

# Identifying the gap between practical and educational fields in the Egyptian AEC industry in the age of digitalization

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## 1. Abstract.

The adoption of digital technology has become an important requirement of the construction industry as a convenient to improve the industry efficiency to meet its increasing requirements Through the analysis of extant literature sources, it was found that BIM system is a very important technology to adapt the others, where most of these technologies need a project model to be adapted. also, it was found that, one of the most important obstacles facing the adaptation of digital technology, among others, lack of experts and lack of awareness. of its importance. Many studies emphasized the importance of including this technology in educational curricula to provide the market with a generation capable of achieving its requirements in the era of digitization. On the other hand, computer technology techniques have yet to be adapted by the industry in Egypt compared to developed countries, so the research aimed to evaluate the Egyptian education outputs according to the new requirements of industry. Also pave the way to connect the education and the market to a common point. To achieve that, the current situation has been studied through a literature review for each of construction market, and education institutes in Egypt and compared with their counterparts globally to form a comprehensive vision for this matter by studying the needs, challenges, and trends. The research emphasized the importance of developing the curriculums to keep pace with the challenges of digitization in the construction market. It also clarified the gap between the global and Egyptian situation in this regard. Finally, this research will help in orienting research -related to the development of education- towards the points that need to be studied and analyzed.

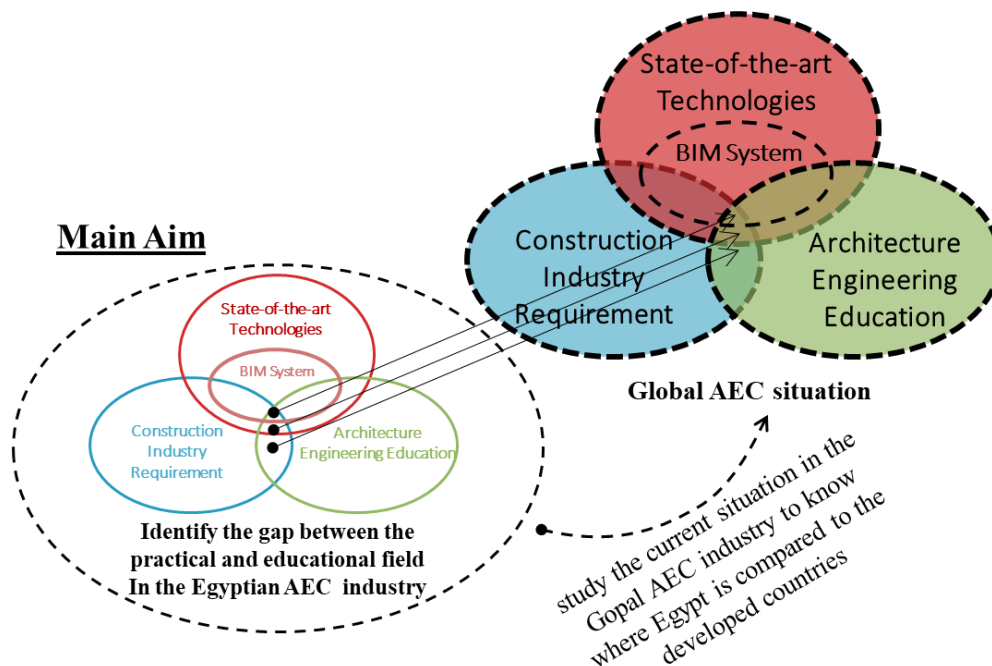
**Key Words:** AEC Practical Field, AEC Education, Curriculums Development, Digitalization, Egypt.

## 2. Introduction.

In the era of technology, the construction industry is witnessing a paradigm shift that tends to achieve higher productivity, efficiency, quality, sustainability, and value for infrastructure while reducing life cycle and time costs. Therefore, the state-of-the-art technologies adoption and implementation are on the rise due to the benefits associated with it during all phases of construction projects. Benefits have been reported, including life cycle data management, time saving, quality, productivity improvement, cost savings, and improved collaboration in current studies. And regarding the barriers, it was found that most crucial factors barriers hindering the adaption are "BIM is not included in educational curriculum", "lack of awareness", and "lack of experts and skilled personnel in BIM." Among other factors.[1]

**The problem:** On the other hand, although there is widespread agreement on the importance of integrating the state-of-the-art technologies in the Architectural Engineering and Construction (AEC) education, there is no agreement on how to carry out this task [2].

**The Aim:** So, this paper aimed to study the current situation of the construction practical field and the educational one in the context of the digital technology. Therefore, the research aimed to evaluate the Egyptian education outputs according to the new requirements of industry in the age of digitalization, all of that on the light of the current situation in the developed countries too, as a reference to know where Egypt is compared to the global situation, as shown in Fig 1. Also highlight some steps on the way of connecting the education and the market to a common point.

