

Introduction BIM in Engineering Curriculum: Student Perspectives from Gaza Strip's Universities

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ABSTRACT

BIM is one of the most recent acronyms to appear in the world of architecture and construction. However, the Palestinian construction industry is encountering several problems as lack of application modern information technology and the lack of interest in BIM by Palestinian universities in Gaza Strip. So, the universities adopted strategy of using BIM as an innovative technology to allow the acquisition of new skills for student. This paper investigated the current situation and future approaches to incorporating the BIM in the curriculum and main challenges facing the BIM in engineering colleges in Palestinian universities. The population consists of bachelor engineering students; quantitative approach had adopted to collect data by using a questionnaire survey specially prepared for this purpose which was distributed to student. Returned data from 152 engineering students responding to survey were subjected to proper statistical analysis. The results indicated the knowledge about the technique is low, and they were dealing with BIM applications for duration less than one year. Focused recommendation of these results, is containing this technique as educational courses in universities, and updating this courses for suiting the technology changes periodically, providing specialized academics in order to educating and credence it officially.

Keywords— BIM Education, Curriculum, Universities, Undergraduates Students, Gaza Strip

manufactured or created in a simulated environment and identifies any possible problems of design, construction, operation or maintenance [2, 4, 5]. Thus, BIM effectively changes the role of the account in building design by creating a database of building objects used for all aspects of the project from conceptual design to construction and beyond.

The application of BIM is steadily gaining popularity in the construction industry, which is confirmed by a large number of published studies. The advantages and benefits of BIM are very large in the engineering world. BIM minimizes errors and omissions; improves stakeholder collaboration during design and construction phases; reduces rework and cost of construction; and overall project duration; increases cost control, predictability and profitability of the company; improves safety, keeps business repetitive and many more [4]. The BIM application is gaining popularity in the construction industry, and as such BIM represents a significant learning outlet for students. Therefore, BIM education should be introduced into education as soon as possible, and should be part of undergraduate and postgraduate studies. [6,7,8].

Adoption and teaching of BIM in educational program in many universities is relatively a new effort [9]. Some researchers have highlighted the important of introducing and integrating BIM into the curriculums in the engineering universities such as: evaluation student perceptions concerning the advantages and difficulties of incorporating BIM into the formal teaching system as part of the degree in industrial engineering. Students' understanding and satisfaction were analyzed while using BIM in the development of the practical component of a didactic industrial project [10]. Current status quo of the BIM education provided in Croatia and Slovakia, map the reasons of scarce BIM initiatives and propose guidelines for improvements universities need to update their curricula [11]. In addition, assessing educational approaches to building information modeling (BIM) at construction management master studies in croatia through comparing the results with similar education studies and proposed how to improve education practices of implementing BIM [12]. The degree of competence in using and understanding Building Information Modeling

I. INTRODUCTION

Building Information Modeling (BIM) is a smart 2D or 3D modeling process is a digital representation of physical and functional characteristic of a facility that link with database of project information that enhances the productivity and management performance of construction projects [1] [2]. Building Information Modeling (BIM) is an advanced stage for studying and implementing construction projects, thus, it has been rapidly deployed in construction industry. In particular, the increased demands for such technology were laid behind the use of one integrative software package instead of employing several different incompatible software. [3]. The BIM technology element informs industry stakeholders of what will be

of construction undergraduates at the Polytechnic University of Madrid, from the beginning of their degrees until they get their first jobs. [13]. In addition, [14] identified six key areas required for BIM to be inclusive in higher education sector: A UK and US perspective, as collaborative curricula, space, teamwork, relevance to the industry, technical/technological skills and the role of the professor or lecturer. Explored the current state and future approaches of incorporating BIM into architectural and engineering curriculum in Kuwait institutions and described both a general strategy and execution plan for BIM education in Kuwait [15]. Also, [9] analyzed the current state of BIM education in the CM program in universities of Pakistan and developed countries offering architectural, engineering, and construction education.

Furthermore, a systematic way to address challenges of industrial BIM needs and sustainability education in a real-world scenario [16]. This research addresses curriculum planning by considering major components of BIM education, such as TQC and TQM modules. Also, a systematic review of research on BIM curriculum design in AEC education [17]. The ways in which schools can be an important driver of BIM knowledge through the new professionals who will incorporate it in their future AEC activity, and important of focus on the strategy of using innovative technologies to allow students to acquire new skills in the use of BIM software, and knowledge about the capabilities of BIM, to better prepare them for their future activity in a world that is ever more competitive [18]. [19] developed a BIM course suitable for undergraduate construction and engineering programs using a systematic course-development approach consisting of three stages, as follows: (1) preparation, (2) development, and (3) improvement. Building information modeling education for construction engineering and management and a brief review of how BIM teaching is being introduced into universities around the world [20,21] to compile a framework for BIM education that lays out the necessary topics and development of BIM content for undergraduate and graduate construction engineering and management degree programs.

