



## **Submitting BIM to the Educational Plan for the Faculty of Architecture According to NARS and ARS Standards.**

**Eisa Al Hammoud<sup>1</sup>, Sonia Ahmed<sup>2</sup>**

<sup>1</sup>Mastering in Building Information Modeling and Management BIMM program – Syrian Virtual University,  
Teacher at Al Baath University faculty of architecture, Syria

<sup>2</sup>Director of the Master's Program in Building Information Modeling and Management, Syrian Virtual University,  
Syria

Emails: [eisa\\_161270@svuonline.org](mailto:eisa_161270@svuonline.org); [bimm\\_pd@svuonline.org](mailto:bimm_pd@svuonline.org)

### **Abstract**

Building Information Modeling (BIM) has imposed itself as a powerful engineering and technological tool over time. It's even become mandatory in some countries (UK) and is gradually gaining more and more awareness worldwide. However, BIM education is still a new concept even in some countries that are already implementing it in their various engineering and construction projects. This research aims to conclude with an educational plan and curricula for the faculty of architecture that contains BIM as the core of it. The methodology used in this research is the online-structured questionnaire, distributed to students and staff of the faculty of architecture at Al-Baath University which is the case study of this research.

Architecture faculty undergraduates and graduates with different degrees were surveyed by an online-structured questionnaire, and the results of the questionnaire were gathered and analyzed using google forms. This study concludes with the proposed modified plan and curricula for the previously mentioned faculty in light of the theoretical study, questionnaire results, and similar experiences around the world. This new plan is expected to prepare a new generation of architects who are High-tech qualified and fully aware of BIM and its general ideas, which makes it easier for these architects to emerge within the job market and fulfill AEC firms' requirements of course this would also help to promote the university's reputation and help to spread BIM education among other local universities and also to other engineering competencies.

**Keywords:** Architecture; BIM; BIM Program; BIM Education, Digital Education; Engineering Education; ARS; NARS.

### **1. Introduction**

BIM has been spreading massively all over the world especially since the dawn of the past decade, not only in Europe and North America but also in Asia, South America, and the Middle East region with no signs of holding back any time soon, in fact, more and more numbers of AEC firms, engineers and other stakeholders are entering the BIM world every day, BIM adoption has grown substantially. Today, awareness is almost universal, with 73% using

BIM. (NBS 10<sup>th</sup> annual BIM report 2020). Setting the standards for engineering and technological development and representing the job market's most wanted method of work, and even mandatory by some governments like the UK. The following chart indicates the result of a previous study that shows overall BIM adoption around the world:

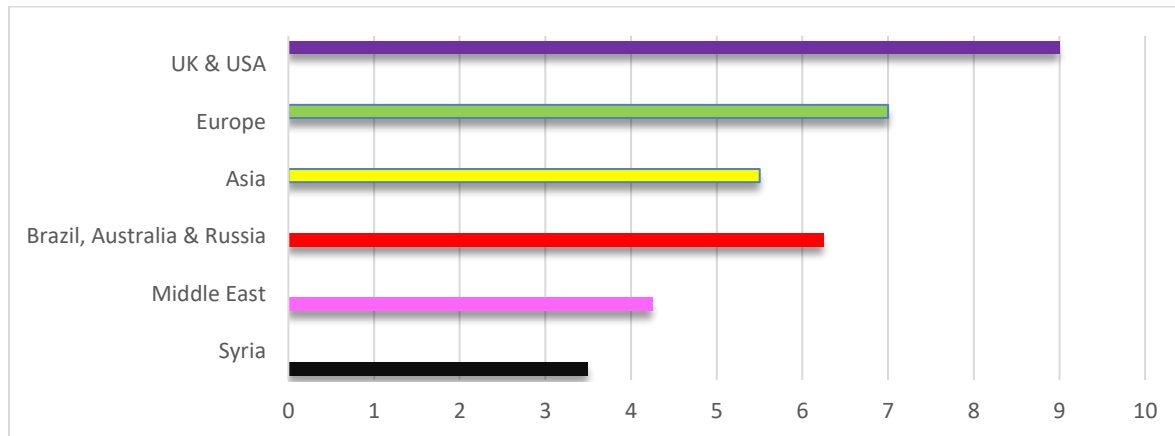


Figure 1: Bar chart/1/ representing an overall comparison between all six groups  
Al Hammoud. Eisa, (2021)[1]

In spite all that, BIM education is still in a very early stage in engineering schools and colleges and nearly not existed in numerous cases. this would cause a problem in the long run as it would produce new engineers lacking an important aspect and a vital working method required in the job market and here lies the importance of this research.

Universities, colleges, faculties, and other educational foundations and institute's goals should be to prepare students to engage in the community according to their field of study to become an impactful and contributing factor ie society and to step into the job market easily, and this is why BIM is vital as an educational tool in engineering schools.

On the other hand, BIM represents the amount of digital and technological development in the country's engineering field, and so it gives an important and clear indication of the proficiency of the educational institute including it in its learning process. It also provides a very easy-to-use demonstrational tool that can be used by academic staff for a better understanding of the students' assignments, projects, and other educational outcomes, it also allows students to represent their thoughts easily and removes most popular misunderstandings and vague concepts throughout their educational journey.

## 2. Research method:

In order to conclude with a proper result from this research, first, an introduction to the university and faculty's current situation is crucial, to see its material and human resources, potentials, tools, and equipment, discussing particularly faculty of architecture educational plan, staff and curricula, also a questionnaire survey was applied to current and previous students of the faculty investigating multiple discussion points related to the research. After that, we'll take a look at BIM education examples and experiences from similar universities to benefit from it and try to implement it in the new recommended plan for the faculty.

## 3. The Reality of Educational Process in Syria

The educational field in Syria has suffered major deterioration as a result of the recent years of war and conflict since 2011 which caused a significant step back in the learning and scientific research process throughout its different levels.

The damages were numerous, and took many different forms; some educational buildings (schools, institutes, faculties...) were physically damaged fully or partially. Another crucial point is the lack of academic staff (teachers and professors) that occurred throughout this phase, some were missed in action, some retired for safety reasons and some of them emigrated. Students were the ultimate victim in this situation, due to the previous reasons mentioned above, students in conflict areas all over Syria were forced to skip lectures and even exams, all of that played a tremendous role in degrading the educational process in Syria.

Of course, this hadn't always been the case for the educational field in Syria, actually, Syrian universities used to be one of the most prominent educational institutes in the middle eastern and Arabian regions. Damascus University (DU), was ranked the 2<sup>nd</sup> Arabian University after Cairo University in 1970, and in 2011 (before the war was initiated) was ranked 57<sup>th</sup>.

