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Evaluating the Knowledge for Integrating RM and VM Using BIM in the Iraqi Construction Sector

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ABSTRACT

The construction industry plays a crucial role in the countries' economy, especially in the developed country. This point encourages the concerned institution to use new techniques and integrate many techniques and methods to maximize the benefits. The main objective of this research is to evaluate the use of risk management, value management, and building information modeling in the Iraqi construction industry. The evaluation process aims at two objectives. The direct objective was to evaluate the knowledge in risk management (RM), value management (VM), and building information modeling (BIM). The indirect objective was to support the participants with information related to the main items mentioned. The questionnaire survey was used as a data collection method. The participants in the survey were engineers from the Iraqi construction sector. The sample size was 121 engineers from 34 institutions with multidisciplinary backgrounds. The results showed that the engineers need to develop the training system and merge many methods and techniques in their institution to maximize the benefits using an integration model capable of dealing with the variable environment in construction, especially in developing countries like Iraq.

Keywords: Risk management, Value management, Building information modelling.

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تقييم المعرفة في تكامل إدارة المخاطر وإدارة القيمة بإستخدام نمذجة معلومات البناء في قطاع الإنشاءات العراقي

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الخلاصة

تلعب صناعة البناء دوراً مهماً في اقتصاد البلدان وخاصة في البلدان النامية. من هذا المنطلق، تشجع هذه النقطة المؤسسات المرتبطة بهذا القطاع على استخدام التقنيات الجديدة ودمج العديد من التقنيات والأساليب الحديثة لتحقيق أقصى قدر من الفوائد. إن الهدف الرئيسي من هذا البحث هو تقييم المعرفة في استخدام إدارة المخاطر وإدارة القيمة ونمذجة معلومات البناء في صناعة البناء العراقية. تهدف عملية التقييم إلى هدفين. الهدف المباشر هو تقييم المعرفة في إدارة المخاطر وإدارة القيمة ونمذجة معلومات البناء. أما الهدف غير المباشر هو دعم المشاركين بالمعلومات المتعلقة بالبنود الرئيسية المذكورة. وتم استخدام الاستبيان كطريقة لجمع البيانات. تم استخدام الاستبيان كطريقة لجمع البيانات. تضمنت العينة المهندسين العاملين في قطاع البناء العراقي. كان حجم العينة 121 مهندساً من 34 مؤسسة من خلفيات متعددة التخصصات. أظهرت النتائج أن المهندسين بحاجة إلى تطوير نظام التدريب ودمج العديد من الأساليب والتقنيات في مؤسسته لتعظيم الفوائد باستخدام نماذج تكاملية قادرة على التعامل مع المتغيرات الجديدة في بيئة الإنشاءات وخاصة في الدول النامية مثل العراق.

الكلمات المفتاحية: إدارة المخاطر ، إدارة القيمة، نمذجة معلومات البناء.

1. INTRODUCTION

The construction sector is one of the sectors most affected by the global financial crisis and the economic recession that followed **(Fadhil and Burhan, 2022)**. Risk management is a complex process that becomes increasingly complex in changing business environments. It requires specific procedures to assess each risk and repair appropriate plans to mitigate and contain it **(Fadhil and Burhan, 2021)**. The risk management process involves identifying risks, evaluating them qualitatively and quantitatively, and responding to them **(AL-Aga and Burhan, 2023).** Identifying risks in construction projects indicates potential risks during project planning, construction, or management **(Wideman, 2022).** Therefore, identifying these risks and preparing the necessary plans to respond is an essential detail of the project's success from its failure **(Radi Al-Aga and Burhan, 2022).** Value management is a modern methodology concerned with three main elements: performance efficiency, project quality, and project cost **(Smith et al., 2014).** The importance lies in overcoming the causes of increased costs while maintaining performance and quality **(Hardin and McCool, 2015).** In addition, it identifies and analyzes the functions performed by the project to achieve them in different ways and at a lower cost with higher performance or both without compromising the main functions **(Miles, 2015).** The VM needs to be recognized and comprehended at every project phase. This is one of the methods the designer and VM team can apply to projects such that the project's whole-life value is realized **(Tom and Gowrisankar, 2015).** VE uses a

very successful strategy, analyzing project needs to accomplish essential tasks and offering superior value **(Heralova, 2016)**.
Building institutions work to complete projects at the lowest possible cost while preserving performance and quality to generate a high return **(Harris et al., 2021)**. Owners prioritize financial gain over the aesthetics or functionality of their creations, while creators prioritize both **(Reddy, 2011)**. Based on the projected expenses, the stakeholders are concerned about the likelihood that the construction will be completed on schedule **(Atabay and Galipogullari, 2013)**. Building Information Modeling is witnessing a wide demand to increase the transfer of information to the parties involved in the project to reduce conflicts and improve the performance of construction projects **(Al Saffar et al., 2014)**. The main goal behind BIM technology is to solve the two basic problems that barely exist: separate drawings and lack of coordination between different disciplines **(Yousif and Burhan, 2021)**.
3D object modeling technology in BIM improves the clarity of the design display and streamlines the creation of drawings **(Sacks et al., 2018)**. Removing inconsistent content from individual files or groups of documents and files leads to increased clarity and uniformity, facilitating a more efficient design-making process for the firms involved and fostering collaboration among the construction team **(Panya et al., 2023; Sun et al., 2021)**.
In the three case studies that were carried out, the visualization can be supported throughout the project **(Zhang et al., 2020)**. The American Institute of Architects (AIA) has proposed Integrated Project Delivery (IPD) and stated that the application of BIM is highly significant to assist the effective delivery of IPD **(Piroozfar et al., 2019)**. The technology known as BIM has also been shown to have more strength in creating dimensions beyond those of 3D objects **(Fernández-Mora et al., 2022)**.
Construction projects are invariably complicated. Various service providers and stakeholders will contribute to different stages of any construction project **(Yuan et al., 2018)**. It becomes necessary to cooperate with them and provide important information from various sources **(Alreshidi et al., 2017)**. It is to be expected that there would occasionally be conflicts between architectural, structural, and MEP concepts, particularly during the design phases when these designs are distinct **(Wang et al., 2016)**. Accurate coordination and process communication are ensured by BIM through cloud functionality and integration scope **(Hassanain et al., 2019)**. Information is BIM's main advantage. Every project stage and information from many design disciplines are included in the BIM model **(Ghaffarianhoseini et al., 2017)**. The team is now more accessible as a result. Reviewing and annotating the design is open to everybody **(Saieg et al., 2018)**. One of its primary drawbacks is the incapacity of traditional paper designs, or even 2D designs, to fully display all aspects of the project**(Meloni et al., 2021)**. The project is hard to picture in real life. Ultimately, it produces overwhelming and intricate design drawings. A foundation for understanding the entire design, including floor plans, elevations, and 3D models, is provided by BIM **(Joseph et al., 2020; Sacks et al., 2018)**. The benefits of using BIM are unlimited because of the up-to-date nature of the BIM **(Alizadehsalehi et al., 2020)**.
The primary function of computer-aided design (CAD) is to create two-dimensional drawings showing every building aspectn detail **(Byun and Sohn, 2020)**. These drawings are then divided into sections, each with unique architectural, structural, mechanical, and electrical elements **(Ching et al., 2014)**. All these components are assembled at the workplace to create the structure, allowing them to comprehend the intricacies of each component readily. Occasionally, certain aspects are overlooked during construction, which can cause issues and necessitate the reconstruction of certain building components or, on occasion, rework **(Czmoch and Pękala, 2014; Herrera et al., 2021)**.

