

# Building Information Modelling (BIM) as Claims Control Tool for Buildings Projects in Jordan

Altayeb Qasem, Areej Hamad Mahmoud Hamad, Eshaq Abdulrazaq Alhashimi, Abdulaziz Alkelani, Mohammed A. Alkhater



**Abstract:** Building Information Modelling (BIM) has been viewed as capable of addressing the problems of the construction industry. Hitherto, some firms have acknowledged BIM as a novel way to work and gone on to record success, others (which have not so done) have elevated such questions as: 'How is BIM defined? Is it a tool or a process? Which breeds and sizes of organizations stand to value from BIM?' These questions formulate the basis of this research. Most of the buildings projects suffered from cumulative total cost and duration in Jordan, therefore, there is a dire need for implementing BIM to control the claims in buildings projects in Jordan. This research study was pragmatic to assess the impact of implementation of BIM in building projects and to clarify its effect on controlling the claims that can be avoided by using BIM. The proposed BIM adoption plan is developed to analyze in depth by strategic analysis tools. PESTEL analysis is apprehensive about six issues; political, economic, socio-cultural, environmental, technological, and legal. Complete SWOT analysis is used as planning tool to understand strengths, weaknesses, opportunities, and threats, these strategic analysis tools aids to propose BIM adoption plan for building project describes by ADKAR change management model ; awareness ,desire ,knowledge ,ability and reinforcement. The outcomes of the research demonstrated that successful projects performed in the organizations that have used BIM is established on its adoption as a tool of technology, rather than as a process; a tool that transform the way, work in the construction industry is archetypally done. Additionally, the accomplishments recorded in the firms researched give credibility to project success consequent upon adopting BIM. Nonetheless, the conclusions of this research illustrate that the foundation of this success is leadership-driven innovation.

**Keywords:** Building Information Modelling; Construction; Success; Leadership; PESTEL, ADKAR

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## I. INTRODUCTION

### 1.0 Background

Construction sector in Jordan considers as one of the most important economic sectors, and uniqueness to this sector is the diversity of experiences and complexity with a number of other sectors, making it more sensitive to changes in the economic activities and social and demographic factors [1]–[4].

These changes are shown in figure (1) by the total size values of work of the construction sector in both the public, and private sectors (million Jordanian Dinar) as tables of Jordan Contractors Association from year 2000 to 2012 shows that the minimum value which scored in the year 2000 is 853 million JD and the maximum value which is scored in 2009 is 3413.86 million JD.

While the total number of the contractors and engineering offices registered in Jordan Engineers Association JEA ,according to Governmental Tenders Department among 2000- 2012 was changing every year and the minimum number is 899 in 2001, while the maximum is 2352 in 2009 which shows in figure(1.2)( Governmental Tenders Department,2013).

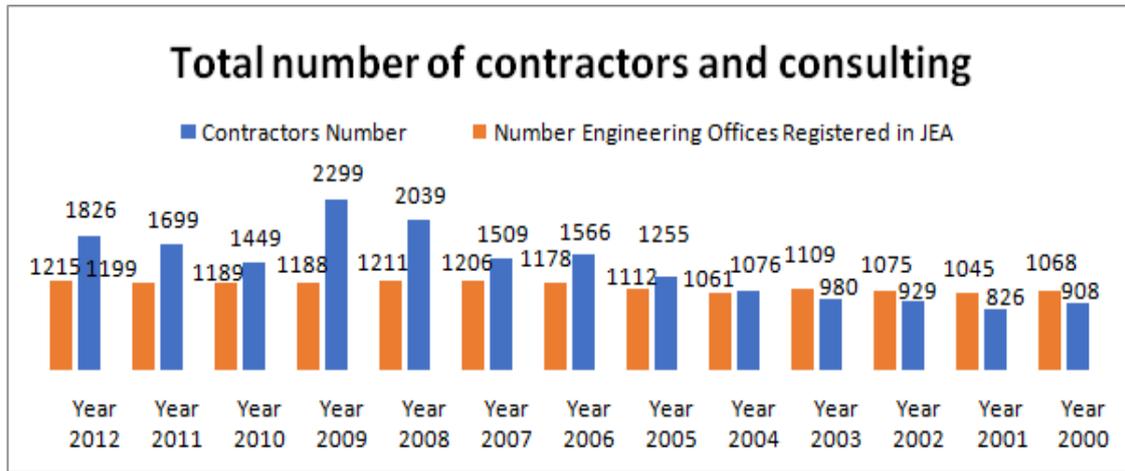


Figure 1: Total Size Values of Work of the Construction Sector in Both the Public and Private Sectors from Year 2000 to 2012 Million JD (Governmental Tenders Department, 2013).

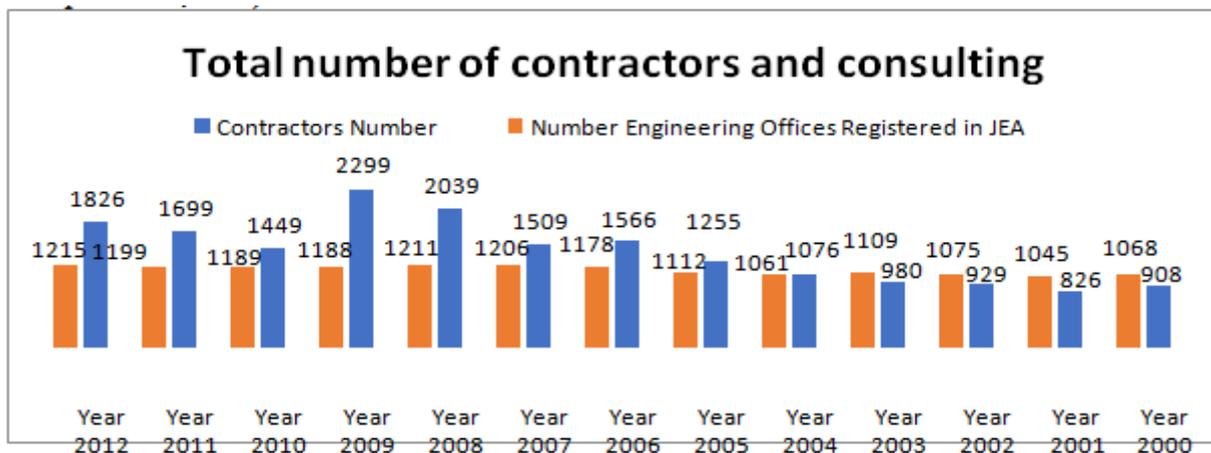


Figure 2: Total Number of the Contractors and Engineering Offices Registered in JEA (Governmental Tenders Department, 2013).

Due to this fluctuation in the total size values of work of the construction sector in both the public and private sectors, and the number of consulting and contractors during the past 13 years, It seems that must have more concerning to study the status of construction projects. Figure (3) shows that the year 2012 had the lowest value to the central tenders allocated from governmental tenders department since 12 years, with

amount 134.15 million JD, this lead to state that there is limited amount of money that can be used in construction projects, so there is no possibilities to increase the total amount of the contract values due to any problem appears related to design, materials, labours and other resources affect construction projects in Jordan.

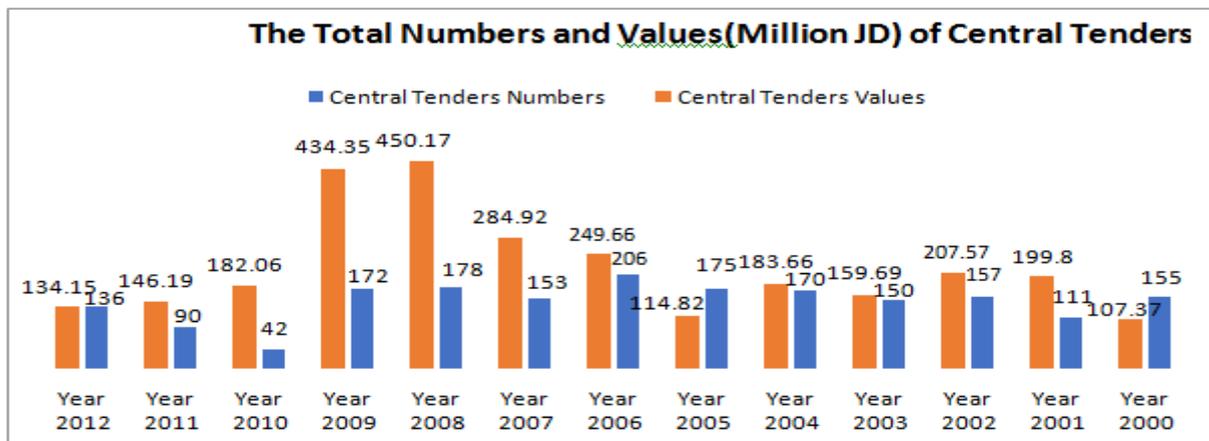


Figure 3: The Total Number and Values (million JD) of Central Tenders (Governmental Tenders Department, 2013)

These problems are varying from one project to another in their nature, size and complexity. Settling by claims, [5] defines construction claim as a request by a construction contractor for compensation over and above the agreed-

upon contract amount for additional work or damages resulting from event that were not included in the initial contract.

