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RESEARCH PAPER

A Study of Current situation, Difficulties, and Advantages of implementing BIM in the Construction Sector in Northern Iraq

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A B S T R A C T:
Building Information Modeling (BIM) as an effective Technique of construction projects management has been adopted by the AEC (Architectural, Engineering, and Construction) industry. BIM has substantial benefits over the whole construction lifecycle. In spite of the importance of applying BIM in construction projects, It looks there is fewer study presented to rank the difficulties factors of implementing BIM , also there is less study conducted to show the advantages of using BIM in the construction sector in Northern Iraq. The major objective of this study is to investigate the current situation of applying BIM in the construction sector in Northern Iraq, examine the difficulties of implementing BIM and identify the advantages of implement BIM in the construction industry. A questionnaire was prepared and distributed to 276 engineers in three Governorates (Erbil, Kirkuk, and Sulaymaniyah) in both sectors (private and public). The collected data analyzed using the relative importance index (RII) and mean to rank the difficulties and advantages of implement BIM in Northern Iraq. The analysis results revealed that the most significant difficulties factors in adopting BIM in Northern Iraq are lack of education and syllabus in college regarding the sophisticated package, e.g., ArchiCAD and Revit, there is no training and tutoring for BIM applications in government departments and lack of government supporting and encouraging implementing BIM. The results also revealed the most significant advantages of using BIM are reduce risks in the design stage, improve building design and models, and improve the quality of the building.

KEY WORDS: BIM, difficulties, advantages, current situation, RII
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1.INTRODUCTION

The actual implementation and application of BIM are so far remains challenging for the construction industry. Nevertheless, investigations and studies show a considerable escalation in the percentage of BIM adoption and implementation in typical activities in the construction through the latest five years (Delavar, 2017). BIM is the data and documents process involving information about all stages of the project like planning, design, construction, and operation. It is also useful for extracting estimates such as time, cost, and so on (Kumar and Mukherjee, 2009).

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BIM is not only a technology or a software tool that can be learned and applied. It is rather a model that joins and merges technology with people and progression problems in the construction industry (Haron et al., 2017).

Some of the software which has work in the field of BIM system technology is Graphisoft's ArchiCAD, Autodesk's Revit, etc. Propositions BIM tools are cooperative in the improvement of the project plan and design and generating enhanced coordinated building information and documents (Gajbhiye, 2011).

BIM technology is reflected in the Architectural, Engineering, and Construction (AEC) Industry. In the earlier ten years, design tools have been developed in the AEC industry from 2D modeling to 3D modeling (Yan and Demian, 2008).

The unique benefits can be obtainable by BIM is the incorporation of the interested party during entirely project phases and the imposition of a cooperative working condition among them to increase the zone of interest (Hatem et al., 2018b).

The future project design and construction will progressively be dependent on BIM. Nowadays, BIM is being implemented in several phases of the project lifecycle, making substantial advantages for the project parties and society (Sun et al., 2017).

BIM find out integrated progressions during the whole lifecycle of the project. The attention is to produce reliable information by the stakeholders during the lifecycle (Arayici et al., 2012).

Academic investigations and case studies, principally within the construction and post-construction phases, unsuccessful to examine and measure BIM benefits, Therefore, Understanding the positive advantages of BIM is a vital driver for active adaptation (Talebi, 2014).

This paper aims to:

1- Investigate the current situation of Applying BIM in Northern Iraq.

2- Examine the difficulties of implementation BIM in the construction industry.

3- Identify the advantages of implementation BIM in the construction industry.

2. THE LITERATURE REVIEW

BIM has improved the design, construction, and operation stages of the buildings. The applied of BIM has run to better profitability, improved time managing, reduced costs, and enhanced customer-client connections.

Azhar et al. (2012) focused on BIM's core concepts by presenting an overview of BIM uses in the construction life cycle and advantages for the project stakeholders. This study also explains barriers and risks to BIM application and future trends.

Even though the several advantages of BIM were identified, there are difficulties remains to be overcome. The main barriers to BIM implementation in the UK were identified and ranked by Eadie et al. (2014), which were "Scale of Culture Change Required/Lack of Flexibility" came as the first barrier. "Lack of supply Chain Buy-in" and "Doubts about Return on Investment/Lack of Vision of Benefits" are ranked second and third respectively.

Saleh (2015) and Matarneh and Hamed (2017) showed the main barriers to implementing BIM in Libya and Jordan, respectively.

BIM implementation was until 2016 even not were discussed a lot in Ghana and other African developing countries. Therefore, Armah (2016) explored the benefits and barriers faced BIM implementation in the Ghanaian Construction Industry. This study discovered the major benefits of BIM, which were improved constructability, improved Visualization, and improved productivity. Additionally, explored the main barriers which were: Lack of knowledge in the usage of BIM, Software compatibility, and BIM cost setup.

BIM aiding code officials visualize the building project, from selecting items could be extracted essential information, e.g. quantities, allow the tasks to have the best understanding of unique project characteristic and how they relate to other components (Belliard and Shantalle, 2016).