Building information modeling (BIM) offers a solution by creating a 3D digital base with all the building features, which eliminates the need for demolition and rework caused by inadequate drawing data. As a result, errors are notably decreased as the project team may share information. Additionally, during the design phase, the client can view his building constructed in a wholly digital representation. As a result, the distance between the project team, the client, and the stakeholders is bridged **(Ding et al., 2014)**.
In this research, researchers assess the Iraqi construction sector from three main axes: risk management, value management, and building information modeling. The knowledge of engineers working from multiple disciplines is evaluated to assess the extent of their understanding of the importance of these elements to see the possibility of integrating these elements to achieve the most significant benefit of each component and employ it as required.

2. RESEARCH METHODOLOGY

The research aims to evaluate the knowledge of the engineers working in the Iraqi construction sector in three main elements from two aspects. The first aspect includes studying risk management, value management, and building information modeling separately. The second is to evaluate the importance of combining these elements to maximize their benefit. The research stages go through several steps, which are as follows:
1- Preparing a preliminary version based on previous studies and presenting it to an evaluation committee consisting of three experts specialized in the construction sector in Iraq to evaluate the preliminary version and make amendments to it.
2- Building a questionnaire through Google Forms and distributing it to 34 establishments concerned with construction in Iraq.
3- The election of a sample of 121 engineers working in the construction sector in Iraq.
4- Collecting samples and conducting operations to organize and treat them.
5- Data analysis using the SPSS program to assess engineers' level of knowledge in risk management, value management, and building information modeling.
6- Discuss results and prepare recommendations. **Fig. 1** shows the research methodology and stages.

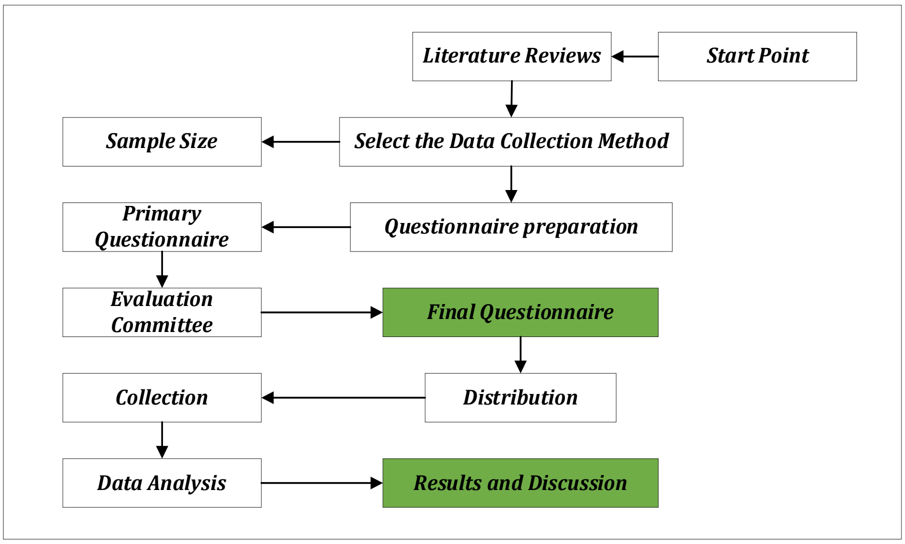


Figure 1. Flowchart for research methodology.

3. QUESTIONNAIRE DESIGN

Initially, previous research was examined to collect, arrange, and analyze relevant information in a manner appropriate to the intended goal **(Benjamin and Cornell, 2014).** The information was then put through a series of conversations, analyses, and reviews to create the questionnaire **(Abbas and Burhan, 2023)**. In this research, the questionnaire was used as a method for data collection in parallel with Google Forms to facilitate the data collection.

3.1 Sample Size

The samples were selected based on Thompson equation where 34 institutions working in the construction sector were elected. The rate of engineers in the engineering departments related to the elements under study was 4 engineers per institution. Thus, the study population included 170 engineers. The sample volume is calculated as **(Scheaffer et al., 2010)**

$$n = \frac{N \times p \times (1-p)}{(N-1) \times \frac{d^2}{Z^2} + p \times (1-p)} \quad (1)$$

where n= sample size; N is the population size; Z is the Standard score corresponding to the significance level (0.95), which is equal to (1.96); d is the standard error of the sampling distribution (0.05); p: population proportion; The recommendation value for (p) is 0.5 when the p-value is unknown depending on **(McClave et al., 2014)**, so that at least as large a sample size is obtained as needed. The researcher used a 95% confidence level score at a 5% indication. Based on Eq. (1), the minimum sample size was 118, as calculated below:

$$\text{n} = \frac{170 \times 0.5 \times (1-0.5)}{(170-1) \times \frac{0.05^2}{1.96^2} + 0.5 \times (1-0.5)} \approx 118$$

3.2 Questionnaire Evaluation

To increase the reliability of the questionnaire, the questionnaire is presented to a panel of experts specialized in civil engineering/project management to evaluate its language, clarity, and consistency. The questionnaire was presented to a carefully selected panel of experts to ensure a good structure for the questionnaire. The committee includes engineers with 20 years of experience in the construction sector and two university professors in project management. This stage was to update from the initial version of the questionnaire to the final version. **Appendix (A)** illustrates the questionnaire distributed to the study sample.

3.3 Validity and Reliability

Using powerful research tools is one of the most important elements in obtaining an acceptable and valuable result. One of the main objectives of the researcher is to create their research tool and give it three crucial characteristics to be meaningful, accurate, and effective **(Rajasekar and Verma, 2013).** To determine the amount of validity and reliability, the data collected through the necessary tests were developed using the statistical analysis software called Statistical Package for Social Sciences (SPSS) version 27. The validity test determines the Cronbach alpha coefficient for each element **(Tavakol and Dennick 2011),** and **Table 1** presents the interval of Cronbach's coefficient of the internal validity test.

Table 1. Cronbach's alpha Intervals

Cronbach's alpha	Degree of Reliability
α ≥ 0.9	Excellent
0.9 > α ≥ 0.8	Good
0.8 > α ≥ 0.7	Acceptable
0.7 > α ≥ 0.6	Questionable
0.6 > α ≥ 0.5	Poor
0.5 > α	Unacceptable

The results show that the degree of reliability ranges between acceptable and good, according to the values that appeared from the SPSS. It ranged between 0.779 and 0.876, as shown in **Table 2.**

Table 2. Cronbach's alpha for all items.

Code	Items	Cronbach's Alpha
RM1	Decrease the probability of the risk.	0.861
RM2	Decrease the effect of the risk.	0.838
RM3	Mitigate the risks.	0.834
RM4	Assess the risk effect of the cost	0.838
RM5	Assess the risk effect of the schedule	0.842
RM6	Assess the risk effect of the quality	0.863
RM7	Decrease the Project termination	0.854
RM8	Support safety	0.779
VM1	Conduct the functional analysis.	0.85
VM2	Waste management.	0.818
VM3	Minimize the cost.	0.849
VM4	Decrease the schedule based on the requirements.	0.849
VM5	Alternative analysis.	0.803
VM6	Select the best alternative.	0.85
VM7	Increase the value.	0.876
BIM1	Improved design quality and Change orders	0.78
BIM2	Clash Detection	0.835
BIM3	Reduce the waste rate of materials	0.79
BIM4	Improvement of Project Quality	0.79
BIM5	Model-based quantity take-off of materials	0.834
BIM6	Project schedule management	0.834
BIM7	Manage total project costs	0.814
BIM8	Improve communication between project parties	0.865
BIM9	Improved design to reduce risk (supports safety)	0.856
BIM10	Flow of information during the life cycle project	0.851
BIM11	Improve project Management	0.842
BIM12	Risks Management	0.844
BIM13	Decrease the Project termination	0.828
IM1	Reduce Risks and manage those that have a high probability	0.78
IM2	Integrate risk with value to minimize the cost	0.848

IM3	Improve project performance	0.859
IM4	Enhance innovated design	0.866
IM5	Eliminating unnecessary functions and cost	0.826
IM6	Eliminating the increased budget in the project	0.851
IM7	Reduce excessive project design	0.79
IM8	Decrease of design deficiencies	0.848
IM9	Provide appropriate alternatives	0.838
IM10	Select the appropriate solution to improve the cost	0.849
IM11	Access the best value through the specification	0.779
IM12	Improve project specifications	0.833
IM13	Strengthening the projection function	0.849
IM14	The efficiency of generated ideas	0.834
IM15	It gives a strong Visualization to compare alternatives and choose the best	0.842

4. DATA ANALYSIS

4.1 Sample Specifications

The specifications of the targeted sample are shown below.