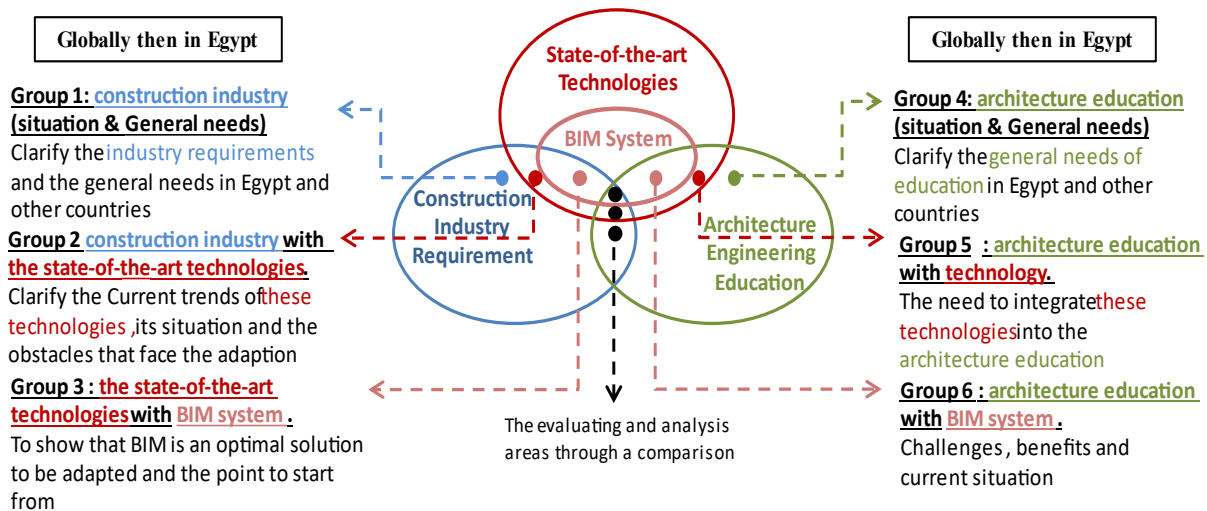


**Fig 1. Main aim and objectives of the paper**  
source: author

**The Hypothesis:** 1-the problem is that the architectural engineering education output doesn't meet the construction market requirements  
 2-if the technologies successfully integrated into the education curriculums and process, that would facilitate its adaption in the construction market

**The used methodology:** To achieve the aim , the current situation has been studied through a literature review for each of construction market, and education institutes in Egypt and compared with their counterparts globally to form a comprehensive vision for this matter by studying the needs, challenges, and trends. the researcher defined initial key words to gather related data to the topic the key words were Construction industry requirements, Architectural engineering education , State-of-the-art technologies , and After the initial search, the (BIM system integration with other technologies) was added to the keywords as a one of the technoloageies. as shown in **Fig 2**

81 research was collected related to these keywords and after examine them 35 was eliminated. So There were 46 research that have been added to the literature that were distributed over the keywords in two groups as it is shown in **Fig 2**. The firs group studed the construction markt matters generaly and withn the-state-of-the-art technologies glopally and localy (in Egypt). As so the second group but studing the architectural engineering education.



**Fig 2. the literature review main structure illustrated with its position in the key words' circles source: the author after extant literature sources**

### 3. Architecture engineering construction industry.

The construction sector is considered as one of the most important sectors of the global economy, so it is necessary to pay attention to studying how to develop it and improve its efficiency and productivity, especially in the age of technology, where it was found that the adoption of technologies has a positive impact not only on the construction sector, but on all sectors of the economy in developed and developing countries on the Both.[3].

### **3.1. The industry current trends worldwide**

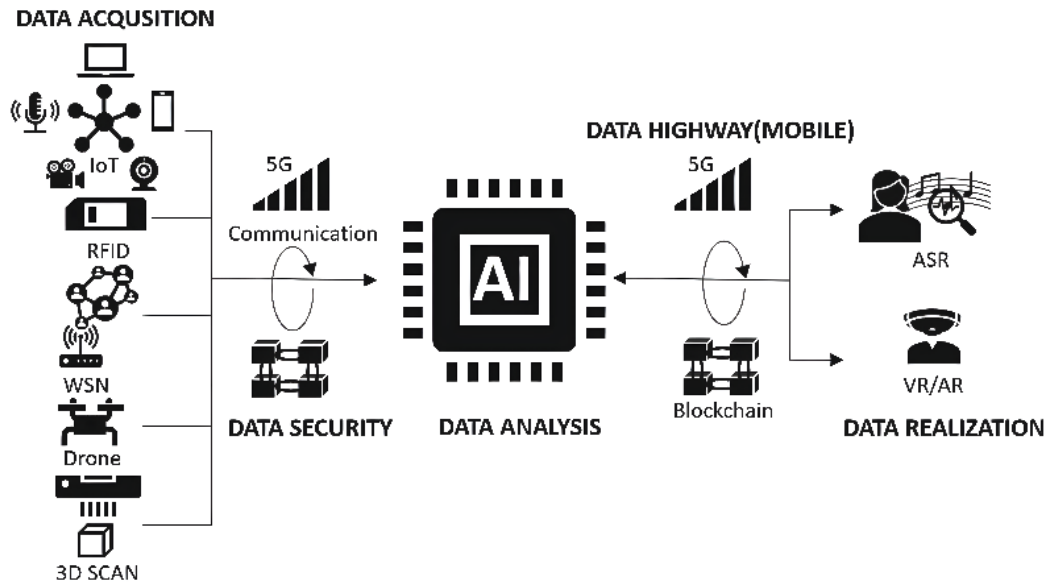
in this part the researcher clarified the current situation of the construction industry worldwide needs and requirement. that led the literature to the latest technologies used in the AEC industry, to present it and its situation of adoption and implementation as the most significant requirement. through that the literature focused on the importance of BIM, so the paper focused on this area in the literature review.