Hamada et al. (2017) and Hamada et al. (2016) and Hatem et al. (2018a) and Hatem et al. (2018b) concentrated on the implementation of BIM technology and identified the benefits desired and challenges that reduce adoption this technique in the Iraqi construction industry.

The differing opinions of BIM implementation obstacles between the owners, designers, and contractors were identified by (Li et al., 2017).

Seed (2015) recognized the important variations of implementation BIM by company type and size in the UK construction industry.

In Germany, the barriers to implement BIM techniques and the current practice regarding BIM were analyzed by (Both, 2012).

Chan (2014) in Hong Kong examined the BIM implementation among the design companies and identified their requirements and obstacles in the BIM application process.

Sreelakshmi et al. (2017) found the challenges in the implementation of BIM and involved studying the situation of BIM knowledge in India's construction projects. Collected data were analyzed using RII. The majority of respondents proposed that the cost of BIM implementation is the main barrier.

Zahrizan et al. (2014) determined the actual barriers that obstruct BIM implementation and the motivating factors that could improve its application in the Malaysian construction industry.

Several group meetings were held in China and Australia by Liu et al. (2015) to identifying, classifying, and ranking the main barriers to implementing BIM through a survey.

Memon et al. (2014) focused on assessing the present situation of BIM application in the Malaysian construction industry. This study also examined advantages and disadvantages with obstacles to implementations of BIM and suggesting practical plans for improving the BIM application in the construction industry.

Azhar (2011) discussed the current trends, benefits, possible risks, and future challenges of BIM applications for the AEC industry. The results of this research provided beneficial information for AEC industry parties considering applying BIM techniques in their projects.

Examination of the present status of BIM applications in the Middle East by discovering the range of BIM adoption among stakeholders in the AEC industry in this region were researched by (Gerges et al., 2017).

In the South African construction industry, Kekana et al. (2014) studied the critical barrier's factors to implement BIM. The study revealed that the major barriers, which are attributed to contractual subjects such as licensing, insurance, and persons lacks in terms of training, education, and skills improvement.

3. MATERIALS AND METHODS

The questionnaire survey prepared and designed with the detailed understandable questions in order to create an easily answered survey for the respondents and distributed to professional engineers who have dealt with project in the northern Iraq construction industry in two departments and in both sectors (public and private), taking the Designers, Owners, Contractors, Consultants, Site engineers and Project Managers ideas that have different years of experience in construction industry with the aim of conclude all the required data to accomplish an effective survey to obtain the objective of the study.

3.1 Data collection

The survey was distributed to 300 engineers in three Governorates (Erbil, Kirkuk, and Sulaymaniyah). From the 300 surveys distributed, 17 rejected because of random and unreliable answering with seven uncompleted. Therefore, the total filled and accepted surveys were 276, so meaning that 92 % of the people who were part of this survey answered.

3.2 Determining the sample size in the governorates

The questionnaire distributed for the target engineers in the three governorates using Stratified Sampling depending on the population size (Civil and Architecture engineers) that registered in the Engineers Syndicate. The population size (N1) in Erbil Governorate is 2932 engineers (Kurdistan Engineers Union/Erbil branch), (N2) in Kirkuk is 2506 engineers (Iraqi Engineers Syndicate/Kirkuk branch), and (N3) in Sulaymaniyah is 3051 engineers (Kurdistan Engineers Union/ Sulaymaniyah branch). The total population size (N) is 8489. BY approving proportional allocation, the sample sizes shall be obtaining asunder for the different strata: 1. Strata with N1 = 2932, we have P1 = 2932/8489, n= Sample size =276

$n1 = n.\ P1$ (1) (Kothari, 2004)

$= 276\ (2932/8489) = 95.3 \approx 95$

2. Strata with N2 = 2506, P2= 2506/8489,

$n2 = n.\ P2 = 276\ (2506/8489) = 81.5 \approx 82$, and

3. Strata with N3 = 3051, P3 =3051/8489

$n3 = n.\ P3 = 276\ (3051/8489) = 99.1 \approx 99$.

Therefore, by using proportional allocation, the sample sizes for different strata are 95, 82, and 99, respectively.

3.3 The questionnaire design

The questionnaire designed to cover four main parts:

Part 1 (Personal information): This part includes Personal information regarding the respondent (Work Sector, Gender, Age group, Engineering Department, Experience, Educational level, Type of construction work, Position and Governorate).

Part 2 (BIM technique knowledge Information): This part was prepared to define the current situation of applying BIM in Northern Iraq construction industry and it's practiced in three governorates (Erbil, Kirkuk, and Sulaymaniyah) as a case study, which comprised questions about the software or tool that the engineer is using in his/her work, how much he/she knows about BIM, number of projects implemented by BIM that he/she has worked on and how did he/she train for using BIM.

