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

Altayeb Qasem, Areej Hamad Mahmoud Hamad, Eshaq Abdulrazaaq 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 done so) 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 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 archetypepally 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

1. INTRODUCTION

I. 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.

![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).](image)

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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).
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.

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 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, subcontractors 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 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.

![Image](https://via.placeholder.com/150)

**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 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].
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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.

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.

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).

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.

| 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.

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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.

| Sector of Participant | No. of Forms Responded to | % out of 42 Returned Forms of Response |
|-----------------------|---------------------------|--------------------------------------|
| Owner                 | 2                         | 4.8%                                 |
| Consultant            | 3                         | 71%                                  |
| Contractor            | 3                         | 7.5%                                  |

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

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

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

| Variable                | Frequency | Percent |
|-------------------------|-----------|---------|
| Academic                | 2         | 4.8%    |
| Public/Government       | 2         | 4.8%    |
| Arbitration             | 1         | 2.3%    |
| Other                   | 2         | 4.8%    |
| Total                   | 4         | 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, ΣS2 = Summation of standard variation square, S2 = Square of total standard variation.

### 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

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 an average percentage of 78.6%, while the "Increased Return of Investment (ROI)" was indicated as the less benefit with an average percentage of 50.4%. The results show that there is a high level of awareness for benefits of BIM, the results show 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                |
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”

| Reason                                                                 | 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.

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.
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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   |      |

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 |
|                       | Availability of skilled professionals | 4.33 | 0.751          | 86.6 | High   | 1    |

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 (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     | 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   |
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| Reason                                      | Mean | Standard Deviation | Medium | Random Sample     |
|---------------------------------------------|------|--------------------|--------|-------------------|
| 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            |

| Reason                                      | Mean | Standard Deviation | 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              |
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, 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.

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 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 |
|------------------------------------------------------------------------|----------|---------------|-----------------|
| Would you be willing to take a short course on the principles of new    | yes      | 111           | 40              |
| techniques, tools, softwares and systems for project management to      |          | 89.5          | 95.2            |
| advance your knowledge of the subject                                  | no       | 4             | 0               |
|                                                                        | not sure | 9             | 2               |
|                                                                        |          | 7.3           | 4.8             |
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| 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 |
If there an elective undergraduate class was offered in new knowledge, would you suggest student to take it  

| Random Sample | 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 engineering curriculum |
|---------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
|               | 4.59 0.598 91.8 High                                                             | 4.44 0.757 88.8 High                                                                               |
|               | 4.29 0.763 85.8 High                                                             |                                                                                                  |
| Average       | 4.44 0.149 88.8 High                                                             |                                                                                                  |

**New Knowledge Through Undergraduate Stage**

| Random Sample | Selected Sample |
|---------------|-----------------|
| A class of new knowledge should be a requirement for the student in the engineering | 95.0% 92.0% |
| Having new knowledge would make someone a more attractive candidate to employers | 90.0% 95.2% |
| If there an elective undergraduate class was offered in new knowledge, would you suggest | 91.8% 97.2% |