#### **3.1.1. The AEC industry Situation, Needs and requirements**

In the era of technology, the construction industry is recently undergoing a paradigm shift that tends to achieve higher productivity, efficiency, quality, sustainability, and value for infrastructure while reducing life cycle and time costs. Therefore, the state-of-the-art technologies adoption and implementation are on the rise due to the benefits associated with it during the design, construction, and commissioning phase of construction projects. Benefits have been reported, including life cycle data management, time saving, quality, productivity improvement, cost savings, and improved collaboration in current studies.[4][5]. so, in this paper the-state-of-the-art-technologies in AEC field will be focused on in the next point.

#### **3.1.2. The state-of-the-art-technologies in AEC field**

Adapting the digital technologies will has a positive impact on all income sectors like education, medicine, agriculture, energy, and especially the construction sector, as one of the most significant one of them, Etc.[3]. so, there are the researchers tried to study these technologies, its benefits, and the obstacles facing the adaption to find optimal solutions and best practices for these technologies. Woo & other presented an overview of the state-of-the-art-technologies and the expected impact from implement on the construction industry performance. through reviewing the literature related to the construction industry technologies they collected the most common technologies that are used in the construction industry as follow: blockchain, internet of things (IOT), augmented reality (AR), virtual reality (VR), machine learning (ML), robotics, speech recognition technology, 3D laser scanning, drones, robots, 5G communication technologies, and radio frequency identification (RFID).as shown in Fig 3 they summarized the applications of each of these technology in the CEA industry and its benefits. and they found that despite the agreement on the importance of those technologies it is stagnant to be integrated in the AEC industry projects and procedures[4]. many researchers agreed with that as they pointed out the lack of the BIM implementation in the actual practice of the AEC industry as a one of the most important technologies that is required [6],[7].



**Fig 3.Overview of the-state-of-the-art-technologies in the AEC industry [4]**

also, Shafiq & Afzal studied the awareness, potential, and barriers of these technologies in gulf cooperation council countries to enhance the job-site safety. they found that, "lack of knowledge about these technologies" and "lack of knowledge about its return investment" are the most significant barriers of its adaption. Finally, they pointed out the importance of the cooperation of the industry, education, and government sectors to achieve the best way for adopting these technologies.[8]

many researches emphasized the importance of education curriculums review and integrate these required technologies into it as lack of expertise within the organizations and the projects team were obviously considered as one of the most common obstacles facing the adaption among other like the highly cost ,cultural barriers ,and inadequate government policies [4],[5] [6], [7] ,[9]. But on the other hand, Considering the cultural barriers some other researchers thought that changing the culture of building and construction is not the solution also emphasized the importance of understanding the industry existing patterns, especially within the contexts of existing priorities and values in order to better cope with changes and make the transition to digitalized construction easier [10], and some other researches agreed with them as [11]. the studies illustrated that Building information modeling (BIM) is the most integrated digital technology with all other one in the AEC industry and emphasize the importance to implement it as a significant step to adapt the other technologies. but there are still many problems to achieve that. [3] [5] [12]

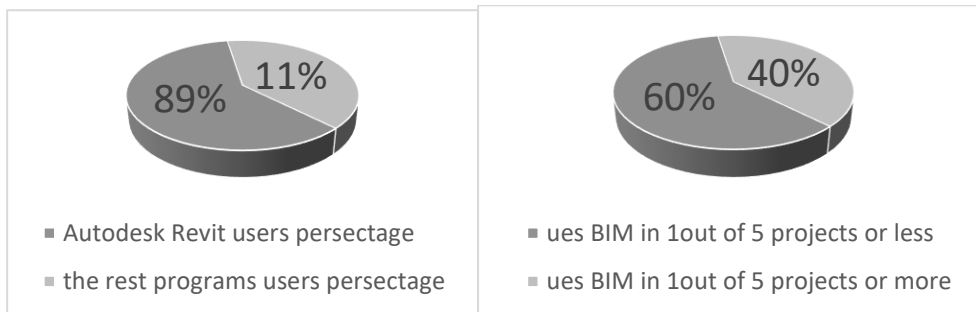
### **3.1.3. The situation of BIM adoption and its integration with the latest technologies.**

Through the previous literature review BIM system implementation is the optimal way to adapt the construction digital technologies. as it can be integrated with most of these technologies, and it considered a base of the digital technology's adaption.so we could find many studies aimed to integrate BIM with different technologies to achieve many different targets under one utmost aim that is improve the performance and efficiency of the AEC industry. for instance ,BIM integration with radio

frequency identification (RFID), augmented and virtual reality technologies (AR,VR), internet of things (IOT), BIM integration with(GIS), and BIM integration with laser scanning, etc.[5]

finally, as an expected result some researchers studied the current situation of implementing BIM in the AEC industry worldwide. The latest research was by Rocha and Mateus they pointed out that the global adaption of BIM has increased annually parallel with the demands for professionals. The most cited digital tools directed to BIM system was Autodesk Revit by percentage of 89.3% as shown in **Fig 2** and the supported tools were Autodesk Recap by 71% and Autodesk AutoCAD by 51.9%. the professionals that indicated that the use of BIM into the project is only 1 out of 5 projects present 60% from all respondents and they attributed this to the incorporating of the BIM in their country, which is still happening with hesitation. the rest of the respondent that present 40% indicated that projects used BIM into the project by 3 out of 5. as shown in **Fig 3**

the most significant countries were united states US by 53% as the heist percentage, followed by United Kingdom UK by 42% and Australia by 40% and the rest of country present only 25% that use BIM into more than 3 projects out of 5. Based on this study it can be said that BIM adaption is on its way to globally adaption as it has a quiet high percentage of implementation in the developed countries but on the other hand it is still in its initial phase in the developing country.[13]



**Fig 4.the percentage of using Autodesk Revit to the other tools**

**Fig 5.the percentage of using BIM Source: [13]**

Saka and Chan found out in their review about the BIM researches in Africa that there is lack of BIM adaption, framework, implementation, and guides in the, projects, organizations, industry level in most of countries AEC industry on the continent they also clarify the barriers which led to that delay in the adoption as lack of training, awareness, and professionals among other barriers so, there is still many challenges to achieve the globally adaption and there is still significant need for more researches. [1] And regarding the solutions Nenad & Rebolj illustrated that providing a plan to be followed to adopt the suitable culture all over the world that would lead to the best way of BIM-based working is not applicable. also imposing the adoption of BIM by law without a systematic study would lead companies to create BIM models for project just to meet the conditions without even using it in the project actual work.