Part 3 (the difficulties of implementing BIM in the construction industry): This part is carrying out to identify the obstacles of implementing BIM in the construction industry, and it contains a list of the key obstacles factors that are facing the BIM. It includes 28 questions designed by the five-point Likert scale. The scale is (1: Strongly disagree 2: Disagree 3: Neural 4: Agree 5: Strongly agree). Each respondent was requested to provide a degree of agreement to each question according to what he/she believes within the environment of the Northern Iraq construction sector.

Part 4 (Advantages of using BIM in the construction industry): This part consists of the critical factors of the advantages of using BIM by the five-point Likert scale. The scale is (1: Not important 2: Less Important 3: Fair 4: Important 5: Very important). This part is carrying out to gather with the level of importance of appliance BIM in the construction industry.

3.4 Pilot study

A pilot study was conducted in this study to test and refine their questionnaires using a pilot study before implementing it in a formal survey that is considerably more recommended from several researchers(Saleh, 2015), (Hatem et al., 2018a), (Li et al., 2017). A pilot study is a small sample done for the complete survey to assess and improve the questionnaires. It is as well-known as a 'feasibility' study (Calitz, 2009).

Blaxter (2010) mentioned that "You may think that you know well enough what you are doing, but the value of pilot research cannot be overestimated. Things never work quite the way you envisage, even if you have done them many times before, and they have a nasty habit of turning out very differently from how you expected". When the questionnaire is conducted and prepared, the information should be recorded and prearranged. Pilot test for the survey should be performed by the researcher "with a small set of respondents" that are like those in the final study (Neuman, 2011). Therefore, the collected pilot study's size in this research is ten surveys.

3.4 The participate respondent's sectors

The respondents were specialists in construction sectors are from following public and private sectors:

1. Salahaddin University/ college of engineering.
2. Kirkuk University/ college of engineering.
3. Sulaymaniyah University/ college of engineering.
4. Tishik University/ college of engineering.
5. Ministry of Construction & Housing.
6. General Directorate of the Municipality- Erbil.
7. General Directorate of Road & Bridge- Construction & Housing- Erbil.
8. Directorate of Construction & Housing- Erbil.
9. General Directorate of Roads - Construction & Housing- Sulaymaniyah.
10. General Directorate of the Municipality- Sulaymaniyah.
11. Directory of Roads& Bridge- Sulaymaniyah.
12. Directorate of Reconstruction & Housing- Sulaymaniyah.
13. School buildings department- Kirkuk.
14. Iraqi Engineers Syndicate/ Kirkuk branch.
15. Directorate of Construction & Housing- Kirkuk.
16. General Directorate of the Municipality- Kirkuk.
17. General Directorate of Road & Bridge- Kirkuk.
18. Engineering consultancy offices in Erbil Governorate are Bunyan, Amran, Al-amara, Kurdo and Kapr offices.
19. Engineering consultancy offices in Kirkuk Government are CAD, AL-Ofoq, Solaf and Dar Al-handasy offices.
20. Engineering consultancy offices in Sulaymaniyah Governorate are Design Center, Khanay andazyari Sako , Groupi andazyaran, Asos, and Bahramand offices.

4. Data Analysis

For analyzing the survey questionnaire, the quantitative statistical techniques in SPSS programmer were used. The below techniques have been used in this paper:

1. Frequencies

The Frequencies process is commonly used, particularly with investigation and survey researches. It is an adequate number to brief the collected data (and is mainly essential with vast data collections). Through using the Frequencies method, other analyses can be generated (e.g., generating descriptive statistics, such as the mean or mode). Also making separate frequency tables (e.g., to compare the number of course taken by male vs. female students) (Arkkelin, 2014)

2. Reliability analysis

Reliability is one of the most desirable technical merits in any educational research through its meaning differs in quantitative and qualitative research. Quantitative research assures the possibility of replication (Oluwatayo, 2012). The Cronbach Alpha coefficient is the furthermost used internal consistency measure. It is viewed as the most appropriate measure of reliability when making use of Likert scales. No absolute rules exist for internal consistencies. However, most agree on a minimum Cronbach Alpha coefficient is .70 (Taherdoost, 2016). The four cut-off points that recommended by (Hinton et al., 2004) for the reliability test are:

Excellent reliability is 0.90 and above.
High reliability is 0.70 to 0.90.
Moderate reliability is 0.50 to 0.70
Low reliability is 0.50 and below.

3. Relative Importance Index (RII)

The techniques method used to analyze the questionnaires and data that employ Likert scales to capture respondents' self-reported attitudes the surveys commonly used by Construction Management Research (CMR) (Holt, 2014). The object of using RII is to rank each factor in a specific part in the survey.

The equation of RII: (Abubakar et al., 2014)

$$RII= \frac{\Sigma w}{(A \times N)} \quad (1) \qquad 0 \leq RII \leq 1$$

$$RII= \frac{5(n5)+4(n4)+3(n3)+2(n2)+n1}{5(n5+n4+n3+n2+n1)} \quad (2)$$

W = the weighting given for each item by the respondents and ranges from 1 to 5.

A = highest weight (in this case is 5)

N = respondents' total number.