The Webometrics Ranking of World Universities, also known as Ranking Web of Universities, is a ranking system for the world's universities based on a composite indicator that takes into account both the volume of the Web content (number of web pages and files) and the visibility and impact of these web publications according to the number of external in-links (site citations) they received. The ranking is published by the Cyber-metrics Lab, a research group of the Spanish National Research Council (CSIC) located in Madrid.[6] The ranking started in 2004 and is updated every January and July. As of 2021, it provides Web indicators for more than 31,000 universities worldwide.

Besides the war and conflict situation in Syria, other factors played a major part in the falling of the Syrian universities into lower places in the webometrics ranking including:

- Lack of updating universities' websites on regular basis and uploading master's and Ph.D. thesis.
- Lack of research published in scientific magazines.
- Lack of researchers registered in google scholar.

#### **4. Brief Introduction to Al- Baath University (BU)**

Established in 1979, Al-Baath University ranks as one of the leading Syrian universities, ranked domestically 4th among 27 private and governmental universities, and comes second only after Damascus University in terms of students and employees numbers, hosting more than 100000 students and more than 1500 professors and teacher in 20 faculties, 4 technical institutes, 5 research and social service centers and two high institutes divided into 5 main departments, Medical, Engineering, Literature, and humanitarian Science, Basic Science, and Economy.[8]

The university's vision is "Excel in higher education, scientific research, social service and contributing to the reconstruction and elevates university's ranking." Over 90000 students have graduated from the university as of 2020 with multiple academic degrees including Bachelor's, Diploma, Master's, and Philosophy of Doctorate.[8] The University has a great history and was ranked 65th out of 500 Arabic universities, it used to be the only University in the middle eastern and Arabic world to have a Petro-Chemical Faculty, and students used to come from all over the region to study in it, with its unique high-tech laboratories and having its own separated campus, this faculty helped to promote the university's reputation domestically and regionally.

The Syrian conflicts began in 2011 and carried a massive deterioration to the educational process at BU professors and teachers emigrated or were missed in action, students had to skip lectures and exams due to safety reasons, and the university had to host students from fellow state universities such as Aleppo and Euphrates university, all of this resulted in huge pressure on the academic staff and students at once, and lecturers faced immerse difficulties delivering their information. The Petro-Chemical faculty was the biggest loser of all being severely damaged, its laboratories were completely destroyed and that led to all foreign students leaving the faculty and eventually the

country, later the faculty relocated to the original campus and is still to this date sharing laboratories with other faculties like Electrical and Mechanical engineering faculty.

From 2013 to 2018 the university focused on delivering lectures and scientific information to graduate their students, with huge absence to the scientific research and in most departments, which was another negative effect on the university's reputation and overall ranking, as of 2018 it fell out of the Arabian Ranking, and out of the top 10000 universities in the world. (Webometrics2018).[6]

#### **4.1 Architecture Faculty at BU, Introduction, Stats, and Reality.**

One of few initial faculties that started with the establishment of the university in 1979 known as the faculty of civil engineering and architecture, and later became the faculty of architecture in 1985, the faculty provides Bachelor's, Master's, and Philosophy of Doctorate degrees. The faculty now includes 55 teachers and professors, 2305 undergraduate students, 125 master's degree students, and 17 Philosophy of doctorate candidates,[9] which indicates the first major issue, as teacher to student ratio is 1:42 while it typically should be around 1:10 to 1:20,[7] as the academic staff suffered major reduction during the past decade, the head management of the college tried to fix this issue by allowing Architects and engineers with various scientific degrees from outside the university to become part-time teachers, especially in the 3 Main departments of the faculty, Architectural Design, City Planning, and Urban Planning, and Building Science and Execution. The faculty includes 35 ateliers with a capacity of 25 dashboards each, 2 computer laboratories with 10 devices each, 5 seminar halls, one library and reading hall with a capacity of 100 seats, 2 auditoriums each of them with a capacity of 150 seats, and a gallery that previews different special works of students from different courses. This indicates another problem as these classrooms are not enough for the increasing number of students. The faculty's website is almost disabled; no lectures, assignments, or exercises are uploaded on the site, or even exam results, master's and Ph.D. thesis are nowhere to be found on the website. And there are no online courses or lectures at all.

#### **4.2 Faculty's Current Curricula and Educational Plan:**

In order to modify the learning and educational plan within the faculty, we need to know its current plan and curriculum; and introduce a brief introduction to NARS and ARS. In 2018, the Quality Assurance Center at BU (QAC) was established in order to supervise and monitor the quality of processes taking place within the university and help with the evaluation of each department and prepare the upcoming strategic plan. The QAC's vision is to adopt quality and credibility standards in search of excellence in academic works and to promote BU to become one of the leading educational institutes globally.[10] The center relies on the National Academic References Standards (NARS), *Figure2* which is defined as the least required amount of knowledge and skills that national educational institutes should include throughout their academic programs to guarantee their grads have gained the least number of skills and knowledge set by the higher education national policy.[2]

The Academic Additional References Standards (ARS), *figure 2* is the additional tools and standards each department or program adds to its courses to improve the outcomes, these standards should be approved by the QAC and should be more inclusive than NARS. ARS depends mainly on the Intended Learning Outcomes (ILOs) [2] *Figure3*, which is the results each faculty tries to fulfill throughout its programs and reflects its academic standards and includes 4 basic aspects:

- Knowledge and understanding.
- Brain Skills.
- Practical and Manual Skills.
- General Skills.

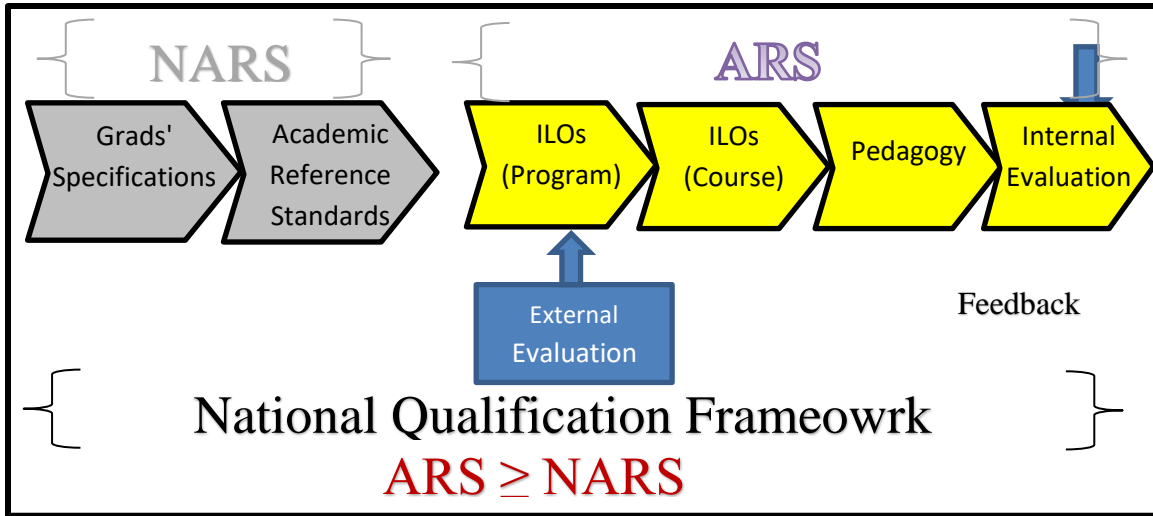


Figure 2: Diagram representing elements of NARS and ARS within the National Qualification framework, Sahyouni Waleed (2018) [2]