However, all of these problems affect projects by increasing the cost and delaying the completion date. Moreover, the claims had bad impacts on the cost of building projects by increasing 10% to 25% of total cost of the projects based on participant's opinions. The claims had also impacts on the duration of projects by increasing 25% to 50% of the completion duration of projects, the researchers found that the main causes of claims in building projects were the changes or variation in the orders related to the owner, while the delay by contractors was the second cause [5]–[7].

This confirm that, there are many deficiencies of the current design and documentation systems in the construction are 30% of the cost of construction is wasted in the field due to: coordination errors, wasted material, labor inefficiencies, so we need more sustainable model of building procurement and all construction industry parties need to be part of the solution.

Construction industry is a dynamic, complex, as well as fragmented process, and the traditional methods and systems a more integrated design and construction process that results in better quality buildings at lower cost and reduced project duration [14]–[21].

Building information modelling is a process to digitally manage the design, construction and operation of a facility with means of collaboration and communication for all project stakeholders, while a building information model is an authoritative database of project information which can be a single model or a federation of models from all project participants. This model consider as three-dimensional 3D intelligent design model leads to references to terms such as fourth-dimensional 4D (adding time to the model) by integrating critical path method CPM schedule data with the model data to identify any out of sequence work and fifth-dimensional 5D (adding quantities and cost of materials), this term used to describe the linkage of estimating software to a model. Essentially, element quantities are downloaded from the model database and imported directly into estimating software.

of construction industry use technology in isolation and there are miss integration and non-interoperability between all Architecture/ Engineering/ Construction (AEC) industry stake holders in the construction process including owner/ developer, project managers, consultants, contractors, sub-contractors and facilities management, these characteristics have produced a decrease in quality and cost efficiency of projects, due to lack of integration of construction knowledge into design [8], [9], National Institute of Standards and Technology (NIST) conducted a study in 2004 and reported that the lack of an Architecture/ Engineering/ Construction (AEC) interoperable software is costing the industry

\$15.8 Billion annually [10]–[13].

With the continuous advancement in technologies, new techniques are constantly being developed in order to improve engineering implementations for the construction industry. One of these promising developments is building information modelling (BIM) where it facilitates

BIM process uses technology in collaboration, in a collaborative environment, all stakeholders in the construction process including owner/ developer, project managers, consultants, contractors, sub-contractors and facilities management, have access to the same design, cost and scheduling information at the same time, with level of authorities, Because disciplines are brought together earlier to share information and work practices which make more control on the problems in design, materials, labours [22]–[26].

According to an earlier report [27], [28] that "Despite this inexperience ,the recognition of the value of the BIM is strong ,with respondents identifying (reduction in design errors 66% , improved quality control 64%, improved productivity 64%) as the primary benefits " shows in figure (1.4),so this reduces or eliminates the main causes of claims in building projects which are the first cause is thechanges or variation in the orders related to the owner, and the second cause is the delay by contractors.



Figure 4: Benefits to BIM users According to the Middle East BIM Report, 2011

1.1 Research Motivation

Most of the buildings projects suffered from increasing the total cost and duration which settled by the claims, according to the researches the main ten causes of claims in building projects in Jordan are: changes or variation orders, delay caused by contractor, delay caused by owner, bad quality of contractor's work, specifications and drawings inconsistencies, estimating errors, contractor is not well organized, contractor financial problems, delay in payments

by owner, design errors or omissions, respectively [5], [29]–[32]. While the value of the building information modelling BIM is strong ,with respondents identifying ( reduction in design errors 66% , improved quality control 64%, improved productivity 64%) as the primary benefits that building information modelling can help.

The most significant benefits of BIM implementations recorded reduction in design errors which becomes from the miss integration between the designers which leads to increase the duration and cost of projects.

Middle East BIM report also found that there was a noticeable concentration of respondents operating in the UAE 77%, Saudi Arabia 41% and Qatar 35%, with Oman, Bahrain, and Kuwait, being 22%, 19% and 18% respectively. Jordan had the lowest representation, accounting for only 7% of respondents. So these benefits for building information modelling encourage searching about how using BIM as claims control tool for building projects in Jordan, also how can apply BIM in building projects in Jordan.

1.2 Research Hypothesis

Based on the previous researches, the following hypothesis has come out as the hypothesis of the research "There is a need for implementing Building Information Modelling (BIM) to control the claims in buildings projects in Jordan"

II. RESEARCH METHODOLOGY AND DATA



Figure 4: Data Collection Methodology.

The second part is collecting claims data from the existing buildings projects in Jordan, then evaluating them as well as measuring their impacts on cost and time of projects and then

evaluates the impact of BIM on the claims and its effect on the project cost and completion time, The data collection methodology are shown in figure (4) .

These findings will be used to test and validate the effects of building information modelling as claim control tool in case study, and will be used for proposing a plan to speed up the adoption process of BIM in Jordan.

COLLECTION

Clear definition about BIM and benefits from implementing BIM in the Construction Industry, the challenges and drivers that control the process of adoption BIM ,types of claims and their causes, and Impacts of BIM and claims on construction projects have been discussed by various researchers [14], [22], [33]–[39].

Methodology for this research was divided into two parts. The first part is a field surveying is taken place by using a questionnaire form which was distributed over a selected sample of owners, class (A) contractors, class (A) consultants, arbitrators, engineering services offices, and Jordanian engineering association.

The form of the questionnaire will consist of seven sections: General information (the participant information), introduction, BIM adoption and usage, BIM awareness, Effect of BIM on occurrence of claims in Buildings projects in Jordan, encouragements and obstacles, skills and training.

2.0 Research Methodology to Evaluate the Impact of BIM

The main ten causes of claims in buildings projects in Jordan are; Changes or Variation Orders, Delay caused by contractor, Delay caused by owner, Bad quality of contractor’s work, Specifications and drawings inconsistencies, Estimating errors, Contractor is not well organized, Contractor financial problems, Delay in payments by owner, Design errors or omissions, respectively and each of these causes related to one of the parties engineer, contractor and owner, these causes shows in the figure (5).

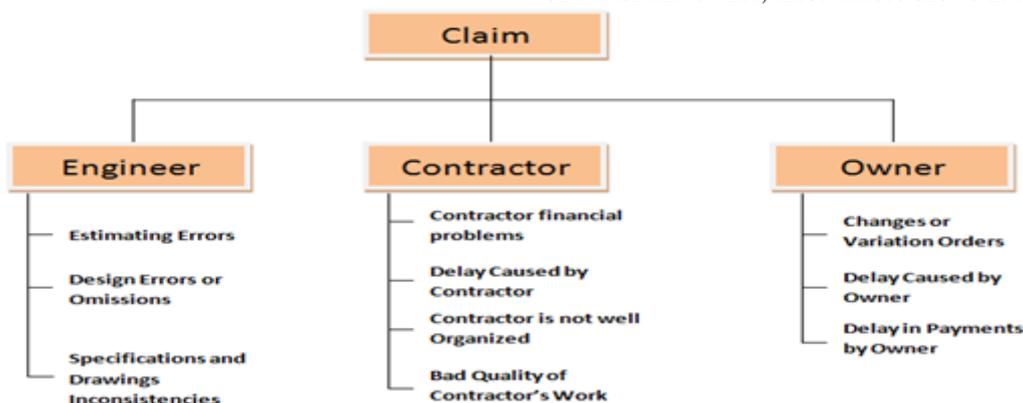


Figure 5: Causes of Claims.

**2.1 Formulation of the survey Questionnaire**

Questions as a questionnaire form were developed in reference to the literature review as the main source of knowledge. Then interviews were conducted with certain experts from; owners, engineers, contractors and arbitrators to get their advices and amendments for the questions that should be written for the needed answers that the research should have.

The questions in the form of the questionnaire were divided into seven sections as shown in appendix (I), section one: composed of questions that are related to general information which was got from the participants and their experience, qualifications and type of organization. The Second section includes questions that are related to; the programs used to generate three dimensional models if it arises in the company, the knowledge of the participants about BIM. Section three was directed for determining the current status of the adoption and usage of BIM in buildings projects from the participant point of view. While Section four about BIM awareness is directed to collect participant's views about the benefits of applying BIM on buildings projects in Jordan and

section five is to determine the percentage of using the BIM in Buildings projects in Jordan to reduce occurrence of claims by reducing their causes. Then, section six is directed to determine the encouragements and obstacles. Finally, section seven is to create a clear image about the behaviour of skills development, the ability to have trainings and how to take the trainings.