1. The results of the analysis of qualification level showed that the sample is divided into 64% having a bachelor's degree, 21% having a master's degree, and 16% having a doctorate, as shown in **Fig. 2a**.
2. The analysis of experience in the construction industry showed that the sample included 16% of a 1- 5 years category, 27% of a 6- 10 years category, 33% of an 11- 15 years category, and 24% of a more than 15 years category as shown in **Fig. 2b**.

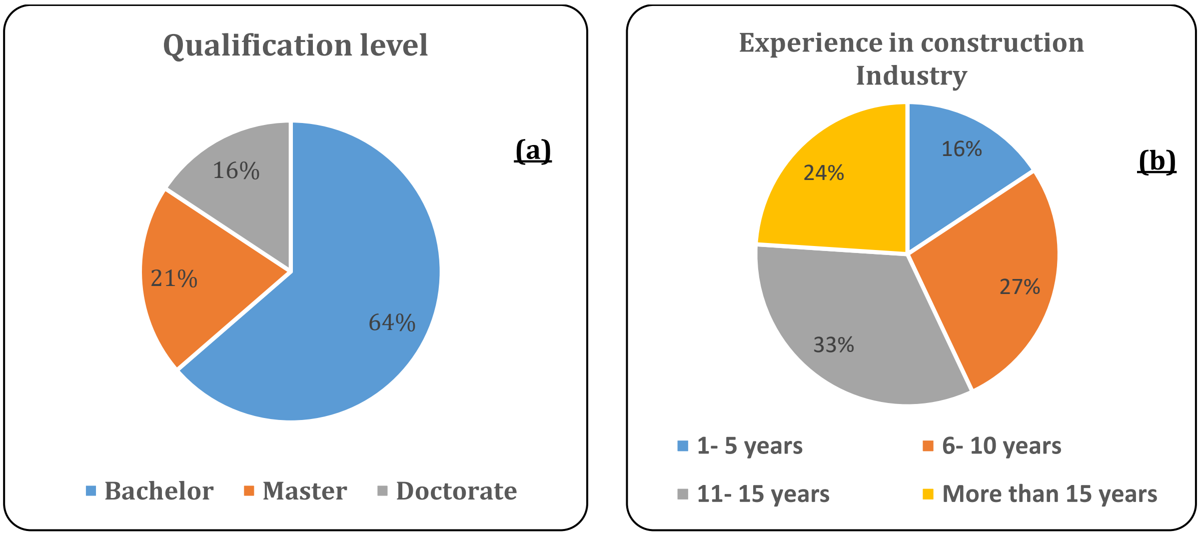


Figure 2. Qualification Level and Experience.

3. The analysis of the respondents' speciality showed that the sample included 58% of a civil engineer, 9% of an electrical engineers, 21% of an architect engineer, 7% of a mechanical engineer, and 5% of another engineer, as shown in **Fig. 3a**.

4. The analysis of job type showed that the sample included 34% of an executive, 22% of a consultant, 24% of a designer, 16% of a contractor, and 4% of another type, as shown in **Fig. 3b**.

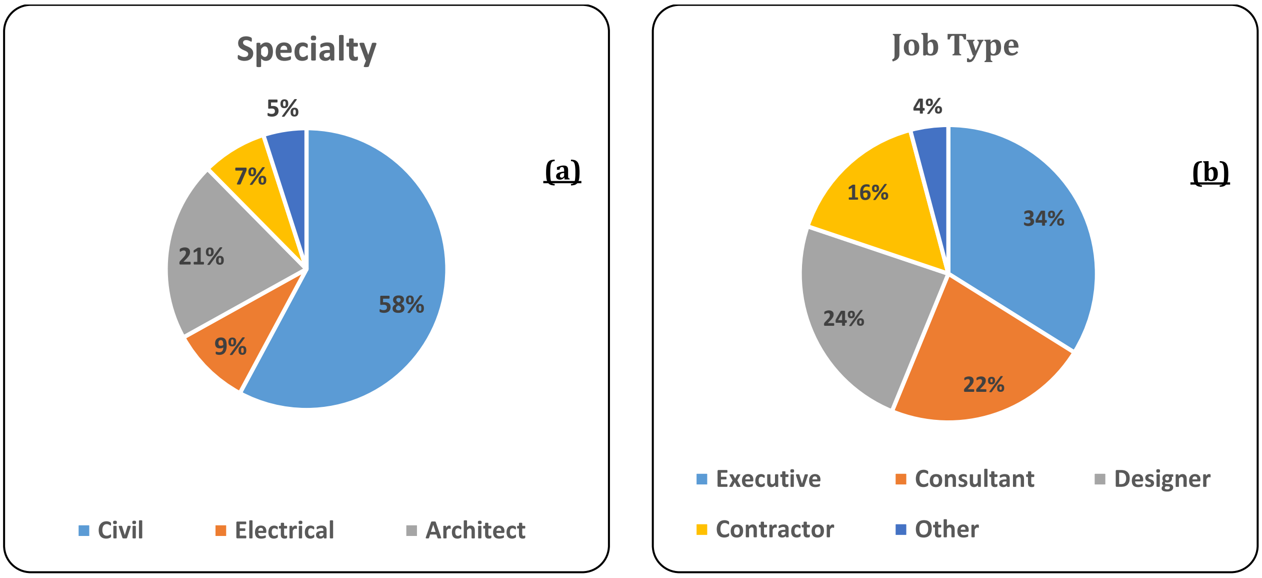


Figure 3. Speciality and job type.

5. The analysis of the organisation's classification showed that the sample included 45% of a governmental category, 23% of a university, 20% of a non-government, 7% of a consultation office, and 5% of another, as shown in **Fig. 4a**.
6. The analysis of the company sector showed that the sample included 8% of commercial, 9% of industrial, 34% of heavy civil, 44% of residential, and 5% of other sectors, as shown in **Fig. 4b**.

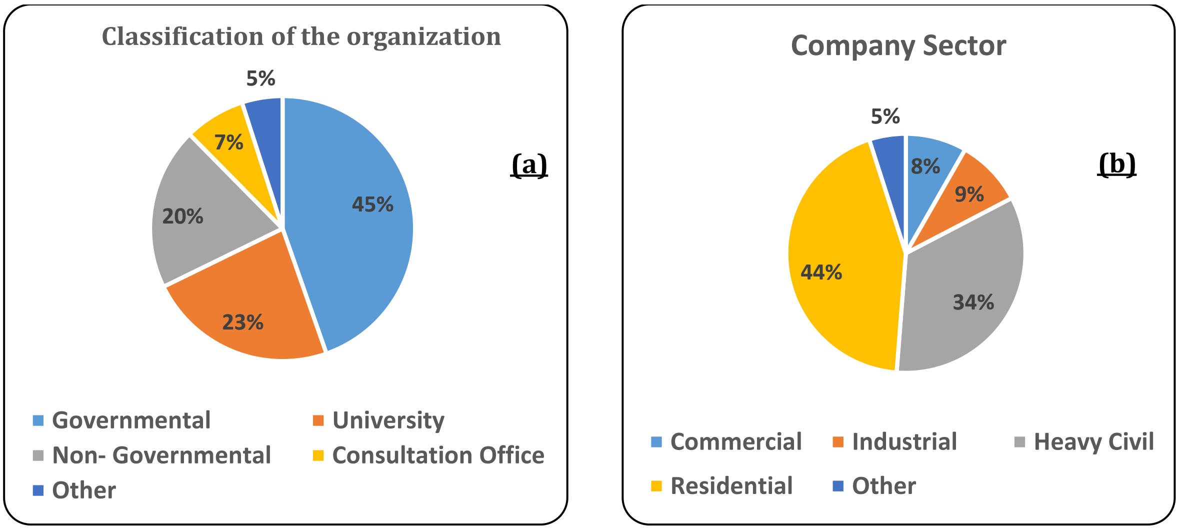


Figure 4. Classification and sector.