**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.
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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 Hananede, ‘Environmental assessment of popular single-family house construction alternatives in Jordan’, Build. Environ., 2015.
4. A. El Hananede, ‘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. Ullik 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. Detthorn, 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-mená and R. Wakefield, ‘Interoperability of building information: myth or reality?’, eWork Elbas. Archit. Eng. Constr., 2006.
13. C. Olson, ‘Are You Using BIM for Maintenance’, Buildings, 2010.
14. D. Bryde, M. Broquetas, and J. M. Volf, ‘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.
16. ‘Building Information Modelling (BIM)’, in Handbook for Construction Planning and Scheduling, 2014.
17. K. din Wong and Q. Fan, ‘Building information modelling (BIM) for sustainable building design’, Facilities. 2013.
18. HM Government, ‘Building Information Modelling’, 2012.
19. B. Succar, ‘Building information modelling framework: A research and delivery foundation for industry stakeholders’, Autom. Constr., 2009.
20. K. M. Kensek, Building information modelling, 2014.
21. B. Succar, ‘Building Information Modelling Maturity Matrix’, 2010.
22. R. Volk, J. Stengel, and F. Schultmann, ‘Building Information Modelling (BIM) for existing buildings - Literature review and future needs’, Automation in Construction, 2014.
23. S. Azhar, M. Khalfan, and T. Maqsood, ‘Building information modelling (BIM): Now and beyond’, Australas. J. Constr. Econ. Build., 2012.
24. T. Cerovsek, ‘A review and outlook for a “Building Information Model” (BIM): A multi-standpoint framework for technological development’, Adv. Eng. Informatics, 2011.
25. N. Bui, C. Merschbrock, and B. E. Munkvold, ‘A Review of Building Information Modelling for Construction in Developing Countries’, in Procedia Engineering, 2016.
26. 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.
27. M. Gerges et al., ‘An investigation into the implementation of building information modeling in the middle east’, J. Inf. Technol. Constr., 2017.
28. 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.
29. G. Sweis, R. Sweis, A. Abu Hammad, and A. Shboul, ‘Delays in construction projects: The case of Jordan’, Int. J. Proj. Manag., 2008.
30. N. Al-Hazim and Z. Abusalam, ‘Delay and cost overrun in road construction projects in Jordan’, Int. J. Eng. Technol., 2015.
31. J. M. Assbelah, ‘FACTORS AFFECTING DELAYS ON PRIVATE CONSTRUCTION PROJECTS’, Int. J. Civ. Eng. Technol., 2016.
32. A. Samarah and D. A. Bekr, ‘Causes and Effects of Delay in Public Construction Projects in Jordan’, Am. J. Eng. Res., 2016.
33. K. Barlish and K. Sullivan, ‘How to measure the benefits of BIM - A case study approach’, Autom. Constr., 2012.
34. S. Azhar, ‘Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry’, Leadersh. Manag. Eng., 2011.
35. M. F. Hergunsel, ‘Benefits of Building Information Modeling’, Design, 2012.
36. P. E. D. Love, I. Simpson, A. Hill, and C. Standing, ‘From justification to evaluation: Building information modeling for asset owners’, Autom. Constr., 2013.
37. S. Azhar, M. Hein, and B. Sketo, ‘Building information modeling (BIM): Benefits, risks and challenges’, in Proceedings of the 44th ASC Annual Conference, 2008.
38. N. Lu and T. Korman, ‘Implementation of Building Information Modeling (BIM) in Modular Construction: Benefits and Challenges’, 2010.
39. J. K. W. Wong and K. L. Kuan, ‘Implementing “BEAM Plus” for BIM-based sustainability analysis’, Autom. Constr., 2014.
## APPENDIX 1

### Section 1: General Information (Participant Information)

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

### Section 2: General Information (Introduction)

9- Are arises three-dimensional model of the buildings projects in your workplace? OYes
ONo
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10 - Do you have enough information about Building Information Modeling (BIM)?

- Yes

- No

- 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?

- Very Poor

- Medium

- High

- Very high

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

- Just for pilot project(s) 0

- 1

- 2 to 6

- 7 to 9

- More 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:

| BIM Software | Never (1) | Rarely (2) | Some Times (3) | Usually (4) | Always (5) |
|--------------|-----------|------------|----------------|-------------|------------|
| Bentley's MicroStation | | | | | |
| TriForma | | | | | |
| Autodesk's Revit R | | | | | |
| Architectur ----- | | | | | |
| Structure ---- | | | | | |
| MEP | | | | | |
| VicoSoTiware | | | | | |
| Vico Constructor* | | | | | |
| Nemetschek's Vectorworks | | | | | |
| Architect | | | | | |
| Digital Project* | | | | | |
| by Ghry Technologies | | | | | |
| Graphisott R ArchiCAD | | | | | |
| Tekla Structure | | | | | |

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

| Capability | 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**

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

| Benefit                                      | 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                       |          |           |           |           |            |
| Improved Bill of Quant ity                   |          |           |           |           |            |
| Improved quality control                     |          |           |           |           |            |
| Reduction in design errors                   |          |           |           |           |            |
| Improved productivity                        |          |           |           |           |            |
| Easier coordination of project personnel     |          |           |           |           |            |

If—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:

| Cause                          | 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     |          |           |           |           |            |
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 |
|----------------------|-------------------|----------|------------------|-------|----------------|
| Engineers            |                   |          |                  |       |                |
| Managers             |                   |          |                  |       |                |
| Chief Executive Officer |               |          |                  |       |                |

8-P lease tick (9) for the suitable place according to your level of agreement that the following reasons 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
- O 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 Agree | Disagree | Moderately Agree | Agree | Strongly Disagree |
|----------------|---------|------------------|-------|------------------|
| If there is 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 curriculum |  |  |  |  |
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| Accreditation process |   |   |   |
|-----------------------|---|---|---|
| Availability of accredited trainers |   |   |   |
| Availability of skilled professionals |   |   |   |
| Mandated for project |   |   |   |
| Availability of Standards |   |   |   |
| Upgrading of the company |   |   |   |