BIM is a modern technology and widely distributed in most developed countries, but it is not widely known in Gaza Strip either academically or in construction projects [3,22], which makes it difficult to accept this technique by universities, lecturers, and students, and because BIM technology is still relatively new, most universities have very few people whose expertise in that area. Therefore, we are working in this research to highlight BIM technology in our Palestinian universities to determine the extent to keep pace with the technological and scientific development for this technology and its core. Therefore, BIM technology is a

good advantage for engineering graduates, providing them with a greater opportunity to work than those who do not know BIM technology.

The adoption of teaching BIM technology will lead to stronger interaction and collaboration between the different engineering disciplines. The Objectives of this research can be summarized in the following points:

- To explore the degree of knowledge and awareness of undergraduates students of engineering colleges in Palestinian universities for BIM technology.
- To identify & explore the current state, main challenges and future approaches of incorporating BIM into architectural and civil engineering curriculum in Palestinian universities.

II. METHODOLOGY

After the preliminary study, a detailed literature review was carried out about the knowledge of students in Gaza Strip universities about the BIM technology. Based on the gathered knowledge, the research was chosen the questionnaire to be the approach of collecting data, using questionnaire consider the easiest and the fastest approach to collecting data and is more precise in processing and analyzing the data. The related data collected from secondary sources such as: books, journals, work papers, historical data and results, and scientific references etc... The primary source of the data will be the questionnaire. The researchers designed and prepare the questionnaire with consulting experts in construction management and BIM. After the development of all factors based on pilot studies, the online questionnaire will be developed and distributed among the Civil and Architecture Engineering students in engineering colleges to obtain their perspectives regarding the mentioned aspects of the knowledge of the BIM technology and challenges of introducing BIM in curriculums. The questionnaire included multiple choice questions which are used widely in the questionnaire. The variety in these questions aims to meet the research objectives, and to collect all the necessary data that can support the discussion, results and recommendations in the research. The main items of this questionnaire will be:

Part I: Personal information designed to collect data about responders such as; Gender, University, Department, and Level.

Part II: Knowledge of BIM: It aims at the extent to which the sample of the study knows the concept of building information modelling.

Part III: Study plan: It aims to know the availability of BIM techniques in the study plan for engineering students.

The population of this research was included architecture and civil engineering students of the three universities in Gaza Strip, namely University of Palestine,

Islamic University and College of Science and Technology. In all, one hundred and fifty-two students from the three universities answered online questionnaire, which sixty five (65) students in Islamic University, sixty two (62) in University of Palestine, and twenty three (23) in College of Science and Technology. A stratified sampling technique was used to determine the number of respondents for distribution of the questionnaires [23] as indicated in Table 1.

Table 1: Description of the distributed questionnaires

University	Average Population	Number of Respondents
Islamic University	200	65
University of Palestine	175	62
College of Science and Technology	30	23
Total	405	152

III. RESULTS & ANALYSIS

This section included analysis and discussion of the results that have been collected from field surveys. A total of 152 respondents had been returned. Data were analyzed quantitatively using IBM (SPSS) version 22 including descriptive and inferential statistical tools.

3.1 Personal Information

The results in Table 2 show that the largest percentage of the respondents of the study was male with 69.1%, while female 30.9%. Respondents' profiles were classified according to the location of the respondents engineers, 51.3% that of the respondents from university of Palestine, 38.2% from Islamic university, 10.5% from College of Science and Technology. In addition, the largest percentage of the sample of the study were civil engineer with (66.4%), while Architect (33.6%). However, the respondent's engineers have different level, where 36.8% of the respondents were graduated, 34.9% of the fifth level, 18.4% of the fourth level, and 9.9% of the third level.

3.2 Knowledge of BIM

The results shown in table 3 that 57% of respondents, who heard about BIM from a year ago, while 20% of respondents had heard from 1-2 years ago, 13% of respondents, had heard from 2-3 years ago, and 10% of respondents have heard since more than 3 years. In terms of level of knowledge in BIM, respondents were having varied knowledge. About 39% of engineers know very low, while 22% low knowledge, also show that 21% of their knowledge is medium while 13% have high knowledge and 5% have very high level of knowledge.