4.2 Evaluation of Risk Management in Construction Projects

The analysis results of section two, which specialized in evaluating risk management in the Iraqi construction sector, showed many points below.

1. Regarding RM in the Iraqi construction sector, 66% of the respondents know, and 34% don't know, as shown in **Fig. 5a**.

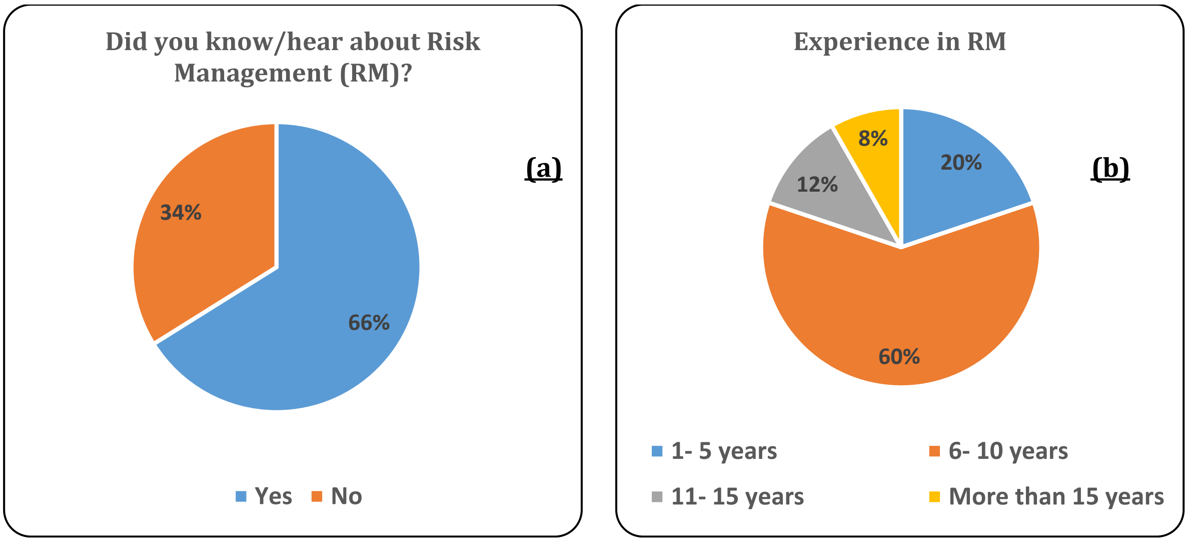


Figure 5. Knowledge and Experience in RM.

2. The analysis of the experience of RM showed that the sample included 20% of a 1- 5 years category, 60% of a 6- 10 years category, 12% of an 11- 15 years category, and 8% of a more than 15 years category as shown in **Fig. 5b**.
3. The analysis of the percentage of RM application showed that the respondents included 51% of a less than 10% category, 17% of a less than 20% category, 17% of a Between 21-30% category, and 15% of a more than 30% categorized as shown in **Fig. 6a**.
4. The analysis of the stage of project use RM showed that the respondents included 69% of a planning stage, 20% of a design stage, 5% of an execution stage, and 6% of a close-out stage, as shown in **Fig. 6b**.

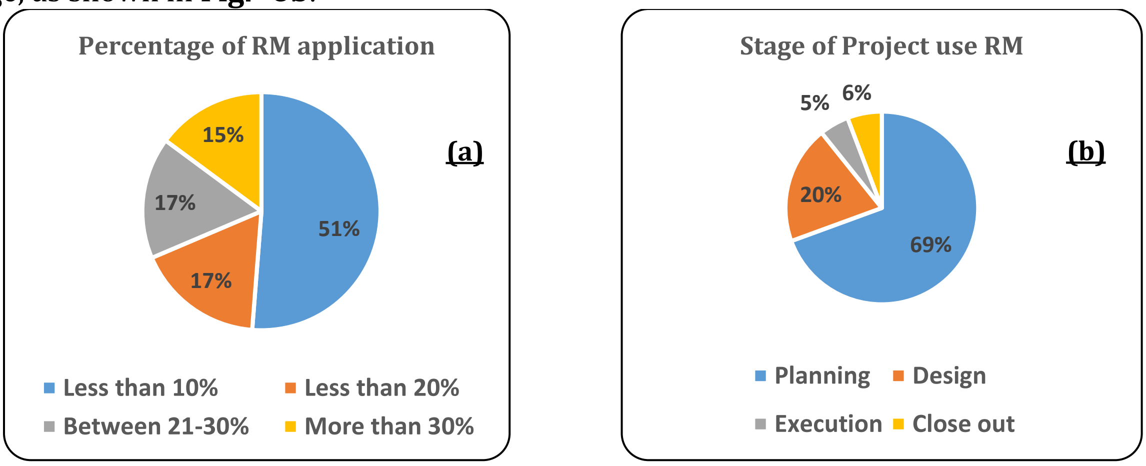


Figure 6. Application percentage and stage of use RM.

5. The analysis of RM's role within work showed that the respondents included 53% of a mitigation function, 23% of an assessment function, 17% of an identification function, and 7% of other functions, as shown in **Fig. 7a**.

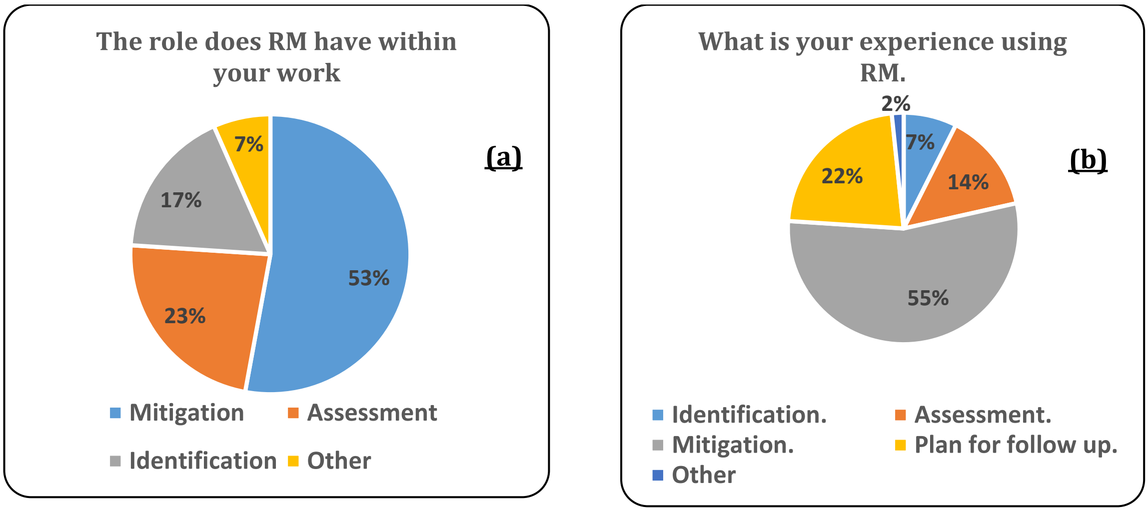


Figure 7. The role and experience in RM

6. The analysis of experience using RM showed that the respondents, including 7%, have experience in the identification step, 14% have experience in the assessment step, 55% have experience in the mitigation step, 22% have experience in follow-up the risk step and 2% have experience in another step as shown in **Fig. 7b**.