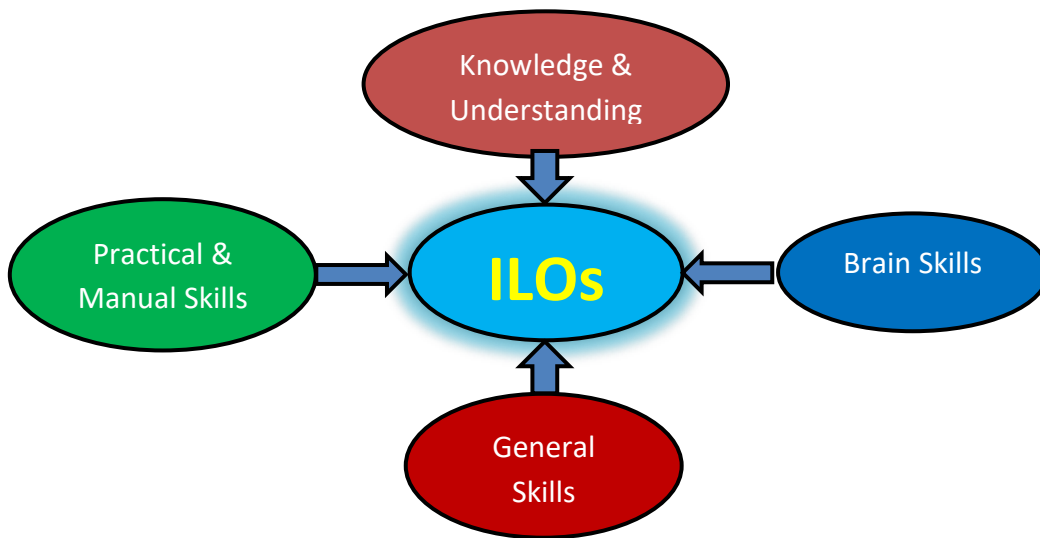


Figure 3: Diagram representing the main four aspects of ILOs Sahyouni Waleed (2018) [2]

ARS also takes into consideration the pedagogy element throughout its cycle and finally requires internal evaluation from specialists within the faculty to address the process advantages and disadvantages and provide feedbacks in order to enhance the educational process. After all of this an external evaluation for these elements is essential to be done and these external specialists could be from the QAC center or specialists from other universities to give a non-bias verdict about the process and its outcomes.[2]

The QAC at BU assured that graduates at BU lack the following skills:

- Communication Skills.
- Identifying problems and finding the proper solutions.
- Collaborative work skills.

- Digital and technological skills.
- Creativity and Pioneering skills.

#### 4.3 What can BIM provide to AEC Industry and the education sector in Syria?

Elhendawi. A, et Al (2019) in previous research proved BIM's competence to eliminate waste and inefficiency to improve quality and profitability of the construction industry.[11][12]

Ahmed. S, et Al (2018) proved that the majority of the public administration staff in Syria know quite about BIM. clients are usually worried about quality improvement with reduced time, and cost, contractors, and architects are interested in performance improvements to increase their profits and enhance their competitive advantages. BIM proves its capability to enhance the cooperation between all project parties. Unfortunately, BIM is not fully applied in Syrian projects in general.[13]

Essentially, BIM is a communication-based collaborative working method in its core, it is also a high-end digital engineering tool that sets the standards in the engineering world, so by engaging BIM into the educational plan for engineering schools, these 3 problems would be reduced massively. BIM is also a problem solver, one of the main reasons that led to BIM creation actually was the desire to reduce common errors and misunderstandings between engineering competencies, and its programs are considered the best clash detectors for Engineers. In terms of creativity, BIM provides a very creative friendly environment for engineers especially architects, allowing them to develop their designs easily and dedicate more time focusing on designing and modeling rather than drawing and drafting. It is also worth mentioning that BIM fulfills the ARS standards mentioned previously in *figure2*, as it provides the four main elements of ILOs *figure3* and is able to be developed over time.

Another important case is that during the digital transformation era in Syria, BIM leads the way toward a digital engineering future and is highly recommended to Introduce this system in the curriculum of engineering colleges as one of the requirements for the implementation of the BIM system in Syria.[14]

#### 5. Current Curricula:

To investigate the ability and capability of implementing BIM education in the architecture program at BU, we need to take a look at the current educational plan, the following table indicates the courses that are being taught currently and in which term and year.

##### 5.1 First Year's Syllabus:

Table 1: represents the current syllabus of courses in the first year at BU faculty of architecture

Course	Semester	Department
Architectural Design1	1&2	Architectural Design
Drawing and Modeling 1	1	Architectural Design
Descriptive geometry	1	Building and Execution Science.
Mathematics and mechanic	1	Basic Science
Foreign language 1	1	-
Arabic	1	-
National studies	1	-
Drawing and Modeling 2	2	Architectural Design
Shadow and Perspective 1	2	Architectural Design

History of Architecture	2	Theories and History of Architecture
Computer-Aided Design (1)	2	Architectural Design
Foreign Language 2	2	-

## 5.2 Second Year's Syllabus:

Table 2: represents current syllabus of courses in second year at BU faculty of architecture.

Course	Semester	Department
Architectural Design2	1&2	Architectural Design
Drawing, Modeling and Models	1	Architectural Design
Shadow and Perspective 2	1	Architectural Design
Computer-Aided Design (2)	1	Architectural Design
Architectural Construction 1	1	Building and Execution Science.
Foreign language 3	1	Basic Science
History of Architecture 2	1	Theories and History of Architecture
Architectural Construction 2	2	Building and Execution Science.
Theories of Architecture 1	2	History and Theories of Architecture
Surveying Geometry	2	Building and Execution Science.
Resistance of Materials	2	Structural Engineering
Foreign Language 4	2	-

## 5.3 First and Second year's analysis:

-In the first and second year, the learning plan focuses particularly and greatly on improving hand drawing techniques and creating conceptual models which is an essential and important tool to each and every architect, as it is not possible to translate any idea or concept to a digital or real construction project without the ability to create hand sketches, plans, concepts, and other architectural drawings. It is worth noting though the CAD 1&2 Subjects as they're the entrance to a digital transformation for the students in which they learn how to translate their hand drawings to digital ones. CAD1 teaches students to produce 2d drawings with strong emphasis on Autodesk AutoCAD and its main commands. In CAD 2 students are introduced to the 3d drawings using Archicad software, this sounds encouraging on paper but in fact the educational plan only focuses on 3d modeling commands within the mentioned program without any further information about BIM and other important aspects of the program.