4. One-Way ANOVA test.

Analysis of variance (known as "ANOVA") "can examine differences between any number of means. This small change not only enables researchers to investigate designs with three or more groups but also allows them to make conceptual leaps, such as from comparing group means defined by one independent variable (IV)" (Berkman and Reise, 2011).

5. RESULTS AND DISCUSSION

5.1 Respondents Personal Information

The survey showed the profile of respondents for five items in **Table 1**.

Table 1: **The profile of respondents**

Personal information	Categories	Percent
1. Work Sector	Public Private Both sectors (public and private)	65.6 12 22.5
2. Gender	Male Female	64.1 35.9
3. Age Group (years)	18-24 25-34 35-44 Over 45	3.3 33.3 36.2 27.2
4. Engineering department	Civil Engineer Architect Engineer	74.3 25.7
5. Experience (years)	Under 5 5_9 10_19 Over 20	7.6 30.4 40.9 21
6. Educational level	BSc High Diploma MSc PhD	76.8 2.5 13.8 6.9
7. The main type of construction work	Highway Building sanitary work Others	12.7 84.1 1.4 1.8
8. Position	Designer Owner Contractor Consultant Site engineer Project manager	26.1 8.3 2.2 9.4 44.9 9.1
9. Governorate distribution	Erbil Kirkuk Sulaymaniyah	34.4 30.1 35.5

5.2 BIM technique knowledge Information

This paper has studied all the required data to perform an effective questionnaire, the survey designed and prepared to take the respondents' knowledge about the BIM. The respondents asked four questions related to their implementing of BIM and knowing the extent of applying BIM in the Northern Iraq region.

Figure.1 illustrates the percent of BIM users which 13.41% of the respondents do not use any software, 58.70% used 2D CAD software or that not based-BIM (like AutoCAD) only, 2.17% using 3D CAD or software that based-BIM (like Revit, ArchiCAD) only, 23.29% used both 2D CAD and 3D CAD (BIM), and 2.54% using other software.

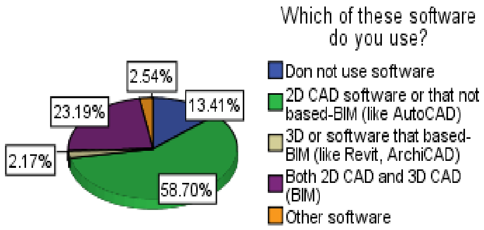

Figure 2: The percent of BIM users.

The result shows that a minor percent of engineers are far from computer’s software using. In contrast, a more significant percentage of respondents are using 2D CAD (like AutoCAD). The total percent of BIM users in these three governorates is 25.73%, and that is a progressive point towards BIM's future in Northern Iraq.

Figure.2 shows the level of BIM skills for the respondents where expert users are only 3.99%. While 37.32% have no expertise or they do not know anything about the BIM.

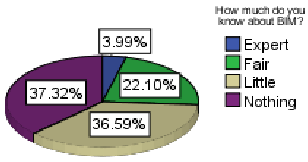

Figure 2: Respondents knowledge about BIM

The result reveals that the experts in BIM skills in the Northern Iraq construction industry are very low.

Figure.3 demonstrated the number of projects that involved or implemented by the respondents, where 9.06% are implemented 2-5

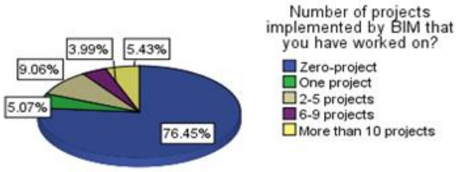

Figure 1: The number of projects that implemented by the respondents.

projects using BIM techniques. On the other hand, 79.45% do not perform any project.

This result shows the project implementing by the BIM techniques in Northern Iraq is low and maybe most of them performed by the private sector.

Figure.4 shows how the respondents gained their BIM skills. The result illustrated that the engineers who know using BIM they taught themselves and dependent on themselves to learn this technique with 20.65%, and the high percent is 59.42% for respondents who do not train to use BIM.

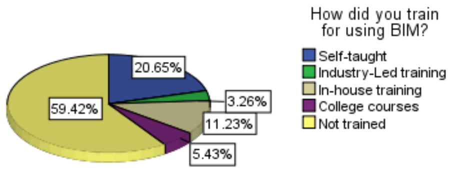

Figure 3: The training method of respondent use BIM techniques

5.3 RII analysis and mean for ranking the difficulties of implementing BIM in Northern Iraq.

Statistical analysis of collected data using mean and RII were performed to rank the main 28 factors that effected on implement BIM in Northern Iraq, as presented in **Table 2.**

Table 2: Ranking of the difficulties of implementing BIM in Northern Iraq using RII and mean.