7. The analysis of the type of project executed by RM showed that 8% of commercial projects, 42% of industrial projects, 31% of heavy civil projects, 17% of residential projects, and 2% of other types of projects, as shown in **Fig. 8**.

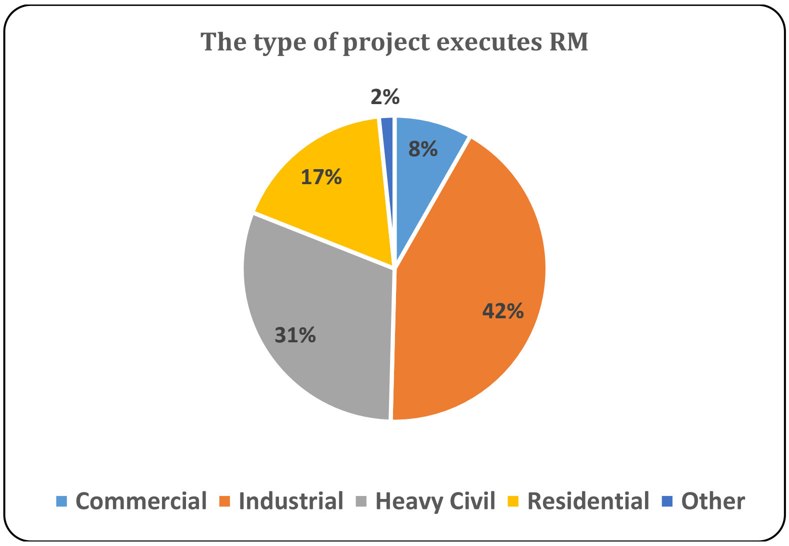


Figure 8. The type of projects executed by RM

8. The statistical analysis results showed that the third item (RM3: mitigate the risk) was the most important item with a mean value of 4.289 and, therefore, ranked as first order in the rank column. The fourth item (RM4: an assessment of the risk effect on the cost) was in the second order, with a mean value of 4.239. The third order was for the second item (RM2: decrease the impact of the risk on the projects) with a mean value of 4.141. **Table 3** shows the mean and standard deviation for each item.

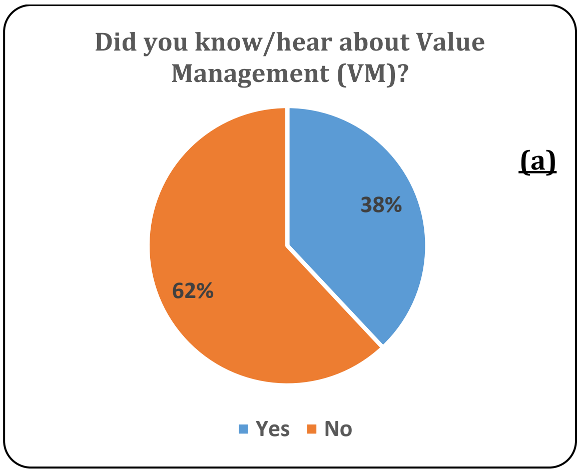
Table 3. Ranking of RM importance items

Code	Items	Mean	Std. Deviation	Rank
RM3	Mitigate the risks.	4.2893	0.8606	1
RM4	Assess the risk effect of the cost	4.2397	0.76403	2
RM2	Decrease the effect of the risk.	4.1405	0.88794	3
RM8	Support safety	4.124	0.98801	4
RM1	Decrease the probability of the risk.	4.0579	0.8093	5
RM5	Assess the risk effect of the schedule	3.9835	1.01639	6
RM6	Assess the risk effect of the quality	3.9256	1.05803	7
RM7	Decrease the Project termination	1.6777	0.9593	8

4.3 Evaluation of Value Management in Construction Projects

The results of the analysis of section three specialized in evaluating the value management in the Iraqi construction sector, showed many points as below.

1. Regarding VM in the Iraqi construction sector, 38% of the respondents know, and 62% don't know, as shown in **Fig.9a**.
2. The analysis of the experience of VM showed that the sample included 74% of a 1- 5 years category, 23% of a 6- 10 years category, 2% of an 11- 15 years category, and 1% of a more than 15 years category as shown in **Fig. 9b**.



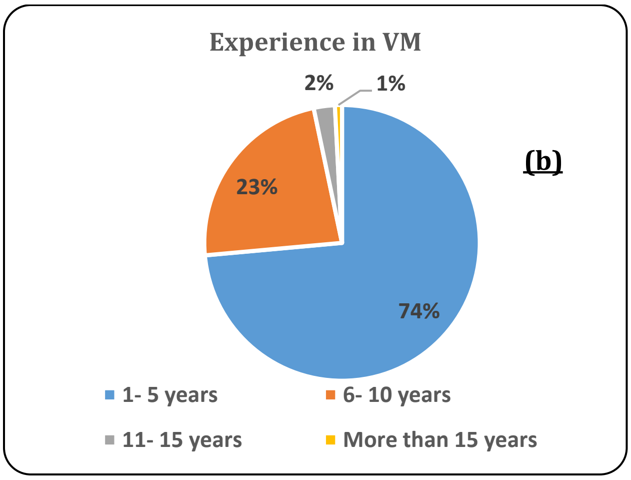


Figure 9. Knowledge and Experience in VM.

3. The analysis of the percentage of VM application showed that the respondents included 53% of a less than 10% category, 17% of a less than 20% category, 14% of a Between 21-30% category, and 16% of a more than 30% category as shown in **Fig. 10a**.
4. The analysis of the stage of project use VM showed that the respondents included 54% of a planning stage, 41% of a design stage, 3% of an execution stage, and 2% of a close-out stage as shown in **Fig. 10b**.
5. **Fig. 11a.** shows that the most efficient parties to participate in the pre-workshop is 14% selected the owner as the most efficient party, 26% selected the VM team, 40% selected the designer, 18% selected the consultant, and 2% selected other party
6. The analysis of the information sources in the Workshop Phase showed that 51% of information came from documents, 13% from drawings, 12% from reports, 9% from project estimates, 8% from project schedules, and 7% from specifications, as shown in **Fig. 11b.**
7.

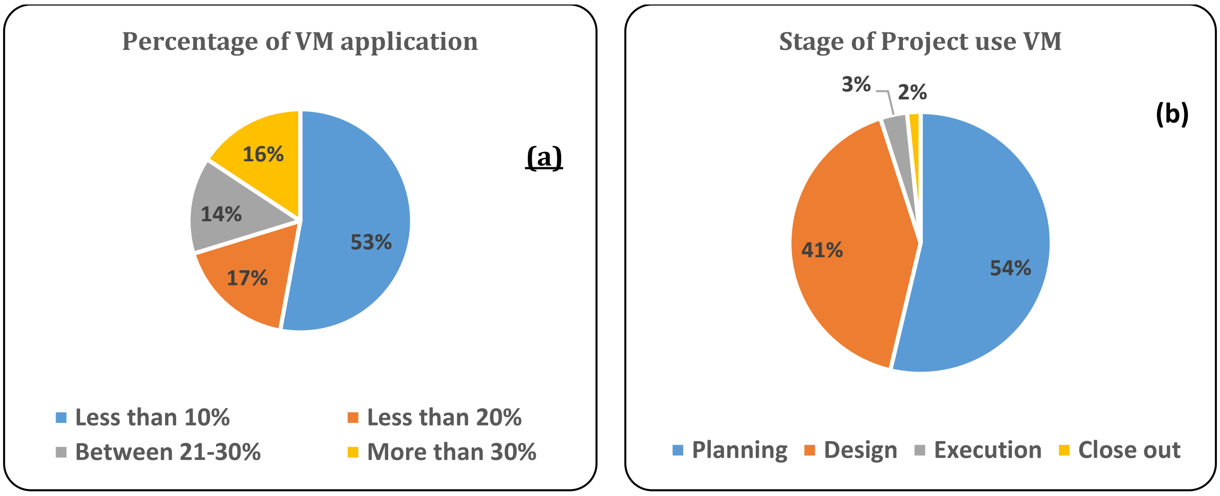


Figure 10. Application percentage and stage of use VM.