## 5.4 Third Year's Syllabus

Table 3: represents current syllabus of courses in third year at BU faculty of architecture.

Course	Semester	Department
Architectural Design3	1&2	Architectural Design
Execution Designs1	1	Building and Execution Science.
Buildings and Equipment (MEP)	1	Building and Execution Science.
Theories of City Planning	1	City Planning and Urban Planning.
History of Architecture 3	1	Theories and History of Architecture
Constructions' Calculation	1	Structural Engineering
Execution Designs 2	2	Building and Execution Science.

Landscape and Site Planning	2	City Planning and Urban Planning.
Theories of Architecture 3	2	Theories and History of Architecture
Theories of Construction	2	Structural Engineering

### 5.5 Third Year's Analysis:

The third year is a very important and vital one for students as it introduces them to new concepts and information.

-In Architectural Design 3, Students are allowed to deliver, present and print their projects using any digital designing software they want, this is a very important discussion point as students now are considered to have good knowledge in architectural Software especially after being taught CAD (1&2) in the previous years.

-Buildings' equipment is a very crucial for the students as it provides them with the required information they should know about Mechanical, Electrical and Plumbing Competencies, although that, the time given to the subject is way too short, 14 lectures are not enough at all to demonstrate and form full knowledge about these 3 important aspects, this subject allows the future architect to manage and coordinate the engineering process between these competencies, so it is really important to give it the time and tools to a better learning experience.

-Execution designs 1&2 is an important subject that teaches students the proper way of delivering execution-ready architectural drawings, in ED1 students are obliged to deliver their projects by hand drawings only and then allowed to deliver them using any digital software of their own pick in ED2.

-In Landscape and Site Planning the students are allowed to deliver the final site project using digital programs as well, the subject alongside theories of city planning is considered the stepping stone to City Planning 1,2&3 in the following years which is the second most important department in the faculty after Architecture Design.

### 5.6 Fourth Year's Syllabus

Table 4: represents current syllabus of courses in fourth year at BU faculty of architecture.

Course	Semester	Department
Architectural Design4	1&2	Architectural Design
Execution Designs 3	1	Building's Execution Science.
City Planning 1	1	City Planning and Urban Planning.
Reinforced Concrete 1	1	Structural Engineering
Steel Structures.	1	Structural Engineering
Urban Sociology	2	City Planning and Urban Planning.
Execution Designs 4	2	Building's Execution Science.
City Planning 2	2	City Planning and Urban Planning.
Interior Design and Decoration	2	Architectural Design
Reinforced Concrete.	2	Structural Engineering

### 5.7 Fourth Year's Analysis

-In Architectural design 4, students are introduced to the sustainable design concept with more complicated design projects like hospitals and hotels, but the missing ring in this chain that there is no tool that shows the student how to manifest sustainability in their designs, only theoretical information is given and students are left to struggle to find the convenient way of representation.

-In interior design, students learn how to design and decorate different architectural spaces and are left to choose the most suitable way for them to deliver their assignments, it is worth noting though that in certain assignments and final projects they're required to design internally one of their previous Architectural Design projects.

-City Planning 1&2 are considered as an expansion to Landscape architecture where students learn urban design, neighborhood planning, and once again students are given only theoretical information and left on their own to translate it into a comprehensive planning project.

-Steel Structures and Reinforced concrete 1&2 are also taught as theoretical subject that depends on old fashioned 2d drawings of steel and concrete beams and columns, as structural engineering department courses, architecture students always find these subjects vague and don't really get the point of it, especially without any further explanatory methods or applications

### 5.8 Fifth Year's Syllabus

Table 5: represents the current syllabus of courses in the fifth year at BU faculty of architecture.

Course	Semester	Department
Architectural Design 5	1	Architectural Design
City Planning 3	1	City Planning and Urban Planning.
Quantities and Specifications	1	Building's Execution Science.
Regional Planning	1	City Planning and Urban Planning.
Environmental Science (Ecology)	1	City Planning and Urban Planning.
Graduation Project	2	Architectural Design, City planning and Urban Planning, Buildings and execution science.

### 5.9 Fifth Year's Analysis

-The first thing we notice here is that Ecology (Which should be an entry level subject to both architectural design, landscape and city planning) is given as a senior subject. Depending only on old books and researches and theoretical information.

-Quantities and specifications is a vital and very important course to all architects, the staff is still using old methods of estimation and quantity calculation which could be really painful in complicated organic and parametric projects.

-The Graduation Project contributes to 15% of the overall graduation average and lasts for 90-100 days during the second semester.

Usually the graduation projects in the faculty deal with huge topics such as (Reconstruction and Renovation, Planning touristic resorts, Universities, Health Centers, Sports' cities.... etc.) The take on these projects here is the lack of integrated studies with other competencies, and lack of scheduling, programming for the project, and especially cost estimation of the project despite delivering mesmerizing plans elevations perspectives and other architecture-only focused drawings.

### 6. Questionnaire and its analysis:

122 people participated in the questionnaire, all of them are current or previous students at BU faculty of Architecture, in order to verify the validity of the answers, e-mails and full names were collected. The survey was divided into 3 sectors, the first sector was designed to collect participants' data as the following:

**6.1 First Question, Age Category**

Only 4.9 % of participants are between 18 and 20 years old which marks the first 3 years of undergraduate students, meanwhile 39.3% were between the age of 20 and 23 which represents seniors and new graduates this indicates that around 45% of the answers are from current under graduate students. the other 55% distributed as the following: 37.7% are between 23 and 27 years old, 15.6% are between 27 and 35, meanwhile only 2.5% are above the age of 35. Figure-4-

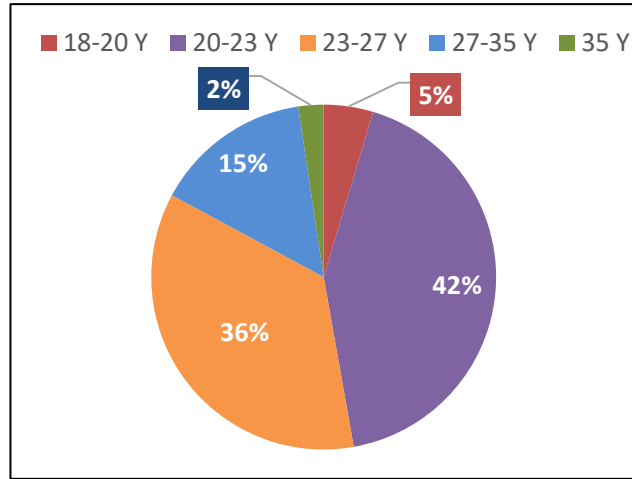


Figure-4- Pie chart/1/ represents votes for the first question.