Factors		1	2	3	4	5	∑W	RII	Mean	Rank
D1	There is no training and tutoring for BIM applications in government departments.	4	13	35	125	99	1130	0.819	4.09	2
D2	Lack of government supporting and encouraging implementing BIM.	4	18	36	120	98	1118	0.810	4.05	3
D3	Lack of standards and guidelines for BIM implementation in projects.	7	16	48	124	81	1084	0.786	3.93	6
D4	Organizations are not sufficiently familiar with BIM use.	3	19	77	114	63	1043	0.756	3.79	9
D5	There are no practical solutions to implement BIM at an adequate level in spite of many studies find the theoretical requests of BIM application.	5	29	76	130	36	991	0.718	3.59	11
D6	Benefits from carrying out BIM do not balance the costs to appliance it.	35	81	91	51	18	764	0.554	2.77	25
D7	No demands for BIM use from owners, contractors, government and other parties.	4	23	40	123	86	1092	0.791	3.96	5
D8	The high cost of training on the BIM tools.	11	53	109	79	24	880	0.638	3.19	18
D9	Lack of clear benefits of BIM.	17	62	63	83	51	917	0.664	3.32	17
D10	Lack of skilled BIM tools operators.	12	43	67	114	40	955	0.692	3.46	14
D11	Current tools are enough (AutoCAD, Excel sheets, and other)	45	96	52	66	17	742	0.538	2.69	26
D12	BIM is unsuitable for small projects.	40	85	89	52	10	735	0.533	2.66	28
D13	Engineers refuse to learn especially the senior engineers .	26	67	88	75	20	824	0.597	2.99	23
D14	People comparing BIM to CAD (They think it is same).	13	57	96	96	14	869	0.630	3.15	21
D15	Contractor and engineers look at BIM as a waste of money, time, and human resource.	13	55	99	91	18	874	0.633	3.17	20
D16	BIM needs collaboration between parties, particularly in organizing change management situations.	6	12	81	143	34	1015	0.736	3.68	10
D17	The engineers use the software just that familiar to them (like Auto CAD, Excel, etc.)	4	19	45	145	63	1072	0.777	3.88	7
D18	Lack of cooperation between engineers from a different department to implement an integrated BIM system.	4	19	65	131	57	1046	0.758	3.79	8
D19	Lack of education and syllabus in college regarding the sophisticated package e.g. ArchiCAD and Revit.	3	13	37	112	111	1143	0.828	4.14	1
D20	Lack of managers' and owners' awareness and support.	5	9	48	129	85	1108	0.803	4.01	4
D21	BIM requests to professionals to use and implement it.	2	17	108	121	28	984	0.713	3.57	12
D22	Lack of BIM tools interoperability.	7	26	127	93	23	927	0.672	3.36	15
D23	Requirements of BIM contracts frame.	5	28	128	93	22	927	0.672	3.36	16
D24	The high cost of BIM software and its updates.	11	52	108	86	19	878	0.636	3.18	19
D25	The additional time needed to implement BIM.	9	77	100	74	16	839	0.608	3.04	22
D26	The future of the BIM is not clear.	24	91	98	50	13	765	0.554	2.77	26

D27	Lack of BIM applications currently.	8	38	75	105	50	979	0.709	3.55	13
D28	Engineers think BIM is losing of process documents, information, and productivity.	21	76	112	58	9	786	0.570	2.85	24

According to the RII and mean ranking analysis the results revealed the top ten significant factors causes the difficulties of implementing BIM in Northern Iraq construction sector, in the first rank comes lack of education and syllabus in college regarding the sophisticated package, e.g., ArchiCAD and Revit, followed by there is no training and tutoring for BIM applications in government departments, lack of government supporting and encouraging implementing BIM, lack of managers' and owners' awareness and support, no demands for BIM use from owners, contractors, government and other parties, lack of standards and guidelines for BIM implementation in projects, the engineers use the software just that familiar to them (like Auto CAD, Excel, etc.), lack of clear benefits of BIM, organizations are not sufficiently familiar with BIM use, and BIM needs collaboration between parties, particularly in organizing change management situations with RIIs of 0.828, 0.819, 0.810, 0.803, 0.791, 0.786, 0.777, 0.758, 0.756, and 0.736 respectively. The means are 4.14, 4.09, 4.05, 4.01, 3.96, 3.93, 3.88, 3.79, 3.79, and 3.68 respectively.

5.4 RII analysis and mean for ranking the advantages of using BIM in the construction industry in Northern Iraq.

Statistical analysis of collected data using mean and RII were performed to rank the main 30 factors of the advantages of using BIM in the construction industry, as presented in **Table 3**.

Table 3: Ranking of the advantages of using BIM in Northern Iraq using RII and mean.