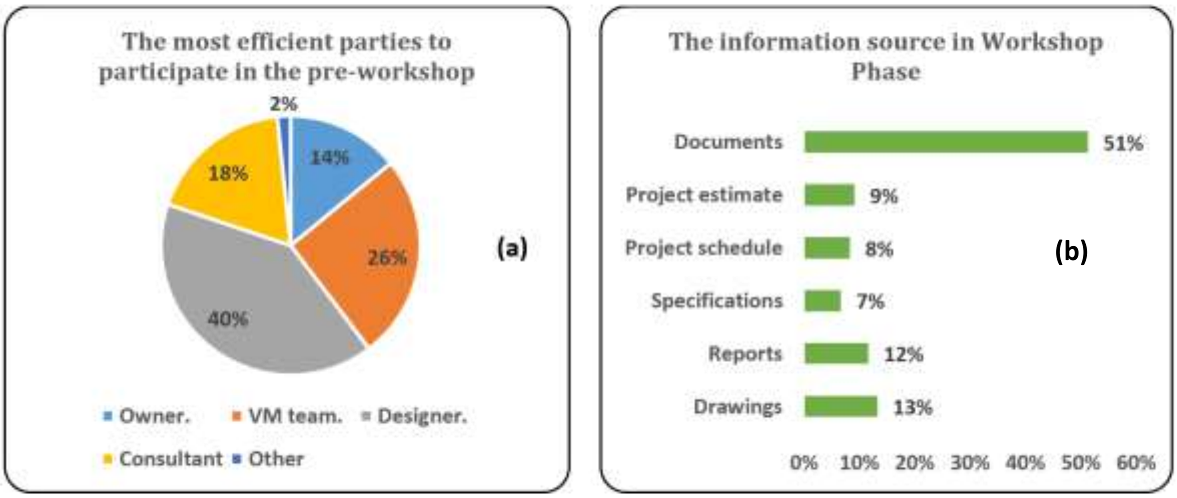


Figure 11. The most efficient part and documents used in the VM

8. The analysis of the techniques used in assessing the problem of the design in the workshop phase showed that the importance of focus group discussion was 32%, 24% in brainstorming sessions and building a functional model, 11% in determining best opportunities and 9% of estimate the cost as shown in **Fig. 12**.

9. The results of the statistical analysis of value management items showed that the first item (VM1: Conduct the functional analysis) was the most important item with a mean value of 4.223 and, therefore, ranked as first order in the rank column. The second order was (VM5: Alternative analysis) with a mean value of 4.198. The third order was (VM6: Select the best alternative) with a mean value of 4.19. **Table 4** shows the mean and standard deviation for each item.

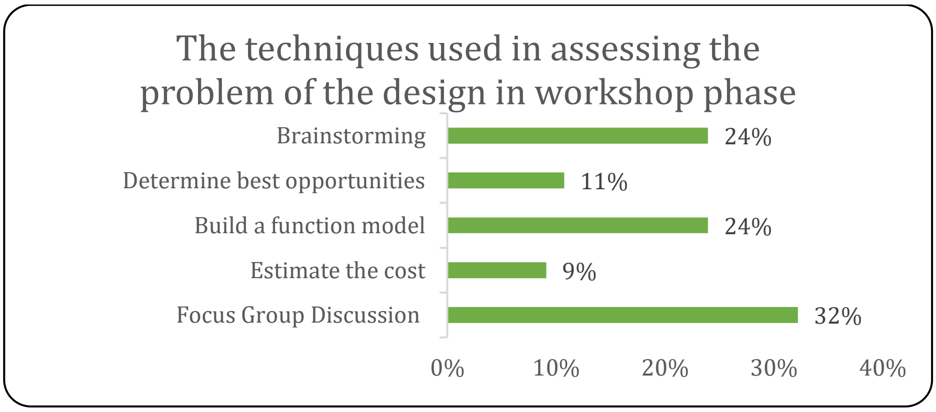


Figure 12. The techniques used in assessing the problem of the design in the workshop phase

Table 4. Ranking of VM importance items

Code	Items	Mean	Std. Deviation	Rank
VM1	Conduct the functional analysis.	4.223	0.841	1
VM5	Alternative analysis.	4.198	0.936	2
VM6	Select the best alternative.	4.190	0.942	3
VM3	Minimize the cost.	4.173	0.909	4
VM7	Increase the value.	4.016	1.032	5
VM2	Waste management.	3.991	1.012	6
VM4	Decrease the schedule based on the requirements.	3.884	1.058	7

4.4 Evaluation of Building Information Modeling in Construction Projects

The analysis results of section four, which specialized in evaluating the building information modeling in the Iraqi construction sector, showed many points.

1. Regarding BIM in the Iraqi construction sector, 79% of the respondents know, and 21% don't, as shown in **Fig.13a**.
2. The analysis of the experience of BIM showed that the sample included 75% of a 1-5 years category, 22% of a 6- 10 years category, 2% of an 11- 15 years category, and 1% of a more than 15 years category as shown in **Fig. 13b**.
3. The analysis of the percentage of BIM-Project implementation showed that the respondents included 17% of a less than 10% category, 47% of a less than 20% category, 14% of a Between 21-30% category, and 21% of a more than 30% category as shown in **Fig. 14a**.
4. The analysis of BIM software packages the company uses showed that the respondents included 56% used Autodesk Revit, 3% used Autodesk Revit-ArchiCAD-Bentley, 4% used

ArchiCAD, 22% used Autodesk Revit-Navisworks, and 14% used other software as shown in **Fig. 14b**.

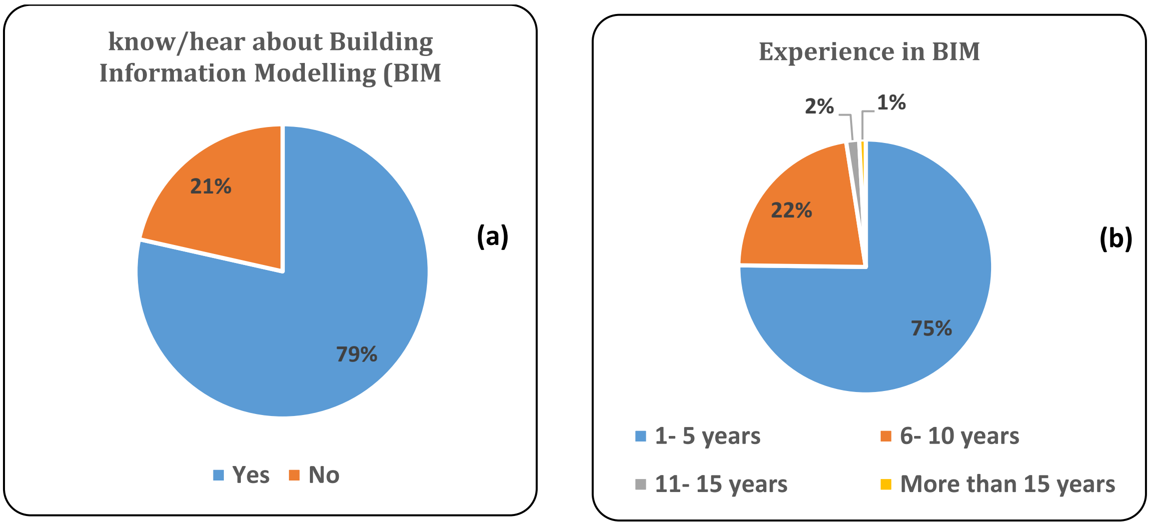


Figure 13. Knowledge and experience in BIM.