Based on the results, the awareness of BIM level by the engineering students in Gaza Strip is low and considers it modern techniques to better understanding of the design.

Moreover, the result shows that 47% of respondents describe BIM as new technologies and 26% describe as cooperative process, and 23% as just software's, while 4% see it as otherwise. Next, respondents were asked to reasons for interest in BIM technology. It has been found that 22% of respondents interest in BIM technology as they contribute to a better understanding of design, while 19% are interested in it because of the quality of projects, and 17% because it gives better features and possibilities. Also, 14% interested in because it more effective than CAD, and 13% because it changes and look for something new and fewer mistake, while 2% interested by otherwise reasons.

Since the high percentage of interesting reasons in BIM technology by the students were better understanding of the design and projects quality, there is some illusions pushed the students to choose these reasons, that's might be returns to university education. Table 4 clarifying that is Islamic university and University of Palestine students says moreover the previous results, the possibilities and features of this technique are better and more effective than CAD, while College of science and technology students says that this technique has fewer mistakes and more effective than CAD to be interested.

Table 2: Respondents' profile

Respondent Information	Categories	Frequency (F)	Percent (%)
Gender	Male	105	69.1
	Female	47	30.9
University	University of Palestine	78	51.3
	Islamic University	58	38.2
	College of Science and Technology	16	10.5
Department	Civil	101	66.4
	Architecture	51	33.6
Level	3rd	15	9.9
	4th	28	18.4
	5th	53	34.9
	Graduated	56	36.8

Table 3: Respondents' Knowledge of BIM

	Respondent Information	Categories	Frequency	Percentage
1	Specify your period of hearing about BIM applications	Less than one year	86	57%
		1-2 years	30	20%
		2-3 years	20	13%
		More than 3 years	16	10%
2	Level of knowledge in BIM	Very low	59	39%
		Low	34	22%
		Medium	32	21%
		High	20	13%
		Very high	7	5%
3	Describing BIM technology according to personal knowledge	Just software's	45	23%
		Cooperative process	52	26%
		Modern techniques	94	47%
		Others	8	4%
4	Reasons for interest in BIM technology	Projects quality	63	19%
		More effective than CAD	47	14%
		Fewer mistakes	45	13%
		Better understanding of the design	72	22%
		Possibilities and features are better	56	17%
		Change and look for something new	44	13%
		Others	7	2%

Table Error! No text of specified style in document.4: Interesting in BIM vs. University

Interesting in BIM	University					
	Islamic University (58)		University of Palestine (78)		College of science and technology (16)	
	Freq. (F)	Percent %	Freq. (F)	Percent %	Freq. (F)	Percent %
1 Fewer mistakes	20	34%	18	23%	7	44%
2 Projects quality	23	40%	34	44%	6	38%
3 Better understanding of the design	33	57%	33	42%	6	38%
4 More effective than CAD	23	40%	18	23%	6	38%
5 Better possibilities and features	26	45%	28	36%	2	13%
6 Change and look for something new	19	33%	21	27%	4	25%
7 Others	3	5%	3	4%	1	6%

Practice and Importance of BIM in Career Life

The results in Table 5 show that a large percentage of the respondents believe that the practice of BIM requires prior knowledge in the construction field and that this technique is considered a turning point in the employee's working life, and they also believe that their

knowledge of BIM technology distinguishes them from other graduates. In other side 50% of respondents believe that the technique of BIM is feasible in Gaza Strip, while the other percentage was between opposing it and not knowing

Table 5: Practice and importance of BIM in career life

Paragraph	Frequency (F)	Percent (%)
Do you think that the practice of this technique requires prior knowledge in the field of construction?		
Yes	101	66.5
No	18	11.8
I don't know	33	21.7
Do you think this technique may be a turning point in your career life?		
Yes	102	67.1
No	25	16.4
I don't know	25	16.4
From your point of view, does BIM technology distinguish you from the other graduates?		
Yes	103	67.8
No	21	13.8
I don't know	28	18.4
Do you think the use of BIM technology in Gaza Strip is feasible?		
Yes	81	53.3
No	42	27.6
I don't know	29	19.1

Engineering Programs used by the Study Sample of Engineers

Table 6 illustrate that the more commonly engineering programs used by the respondents is CAD software with 30%, this results indicate the lack of the use of 3D program. In addition, 19% of the respondents use Ms Project, 11% of the respondents use Sketch up, 9% of the respondents use 3ds Max and Revit Structural, 6% of the respondents use Revit Architecture, 5% of the respondents use ArchiCAD, 4% of the respondents use Primavera and Tekla Structure while 3% of the respondents use other program.