Factors		1	2	3	4	5	∑W	RII	Mean	Rank
A1	Reduced construction cost.	8	14	89	117	48	1011	0.733	3.66	23
A2	Minimizing of time needed to complete the project.	7	12	66	124	67	1060	0.768	3.84	10
A3	Improve the quality of the building. of the building.	3	7	53	134	79	1107	0.802	4.01	3
A4	manage operation and maintenance of constructions during their operating lifecycle.	2	17	56	129	72	1080	0.783	3.91	6
A5	Reduce risks in the design stage.	1	20	39	117	99	1121	0.812	4.06	1
A6	Extract estimates from BIM models e.g. quantities and so on.	6	10	48	142	70	1088	0.788	3.94	5
A7	Improve visualization.	3	13	74	132	54	1049	0.760	3.80	12
A8	Provide accurate cost, time, and relevant information throughout the lifecycle management	4	15	56	144	57	1063	0.770	3.85	9
A9	Improve communication.	8	28	85	120	35	974	0.706	3.53	28
A10	Clash detection.	2	17	58	116	83	1089	0.789	3.95	4
A11	Minimizing rework and change order.	3	13	82	135	43	1030	0.746	3.73	20
A12	Maximizing productivity.	3	19	59	148	47	1045	0.757	3.79	13
A13	Improve document management and integration.	1	14	58	149	54	1069	0.775	3.87	8
A14	Improve distribution of materials during Construction.	4	24	50	151	47	1041	0.754	3.77	16
A15	Improve building design and models.	1	10	39	153	73	1115	0.808	4.04	2
A16	Arrange location and placement of facility elements (like configure, layout, locate, place)	5	21	63	137	50	1034	0.749	3.75	18
A17	Provide a building assembly.	4	19	64	133	56	1046	0.758	3.79	14
A18	Produce as-Built Model	4	18	55	123	76	1077	0.780	3.90	7
A19	Arrange for Construction consequence.	3	17	70	147	39	1030	0.746	3.73	21
A20	Facilitate feasibility studies.	4	13	75	142	42	1033	0.749	3.74	19

A21	Improve the communication between all parties in the construction.	5	16	75	133	47	1029	0.746	3.73	22
A22	Increased efficiency of procurement.	5	19	83	136	33	1001	0.725	3.63	24
A23	Facility management.	5	25	85	128	33	987	0.715	3.58	25
A24	Develop the arrangement in the form of contracts	5	27	78	135	31	988	0.716	3.58	26
A25	Improve Sustainability of the project by analyze models for environmental concerns (energy, day lighting, and other)	5	12	64	134	61	1062	0.770	3.85	10
A26	Reduce Contingencies.	12	40	79	104	41	950	0.688	3.44	29
A27	Improve cooperation skills.	8	24	81	132	31	982	0.712	3.56	27
A28	Analyze models for safety.	5	21	68	120	62	1041	0.754	3.77	17
A29	Reduce human resource.	11	40	77	118	30	944	0.684	3.42	30
A30	All of the shop drawings of the building systems for the fabricators can be more easily and quickly produced.	3	17	72	131	53	1042	0.755	3.78	15

According to the RII and mean ranking analysis the results revealed the top ten significant factors of the advantages of using BIM in the construction industry in the Northern Iraq, in the first rank comes reduce risks in the design stage followed by improve building design and models, Improve quality, clash detection, extract estimates from BIM models e.g. quantities and so on, manage operation and maintenance of constructions during their operating lifecycle, produce as-Built Model, improve document management and integration, Provide accurate cost, time, and relevant information throughout the lifecycle management, and minimizing of time needed to complete the project with RIIs of 0.812, 0.808, 0.802, 0.789, 0.788, 0.783, 0.780, 0.775, 0.770, and 0.768 respectively. The means are 4.06, 4.04, 4.01, 3.95, 3.94, 3.91, 3.90, 3.87, 3.85, and 3.84 respectively.

5.5 Fishbone diagram for the difficulties of implementing BIM in Northern Iraq and the advantages of using BIM in the construction industry in Northern Iraq

The Fishbone diagram, also known as Ishikawa diagram is an analysis tool used to determine the potential root causes of a problem. This analysis also provides a systematic way of examining the effects of the causes that involve those effects (Watson, 2004).

Figure 5 shows the root causes of difficulties of implementing BIM in Northern Iraq which are lack of education and syllabus in college regarding the sophisticated package, e.g., ArchiCAD and Revit come in the first rank, followed by there is no training and tutoring for BIM applications in government departments, lack of government supporting and encouraging implementing BIM, lack of managers' and owners' awareness and support, no demands for BIM use from owners, contractors, government and other parties, and lack of standards and guidelines for BIM implementation in projects.

Figure 6 shows the main advantages of using BIM in the construction industry in Northern Iraq which are reduce risks in the design stage comes in the first rank followed by improve building design and models, Improve quality, clash detection, extract estimates from BIM models e.g. quantities and so on, manage operation and maintenance of constructions during their operating lifecycle, produce as-Built Model and improve document management and integration.

