproving sub-suppliers and delivery methods.	Impact	3.75	11.25
	probability	3	
R24- Difficult to obtain a source of materials, equipment, and others.	Impact	3.5	10.5
	probability	3.00	
R25- Delay in request of school furniture especially if it from outside the country causing delays in starting the study.	Impact	3.50	11.37
	probability	3.25	
R26- Delay in activities because of poor procurement management.	Impact	3.50	11.37
	probability	3.25	
R27 - Unskilled labor causing damages by their errors.	Impact	3.75	13.13
	probability	3.50	
R28- An incompetent selection of contractor and sub-contractors for the construction school building.	Impact	4.25	18.06
	probability	4.25	
C- Project Operation and maintenance risks			
R29 –Continual maintenance of faucet and pipes.	Impact	4.00	15.00
	probability	3.75	
R30- Keep the toilets clean to avoid disease.	Impact	4.25	17.00
	probability	4.00	
R31- Provide guard for monitoring the gutter in case of rain and electric fusses.	Impact	4.00	14.00
	probability	3.50	
R32-Maintenance the furniture and rid of fracture furniture.	Impact	3.50	11.38

	probability	3.25	
R33- Providing a proper water supply and storage system to maintain the continuous good quality of water.	Impact	4.50	20.25
	probability	4.50	
R34- Leakage from roofs causing breakdown of devices and furniture damage due to lack of maintenance system.	Impact	4.00	14.00
	probability	3.50	
External Risk Factors			
D-Environment and location risks			
R35- Unusual climate conditions.	Impact	3.50	10.50
	probability	3.00	
R36- Place of the school should be away from the public streets and noise that causes dispersion and lack of student's concentration.	Impact	3.50	12.25
	probability	3.50	
R37-School's location should be far away from different pollution resources like places of throw wastes.	Impact	4.25	14.88
	probability	3.50	
R38- School access and nearness to public transportation means.	Impact	3.75	13.13
	probability	3.50	
R39- School place should have beautiful views, green lands and there are no high buildings around it.	Impact	3.75	14.06
	probability	3.75	
R40- School building should expose to longer sunlight during the day for sure obtain enough lighting.	Impact	4.00	13.00
	probability	3.25	
E-Political risks			
R41- The economic crisis in the country.	Impact	4.25	15.94
	probability	3.75	
R42-The weakness of the administrative and technical structure of country departments.	Impact	4.00	14.00
	probability	3.50	
R43-Variation of government policies.	Impact	3.75	13.13
	probability	3.50	
R44-Weak of monitoring system and Integrity Commission.	Impact	4.00	15.00
	probability	3.75	
R45-Government difficulties in financing the project causing a delay in finishing the school building.	Impact	4.25	15.94
	probability	3.75	