So the understanding of industry existing patterns, is required in order to better cope with changes and make the transition to BIM-based construction easier [10].

### **3.2. The industry situation in Egypt.**

After studying the AEC industry globally utmost targets, general needs, and the requirements. That focused on the-state-of-the-art-technologies, its adaptation situation, obstacles that facing it as it was emphasized that BIM is considered as the base point to adapt the other technologies. So, in the next part through the gathered literature the same points were studied but in Egypt, the construction needs, and requirements towards the fresh graduates and the education sector. And clarified the current BIM practices in Egypt and the barriers of adaptation.

#### **3.2.1. the AEC industry Current trends and needs in Egypt.**

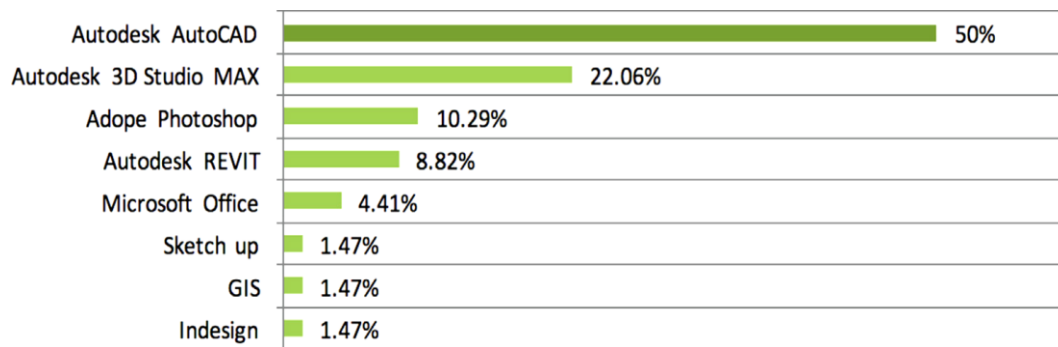
As the global AEC industry, the Egyptian one also considers as an important sector in the national economy. so there is critical need to develop the AEC industry in Egypt to meet its requirements by improving its performance and increase the productivity which lead to enhance the national economy among so many other benefits[14]. and to achieve that utmost target it requires some important steps in the way of development like adapting the digital technologies. on the other hand Egypt is one of the countries facing the challenge of not adopting technology and computer visualization techniques among stakeholders, so the construction industry doesn't cope with the rapid development in the construction management and processes like the developed countries.[15, 16] so on the light of that, many researches illustrating the importance to adapt the technologies especially BIM system. As it considered one of the most important technologies on the way of adapting digitalization. [17, 18]

#### **3.2.2. The fresh graduate performance and requirements in Egypt.**

The human resources play a significant role in all sectors as far as the construction one. And as it was illustrated the AEC industry lean towards the digital technologies.so there is a critical need to develop the curriculums to meet the requirement of the construction market by Providing graduates with the required qualifications. as so the studies agreed with that orientation towards the education process as it plays a vital role in developing the industry performance. [17, 19-22] so, it was obvious to study the architects, engineers' interests, and study what the AEC have expected them to produce. So, by studying the literature it was found that most of fresh graduates' purpose of learning computer application is improving their work field and qualifications rather than being interested in new trends.[19] farther more, many researches (like the global one) , emphasized the importance of collaborating the world of construction industry with the academic one and working together to establish a partnership to transfer knowledge through research, education, and consulting teams.[23-25]

### 3.2.3. The state-of-the-art-technologies that are used in Egypt

Through searching the literature of technologies in Egypt it was noticed that a many construction technology researches in Egypt is related to BIM system and its benefits, also there is lack of integration of BIM with other technologies in the industry practice.[22] However, there are researchers that dealt with the integration of BIM with other technologies. For instance, Khodeir & Nessim under an utmost aim that was providing buildings cope with updates in environmental policies. They found that BIM2BEM integrated approach required the readiness of the industry[21].Also, Ghareeb & others studied the adoption of robots in the construction industry. They mentioned that one of the encouragements for its adoption is that the application of BIM is increasing in Egypt, as BIM represents an important base for robots' adoption. [26] so and depending on the literature the used technology in the Egyptian AEC industry is limited to the well-known programs and the basic one in this field as shown in Fig 6, apart from the modern technologies used globally. [19]



**Fig 6. The most used computer application (software) Source: [19]**

### 3.2.4. BIM system implementation situation in Egypt

BIM system was proposed as an interesting tool for the design, project, construction and maintenance of new buildings and constructed buildings. Its use allows optimizing structures, controlling costs, ensuring safety, minimizing environmental impact, and rehabilitating heritage, among other aspects. It can also be integrated with the mentioned technologies in BIM adaption level 3 as a base tool and essential model that contains all the information about the building.[2] Therefore, the researchers are interested in studying how to apply BIM and the obstacles facing its adoption and presenting proposals to lead the construction industry towards its adoption. but even so, a practical strategy for implementing BIM in Egypt is still not available although several frameworks have been proposed to assist in the implementation of BIM [17] [22]. Also, the current market scope studies ignore the non-software aspects of BIM adoption, and do not identify market gaps or reflect market-specific standards. As such, it cannot be used by policy makers to facilitate BIM deployment[22].