**2.2 Selection of the Research Sample**

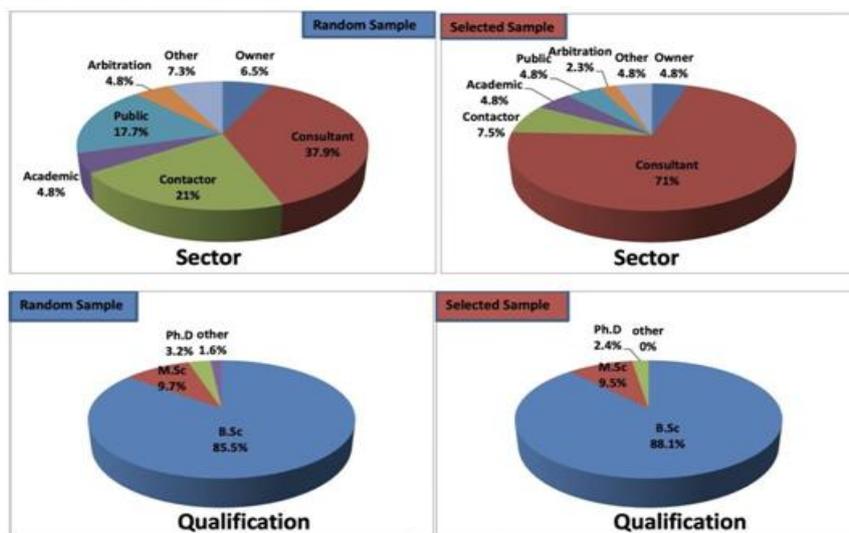
The selection of the research random sample was based on selecting population size from Grade (A) of contractors and Grade (A) of engineers, as well as certain numbers of owners , arbitrators, academic, public/government and others associations like Jordanian Engineering Association as shown in Table (1) and figure (5) for the breakdown of random sample and the responses.

**Table 1: Breakdown Details of the Research Random Sample.**

Sector of Participant	No. of Forms Send	No. of Forms Responded to	% of Responding	% out of 124 Returned Forms of Response
Owner	20	8	40%	6.5%
Consultant	120	47	39%	37.9%
Contractor	76	26	34%	21%
Academic	15	6	40%	4.8%
Public/Government	30	22	73%	17.7%
Arbitration	15	6	40%	4.8%
Other	20	9	45%	7.3%
Total	296	124	42%	100%

More than 296 questionnaire forms were distributed, only 124 was responded which represented 42% of the total spread questionnaire forms. Public/Government sector were

the most cooperative in responding, while the contractors were the least. Most of the contractors refused to participate in the survey and answering the questionnaire forms.



**Figure 6: General Information: Sector and Qualification for Random Sample and Selected Sample.**

## Building Information Modelling (BIM) as Claims Control Tool for Buildings Projects in Jordan

To get accurate answers about section three, four and five, there is another sample which considered as a selected sample, this sample contains respondents who are really know enough information about BIM from Grade (A) of contractors and Grade (A) of engineers, as well as certain

numbers of owners, arbitrators, academic, public / government and others associations like Jordanian Engineering Association as shown in Table (2) and figure (6) for the breakdown of selected sample, and the responses are equal 42 respondents.

**Table 2: Breakdown Details of the Research Selected Sample.**

Sector of Participant	No. of Forms Responded to	% out of 42 Returned Forms of Response
Owner	2	4.8%
Consultant	30	71%
Contractor	3	7.5%
Academic	2	4.8%
Public/Government	2	4.8%
Arbitration	1	2.3%
Other	2	4.8%
Total	42	100%

Distribution of Study Sample (Participant Information) are discussed in detailed in table 3 below.

**Table 3: Distribution of Study Sample (Participant Information)**

Variable		Random Sample		Selected sample	
		Frequency	Percent	Frequency	Percent
qualification	B.Sc.	106	85.5	37	88.1
	M.Sc.	12	9.7	4	9.5
	Ph.D.	4	3.2	1	2.4
	other	2	1.6	0	0
The Engineering Specialization	Architectural	15	12.1	14	33.3
	Civil	75	60.5	17	40.5
	Mechanical	21	16.9	7	16.7
	Electrical	10	8.1	3	9.5
	Other	3	2.4	0	0
Years of Experience	0-5	54	43.5	17	40.5
	10-Jun	26	21	13	31
	15-Nov	15	12.1	5	11.9
	More than	29	23.4	7	16.7
	Total	124	100	42	100

Table (4) suggests the value of reliability for each tabulated answer from section three to section seven. Results in Table (4) shows that the values of reliability concerning each tabulated answers. The values are ranged between (0.85) for K = No. of Items,  $\Sigma Sd^2$  = Summation of standard variation square,  $Sd^2$  = Square of total standard variation.

benefit of applying BIM and (0.92) for type of BIM software. All these values are considered to be high and appropriate for the study purposes. To calculate value of Cronbach Alpha Approach, the following equation was used: Value =  $K / K-1 (1 - (\Sigma sd^2 / sd^2))$  where,

**Table 3.4: Reliability Analysis for the Tabulated Answers by Using Cronbach's Alpha**

Subject	No. of items	Cronbach's alpha
Type of BIM software	7	80%
Capabilities and functions of BIM	9	87%
Benefit of applying BIM	13	90%

Effect of BIM on occurrence of claims	10	91%
Who are the principle drives of use new techniques	3	89.0%
Reasons encourage to use new techniques	6	88.0%
Obstruct to use new techniques	14	81.0%
Processes are improving the way to adopt new techniques	3	90.0%

These results indicate that the responses in section three, four and five in the questionnaire are considered as high quality due to high knowledge from participant about BIM.

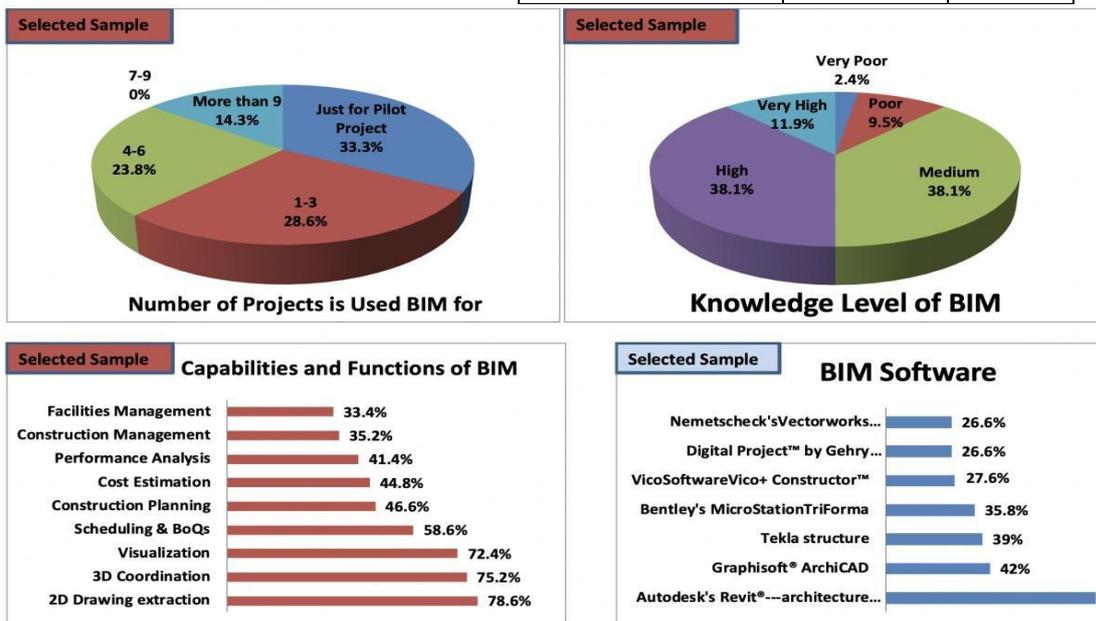
The second part which is about using BIM, the result shows in table (5) and figure (8), the responses to how many projects has your company used BIM for, the highest percentage is 33.3% goes to just for pilot project, then 28.6 % from responses used BIM for 1 to 3 projects, next 23.8%

used BIM for 4 to 6 projects, while there are no responses used BIM for 7 to 9 projects, and 14.3 % responses used BIM more than 9 projects.

These result shows that BIM is at early stage of adoption and usage in buildings projects in Jordan, this clear because the highest percentage of used BIM is just for pilot projects, and the other percentages of used BIM is for buildings projects outside Jordan.