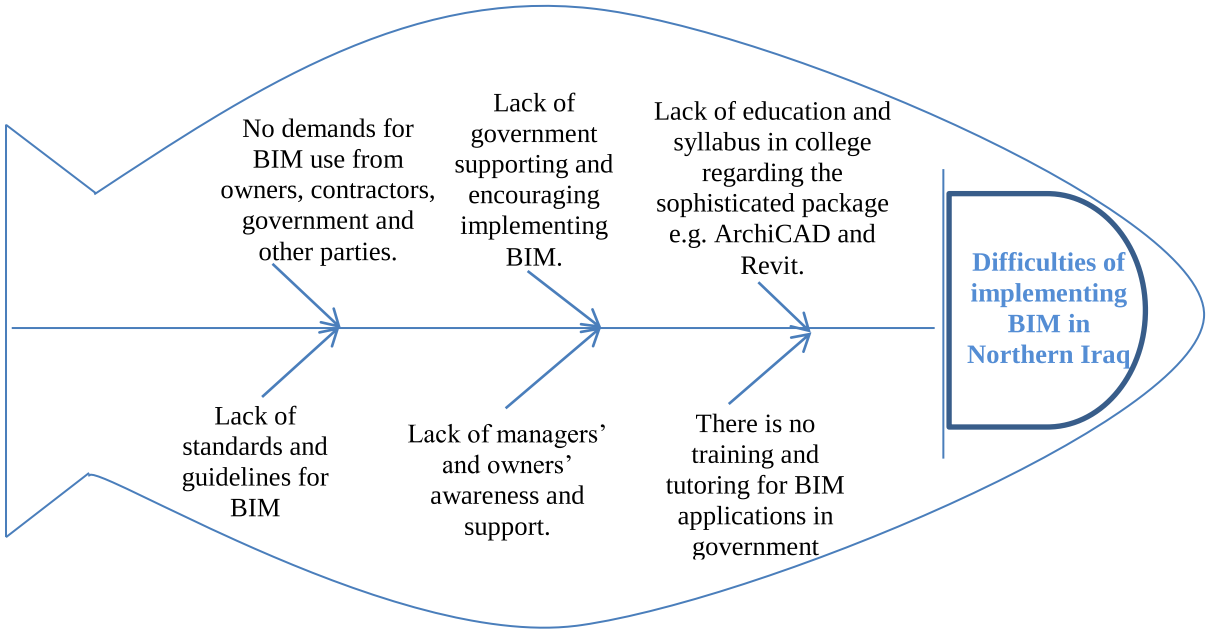

Figure 4: Fishbone diagram for difficulties of implementing BIM in Northern Iraq.

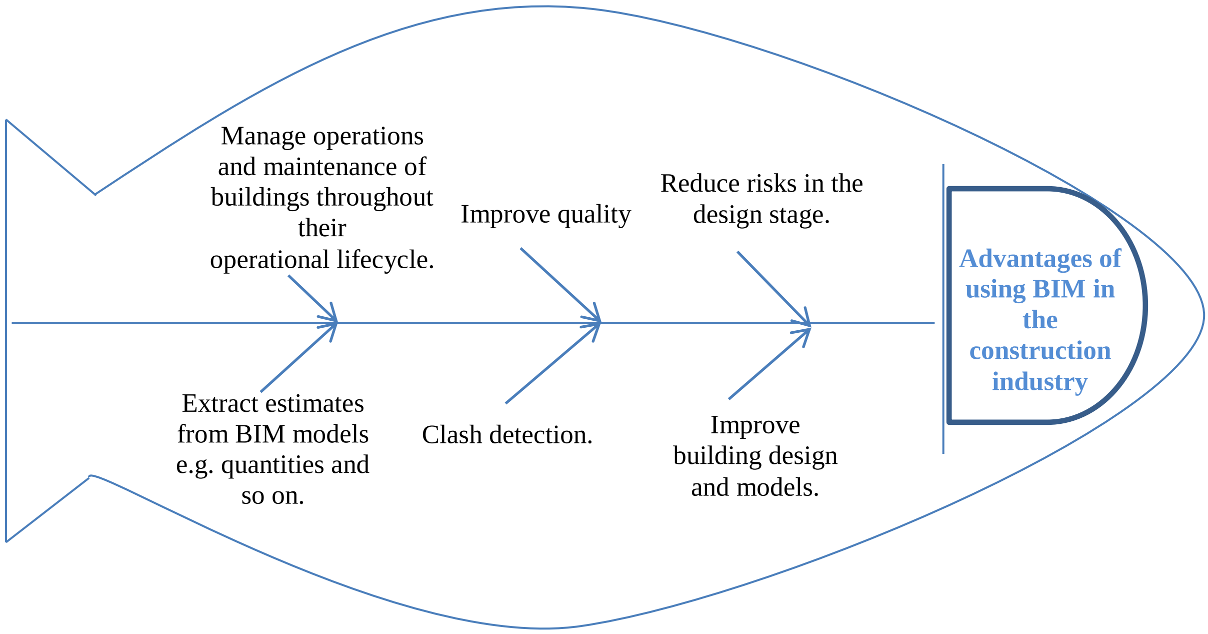

Figure 5: Fishbone diagram for the main advantages of using BIM in the construction industry in Northern Iraq.

5.6 Reliability statistical testing results:

The Cronbach's Alpha result for the difficulties of implementing BIM in Northern Iraq is 0.833, which is within the high reliability and the Cronbach's Alpha result for the advantages of using BIM in Northern Iraq is 0.918 which is within the excellent reliability as shown in **Table 4**.