Regarding the current percentage of adaptation through the market practices. Elyamany through his survey, mentioned that only 48% of the participants were using 2D AND 3D BIM modeling on projects. while the percentage of the respondents on survey was only 17% which may be because the majority of construction practitioner know little about BIM. [27].as so Taher & Elbeltagi agreed with that. where the percentage of participants who applied BIM as a part of their work was 69% and who have an experience of 5 years in using BIM presented 74%. But by Looking at the questionnaire, we will find that it was distributed to large construction companies in Egypt, and companies that use BIM and apply value engineering. which led to the fact that the high rates of evaluating the status of BIM in Egypt are inaccurate, as the sample was not random one. [15] The findings of Abdelbary & other questionnaire confirmed that, where the percentage decreased to 27% who use the BIM sometimes, 2% who use it always, and 71% who never use it. [16] but on the other hand, there is a very good diffusion of BIM in the Egyptian market but there is a lack of understanding the implementation aspects [20]. And regarding the most common tool of BIM, it was found that it is Autodesk Revit as the international situation.

[21] They attributed the motivation of adopting BIM in the Egyptian market to the practitioners' knowledge of the benefits of BIM, which include saving time, reducing cost, and increasing efficiency. Contrary to [27] he referred the implementation desire to the increasing in the demand on the BIM in the international projects and because of client requirements . but [22] combined the two reasons in analyzing the results of his survey in the Egyptian market.

finally, most of the research that studied the situation of BIM adaption concluded that BIM adaption still in an early stage on its way towards the adaptation. And the significant factors affecting that are " Lack of regulations and government support", "lack of awareness", and "lack of experts and skilled persons in BIM." Among other factors. And one of the most important steps that lead to the adoption of BIM is the integration of government, education, and market practices with each other. And there is still need to conduct more and more researches are needed to study the BIM implementation approaches. [22], [21], [27] [17]

#### **4. Architectural engineering education**

Undergraduate education in Egypt, (like the globally one), aims to provide qualified graduates who can support the growth of the country. so, they must be helped to find their inner compass, develop their professional skills, and ethical attitudes to think independently to make a difference in their community. [28] therefore, the studies have focused on evaluating the situation of education and its tools and curriculums, to determine how fare the education meet the AEC market requirement and trying to provide solutions to produce a generation of graduates capable of achieving the requirements of the professional field. Some studies turned to studying and analyzing the profession market, as what was presented in the construction industry part, to find

out its requirements, and others turned to studying how to achieve these requirements through education like the up-coming one.

#### **4.1 Architecture engineering education worldwide**

In this part the current situation of the architecture engineering education and its targets was discussed to find out how it can be achieved. and as it clarified in the previous part, the AEC industry moving towards digitalization so the integration of these technologies into the curriculums was studied and its application in educational process. And since BIM was classified as the most important of this technology and the first to apply as a step to adopt the applications of these modern technologies as it mentioned in the previous part, the current situation for its teaching and the methods used for that globally were be focused on in this literature review.

##### **4.1.1 The education Current situation, aims, and general needs worldwide.**

the main educational institutes aim is to provide qualified graduates who can support the growth of the country. They should help them find their inner compass, develop their professional skills, and ethical attitudes to think independently and make a difference in their society. [28] [29] [9] however, it was found that the structure of architectural education don't match the innovative challenges and social demands of architect in the digital age [9] . So, the studies focused on the education needs to answer this question how could the education process be improved and developed? to answer this question the AEC industry had to be studied. So there is a critical need to study the construction market requirements also to emphasize the importance of the collaboration between the practical field and the educational one in order to improve the education process to provide qualified graduates.[8] farther more it was called for involving the students in the goals of the educational process towards society by understanding their ideas, communicating with them, knowing their perceptions about the future, and letting them know that they are not just called into cause, but they are the promoter of the cause itself. [29]

and regarding the education process it was recommended to change the traditional one through many ideas that make the student share in the partitional practice as a part of the educational system like students' club, Boot camps etc. as so [28, 30-33] also it was illustrated there is critical need to adapt the digital technologies in the AEC industry practices as it is moving in its way to the digitalization. so many researches agreed with the importance of the educational role to achieve that utmost target [7] [4, 5] so and based on that raise the importance of digital technologies inclusion into the education process and curriculums was raised . [34] [32] [35]

##### **4.1.2 The-state-of-the-art-technologies situation in the education**

After illustrating the importance of the technology's adaptation into the education, which are not enough to cover upcoming generation needs who were born and grew

in the digital age. [36] and illustrating that the structure of architectural education doesn't match the current challenges and social demands of that age architects [9] so it became necessary to study the-state-of-the-art technologies implementation situation, determine the benefit from implement them, their requirements, and the obstacles facing the implementation.