**Table 5: Building Information Modelling (BIM) Adoption and Usage**

Question	Answer	Frequency	Percent
How would you characterize the current knowledge level about BIM	very poor	1	2.4
	poor	4	9.5
	medium	16	38.1
	high	16	38.1
	very high	5	11.9
How many project(s) has your company used BIM for	just for pilot project	14	33.3
	1-3	12	28.6
	4-6	10	23.8
	7-9	0	0
	More than 9	6	14.3
	Total	42	100



**Figure 7: BIM Adoption and Usage: Number of Projects is used BIM for, Knowledge of BIM, Capabilities & Functions of BIM, and BIM Software**

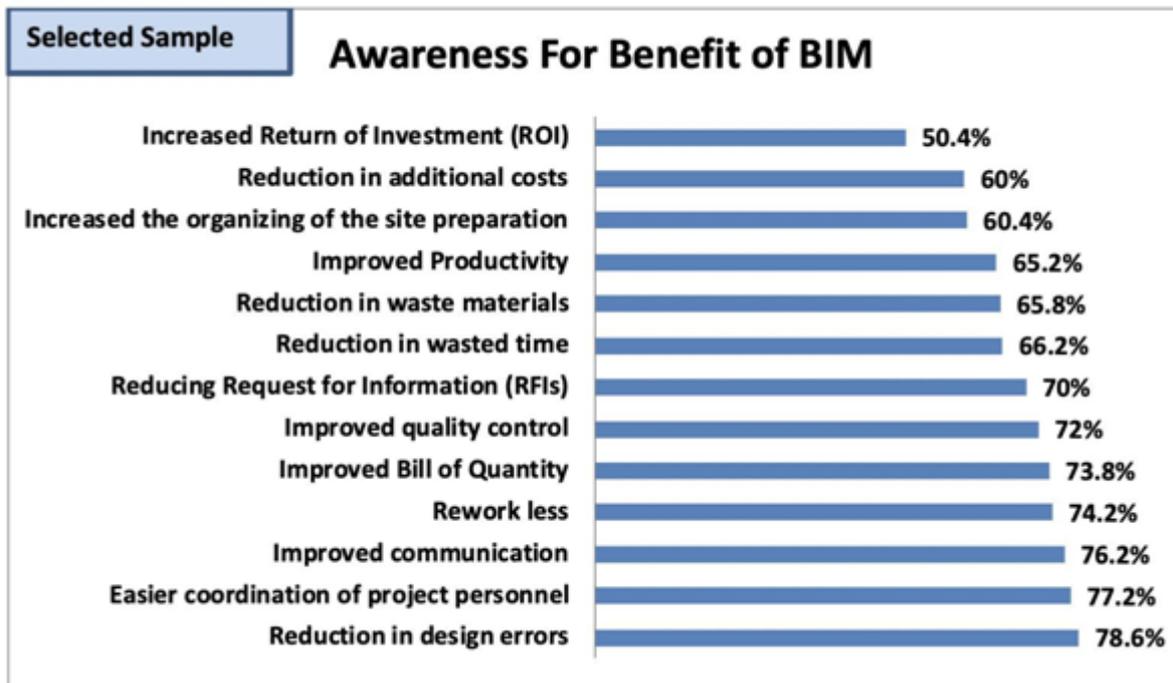
## Building Information Modelling (BIM) as Claims Control Tool for Buildings Projects in Jordan

Table (8) indicates the values of mean and standard deviation and percentages and degrees of Benefits of applying BIM in building projects in Jordan. From this Table it can be seen that the "Reduction in design errors" was indicated the most benefit of applying BIM in building projects in Jordan with

average percentage of 78.6 %, while The "Increased Return of Investment (ROI)" was indicated as the less benefit with average percentage of 50.4%, the results shows that there is high level of awareness for benefits of BIM, the results shows in figure (9).

**Table 8: Mean and Standard Deviation and Percentages of “Benefits of Applying BIM in Building Projects in Jordan”**

Awareness for Benefits of BIM	Mean	Std. Deviation	% As Upper Limit	% As Lower Limit	% Average of Interval	Degree	Rank of Benefits
Reduction in design errors	4.43	0.859	88.6	68.6	78.6	High	1
Easier coordination of project personnel	4.36	0.958	87.2	67.2	77.2	High	2
Improved communication	4.31	0.95	86.2	66.2	76.2	High	3
Rework less	4.21	1.048	84.2	64.2	74.2	High	4
Improved Bill of Quantity	4.19	0.994	83.8	63.8	73.8	High	5
Improved quality control	4.1	0.983	82	62	72	High	6
Reducing Request for Information (RFIs)	4	0.963	80	60	70	High	7
Reduction in wasted time	3.81	1.292	76.2	56.2	66.2	High	8
Reduction in waste materials	3.79	1.159	75.8	55.8	65.8	High	9
Improved Productivity	3.76	1.144	75.2	55.2	65.2	High	10
Increased the organizing of the site preparation	3.52	1.33	70.4	50.4	60.4	High	11
Reduction in additional costs	3.5	1.174	70	50	60	High	12
Increased Return of Investment (ROI)	3.02	1.334	60.4	40.4	50.4	Medium	13
Average	3.92	0.407	78.462	58.462	68.462		



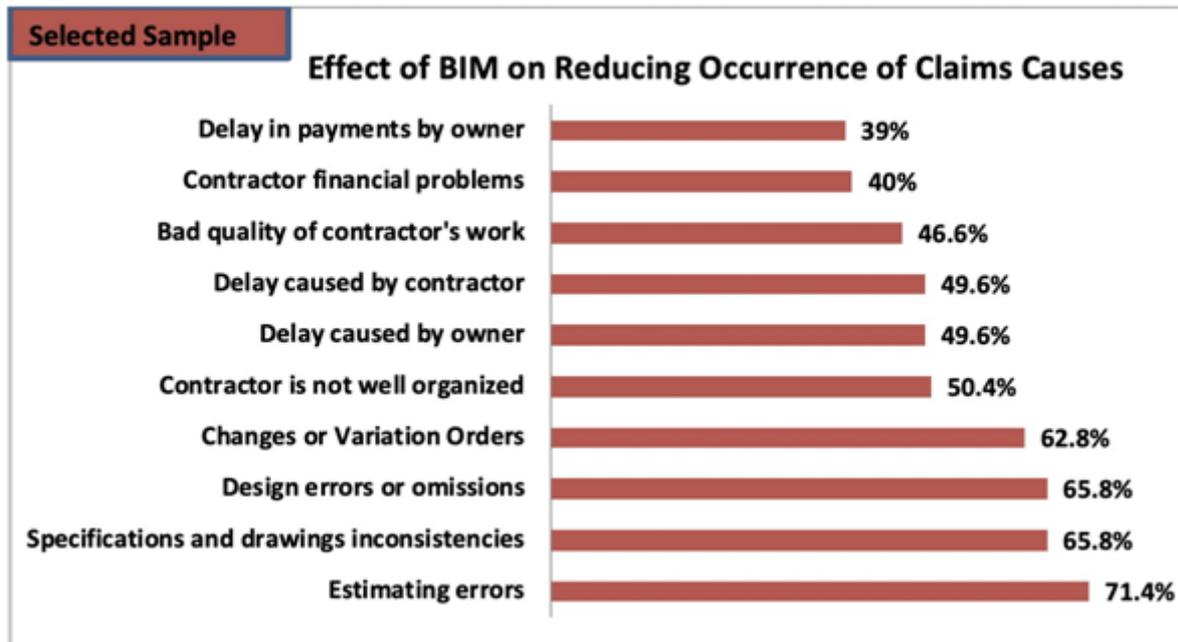
**Figure 9: BIM Awareness: Awareness for Benefit of BIM**

This section study relation between BIM and occurrence of claims, this from using of BIM in Building projects in Jordan will reduce occurrence of claims by reducing the occurrence of their causes, table (9) indicates the values of mean and standard deviation and percentages and degrees of Effect of BIM on occurrence of claims in Building projects in Jordan. From this Table it can be seen that the "Estimating errors"

was indicated the most cause of claims will reduce it occurrence with average percentage of 71.4 %, while The "Delay in payments by owner" was indicated as the less causes will reduce it occurrence with average percentage of 39 %, results shows in figure (10).

**Table 9: Mean and Standard Deviation and Percentages of “Effect of BIM on Occurrence of Claims in Building Projects in Jordan”**

	Mean	Std. Deviation	% As Upper Limit	% As Lower Limit	% Average of Interval	Degree	Rank
Estimating errors	4.07	1.022	81.4	61.4	71.4	High	1
Specifications and drawings inconsistencies	3.79	1.317	75.8	55.8	65.8	High	2
Design errors or omissions	3.79	1.048	75.8	55.8	65.8	High	3
Changes or Variation Orders	3.64	1.206	72.8	52.8	62.8	High	4
Contractor is not well organized	3.02	1.316	60.4	40.4	50.4	Medium	5
Delay caused by owner	2.98	1.093	59.6	39.6	49.6	Medium	6
Delay caused by contractor	2.98	1.179	59.6	39.6	49.6	Medium	7
Bad quality of contractor's work	2.83	1.267	56.6	36.6	46.6	Medium	8
Contractor financial problems	2.5	1.174	50	30	40	Medium	9
Delay in payments by owner	2.45	1.131	49	29	39	low	10
Average	3.20	0.573	64.1	44.1	54.1		



**Figure 10: BIM and Claims: Effect of BIM on Reducing Occurrence of Claims Causes.**

Section six measures the rank of reasons encourage using new techniques, tools, software’s, systems in project management for building projects in Jordan which also search the rank about who are the principal driver of use new techniques, tools, software’s and systems in project management in different sectors, and finally determine the priorities of obstructs to use new techniques, tools, software’s and systems in project management for building projects in

Jordan ,the target group for this section the selected sample and random sample because this section investigate about the attitudes and behaviours among all sectors .