Table 4: The alpha-Cronbach coefficient degree for the difficulties of implementing BIM in Northern Iraq and for the advantages of using BIM in Northern Iraq.

Reliability Statistics (the difficulties of implementing BIM in Northern Iraq)

Cronbach's Alpha	N of Items
.833	28

Reliability Statistics (the advantages of using BIM in Northern Iraq)

Cronbach's Alpha	N of Items
.918	30

5.7 Statistical analysis of One-Way ANOVA by using SPSS results.

After computing two variables (Mean1 for the means of the 28 difficulties factors of implementing BIM in the Northern Iraq and Mean2 for the means of the 30 advantages factors of using BIM in Northern Iraq), One-Way ANOVA analysis was used to compare the opinions of respondents engineers in the three Governorates.

The Null Hypothesis (Ho): μErbil = μKirkuk = μ Sulaymaniyah

Alternative Hypothesis (Ha): μErbil ≠ μKirkuk ≠ μ Sulaymaniyah

The ANOVA results showed that there is no significant different between means (sig. = .639 > .05) that is proof the engineers opinions regarding the difficulties of implementing BIM in Northern Iraq in the three Governorates and their views were very close to each other as shown in **Table 5**. Therefore, the Null Hypothesis (Ho) was accepted.

Table 5: ANOVA test results Mean1(the means of the 28 difficulties factors of implementing BIM in the Northern Iraq)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.153	2	.076	.448	.639
Within Groups	46.544	273	.170		
Total	46.697	275			

Table 6 shows the means converge in the three Governorate Erbil, Kirkuk, and Sulaymaniyah, which is 3.406, 3.463, and 3.419, respectively.

Table 6: Descriptives for Mean1 (the means of the 28 difficulties factors of implementing BIM in the Northern Iraq)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
Erbil	95	3.406	.46129	.04733	3.3117	3.4996	1.82	4.29
Kirkuk	82	3.463	.35828	.03957	3.3838	3.5413	2.75	4.36
Sulaymaniyah	99	3.419	.40588	.04079	3.3382	3.5001	2.36	5.00
Total	276	3.427	.41208	.02480	3.3786	3.4762	1.82	5.00

The results presented that there is no significant different (sig. = .722 > .05) between respondent ideas regarding the advantages of using BIM in Northern Iraq in the three Governorates and their opinions were same or near to each other as shown in **Table 7**. Therefore the Null Hypothesis (Ho) was accepted.

Table 7: ANOVA test results Mean2 (the means of the 30 advantages factors of using BIM in Northern Iraq)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.151	2	.076	.325	.722
Within Groups	63.506	273	.233		
Total	63.658	275			

Table 8 illustrates the means converge in the three Governorate Erbil, Kirkuk, and Sulaymaniyah, which is 3.792, 3.733, and 3.770, respectively.

Table 8: Descriptives for Mean2 (the means of the 30 advantages factors of using BIM in Northern Iraq)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Erbil	95	3.792	.51704	.05305	3.6863	3.8969	2.20	5.00
Kirkuk	82	3.733	.46570	.05143	3.6310	3.8357	2.57	4.63
Sulaymaniyah	99	3.770	.46082	.04631	3.6785	3.8623	2.53	5.00
Total	276	3.767	.48113	.02896	3.7097	3.8237	2.20	5.00

6. Conclusions

This investigation has provided important results in the current situation, difficulties, and advantages of BIM Implementation in the Construction Sector in Northern Iraq.

1. In Northern Iraq there is lacking in BIM implementation and knowledge, 3.99% from respondent engineers are experts in BIM, 25.36% from respondent engineers are using BIM tools, and 76.45% of respondents have not implemented BIM in any of their projects whether in private or public sector.
2. The third part of the questionnaire results of this research identified and ranked the major first five difficulties factors of implementing BIM in Northern Iraq, which is lack of education and syllabus in college regarding the sophisticated package, e.g., ArchiCAD and Revit comes in the first rank, followed by there is no training and tutoring for BIM applications in government departments, lack of government supporting and encouraging implementing BIM, lack of managers' and owners' awareness and support, and no demands for BIM use from owners, contractors, government and other parties respectively.
3. The last part of the questionnaire analysis revealed the significant first five advantages of using BIM in the construction industry, which is reduce risks in the design stage comes in the first rank. Followed by improve building design, models and Improve the quality of the building, clash detection, and extract estimates from BIM models, e.g. quantities and so on, respectively.
4. The Fishbone diagram shows the root causes of difficulties of implementing BIM in Northern Iraq and shows the main advantages of using BIM in the construction industry.
5. ANOVA analysis revealed that the respondent engineers have the same opinion or the close view about the

difficulties and advantages of implement BIM in the three Governorate Erbil, Kirkuk, and Sulaymaniyah and the Null Hypothesis (H_o) is accepted ($\mu_{Erbil} = \mu_{Kirkuk} = \mu_{Sulaymaniyah}$).

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