**6.2 Second Question, Academic Degree:**

With a 59% majority of the answers came from undergraduates, and the remaining 41% divided as the following: 25.4% were from Bachelor degree grads, 9% from post graduate and master's degree students, 5.7% have master's degree in architecture, and only 0.8% have PhD Degree. we notice here the diversity of participants in terms of their academic qualification and this is a healthy indicator for a non-biased opinion. Figure-5-

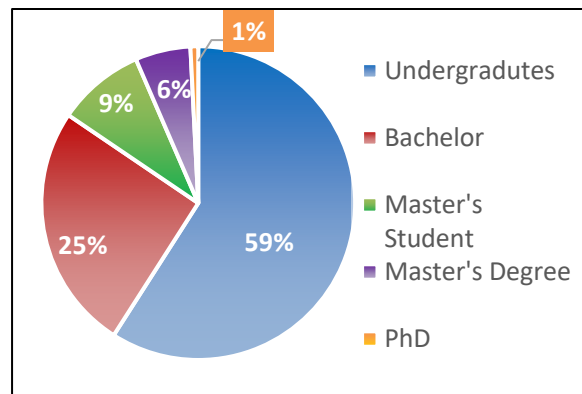


Figure-5- pie chart/2/ represents votes for the second question

### 6.3 Third Question, Learning Obstacles

The second sector focused on the participants learning experience in the faculty and the obstacles they came across during their years of study.

for the third question, multiple answers were able to be chosen by surveyed members and here are the results: 2.5% declared the haven't faced no obstacles during their studying years, meanwhile 73.8% admitted that the main obstacle was that the academic plan is very different from the job market requirements, 56.6% also assured that the lack of technological and demonstration tools in the faculty is the biggest obstacle, 35.2% of the answers chose the lack of collaboration with other engineering competencies as the main obstacle. Figure-6-. It's also worth mentioning that 72.1% also selected external and private condition as their main obstacle in their learning experience, these conditions differed from war and safety conditions, electricity shortage, lack of equipment, expensive fees of materials and printing....etc.

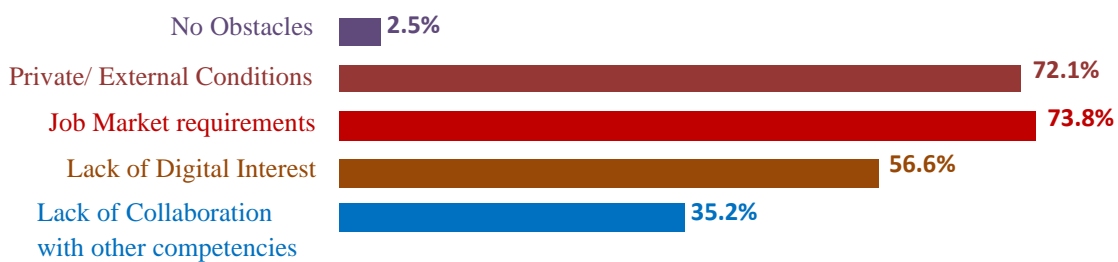


Figure-6: Bar chart/2/ represents votes for the third question

A follow up optional question was proposed to collect opinions and suggestions to improve the educational process in the faculty and here is a summarization of the top answers:

- Modify the curriculum and educational plan to prepare students for the job Market.
- Open extra courses within the faculty to teach students engineering programs (Revit, 3ds Max...etc.)
- provide the faculty's lab with the suitable numbers and quality of tools and equipment to meet students and teachers' needs for a better demonstration
- increase the number of the academic staff to match the huge number of students and prepare them to be able to teach students properly.

The third and final section was meant to measure students' knowledge and interest in Technology and BIM and here are the results:

### 6.4 Fourth question, working method:

The first question in this sector investigated the participants' favorable method of working 2.5% selected freehand drawings as the sole adopted way of working, meanwhile 18.9% chose digital designing software as their most suitable way, however, 78.7% declared that they use both methods. Figure-7-

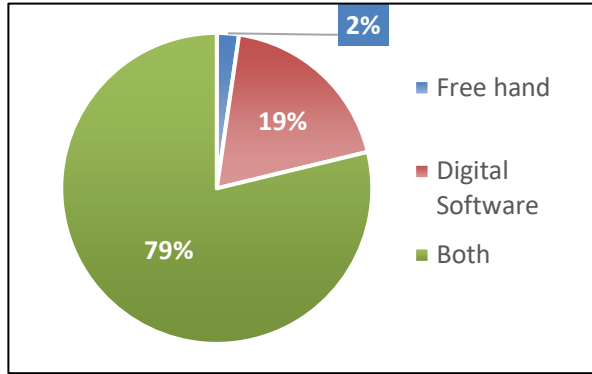


Figure-7- pie chart/3/ represents votes for the fourth question

**6.5 Fifth question, 2D Software**

The second question in this sector questioned the favorite 2d software program, a whopping 85.2% of the answers chose Autodesk AutoCAD as their go-to software, the rest of the answers showed 13.1% selecting another Autodesk software, Revit, meanwhile 0.8% of votes were dedicated to both Graf iSOFT's Archicad and SketchUp. Although Vectorworks was among available answers, 0 votes were given for this choice. Figure-8-

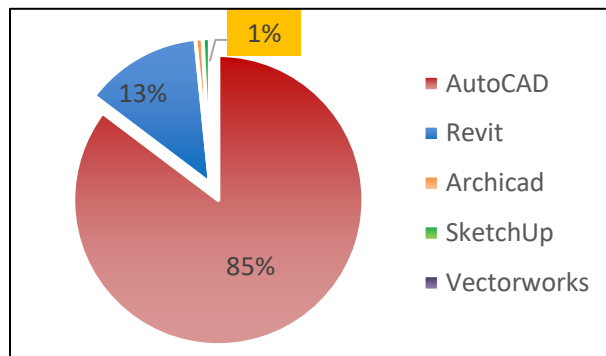


Figure-8- pie chart/4/ represents votes for the fifth question

**6.6 Sixth Question, 3D Software:**

The third question in this sector focused on the preferred 3d software, a vast majority of the answers 75.4% picked Autodesk 3dStudio Max as their primary software, 15.6% preferred Autodesk Revit, less than 10% chose other software, 2.5% voted for SketchUp, and a similar percentage vote for Archicad, and 4.1% still chose AutoCAD. Although Rhinoceros was among available answers, 0 votes were given for this choice. Figure-9-