By studying the application of many technologies like blockchain, internet of things (IOT), augmented reality (AR), virtual reality (VR), machine learning (ML), robotics, Holograms, Wearable Devices, 3D laser scanning, drones, and robots. It was found that technologies have a significant important as a tool in educational institute hands that facilitate in gathering data and sharing it. Also, the educational process would be exiting, and the students will not recognize that they are learning. also, it would enhance the educational process.[28]

also, some studies presented project-based learning and video-based learning as an effective new method that helps in inspire the students' motivation to learn a new technology. but on the other hand, they expected in somehow the interaction between the instructor and student would be decreased. Therefore, they emphasized on the importance of the extra instructors' effort tracking the learning progress of every student. to achieve that, some of the difficulties facing adoption must be overcome. Like training in the use of the adapted technologies is necessary for professors, students, and staff if it is adapted. Besides, special adjustments in infrastructure and networks are needed, which is a challenge for some organizations, and university especially in developing countries [37, 38]. Also, the culture resistance was illustrated as significant barrier. Therefore, so the researches emphasized the importance of the descriptive research exploring the varies ways that facilitate the culture evolution in architectural education, that would play an important role in the integration of the required technologies.[9]

#### **4.1.3 BIM education situation**

As it was clarified, BIM as a technology play a significant role in the practical field, which reflected by necessity on the educational one. Therefore, it became important to study and evaluate the current situation of BIM teaching in the faculties of AEC. In this regard R. Sacks noticed that although the critical need to integrate BIM in the undergraduate education, the market doesn't have a specific form of what is needed [2] he found out that BIM is limited to single discipline in 90% of cases. . And regarding that some researches emphasized the importance of transform the direction from the single course level to the curriculum level involving BIM-standalone and BIM-embedded courses [35] [39] Therefore, he proposed a frame work for BIM education, as the course should focus on BIM basics in the first years represents the junior, for senior-year courses should incorporate BIM aspects as a part of generic engineering and management course, and for the graduate level BIM should focus on collaboration aspects and management across organizations and projects. Finally, he

expected BIM education will enhance the students learning, due to the clear visualization. [40]

Yilei presented the existing BIM adaption approaches and identified the challenges facing the implementation process. for the approaches, it was found that it is divided into four directions, which are: standalone course, cross-discipline courses, project course, and integration into existing courses he attributed most of the problems to faculty, students, and resources of CM programs, which represented in some barriers as follow:

1. lack of facilities that is available to teach BIM.
2. the students do not have the desire or willingness to learn BIM, also the facilities do not have the interest.
3. the curriculums are full enough leaving no room for new BIM courses.
4. there is no inconsistent expectation of BIM skills of the graduates, which represent one of the challenges prevented AEC programs to introducing BIM in the curriculums.
5. Lack of textbooks, tutorials, or models to teach BIM. [41]

Although the studies still study the advantages, disadvantages, drivers, and barriers of BIM education some studies went farther to study the remote teaching of BIM as an online course. Tsai and others aimed to produce a new BIM course integrating the project-based learning and videos-based learning, filling the gap between modern technology and the traditional teaching methods. They emphasized the importance of educate the student the entire BIM workflow not only modeling work, which requires the collaboration of experts from a variety of fields and integrate them into curriculums, as that is important for effectively integration. They found out that integrating project-based learning and video-based learning into the BIM education have many advantages many benefits would be observed in case the effectively applying it. As the student can be free to allocate their study time and understand the BIM prosses more effectively. They still thought that helping students learn BIM tools and cultivate BIM experiences before entering the industry remains unsolved [37]. Boton continued in the same path after the pandemic of Covid-19, as he evaluated the way in which students perceive the issues associated with online BIM learning. he illustrated the necessity of using BIM collaboration platform that would facilitate the collaboration of students into the context of practical work. And the necessity of using distance education in the universities in several industries, especially after the pandemic. [39]

## 4.2 Architectural engineering education in Egypt.

Like global education, the local one tried to produce generations that can fulfill the requirements of the professional field, but it was found that there is a gap between it and global education. Although there are already some problems in education globally. That are being studied to be solved. Therefore, in this part, the current situation was studied through the state-of-the-art technologies, as we illustrated the importance of technology in the previous parts. Therefore, in this part, the analysis and study of how to adopt it in the local educational process.

### 4.2.1 The AEC education current curriculums, situation, and needs in Egypt.

Despite the education sector efforts to keep pace with the requirements of the construction market requirements, there is still a gap between AEC education and the requirements of the profession market[25] one of the obstacles facing the improvement of the education, is there are institutes of architectural education still used traditional methods that no longer fitting the digital age or modern learner. [42]. Therefore, the studies have focused on evaluating the situation of education, its tools, and curriculums, to determine the causes of the problem and trying to provide solutions to produce a generation of graduates capable of achieving the requirements of the profession field.

In that regard, Elsafty and others conclude the stakeholders' requisites towards the engineering education in Egypt as follow. 1.integrate modern innovative teaching methods. 2. Soft skills training. 3.modern software applications training. 4. Practical technical or industrial training. [43] That help student to practice the profession effectively after graduation [42] [25].

Khodeir and Nessim evaluate the architectural education within the context of the construction market requirements to cover the gap between them., they presented their suggestion into two group to overcome the gab. The first one was internal suggestions as follow 1. Changing in courses contents 2. Changing in acquired skills by embedding 21st century skills that were not totally considered in all courses 3. Applying effective teaching strategies 4. Changing the nature of Coursework. And the second one was External suggested actions as follow 1. Increasing the number of the site visits. 2.Organizing academic activities and events (guest lectures/career orientation). 3.Increasing internship duration to be one semester instead few weeks 4. Collaborating with the industry by activating the industrial link committee 5. Training the trainers and providing Continuous Professional Development. [44] by Looking at these suggestions, it was noticed that they combined most of the suggestions that were presented in the rest mentioned research to improve educational performance.