## Building Information Modelling (BIM) as Claims Control Tool for Buildings Projects in Jordan

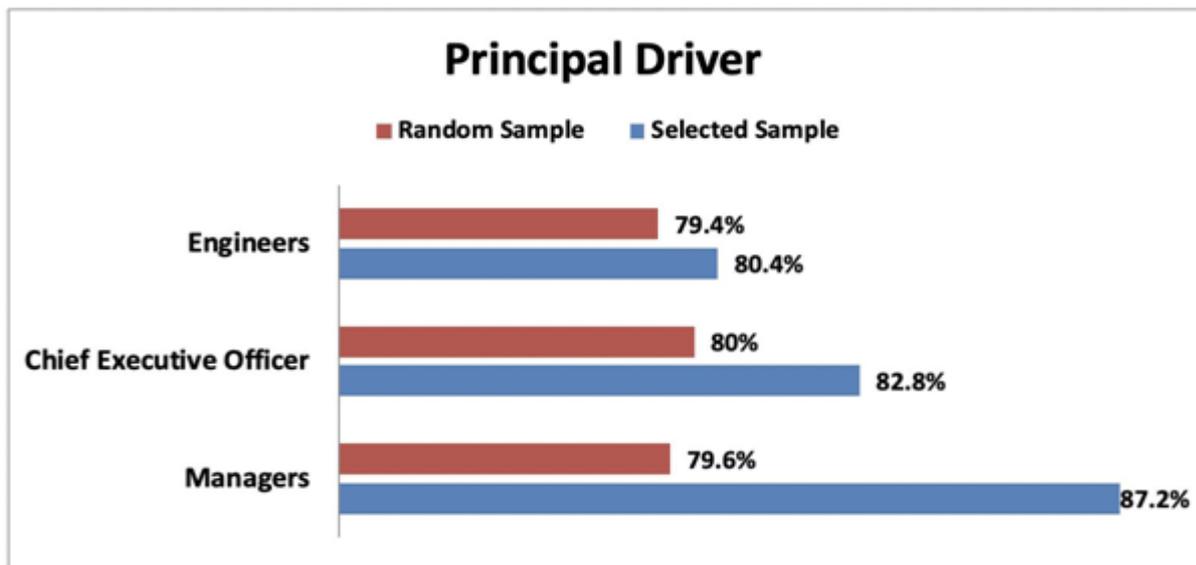
Table (10) and Figure (11) indicates the values of mean and standard deviation and percentages and degrees of who is the principal driver of use new techniques in project management.

The results show that the engineers are the less influential in companies while the most principal drivers limited between

managers and chief executive officer, also the results show that engineers, managers and chief executive officer has high effect on using new techniques, tools, softwares, systems in project management for building projects in Jordan.

**Table 10: Mean and Standard Deviation and Percentages of “Who Is the Principal Driver of Use New Techniques, Tools, Software’s, Systems in Project Management for Building Projects in Jordan”**

Target group		Mean	Std. Deviation	%	Degree	Rank
Selected Sample	Managers	4.36	0.759	87.2	High	1
	Chief Executive Officer	4.14	0.899	82.8	High	2
	Engineers	4.02	0.811	80.4	High	3
	Average	4.17	0.168	83.492	High	
Random Sample	Chief Executive Officer	4	1.004	80	High	1
	managers	3.98	0.946	79.6	High	2
	Engineers	3.97	0.962	79.4	High	3
	Average	3.98	0.016	79.7	High	



**Figure 11: Principal Driver for Random Sample and Selected Sample.**

Table (3.11) and figure (12) indicates the values of mean and standard deviation and percentages and degrees of reasons

encourage using new techniques, tools, and systems in project management for building projects in Jordan.

**Table 11: Mean and Standard Deviation and Percentages of “Reasons Encourage Using New Techniques, Tools, Software’s, Systems in Project Management for Building Projects in Jordan”**

Target group	Encouragements	Mean	Std. Deviation	%	Degree	Rank
Selected Sample	Upgrading of the company	4.38	0.661	87.6	High	1
	Availability of accredited trainers	4.33	0.874	86.6	High	2
	Availability of skilled professionals	4.31	0.68	86.2	High	3

	Mandated for project	4.29	0.97	85.8	High	4
	Accreditation process	4.07	0.973	81.4	High	5
	Availability of Standards	3.83	0.794	76.6	High	6
	Average	4.20	0.210	84.048	High	
Random Sample	Availability of skilled professionals	4.33	0.751	86.6	High	1
	Availability of accredited trainers	4.24	0.859	84.8	High	2
	Upgrading of the company	4.2	0.836	84	High	3
	Mandated for project	4.09	0.996	81.8	High	4
	Accreditation process	4.04	0.999	80.8	High	5
	Availability of Standards	3.9	0.863	78	High	6
	Average	4.13	0.157	82.7	High	