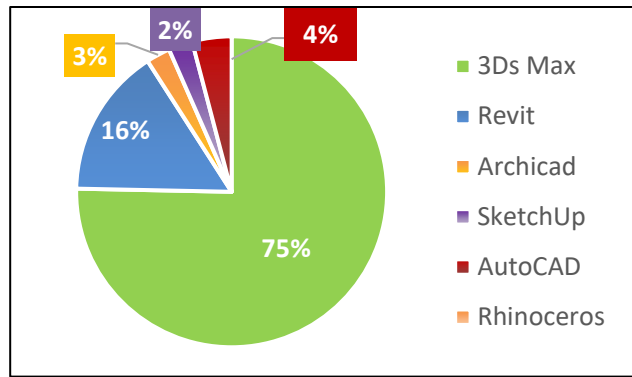


Figure-9- pie chart/5/ represents votes for sixth question

**6.7 Seventh Question, BIM Knowledge**

The 4th question in this sector was specifically proposed to measure the participants' overall knowledge of the BIM concept, surprisingly 9.8% said they've never heard of it, and 44.2% said they've heard of it but don't know much about it, 39.3% declared they are aware of the concept and its basics, meanwhile only 6.7% said they have a very good BIM knowledge and use it in their working process. Figure-10-

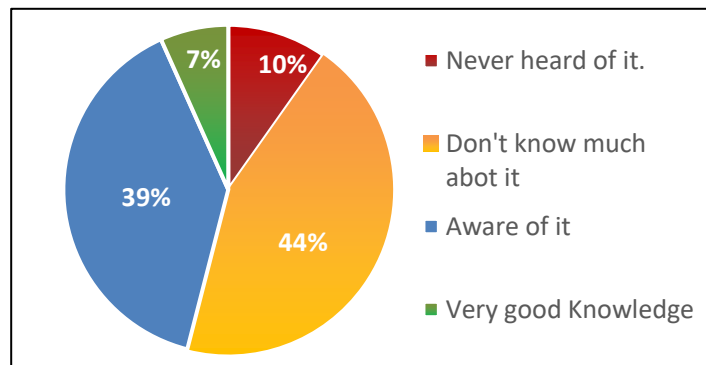


Figure-10- pie chart/6/ represents votes for the seventh question

**6.8 Eighth Question, Willingness to change:**

The 5th and final question in this sector investigated the participants interest in learning a new method that would save time and energy and capable of producing a better outcome, the importance of this question lies in exploring the intention and willingness to change in general, only 1.6% votes said they're ok with the current method and not keen on learning new ways. 59.4% approved learning a new method depending on its benefits and advantages, meanwhile 43.4% are sick of the current process and ready to move on and learn new methods. Figure-11-

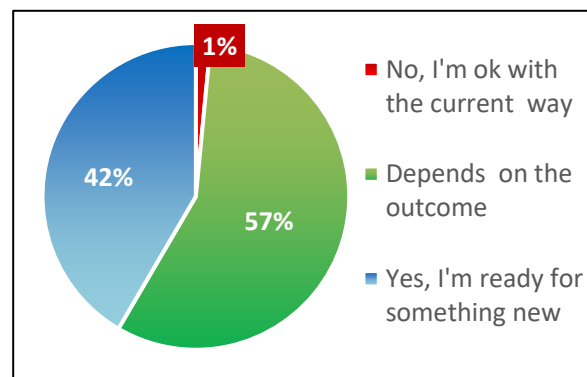


Figure-11- pie chart/7/ represents votes for the eighth question

## **7. Global examples and Practices on BIM Education.**

Many researches and studies discussed the importance of BIM in education on many levels and from different point of view, for example in Czech Republic, technical universities are facing misconceptions about the reality of BIM and its overall application, which is considered the biggest hurdle in its adoption. In addition, to the lack of availability of people with the knowledge to teach it as a new technology, not only to training students in BIM software.[3]

The same study also indicates that there is an increasing need for students, professionals, and engineers to not only know the big important role the BIM plays in the AEC industry, but more importantly, to be aware of the necessity to be trained in adopting BIM into their work environment.

-The University of Wyoming collaborated with Montana state university and Nebraska-Lincoln university to join students from 3 different disciplines (architecture- construction and engineering management) into teams that worked collaboratively over the 10-week term to produce a collaborative body of work. The main obstacles that faced this experience were first the extensive distance between the three universities which resulted in exhaustion and lack of communication especially because this experiment took place in the 2000s before the impressive technological development of online social media and other communicational devices. Another important obstacle was that all three disciplines played the role of an architect in the conceptual and schematic design. Which caused multiple conflicts and clashes that took a significant time of the project's schedule to solve. The project concluded that engineers and architects can't both play the role of an Architect.[4]

-The University of Wisconsin-Milwaukee created an IP/BIM studio that incorporated students from architecture and urban planning with industry professionals such as structural and mechanical engineers in order to achieve further integrated and collaborative experience. The project concluded that both students and professors agreed that the studio produced a faster, better and more integrated design.[4]

-Some other institutes in the United States offer important BIM courses and programs in construction management colleges, New Jersey Institute of Technology's BIM course covers principles and general practices of BIM and advanced studies in computer modeling systems Which are similar to the CAD and BIM for construction managers course presented by Oklahoma State University which covers 3D design and BIM software, estimating and management skills and producing accurate drawings.[5]

The BIMM master's program (building information modelling and management) at the Syrian Virtual University, has a major contribution to spreading BIM culture among Syrian Engineers [1]. Dedicated to architects, civil, mechanical, and electrical engineers, the program lasts for two years, 3 semesters of courses, and a graduation project, the course includes BIM-related courses like BIM Foundation, Successful Implementation, and others, and also includes management courses like Project Management, Quality Management, Contract Management, and others, the program's goal is to produce future BIM Managers in multiple competencies and interests.

## **8. The Proposed new architectural plan and curricula:**

We will divide this new plan into two sections, the first will include the suggested administrative modifications that needs to be done in order to create a BIM- friendly environment within the faculty and provide it with the required staff and types of equipment. And the second sector will present the new suggested curricula and syllabus with an extensive explanation for the suggested changes to the plan.

### **8.1 Administrative modifications required from the management of the faculty and university.**

- 1-Increase the academic staff numbers of teachers and professors in each department to match the increasing numbers of architecture students.
- 2-employ teachers according to their ability to teach the required courses and not just to fill the gap.
- 3- Improve and extend the faculty laboratory and increase the number of computers (currently 20 devices only) and search the ability to use the IT Engineering faculty lab's devices if possible.
- 4- Allow students to deliver projects in the 4<sup>th</sup> and the 5<sup>th</sup> year as a digital copy without printing them, as this would cut off some of the huge costs the architecture students have to pay.
- 5- create The Digital and technological training studio within the faculty monitored by the head management of the faculty, and provides digital and software help to both students and staff, and also launch multiple architectural software courses with affordable prices outside the official lectures time.
- 6- Replace the productive camp in the 4<sup>th</sup> year with a collaborative workshop that incorporates students of the faculty with other competencies students (civil, mechanical, and electrical) with professionals from the community with collaboration of the Engineers Syndicate in Homs to produce a BIM project with full collaboration between the students from all disciplines.