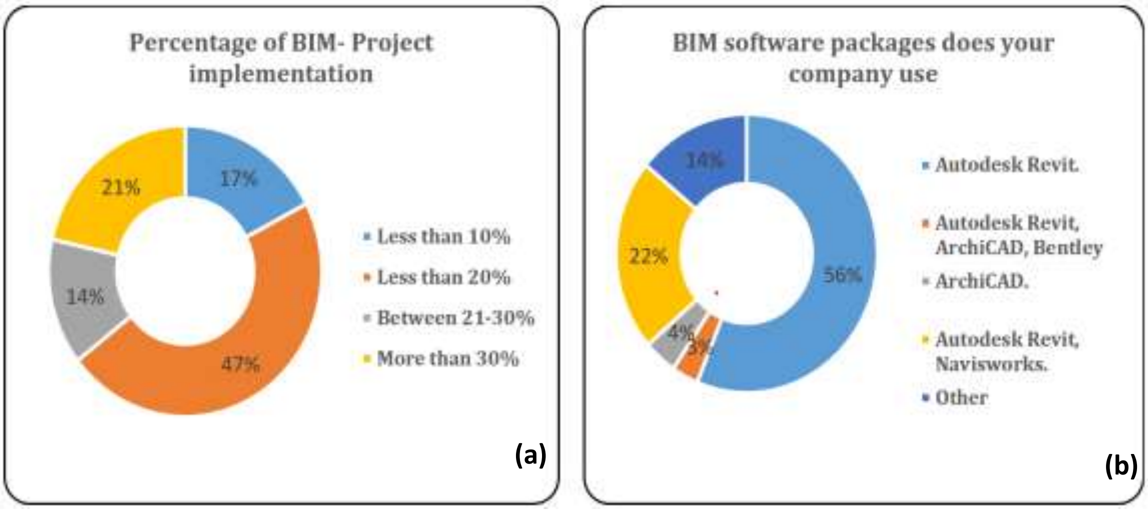


Figure 14. Application percentage and BIM software.

5. The analysis of the role BIM has within your work showed that the respondents selected 55% of a Project Visualization role, 33% of a Project Coordination role, 6% of a Project Analysis role, and 6% of a Project Supply/Vendor Integration role, as shown in **Fig. 15a**.
6. The analysis of the project experience using BIM or other showed that 14% of respondents used Unmanaged CAD, 16% used Managed CAD, 60% used Managed 3D model, 8% used Full 3,4 & 5D integration, and 2% used another method as shown in **Fig. 15b**.

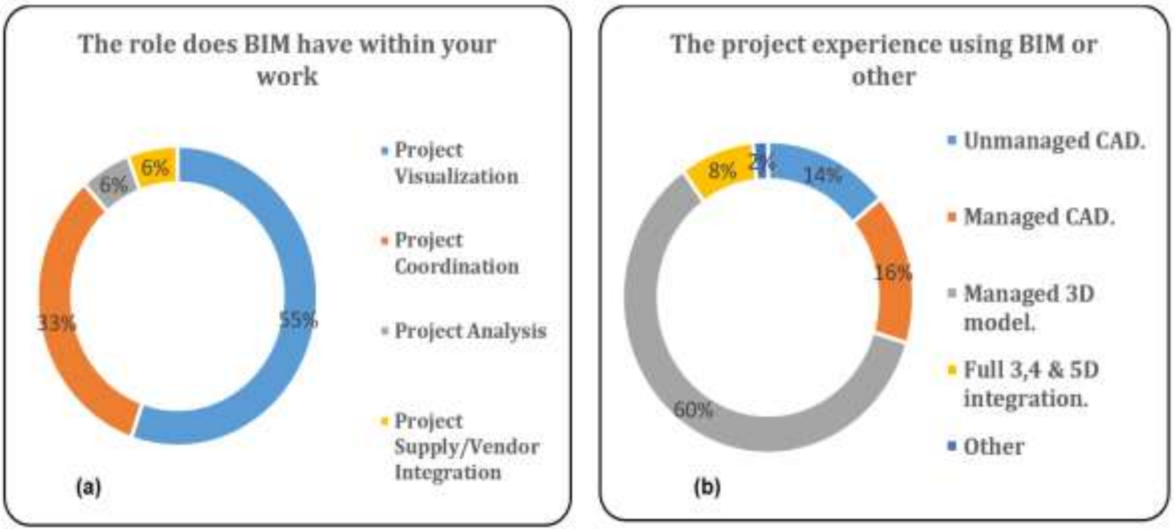


Figure 15. The role and experience in BIM

7. The results of statistical analysis of BIM importance items showed that (BIM11: Improve project Management) was the most important item with a mean value of 4.463 and therefore ranked as first order in the rank column. The second order was (BIM9: Improved design to reduce risk) with a mean value of 4.422. The third order was (BIM8: Improve communication between project parties) with a mean value of 4.306. **Table 5** shows the mean and standard deviation for each item.

Table 5. Ranking of BIM importance items

Code	Items	Mean	Std. Deviation	Rank
BIM11	Improve project Management	4.463	0.646	1
BIM9	Improved design to reduce risk (supports safety)	4.422	0.668	2
BIM8	Improve communication between project parties	4.306	0.705	3
BIM5	Model-based quantity take-off of materials	4.273	0.992	4
BIM6	Project schedule management	4.215	0.710	5
BIM2	Clash Detection	4.157	0.958	6
BIM10	Easy Flow of information throughout the life cycle of the project	4.132	0.921	7
BIM3	Reduce the waste rate of materials	4.099	0.870	8
BIM4	Improvement of Project Quality	4.099	0.870	9
BIM7	Manage total project costs	4.083	0.971	10
BIM1	Improved design quality and Change orders	4.066	1.047	11
BIM12	Risks Management	3.992	1.061	12
BIM13	Decrease the Project termination	1.777	1.053	13

4.5 Evaluation of Integration RM and VM using BIM

The results of the statistical analysis of the Integration model showed that (IM15: gives a strong Visualization to compare alternatives and choose the best) was the most important item with a mean value of 4.463 and therefore ranked as a first-order in the rank column.

This point is considered a strong point of BIM-supported projects. The second order was (IM14: The efficiency of generated ideas) with a mean value of 4.273. The generation idea is the big point to provide the best alternatives. The third order was (IM3: Improve project performance) with a mean value of 4.2316, where this point is the crucial goal. **Table 6** shows the mean and standard deviation for each item.

Table 6. Ranking of Integration importance items

Code	Items	Mean	Std. Deviation	Rank
IM15	It gives a strong Visualization to compare alternatives and choose the best	4.463	0.646	1
IM14	The efficiency of generated ideas	4.273	0.992	2
IM3	Improve project performance	4.231	0.920	3
IM10	Select the appropriate solution to improve the cost	4.190	0.615	4
IM13	Strengthening the project function	4.190	0.687	5
IM9	Provide appropriate alternatives	4.141	0.888	6
IM11	Access the best value through the specification	4.124	0.988	7
IM7	Reduce excessive project design	4.099	0.870	8
IM5	Eliminating unnecessary functions and cost	4.091	0.922	9
IM1	Reduce Risks and manage those that have a high probability	4.066	1.047	10
IM4	Enhance innovated design	4.058	0.925	11
IM12	Improve project specifications	4.050	0.855	12
IM2	Integrate risk with value to minimize the cost	4.025	1.052	13
IM6	Eliminating the increased budget in the project	4.008	0.987	14
IM8	Decrease of design deficiencies	3.934	1.167	15

5. CONCLUSIONS

This research shows that the benefits of using risk and value management can be maximized by integrating them on several levels in models developed for building information modeling. It concludes that there is a possibility for engineers working in the Iraqi construction sector to integrate risks after quantitatively converting them and studying their impact on the cost as the cost had a prominent importance table of the integrative model and that coordination processes between the parties to the project cause many risks and many conflicts. The results showed that preparing the mitigation measures was of the highest importance. Also, the functional analysis of value management principles was the first rank in importance considerations. In addition, the improvement of project management and coordination is the highest rank in importance according to the analysis results. For the integrated model, the visualization is the highest priority in parallel with the alternatives analysis to choose the best. The results showed that most engineers in the Iraqi construction sector use Revit software and, to a lesser extent, use Navisworks, which means they are receptive to new technologies. The researchers recommend studying how to extract numerical factors that affect cost and introduce them into the Revit software and study the evaluation of alternatives through value management on the other side.