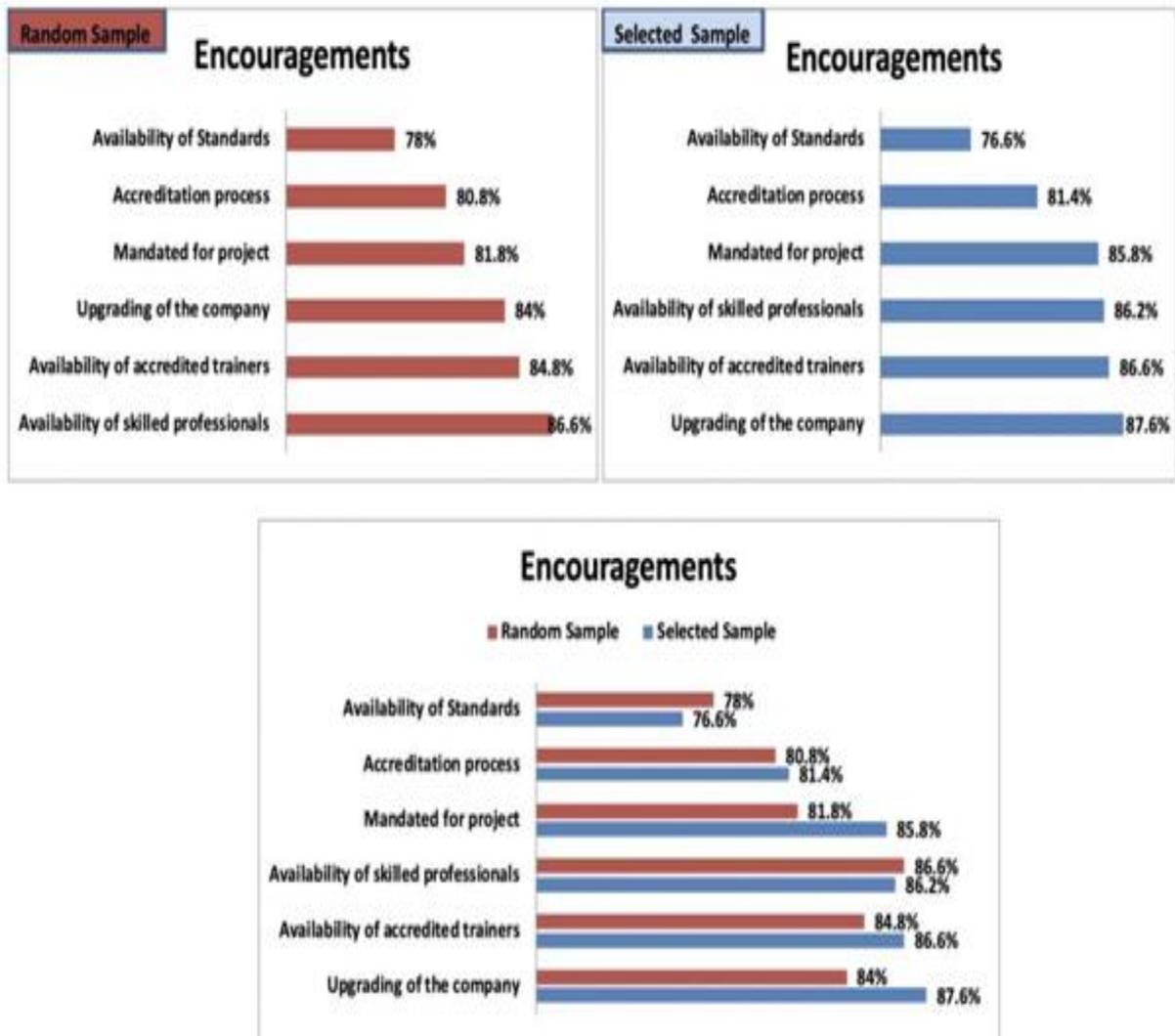


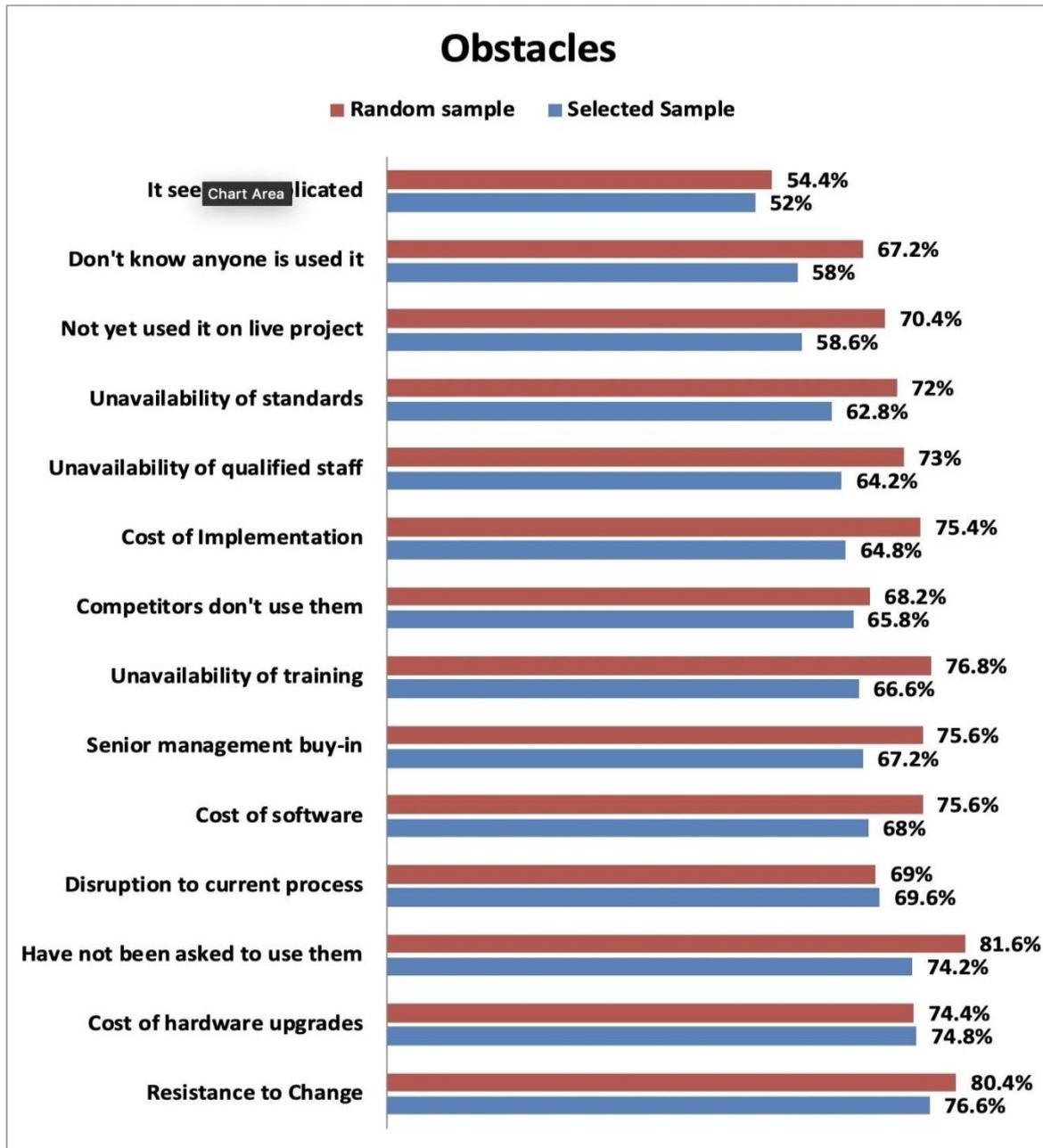
Figure 12: Encouragements for Random Sample and Selected Sample

Table (12) and Figure (13) indicates the values of mean and standard deviation and percentages and degrees of Obstruct

to using new techniques, tools, software's, systems in project management for building projects in Jordan.

Table 12: Mean and Standard Deviation and Percentages of “Obstruct To Use New Techniques, Tools, Software’s, Systems in Project Management for Building Projects in Jordan”

Target group	Obstacles	Mean	Std. Deviation	%	Degree	Rank
Selected Sample	Resistance to Change	3.83	1.167	76.6	High	1
	Cost of hardware upgrades	3.74	1.083	74.8	High	2
	Have not been asked to use them	3.71	1.043	74.2	High	3
	Disruption to current process	3.48	1.042	69.6	High	4
	Cost of software	3.4	1.149	68	Medium	5
	Senior management buy-in	3.36	1.078	67.2	Medium	6
	Unavailability of training	3.33	1.223	66.6	Medium	7
	Competitors don't use them	3.29	1.111	65.8	Medium	8
	Cost of Implementation	3.24	1.055	64.8	Medium	9
	Unavailability of qualified staff	3.21	1.24	64.2	Medium	10
	Unavailability of standards	3.14	0.952	62.8	Medium	11
	Not yet used it on live project	2.93	1.045	58.6	Medium	12
	Don't know anyone is used it	2.9	1.122	58	Medium	13
	It seems complicated	2.6	0.885	52	Medium	14
	Average	3.30	0.342	65.952	Medium	
Random Sample	Have not been asked to use them	4.08	0.88	81.6	High	1
	Resistance to Change	4.02	1.028	80.4	High	2
	Unavailability of training	3.84	0.991	76.8	High	3
	Cost of software	3.78	0.992	75.6	High	4
	Senior management buy-in	3.78	1.056	75.6	High	5
	Cost of Implementation	3.77	0.97	75.4	High	6
	Cost of hardware upgrades	3.72	0.916	74.4	High	7
	Unavailability of qualified staff	3.65	1.098	73	High	8
	Unavailability of standards	3.6	0.891	72	High	9
	Not yet used it on live project	3.52	1.063	70.4	High	10
	Disruption to current process	3.45	1.054	69	Medium	11
	Competitors don't use them	3.41	1.112	68.2	Medium	12
	Don't know anyone is used it	3.36	1.015	67.2	Medium	13
	It seems complicated	2.72	1.048	54.4	Medium	14
	Average	3.62	0.335	72.4	High	



**Figure 13: Obstacles for Random Sample and Selected Sample**

The results show that complication of new technique, tools, software's, systems in project management for building projects in Jordan is the less obstacle in companies, also the most reason obstruct the process of adoption limited between resistance to change and have not been asked to use them, Section seven search about the behavior to increase the knowledge and skills in new techniques, tools, software's, systems in project management for building projects in Jordan which also search the way improves the adoption of new techniques, tools and softwares and systems for project

also the results show that most of reasons have high degree on effect for using new techniques, tools, software's, systems in project management for building projects in Jordan from the opinion of random sample , while the results show that most of reasons have medium degree on effect for using new techniques, tools, software's, systems in project management for building projects in Jordan from the opinion of selected sample.

management through the undergraduate stage, the target group for this section the selected sample and random sample because this section investigate about the attitudes and behaviors among all sectors.

Table 13: Skills and Training

Question	Answer	Random Sample		Selected Sample	
		Frequency	Percent	Frequency	Percent
Would you be willing to take a short course on the principles of new techniques, tools , softwares and systems for project management to advance your knowledge of the subject	yes	111	89.5	40	95.2
	no	4	3.2	0	0
	not sure	9	7.3	2	4.8
What is the way that helps you to improve your skills in new knowledge	Self-development	34	27.4	18	42.9
	Company trained	54	43.5	19	45.2
	Institute trained	36	29	5	11.9
	Total	124	100	42	100

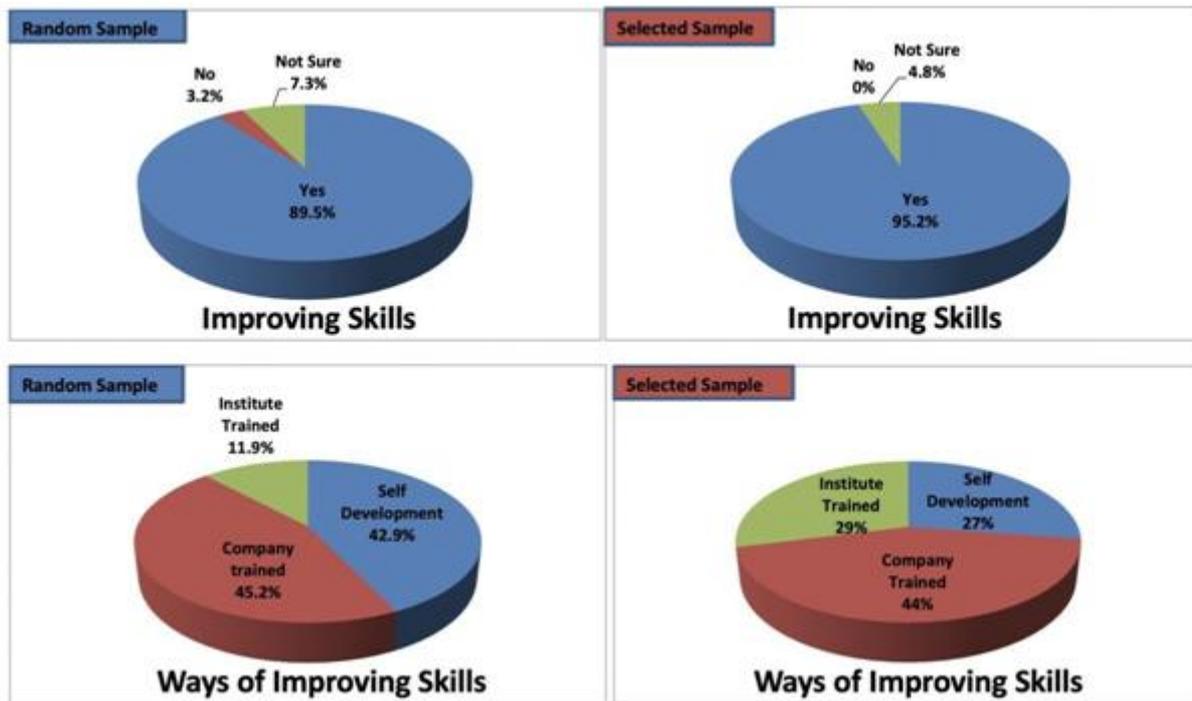


Figure 14: skills and Trainings: Improving Skill and Ways of Improving Skills for Random Sample and Selected Sample.