## 8.2 Modified Suggested Curricula:

The Green Highlighted fields indicate that this course is modified and relocated to a new year/semester, the Light blue indicates a new suggested course, the yellow color indicates light modification to the highlighted course, and the orange color indicates that the highlighted course is heavily modified. Also courses' priority was added to the suggested plan.

### 8.2.1 First Year's suggested Syllabus:

Table 6 :represents suggested modified syllabus of courses in first year at BU faculty of architecture.

Course	Abbreviation	Semester	Department	Prior
Architectural Design1	AD1	1&2	Architectural Design	-
Drawing and Modeling 1	DM1	1	Architectural Design	-
Ecology	ECO	1	Building and Execution Science.	-
Mathematics and mechanic	MM	1	Basic Science	-
Foreign language 1	E1/F1	1	/	-
Arabic	Arb	1	/	-
National studies	Nst	2	/	-
Drawing and Modeling 2	DM2	2	Architectural Design	DM1
Shadow and Perspective 1	SP1	2	Architectural Design	-
History of Architecture 1	His1	2	Theories and History of Architecture	-
Computer-Aided Design (1)	CAD	2	Architectural Design	-
Foreign Language 2	E2/F2	2	/	-

**8.2.2 Changes to First Year's Syllabus**

-Descriptive geometry is scratched as its concepts and ideas are demonstrated in SP1&2, and BU is the only university in Syria that still teaches this course in architecture program. Ecology (Environmental science) is rearranged from 5th year to freshmen, as it provides very important information that would aid students in understanding multiple designing concepts and ideas. The information in the course used to depend on theoretical lectures and 2d graphs and photos, BIM tools can provide a very proper way to demonstrate most ideas the course provides.

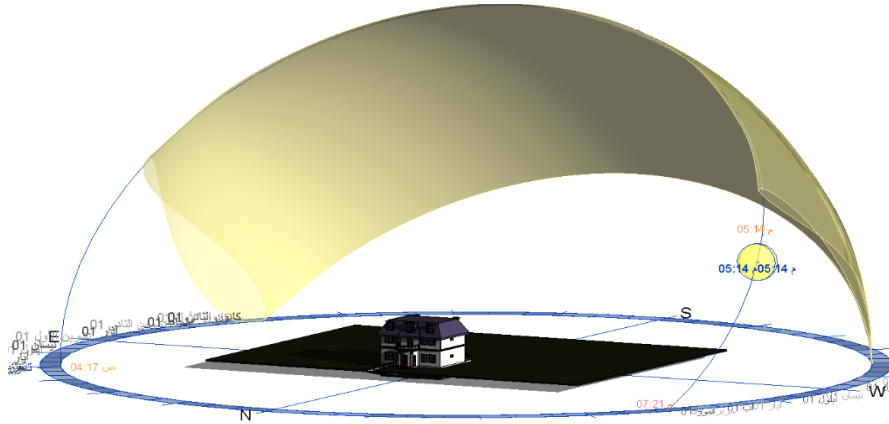


Figure-18: photo demonstrates sun path and shading using Autodesk Revit.

**8.2.3 Secon Year's Suggested Syllabus**

Table 7: represents suggested modified syllabus of courses in second year at BU faculty of architecture.

Course	Abbreviation	Semester	Department	Prior
Architectural Design2	AD2	1&2	Architectural Design	AD1
Modeling and Models	MoM	1	Architectural Design	DM2
Shadow and Perspective 2	SP2	1	Architectural Design	SP1
Introduction to BIM	BIM	1	Architectural Design	CAD
Architectural Construction 1	AC1	1	Building and Execution Science.	-
Foreign language 3	E3/F3	1	Basic Science	-
History of Architecture 2	His2	1	Theories and History of Architecture	-
Architectural Construction 2	AC2	2	Building and Execution Science.	AC1
Theories of Architecture 1	Th.A1	2	History and Theories of Architecture	-
Surveying Geometry	Sur	2	Building and Execution Science.	-
Resistance of Materials	RM	2	Structural Engineering	-
Foreign Language 4	E4/F4	2	Basic Science	-

### 8.2.4 Changes to Second Year's Syllabus:

Introduction to BIM replaces CAD2, as a new course that introduces the main theoretical principles of BIM and its importance, and other important aspects, a very helpful and similar course is being taught in a fellow governmental university, The Syrian Virtual University's Building Information Modeling and management master's program course "BIM Foundation" could provide a strong reference and scientific material, in practical section students are allowed to choose one of two BIM Software: Autodesk Revit or Graphisoft's Archicad, to experiment and practice the proper method of architectural BIM modeling.

### 8.2.5 Third Year's Suggested Syllabus:

Table 8: represents suggested modified syllabus of courses in third year at BU faculty of architecture.

Course	Abbreviation	Semester	Department	Prior
Architectural Design3	AD3	1&2	Architectural Design	AD2
Execution Designs1	ED1	1	Building and Execution Science.	AC2
Buildings and Equipment	MEP	1&2	Building and Execution Science.	-
Theories of City Planning	TCP	1	City Planning and Urban Planning.	-
History of Architecture 3	His3	1	Theories and History of Architecture	-
Constructions' Calculation	CC	1	Structural Engineering	-
Execution Designs 2	ED2	2	Building and Execution Science.	-
Landscape and Site Planning	Lnd	2	City Planning and Urban Planning.	Eco
Theories of Architecture 2	Th.A2	2	Theories and History of Architecture	-
Theories of Construction	Th.C	2	Structural Engineering	-

### 8.2.6 Changes to Third Year's Syllabus:

In AD3, students are introduced to more complex projects like commercial centers & malls, educational institutes and more, although the information given by professors are helpful, but it would be clearer and more interactive to view 3d BIM Models of similar projects, provide walkthroughs and multiple interactive drawings and videos that emphasizes the given information and drifts away from the old-fashioned 2d drawings that are commonly used in most architectural references and handbooks.

-MEP is redesigned to become more adaptive and collaborative course, the suggested plan gives a full calendar year for the course, in the first term students would learn the principles of Mechanical, Electrical, and Plumbing works the usually learn, and then a collaborative project of these 3 competencies is required as a final project for the course, usually students deliver 3 separated projects one for each domain, that used to require more time and effort from students and they're usually not aware of how these domains are integrated with each other. This plan suggests dedicating the final 5 lectures for the students with the professional teachers in the laboratory and help them to

model their project on the BIM software they've learnt in the past year, this would result to a better solution, bigger understanding, and would enhance students practical experience on the chosen BIM Software

-His3 course is very rich and exciting but as the rest of the courses in the program, still uses old fashioned demonstration methods of 2d drawings and pictures, applying more interactive videos and simulators from VR (Virtual Reality) would give a better explanation and allows students to visit these historical sites virtually.