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Appendix A

Closed Questionnaire

Evaluating the Knowledge for Integrating RM and VM Using BIM in the Iraqi Construction Sector

The objective of this questionnaire is to study the impact of the use of Risk management, Value management, and BIM in the Iraqi construction industry. It also examines the expected benefits of integrating RM and VM using BIM to assess a comprehensive understanding of these items and identify a common state of knowledge.

This questionnaire is aimed at engineers working in the construction industry with experience and knowledge of risk management, Value management, and building information modeling. Please kindly respond to all questions posed accurately. The answers will be used for scientific research only and will be confidential.

Sincerely.

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Section One: Personal Information			
1.	Name (Optional): …………………………………………………………………………		
2.	Organization/Company: …………………………………………………………………………		
3.	Qualification level: ☐ Bachelor ☐ Master	☐ Doctorate ☐ Other ……………	
4.	Experience in construction Industry: ☐ 1- 5 years ☐ 6- 10 years	☐ 11- 15 years ☐ More than 20 years	
5.	Specialty: ☐ Civil ☐ Electrical	☐ Architect ☐ Mechanical	☐ Other
6.	Job Type: ☐ Executive ☐ Consultant	☐ Designer ☐ Contractor	☐ Other
7.	Classification of the organization: ☐ Governmental ☐ University	☐ Non- Governmental ☐ Consultation Office	☐ Other
8.	Company Sector: ☐ Commercial ☐ Industrial	☐ Heavy Civil ☐ Residential	☐ Other

Section Two: Risk Management in Construction Projects			
1.	Did you know/hear about Risk Management (RM)?		
	☐ Yes	☐ No	
2.	Experience in RM:		
	☐ 1- 5 years	☐ 11- 15 years	
	☐ 6- 10 years	☐ More than 15 years	
3.	Percentage of RM application:		
	☐ Less than 10%	☐ Less than 20%	
	☐ Between 20-30%	☐ More than 30%	
4.	Stage of Project use RM		
	☐ Planning	☐ Execution	
	☐ Design	☐ Close out	
5.	The role does RM have within your work		
	☐ Mitigation	☐ Identification	
	☐ Assessment	☐ Other	
6.	What is your experience using RM.		
	☐ Identification.	☐ Mitigation.	☐ Other
	☐ Assessment.	☐ Plan for follow up.	
7.	The type of project executes RM:		
	☐ Commercial	☐ Heavy Civil	☐ Other
	☐ Industrial	☐ Residential	

When using RM, determine the importance of RM.							
No.	**Items**	**Code**	**Importance Level**				
			1	**2**	**3**	**4**	**5**
			Very low	**Low**	**Moderate**	**High**	**Very High**
1.	Decrease the probability of the risk.	RM1					
2.	Decrease the effect of the risk.	RM2					
3.	Mitigate the risks.	RM3					
4.	Assess the risk effect of the cost	RM4					
5.	Assess the risk effect of the schedule	RM5					
6.	Assess the risk effect of the quality	RM6					
7.	Decrease the Project termination.	RM7					
8.	Support safety	RM8					

When using a VM, determine the importance of the VM.							
No.	**Items**	**Code**	**Importance Level**				
			1	**2**	**3**	**4**	**5**
			Very low	**Low**	**Moderate**	**High**	**Very High**
1.	Conduct the functional analysis.	VM1					
2.	Waste management.	VM2					
3.	Minimize the cost.	VM3					
4.	Decrease the schedule based on the requirements.	VM4					
5.	Alternative analysis.	VM5					
6.	Select the best alternative.	VM6					
7.	Increase the value.	VM7					

Section Three: Value Management (VM) in Construction Projects
1. Did you know/hear about Value Management (VM)? ☐ Yes ☐ No
2. Experience in VM: ☐ 1- 5 years ☐ 11- 15 years ☐ 6- 10 years ☐ More than 15 years
3. Percentage of VM application: ☐ Less than 10% ☐ Less than 20% ☐ Between 20-30% ☐ More than 30%
4. What is the most important Stage of Project to use VM? ☐ Planning ☐ Execution ☐ Design ☐ Close out
5. Who are the most efficient parties to participate in the pre-workshop ☐ Owner. ☐ Designer. ☐ Other ☐ VM team. ☐ Consultant
6. What are the information sources that using in Workshop Phase? ☐ Drawings. ☐ Specifications. ☐ Project estimate ☐ Reports. ☐ Project schedule. ☐ Documents
7. What are the techniques used in assessing the problem of the design in workshop phase? ☐ Focus Group Discussion ☐ Build a function model ☐ Brainstorming ☐ Estimate the cost ☐ Determine best opportunities

Section Four: Building Information Modelling (BIM) in Construction Projects

1. Did you know/hear about Building Information Modelling (BIM)?
   - ☐ Yes
   - ☐ No

2. Experience in BIM:
   - ☐ 1- 5 years
   - ☐ 11- 15 years
   - ☐ 6- 10 years
   - ☐ More than 15 years

3. Percentage of BIM- project implementation:
   - ☐ Less than 10%
   - ☐ Less than 20%
   - ☐ Between 20-30%
   - ☐ More than 30%

4. Which of the following BIM software packages does your company use?
   - ☐ Autodesk Revit.
   - ☐ ArchiCAD.
   - ☐ Other
   - ☐ Bentley.
   - ☐ Navisworks.

5. What role does BIM have within your work?
   - ☐ Project Visualization
   - ☐ Project Analysis
   - ☐ Project Coordination
   - ☐ Project Supply/Vendor Integration

6. What is your project experience using BIM.
   - ☐ Unmanaged CAD.
   - ☐ Managed 3D model.
   - ☐ Other
   - ☐ Managed CAD.
   - ☐ Full 3,4 & 5D integration.

. When using BIM, determine the importance of BIM.

No.	Items	Code	Importance Level				
			1	2	3	4	5
			Very low	Low	Moderate	High	Very High
1.	Improved design quality and Change orders	BIM1					
2.	Clash Detection	BIM2					
3.	Reduce the waste rate of materials.	BIM3					
4.	Improvement of Project Quality	BIM4					
5.	Model-based quantity take-off of materials	BIM5					
6.	Project schedule management	BIM6					
7.	Manage total project costs.	BIM7					
8.	Improve communication between project partie	BIM8					
9.	Improved design to reduce risk (supports safety	BIM9					
10.	Easy Flow of information throughout the life cycle of the project	BIM10					
11.	Improve project Management	BIM12					
12.	Risks Management	BIM13					
13.	Decrease the Project termination.	BIM14					

Section Five: Integration RM and VM using BIM

No.	Items	Code	Importance Level				
			1	2	3	4	5
			Very low	Low	Moderat	High	Very High
1.	Reduce Risks and manage those that have a high probability	IM1					
2.	Integrate risk with value to minimize the cost	IM2					
3.	Improve project performance	IM3					
4.	Enhance innovated design	IM4					
5.	Eliminating unnecessary functions and cost	IM5					
6.	Eliminating the increased budget in the project	IM6					
7.	Reduce excessive project design.	IM7					
8.	Decrease of design deficiencies	IM8					
9.	Provide appropriate alternatives	IM9					
10.	Select the appropriate solution to improve the cost	IM10					
11.	Access the best value through the specification	IM11					
12.	Improve project specifications	IM12					
13.	Strengthening the project function	IM13					
14.	The efficiency of generated ideas	IM14					
15.	Gives a strong Visualization to compare alternatives and choose the best	IM15					