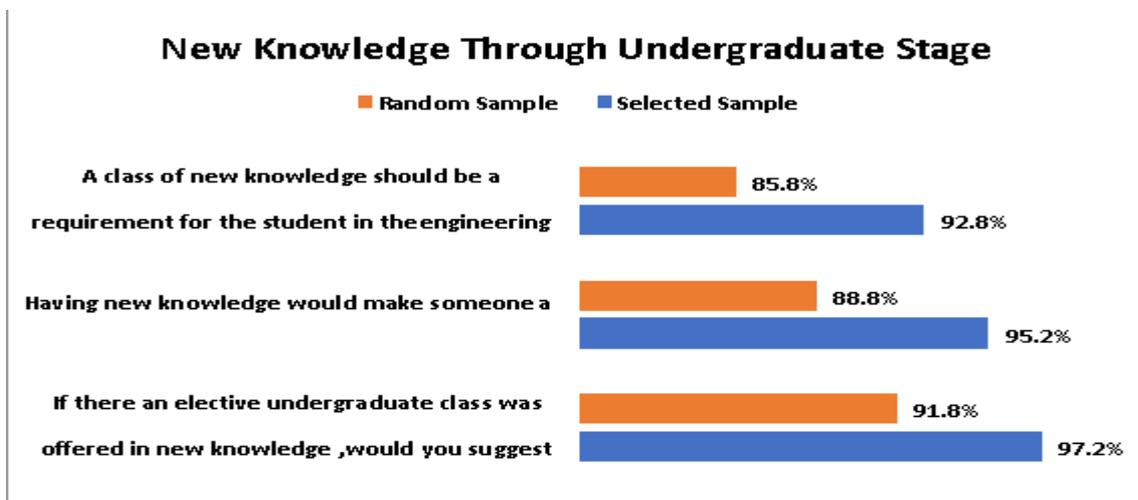
Table (13) and Figure (14) indicates the values of frequencies and percentages of skills and training, to take a short course on the principles of new techniques, tools, software’s and systems for project management to advance participant knowledge of the subject:

Table (14) and Figure (15) indicates the values of mean and standard deviation and percentages and degrees Processes are improving the way to adopt new techniques for project management through the undergraduate stage. The results

also shows that the new knowledge would be suggested through the under graduate stage as an elective class not as mandated class, also the results show that if there is competitive, having new knowledge would make someone a more attractive candidate to employers, also the result show that all the statements are with high degree of importance and should be taken in consider to improve the way to adopt new techniques for project management through the undergraduate stage.

**Table 14: Mean and Standard Deviation and Percentages of “Processes Are Improving the Way to Adopt New Techniques for Project Management through the Undergraduate Stage”**

Target group	Question	Mean	Std. Deviation	%	Degree
Selected Sample	If there an elective undergraduate class was offered in new knowledge ,would you suggest student to take it	4.86	0.354	97.2	High
	Having new knowledge would make someone a more attractive candidate to employers	4.76	0.431	95.2	High
	A class of new knowledge should be a requirement for the student in the engineering curriculum	4.64	0.533	92.8	High
	Average	4.75	0.107	95.08	High
Random Sample	If there an elective undergraduate class was offered in new knowledge ,would you suggest student to take it	4.59	0.598	91.8	High
	Having new knowledge would make someone a more attractive candidate to employers	4.44	0.757	88.8	High
	A class of new knowledge should be a requirement for the student in the engineering curriculum	4.29	0.763	85.8	High
	Average	4.44	0.149	88.8	High



**Figure 15: New Knowledge through under Graduate Stage for Random Sample and Selected Sample.**

**III. CONCLUSIONS**

The research survey finding results could be summarized as follows:

1. The percentage of who really know about building information modeling in buildings projects in Jordan is low with a percentage equal to 12.9% in 2013 while the percentage equal to 7% in 2010 (Middle East BIM Report, 2011), also creation of a three- dimensional models is low percentage in buildings projects in Jordan with a percentage equal to 37.1 %.
2. Building information modeling is at early stage of adoption and usage in buildings projects in Jordan, because the highest percent used BIM for it just for pilot projects and the other percents used BIM for buildings projects outside Jordan

3. Autodesk's Revit@---architecture ----structure---- MEP" considers the most BIM software preferable to use for BIM users in buildings projects with a percentage of 84.8 %.
4. The most companies which using BIM at beginner competency Level because the capabilities and function of using BIM which got high degree are 2D Drawing extraction, 3D Coordination and Visualization.
5. There is high level of awareness for BIM users sector to the benefits of applying BIM in buildings projects in Jordan, BIM users consider that "Reduction in design errors" the most benefit of applying BIM in buildings projects in Jordan with average percentage of 78.6 %.
6. There is medium impact of BIM on reducing the occurrence of claims by reducing their causes, BIM users consider that "Estimating errors" is the most cause of claims will reduce with average percentage of 71.4 %.

7. Engineers, managers and chief executive officer has high effect on using new techniques, tools, softwares, systems in project management for buildings projects in Jordan, the engineers are the less the most principal driver limited between managers and chief executive officer influential in companies while.
8. The most reasons encourage the process of adoption new techniques, tools, softwares, and systems in project management for buildings projects in Jordan because of upgrading of the company and availability of skilled professionals, while availability of standards is the less encouragement.
9. The most reasons obstruct the process of adoption new techniques, tools, softwares, and systems in project management for buildings projects in Jordan because of resistance to change and have not been asked to use them, while it seems complicated is the less encouragement.
10. There is high level of awareness to take a short course on the principles of new techniques, tools, softwares and systems for project management to advance the participant knowledge of the subject.
11. The first choice to improve the skills in new knowledge by taking a short course through their company training, while the second choice is by self development or institute trained.
12. New knowledge must be taken through the under graduate stage as an elective class not as mandated class, also the results show that person has new knowledge would make him a more attractive candidate to employers.