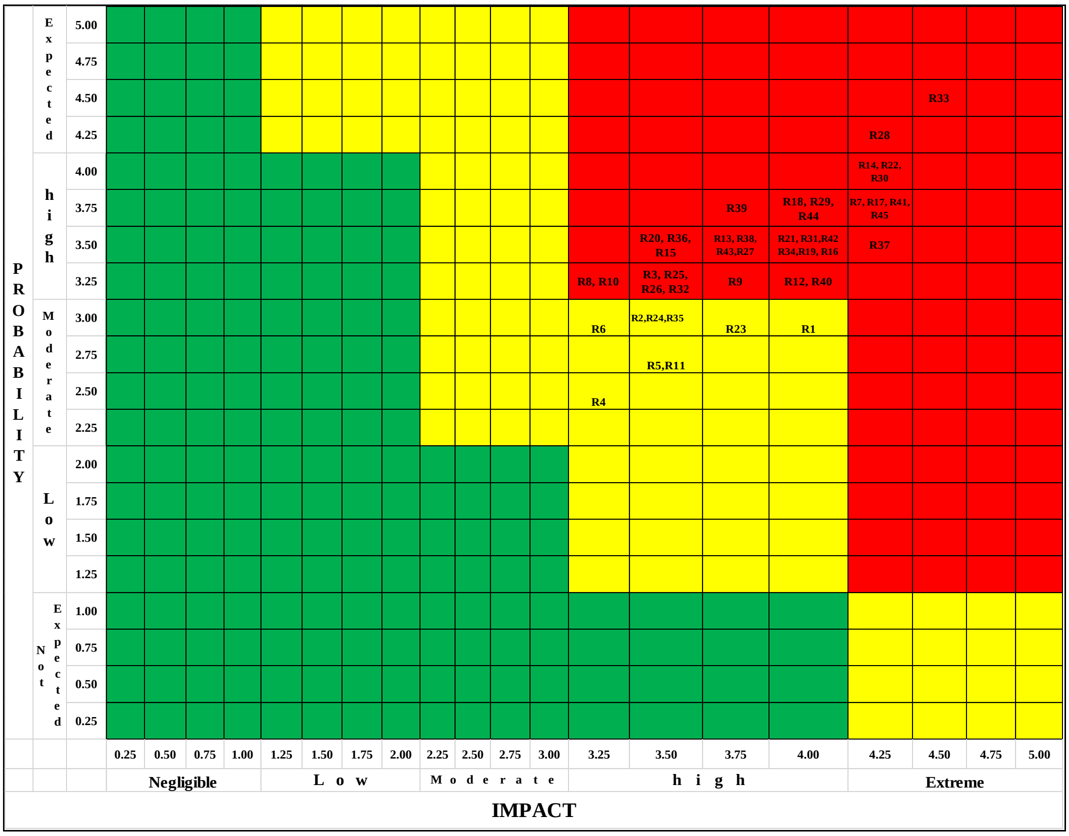

Fig. 5. Risk Assessment Matrix

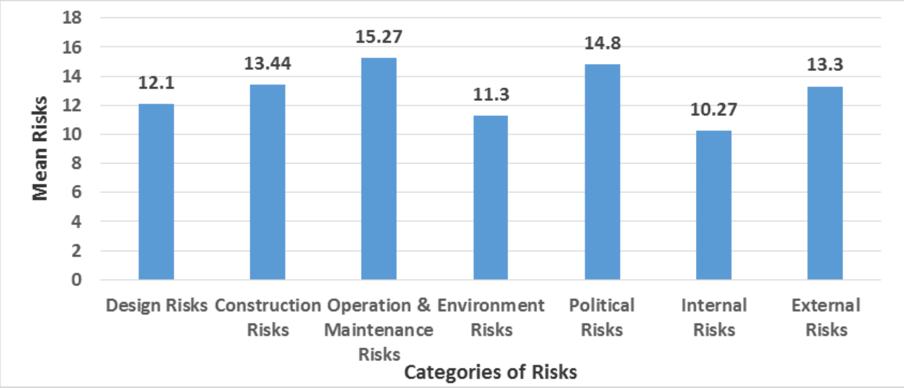

Fig. 6. Lifecycle Risk Allocation

Table 2 shows a comparison between five significant risk factors that carried out between three countries Iraq, Kenya, and Yemen for which an available data in a different arrangement. In Iraq, the significant risk is providing a proper water supply and storage system to maintain the continuous good quality of water as the significant risk, which not mentioned in the other countries, but in Kenya and Yemen, the significant risk is congestion in the classrooms and school, which is the same. These different in arranged of risk factors among these countries return to differ the contract laws, government regulation, environment, and so on.

Table 2

Comparison of Risk factors between Northern Iraq and Kenya and Yemen

Comparison of five significant Risk factors			
#	Northern Iraq (Authors)	Kenya(Omolo, D.O.)[16]	Yemen(Radwan, M.M.)[17]
1	Providing a proper water supply and storage system to maintain the continuous good quality of water.	Congestion in classrooms and the safety of pupils.	Congestion in the school.
2	Incompetent contractor and subcontractors for completing school building.	The structural condition of physical infrastructure and disaster risk reduction in schools.	School's nearest to the main street.
3	using special and perfect materials to avoid cracks in the building	no fire-fighting equipment in schools	Loss of the safety and security in school buildings.
4	lack of safety in the project site	Lack of financial resources as a hindrance to compliance with disaster risk reduction guidelines.	Unsuitability and unclean toilets and bathrooms.
5	Keep the toilets clean to avoid disease.	The poor rapport between the community and the schools.	No places for sports and activities practice.

6.CONCLUSIONS

From this study a number of involved risk factors in school constructions has been identified. Probability-impact matrix proposed as an analysis tool showing the risks in different zones from the critical factors in the high area to safety elements in the low area and this paper reveals the risk values by multiplying the impact by the probability after finding the consequences and likelihood by using RII method.

The most ten significant risk factors that identified in the school constructions and operation in Northern Iraq are providing a proper water supply and storage system to maintain continuous good quality of water, incompetent contractor and sub-contractors for completing school buildings, using special and perfect materials to avoid cracks in the building, lack of safety in the project site, keep the toilets clean to avoid disease, considering emergency exit in case of fire for safe student's life, smooth tiles should not use to avoid slipping, the economic crisis in the country,

Government difficulties in financing the project causing a delay in finishing the school building and a delay in completing the project in specified time causing transforming students into other schools as the matrix and risk values were revealed.

From the matrix analysis it could be noted that there are no risk factors in the low zone. On the other hand, only nine elements are in the medium zone, and the remained 36 factors are in a high zone that means 80% of the total factors are in the critical area and this may be due to the unavailablility of the risk registration, recording, and identifying in school projects.

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