Table 6: Engineering programs used by engineers

No	Reasons	Frequency	Percentage
1	AutoCAD	146	30%
2	3ds Max	43	9%
3	Sketch-up	53	11%
4	ArchiCAD	25	5%
5	Revit Structural	46	9%
6	Revit Architecture	30	6%
7	Ms Project	93	19%
8	Primavera	19	4%
9	Tekla Structure	18	4%
10	Others	16	3%

This results shown that the high percentage of BIM software's were AutoCAD and MS Project, however these software's was predicted to be the most uses by the students, because they are included in civil and architecture engineering curricula. Table 7 refers to the percentage of civil department students whom uses AutoCAD and MS Project, is greater than the architecture did, while there is some software's such that 3ds max and Sketch Up, the percentage of architecture department students whom use it are greater than civil did, which the reasons refers to this result, might be the difference between the department students hobbies. Also, it might be due to the nature of use, which they are dealing with.

3.3 Study Plan

• Opinions about Curriculum Current State

Half of the respondents 50% believe that the study plan includes a sufficient number of courses dealing with BIM techniques. Furthermore, 64% of the respondents believe that the courses of the plan are being developed and updated to be more suitable for technology changes periodically. 58% of the respondents believe that the college or departments offer training courses for students on various engineering programs. Responses to the questions on the current status of BIM education within engineering curricula in Gaza strip's Universities are shown in Table 8.

Table Error! No text of specified style in document.7: BIM Software vs. Department

BIM Software	Department			
	Civil (101)		Architecture (51)	
	Frequency (F)	Percent %	Frequency (F)	Percent %
AutoCAD	96	95%	50	98%
3ds Max	10	10%	33	65%
Sketch Up	20	20%	33	65%
Archi CAD	11	11%	14	27%
Revit Structural	35	35%	11	22%
Ms Project	66	65%	27	53%
Revit Architecture	12	12%	18	35%
Primavera	14	14%	5	10%
Tekla Structure	13	13%	5	10%
Others	12	12%	4	8%

Table 8: Respondents opinion about curriculum current state

No	BIM and University Curriculum	Strongly Disagree	Disagree	Agree	Strongly Agree
1-	The curriculum includes a sufficient number of courses that dealt with BIM techniques	18%	32%	39%	11%
2-	The curriculum courses are developed and updated to be more suitable for technology changes periodically	7%	29%	48%	16%
3-	The college or departments offers workshops for students on various engineering programs	14%	22%	44%	20%
4-	The college or departments offer training courses for students on various engineering programs	14%	28%	36%	22%

- Reasons of Lack of Student's Interest in BIM at the University Stage**

22% of respondents believe that their lack of knowledge of BIM was one of the reasons of lack of student's interest in BIM at the university stage, while 18% believed that it was due to the adequacy of CAD programs, and 16% believed that it was due to the cost of devices what compatible with BIM is high. Also, 13% believed that it was due to high training cost, while 12% believed

that it was due to they no have enough time, and 8% believed that it was due to it unnecessary in work. Furthermore, 6% believed that it was due to weak internet network, while 3% believed that it was due to it doesn't there speciality, and 2% believed that it was due to another reasons as shown in Table 9.

Table 9: Reasons of lack of student's interest in BIM at the university stage

No	Reasons	Frequency	Percentage
1	I don't know what is BIM	60	22%
2	No have enough time	32	12%
3	Don't need it in Work	22	8%
4	The cost of devices that compatible with BIM is high	43	16%
5	CAD software's are enough	51	18%
6	Weak Internet networks	17	6%
7	High training costs	37	13%
8	Not my specialty	9	3%
9	Others	6	2%

Since the high percentage of lack of interest in BIM was lack of knowledge in BIM and CAD software's are enough, these results might be due to adequacy of the students to their existent science and the unwanted motivations to explore a new technologies, but which levels of students whom explained these results are dealing with it. Table 10 shown that the percentage of all levels students seen that results is most likely to be and looking to it such as a real reasons to get lack of interest to BIM, that's might be because they used to dealing with CAD software's and they didn't see any motivation to improve they work, and there is no any reason leading them to improve their knowledge about new technologies that can help them in the work, While the 5th and graduated levels seen that the high cost of devices that compatible with BIM is the most reason to be the result in lack of interest in BIM, and these are just possibilities, not a fact.