### REFERENCES

1. A. H. Al-Momani, 'Housing Quality: Implications for Design and Management', *J. Urban Plan. Dev.*, 2003.
2. S. Jaber and S. Ajib, 'Optimum, technical and energy efficiency design of residential building in Mediterranean region', *Energy Build.*, 2011.
3. A. El Hanandeh, 'Environmental assessment of popular single-family house construction alternatives in Jordan', *Build. Environ.*, 2015.
4. A. El Hanandeh, 'Environmental assessment of popular single-family house construction alternatives in Jordan', *Build. Environ.*, 2015.
5. A. H. Al-Momani, 'Construction delay: A quantitative analysis', *Int. J. Proj. Manag.*, 2000.
6. J. Rooke, D. Seymour, and R. Fellows, 'Planning for claims: An ethnography of industry culture', *Constr. Manag. Econ.*, 2004.
7. K. Peters, L. Maruster, and R. J. Jorna, 'The evaluation of knowledge claims in an innovation project: A case study', *Manag. Learn.*, 2011.
8. F. T. Uhlik and G. V. Lores, 'Assessment of Constructability Practices among General Contractors', *J. Archit. Eng.*, 2002.
9. J. T. O'Connor and S. J. Miller, 'Constructability Programs: Method for Assessment and Benchmarking', *J. Perform. Constr. Facil.*, 2006.
10. M. P. Gallaher, A. C. O'Connor, J. L. Dettbarn, Jr., and L. T. Gilday, 'Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry', 2004.
11. R. E. Chapman, 'Inadequate Interoperability: A Closer Look at the Costs', in *Proceedings of the 22nd International Symposium on Automation and Robotics in Construction*, 2017.
12. G. Aranda-mena and R. Wakefield, 'Interoperability of building information: myth or reality?', *eWork Ebus. Archit. Eng. Constr.*, 2006.
13. C. Olson, 'Are You Using BIM for Maintenance', *Buildings*, 2010.
14. D. Bryde, M. Broquetas, and J. M. Volm, 'The project benefits of building information modelling (BIM)', *Int. J. Proj. Manag.*, 2013.
15. Y. Jung and M. Joo, 'Building information modelling (BIM) framework for practical implementation', *Autom. Constr.*, 2011.
17. 'Building Information Modelling (BIM)', in *Handbook for Construction Planning and Scheduling*, 2014.
18. K. din Wong and Q. Fan, 'Building information modelling (BIM) for sustainable building design', *Facilities*, 2013.
19. HM Government, 'Building Information Modelling', 2012.
20. B. Succar, 'Building information modelling framework: A research and delivery foundation for industry stakeholders', *Autom. Constr.*, 2009.
21. K. M. Kensek, *Building information modeling*, 2014.
22. B. Succar, 'Building Information Modelling Maturity Matrix', 2010.
23. R. Volk, J. Stengel, and F. Schultmann, 'Building Information Modeling (BIM) for existing buildings - Literature review and future needs', *Automation in Construction*, 2014.
24. S. Azhar, M. Khalfan, and T. Maqsood, 'Building information modeling (BIM): Now and beyond', *Australas. J. Constr. Econ. Build.*, 2012.
25. T. Cerovsek, 'A review and outlook for a "Building Information Model" (BIM): A multi-standpoint framework for technological development', *Adv. Eng. Informatics*, 2011.
26. N. Bui, C. Merschbrock, and B. E. Munkvold, 'A Review of Building Information Modelling for Construction in Developing Countries', in *Procedia Engineering*, 2016.
27. W. Shou, J. Wang, X. Wang, and H. Y. Chong, 'A Comparative Review of Building Information Modelling Implementation in Building and Infrastructure Industries', *Arch. Comput. Methods Eng.*, 2015.
28. M. Gerges *et al.*, 'An investigation into the implementation of building information modeling in the middle east', *J. Inf. Technol. Constr.*, 2017.
29. W. Jung, G. Lee, and G. L. Wooyoung Jung, 'The Status of BIM Adoption on Six Continents', *Int. J. Civil, Environ. Struct. Constr. Archit. Eng.*, 2015.
30. G. Sweis, R. Sweis, A. Abu Hammad, and A. Shboul, 'Delays in construction projects: The case of Jordan', *Int. J. Proj. Manag.*, 2008.
31. N. Al-Hazim and Z. Abusalem, 'Delay and cost overrun in road construction projects in Jordan', *Int. J. Eng. Technol.*, 2015.
32. J. M. Assbeihat, 'FACTORS AFFECTING DELAYS ON PRIVATE CONSTRUCTION PROJECTS', *Int. J. Civ. Eng. Technol.*, 2016.
33. A. Samarah and D. A. Bekr, 'Causes and Effects of Delay in Public Construction Projects in Jordan', *Am. J. Eng. Res.*, 2016.
34. K. Barlish and K. Sullivan, 'How to measure the benefits of BIM - A case study approach', *Autom. Constr.*, 2012.
35. S. Azhar, 'Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry', *Leadersh. Manag. Eng.*, 2011.
36. M. F. Hergunsel, 'Benefits of Building Information Modeling', *Design*, 2012.
37. P. E. D. Love, I. Simpson, A. Hill, and C. Standing, 'From justification to evaluation: Building information modeling for asset owners', *Autom. Constr.*, 2013.
38. S. Azhar, M. Hein, and B. Sketo, 'Building information modeling (BIM): Benefits, risks and challenges', in *Proceedings of the 44th ASC Annual Conference*, 2008.
39. N. Lu and T. Korman, 'Implementation of Building Information Modeling (BIM) in Modular Construction: Benefits and Challenges', 2010.
40. J. K. W. Wong and K. L. Kuan, 'Implementing "BEAM Plus" for BIM-based sustainability analysis', *Autom. Constr.*, 2014.

APPENDIX 1

<b>Section 1: General Information (Participant Information)</b>
1- Contact Name (optional):
2- Mobile Number (optional):
3- E- Mail Address (optional):
4- Company name:
5- Your Academic qualification: <input type="checkbox"/> B.Sc <input type="checkbox"/> M.Sc <input type="checkbox"/> Ph.D. <input type="checkbox"/> Other.....
6- The Engineering Specialization <input type="checkbox"/> Architectural <input type="checkbox"/> Civil <input type="checkbox"/> Mechanical <input type="checkbox"/> Electrical <input type="checkbox"/> Other.....
7- The Sector of the Participant: <input type="checkbox"/> Owner <input type="checkbox"/> Consultant <input type="checkbox"/> Contractor <input type="checkbox"/> Academic <input type="checkbox"/> Public/ Government <input type="checkbox"/> Arbitration <input type="checkbox"/> Other.....
8- Years of Experience: <input type="checkbox"/> 0 to 5 years <input type="checkbox"/> 6 to 10 years <input type="checkbox"/> 11 to 15 years <input type="checkbox"/> More than 15 years

**Section 2: General Information (Introduction)**

9- Are arises three-dimensional model of the buildings projects in your workplace? OYes  
ONo

10-Do you have enough information about Building Information Modeling (BIM)? OYes  
ONo

-If your answer is No, Please Go to section number (6)

**Section 3: Building Information Modeling (BIM) adoption and usage**

11 -How would you characterize the current knowledge level about BIM? O Very Poor

- O Medium O
- High
- O Very high

12 -How many project(s) has your company used BIM for?

- Just for pilotproject(s) 0 1 -
- 3
- 04-6
- 07-9
- OMore than 9

13-Please tick (/) for the suitable place according to your level of agreement that the following types of BIM softwares are the most common software does your firm use in buildings projects in Jordan:

	Never (1)	Rarely (2)	Some Times (3)	Usually (4)	Always (5)
Bcnt Icy's MicroStationTriForma					
Autodcsk's Rcv it R . --architcturc ---- structurc ---- MEP					
V icoSotiwareVico* Constructor**					
Ncmctschcck'sVcctorworks Architct					
Digital Project* by Gchry Tchnolouics					
Graphisott R ArchiCA D					
Tckla structurc					

14-P lease tick (I) for the suitable place according to level of agreement for the capabilities and functions of BIM did /do you use:

	Never (1)	Rarely (2)	Some Times (3)	Usually (4)	Always (5)
Visualization					
3D Coordination					
2D Drawing extraction					
Scheduling &BoQs					
Cost Estimation					
Construction Planning					

Performance Analysis					
Construction Management					
Facilities Management					

If you have other capabilities not mentioned above please add them down here, and give them the required evaluation according to the scale above:

1: \_\_\_\_\_  
2: \_\_\_\_\_

Section 4: BIM Awareness

Please tick (I) for the suitable place according to level of agreement for the benefits of applying BIM in buildings projects in Jordan:

	0% - 20%	21% - 40%	41% - 60%	61% - 80%	81% - 100%
Increased Return of Investment (ROI)					
Increased the organizing of the site preparation					
Reducing Request for Information (RFIs)					
Reduction in waste materials					
Reduction in additional costs					
Reduction in wasted time					
Rework less					
Improved communication					
I improved Bill of Quantity					
Improved quality control					
Reduction in design errors					
Improved Productivity					
Easier coordination of project personnel					

Please tick (/) for the suitable place according to your level of agreement that Using of BIM in Buildings projects in Jordan will reduce occurrence of claims by reducing occurrence of their causes:

	0% - 20%	21% - 40%	41% - 60%	61% - 80%	81% - 100%
Changes or Variation Orders					
Delay caused by contractor					
Delay caused by owner					
Bad quality of contractor's work					

Specifications and drawings inconsistencies					
Estimating errors					
Contractor is not well organized					
Contractor financial problems					
Delay in payments by owner					
Design errors or omissions					

**Section 5: Effect of BIM on occurrence of claims in Building projects in Jordan**

**Section 6: Encouragements and Obstacles**

7-P lease tick (/) for the suitable place according to your level of agreement of, who are the principal driver of use new techniques, tools ,softwares and systems in project management, in your company:

	Strongly Disagree	Disagree	Moderately Agree	Agree	Strongly Agree
Enginccrs					
Managcrs					
Chief' Exccecutive Of' ficer					

8-P lease tick (9) for the suitable place according to your level of agreement that the following easons encourage to use new techniques, tools, softwares, systems in project management for buildings projects in Jordan:

9-P lease tick (9) for the suitable place according to your level of agreement that the following obstruct to use new techniques, tools ,softwares and systems in project management for building projects in Jordan:

	Strongly Disagree	Disagree	Moderately Agree	Agree	Strongly Agree
It seems complicated					
Not yet used it on live project					
Don't know anyone is used it					
Have not been asked to use them					
Competitors don't use them					
Cost of hardware upgrades					
Disruption to current process					
Unavailability of standards					
Senior management buy-in					

Unavailability of training					
Cost of Implementation					
Cost of software					
Unavailability of qualified staff					
Resistance to Change					

**Section 7: Skills and Training**

20- Would you be willing to take a short course on the principles of new techniques, tools, softwares and systems for project management to advance your knowledge of the subject?

No  
 Not sure

21- What is the way that helps you to improve your skills the new knowledge?

Self development  
 Company trained  
 Institute-trained

22- Please tick (9) for the suitable place according to your level of agreement that the following processes are improving the way to adopt new techniques, tools and softwares and systems for project management through the undergraduate stage:

	Strongly Disagree	Disagree	Moderately Agree	Agree	Strongly Agree
If there an elective undergraduate class was offered in new knowledge, would you suggest student to take it					
Having new knowledge would make someone a more attractive candidate to employers					
A class of new knowledge should be a requirement for the student in the undergraduate curriculum					

	Strongly Disagree	Disagree	Moderately Agree	Agree	Strongly Agree
Accreditation process					
Availability of accredited trainers					



## Building Information Modelling (BIM) as Claims Control Tool for Buildings Projects in Jordan

Availability of skilled professionals					
Mandated for project					
Availability of Standards					
Upgrading of the company					