By studying the literature, other suggestions were found like improving laboratories and the possibilities available to students, increasing the qualifications of the teaching staff, and trying to involve labor market specialists in developing and defining the skills that the architect need it in the labor market[24]. also, Involving the architectural offices and companies in drawing up lists of skills and knowledge needed in the market. These skills and knowledge could be part of the guidelines on which architectural curriculum developers depend. [23]

in addition to evaluating the university staff member performance and filling the gap between the proportion of student to the staff members also modify the imbalance in the hierarchy of staff members. But in that regard, it was illustrated that the negatively effect of the too many responsibilities, tasks, and roles that is entrusted to them. Also, the importance of encourage students to criticize and express their opinion and spreading the spirit of democracy away from tyranny. As a step towards overcoming the gap between the academic and profession field. [31]

Hanna illustrated the benefits of using (MAR) on the education, teaching, and learning. that were, improve the students' performance and skills and create an attractive learning environment at low cost. She also presented the challenges that facing the integration into two group as follow:

group A peoples' challenges: 1.the educators busy schedule and their many tasks. 2.insuffisient conviction. 3. The lack of teachers who are familiar enough with computer skills. 4. Lack availability of professional human resources in MAR technology who assist the educators and students.

Group B technical and financial challenges: 1.the burden financial required from the governmental university to provide the necessary infrastructure of wireless network. 2. The MAR technologies' heavy reliance on wireless network.[42]

And regarding the needed architectural programs like Revit, and 3D Max etc. it was found through the [19] Soliman & others survey that ,the responce were familiar with cad by percentage of 95%, 3D Max by 69%, PS by 87%, and Revit by 46%. from the undergraduate curriculum. She attributed that to the not integrated computer modules with each other so she emphasized the need to develop the curriculum to be integrated type instead of stand-along course problems. [19] El-Darwish also emphasized that, as she illustrated that 75% of computer module in Egyptian universities are not fully integrated with other. [45]

#### **4.2.2 The-state-of-the-art-technology education situation in the Egyptian universities**

Most of the research unanimously agreed on the importance of developing architectural education and study curricula to keep path with the construction industry requirements, by producing a generation with qualifications that cover these requirements. And as we have clarified globally and in Egypt, adopting the teaching

of modern technologies within the school curricula in an integrated manner, is one of the most important steps that must be followed to improve the skills of graduates in the age of technology. [17, 19-22] to achieve that it was recommended some points as follow to integrate computational tools successfully: 1. Support the arch education with several types of laboratories

2. Survey the market requirements to insert all integrated domains always and update the curricula to meet the technology development 3. The study years should be 5 years 4. Enhancing instructors' capability. [45]

Shaimaa also emphasized the importance of integration digital techniques into the education and the importance of keeping up the rapid technological evolution in all fields, visualization, simulation programs, building physics, and building technology [46]. Not only that, but also emphasized the importance of integrating manual and digital techniques Poth together in architectural education, and as she illustrated that all education stakeholders agreed on that.[31]

she proposed an educational model with different techniques and software distributed between courses and core modules in architecture as shown in Fig 7. also, the visualization software has been divided into two groups: the first is the group of building information modeling which concentrate on design thinking, simulation, modeling, and visualization tool. represented in (Revit, Navisworks, Dynamo studio) the second is the group of modeling, drafting. represented in (3D Max studio, V-Ray, Rhinoceros)

Hanna aimed to pave the way for architecture instructors and head of department to use the visualization software in a better way in different courses and programs. she proposed an educational model with different techniques and software distributed between courses and core modules in architecture. also, the visualization software has been divided into two groups: the first is the group of building information modeling which concentrate on design thinking, simulation, modeling, and visualization tool. represented in (Revit, Navisworks, Dynamo studio) the second is the group of modeling, drafting. represented in (3D Max studio, V-Ray, Rhinoceros). [42]

#### **4.1.1 BIM education situation in Egypt.**

The researcher noticed through gathering data that there is only one research that talk about BIM education in Egypt although the importance of integrating it in the curriculums as it was clarified. which emphasized the lack of research related to this matter in Egypt so more research is required studying the drivers, barriers, and current situation of BIM education in Egypt.

Issa noticed that most of the curricula in university architectural education in Egypt, focus on the teaching of technology computer-aided design (CAD) and little or no focus on BIM technology education. As a result, most architecture graduates In Egypt, they do not have enough knowledge or skill in using BIM technology, which creates a huge gap between academic circles and the construction industry in Egypt.

Module of Architecture Education	Level 1 / Year 1	Level 2 / Year 2	Level 3 / Year 3	Level 4 / Year 4	Proposing Visualization Techniques
Visual Training and Basis for Design					Manual
					Digital
					Soft ware
					VR
Theories of Architecture					Manual
					Digital
		Photoshop			Soft ware
					VR
History of Architecture					Manual
					Digital
					Soft ware
					VR
Environmental Analysis & Building Physics					Manual
					Digital
		Ecotect	Design Builder	Envi-met	Soft ware
					VR
Design Studios					Manual
					Digital
	AutoCAD/ sketch up	3DS Max®	V-Ray	Grasshopper	Soft ware
					VR
Building Construction					Manual
					Digital
		REVIT			Soft ware
					VR
Execution & Working Drawings					Manual
					Digital
			NAVISWORKS	DYNMO STUDIO	Soft ware
					VR
Urban Dimension					Manual
					Digital
		AutoCAD	GIS	GIS	Soft ware
					VR
Graduation Project					Manual
					Digital
					Soft ware
					VR
<b>Key</b>					
Not apply to this course	Not apply to this level	Manual techniques	Digital techniques	Indicating software	VR/ AR