Table Error! No text of specified style in document.10: Lack of interest in BIM vs. Students Level

Lack of interest	Level							
	3 rd (15)		4 th (28)		5 th (53)		Grad. (56)	
	Freq(F)	%	Freq(F)	%	Freq(F)	%	Freq(F)	%
1 The cost of devices that compatible with BIM is high	6	40%	3	11%	16	30%	18	32%
2 CAD software's are enough	7	47%	15	54%	14	26%	15	27%
3 Lack of knowledge in BIM	7	47%	12	43%	24	45%	17	30%
4 Weak Internet networks	1	7%	2	7%	8	15%	6	11%
5 Not my specialty	-	-	-	-	7	13%	2	4%
6 Don't need it in Work	2	13%	4	14%	4	8%	12	21%
7 High training costs	4	27%	7	25%	12	23%	14	25%
8 No have enough time	3	20%	6	21%	11	21%	12	21%
9 Others	1	7%	-	-	2	4%	3	5%

- Reasons for Not Adopting BIM as a Course in Palestinian Universities**

22% of respondents believe that lack of experts in this field was one of the reasons for not adopting BIM as a course in Palestinian universities, while 17% believed that it was due to Lack of educational resources, Weak knowledge of the benefits of BIM, and needs high programs and possibilities not available in the universities.

Also, 14% believed that it was due to lack of communication between academic institutions and the construction industry, while 11 % believed that it was due

to considering it as modern technology, and 2% believed that it was due to another reasons as shown in Table 11.

Table 11: Reasons for not adopting BIM as a course in Palestinian universities

No	Reasons	Frequency	Percentage
1	Needs high programs and possibilities not available in the universities.	63	17%
2	Considers as a modern technology	39	11%
3	Few experts in the field.	81	22%
4	Weak knowledge of the benefits of BIM	64	17%
5	Lack of communication between academic institutions and the construction industry	53	14%
6	Lack of educational resources	61	17%
7	Others	6	2%

The analysis of data in pervious section covered personal information, knowledge of BIM, study plan aspects of BIM education in universities Gaza Strip. The results showed that the majority of respondents heard about BIM from a year ago. Knowledge about BIM was very limited among those who had had some exposure to BIM. Most of the respondents perceived BIM as a tool for better understanding of the design and modern techniques. The analysis indicated that large percentage of the respondents students in Gaza Strip universities believe that the practice of BIM requires prior knowledge in the construction field and that this technique is considered a turning point in the employee's working life. However, results indicated that lack of experts in this field was one of the reasons for not adopting BIM as a course in Palestinian universities. These reasons are sensible due to low knowledge degree of BIM, and these results might be indicates that BIM is unique and there is quite great chance to make who dealing with this technique is special. These reasons unfortunately are predicted due to the lack of development in Gaza Strip, and indicate to a real problem in the educational institutes, which it need to a real solution.

IV. CONCLUSION

Through this research, it was concluded that the results of the information learned could be summarized as follows: The degree of knowledge and awareness of the students about BIM technique was approximately low. There is a significantly high number of students those who

have been hearing about BIM, and they have using its applications in a duration less than one year, most of them dealing with AutoCAD and MS Project programs. The respondent's students have described BIM as modern technique; they were interested in BIM due to better understanding of the design and project quality that can be done with this technique, also the students thought that BIM technique may be a turning point in their career life. The respondents believe that the curriculum includes a sufficient number of courses dealing with BIM technique. Furthermore, most of respondents believe that the courses of the curriculum are being developed and updated to be more suitable for technology changes periodically and the college or departments offers workshops and training courses for students on various engineering programs.

Since the most of information concluded refers to a negative sign of student's knowledge, the recommendations can be summarized as the following: adopting this technique as educational courses in universities engineering colleges in Gaza Strip, to utilize the chance of educating it to big number of students whose are enthusiastic to learn it. Furthermore, providing specialized academics or training a new one if that's possible in order to educating this technique and credence it officially in universities engineering colleges in Gaza Strip and educating students about its truth. It recommended updating the curricula of civil engineering and architecture and these curricula should be working on student development in both modeling skills using BIM tools as well as working skills within the BIM collaborative environment. In addition, create scientific conferences about BIM in the different universities of Gaza Strip periodically, to learning the students more about this technique, inspiring and encouraging them to accept and embracing this technique as educational courses in the curriculum. Furthermore, providing a free or low price training courses, and the devices that compatible with BIM technology which it very expensive as possible, and whatever required making sure that the challenges which facing BIM would be reduce. The main limitation of the study is having a relatively small sample from three Gaza strip universities, which might not be representative of the whole Engineering students in Gaza strip. Nevertheless, such limitations warrant further research on the topic through using larger sample and respondents from other perspectives.

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