-After ED1 and BIM, Students should be ready to deliver their projects in BIM models, in this course the biggest suggestion is to teach students how to illustrate the detailed designs, executional drawings and shop drawings using the chosen BIM software, floor plans with full dimensions, elevations and sections with annotations and callouts, doors, windows and materials schedules and other related drawings.

### 8.2.7 Fourth Year's Suggested Syllabus:

Table 9: represents suggested modified syllabus of courses in fourth year at BU faculty of architecture.

Course	Abbreviation	Semester	Department	Prior
Architectural Design4	AD4	1&2	Architectural Design	AD3
Execution Designs 3	ED3	1	Building's Execution Science.	ED2
City Planning 1	CP1	1	City Planning and Urban Planning.	Und
Reinforced Concrete	RF	1	Structural Engineering	-
Steel Structures.	SS	1	Structural Engineering	-
Urban Sociology	Soc	2	City Planning and Urban Planning.	-
Execution Designs 4	ED4	2	Building's Execution Science.	ED3
City Planning 2	CP2	2	City Planning and Urban Planning.	CP1
Interior Design and Decoration	In.D	2	Architectural Design	SP2
Regional Planning	RP	2	City Planning and Urban Planning.	-

### 8.2.8 Changes to Fourth Year's Syllabus:

-In AD4, students are introduced to a new and important concept (Sustainability and green buildings) and they usually receive theoretical information and left on their own to translate it into their projects, using BIM tools and software would present a more comprehensive way especially because sustainability is the 6<sup>th</sup> dimension of BIM, BIM software are designed for sustainable designs and can provide sustainable analysis easily and quickly saving students the time and effort and also helping professors and teachers delivering this concept clearly.

Another addition that is suggested to enrich this course is introducing Parametric design to students as its increasing use and importance in job market locally and globally, here as well we find BIM as the most powerful demonstrational tool in this domain. Previewing multiple parametric-based and organic buildings that were originally designed using BIM software enhances the visual memory to students and encourage them to adopt BIM software to model these kinds of projects.

- Reinforced Concrete 1&2 are combined into 1 course RF as the current course of RF2 doesn't really require much time and doesn't provide a lot of vital information for future architects and the important ones can be gathered in one course.

- Steel Structure teaches student how to calculate momentums, pressure and other calculations related to steel elements, meanwhile the main goal should be teaching students how to draw these trusses, beams and frames in detailed drawings showing the adopted connection method and where to use these kinds of structures. BIM software can do both, for example, students can learn how to create these frames and trusses and then see how this software calculate and create the required analysis, after students are introduced to this method, ED4 should be a steel structure project where students show all the abilities, they've got to create full steel structured project from floor plans to sections and detailed drawings.

-Interior Design is probably the most beloved course for students as they unleash their artistic flare and learn how to deal with materials and colors inside the various architectural spaces, the final project in this course is usually to decorate one of the previous AD4 projects, and so if the project is already modeled in any BIM software it would allow users to transform to internal design phase easily, using BIM tools also allows teachers to a better demonstration as it provides interactive 3d sections and section boxes, and is compatible with various rendering programs like V-Ray, Lumion, Enscape.... Etc.

- Regional Planning is changed from 5th to 4th year in order to make room for new courses added to the senior year, the regional planning course is heavily theoretical and lacks practical examples and tools and once again BIM software is a proper solution as it could preview pre-modeled site plans for multiple regions with the associated analysis.

- For City Planning 2, the suggestion here is to use more interactive 3d examples and videos, and that might be found in multiple BIM Software such as Revit, another important aspect here is that students are usually introduced to mountains and sloped lands in this course and Revit can demonstrate easily how this works

### 8.2.9 Fifth Year's Suggested Syllabus:

Table 10: represents suggested modified syllabus of courses in fourth year at BU faculty of architecture

Course	Abbreviation	semester	Department	Prior
Architectural Design 5	AD5	1	Architectural Design	AD5
City Planning 3	CP3	1	City Planning and Urban Planning.	CP2
Quantities and Specifications	QS	1	Building's Execution Science.	Th.C
Project Management	PM	1	Building's Execution Science.	-
Construction's Regulations	CR	1	Building's Execution Science.	-
Graduation Project	Grd	2	Architectural Design, City planning and Urban Planning, Buildings and execution science.	AD5/CP3

### **8.2.10 Changes to Fifth Year's Syllabus:**

- Two new courses are proposed to be added to the senior year's syllabus and these courses are Project Management and Construction Regulations, PM is a very important course for all engineers especially architects and future project managers, so it's important to learn the principles of management and how to integrate all the previous engineering knowledge to become a well-managed project, CR is another vital course that every engineer should learn as it prepares students to the job market in their country and informs them the legal restrictions of construction and building process.

- In AD 5 and CP3 the required modification is to keep using BIM tools as previewing and demonstrating methods as this would encourage students to continue using these programs throughout their graduation project which is basically a collaborative and integrated work between 3 or four students, so using BIM technology and software to fulfill this project would facilitate the process.

- QS is a very important course as well but it still teaches students to calculate areas and quantities in a very old fashioned way that no one uses today, as this method might not be precise especially in complicated and organic projects, using specific BIM software would give more accurate results, also adding specifications to materials, descriptions, comments, and many other data is available when using BIM software.

### **9. Acknowledgements:**

The Authors would like to address a special thanks to the Director of Quality Assurance Center at Al-Baath University, Professor Dr. Walid M. Sahyouni, for his valuable efforts contribution to finishing this research. We'd also thank all those who participated in the questionnaire for their time and thoughts they've shared from students and new graduates to teachers and professors.

### **10. Conclusion:**

Since digital and technological movement is taking over all the aspects and domains in our day and age the engineering aspect is no exception at all and BIM had already started to dominate the engineering and construction industry without showing any signs to slow down any time soon, but what's the point of transforming into this new concept without having the proficient staff apply its principles correctly? The only way to prepare future engineers for this working method is to introduce it to them in their undergraduate learning to raise their awareness and notify them about what's waiting for them in the job market.

Of course, the example we've previewed in this research for the faculty of architecture is not enough, because BIM requires all engineering competencies to work collaboratively and simultaneously, so we recommend:

-Set the suggested modified plan that was proposed in this research as a stepping stone towards wider adoption to BIM education in Syrian universities and share this experience with universities from all over the world.

-Encourage other engineering faculties(Civil and Construction, Electrical and Mechanical Engineering) to create similar plans.

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