Fig 7. framework for visualization techniques’ adaption into architectural education source: [46]

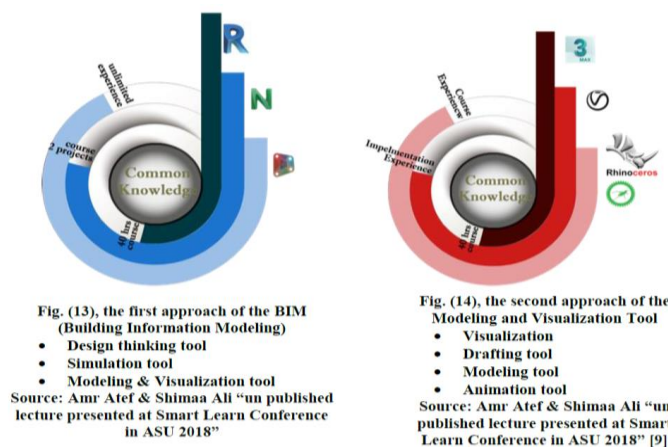


Fig 8. Adaptation approaches for the technologies that were separated into two groups source: [46]



So, she Aimed to formulate an approach to integrate BIM technology effectively in the architectural education in Egypt by analyzing and comparing the current situation of teaching (BIM) in the architectural education in public and privet Egyptian university. She emphasized the significant role that the academic institutions play in transforming into the next generation of BIM experts that leads to reduce the skills shortage. Also, she found out that there was a gap between the global and Egyptian according to the executive experiences in most of the global different levels of education (pre-intermediate- advanced) contrary to the situation in Egypt that teach only the idea of BIM technology and the basics of modeling through an independent course. She emphasized that, The process of integrating BIM technology into the architectural education curricula in Egypt will not be an easy process, as there are many Constraints and obstacles Therefore, it is necessary to gradually apply the proposed methodology to integrate BIM into the curriculums, and Providing a website that presents the experiences of Egyptian universities in teaching BIM technology in programs Education (AEC), research, academic studies and conferences conducted in this field. [23]

## **5. Findings and results.**

Through studding and analyzing the related literature it was found that there are some recurring results and requirements in the research, which were illustrated and emphasized by many researchers Either globally or locally in Egypt. as follows:

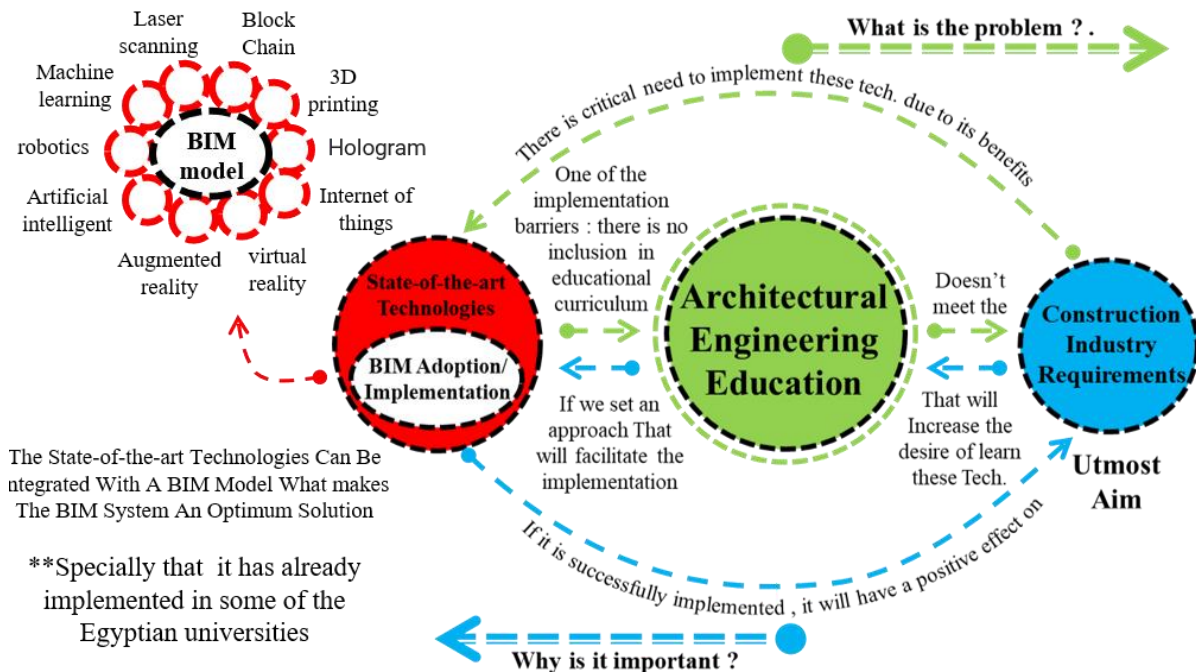
### 1. points related to the architectural engineering education

- The importance of change the traditional education process by the digitized one
- The critical need to collaborate Poth of the educational institutes and the construction firms to improve the education process to meet the market demands
- BIM adaptation in the education process as a tool is important to adapt different technologies as far as including it into the curriculums as a subject
- Budget remains to be a challenge to adapt modern technologies at most universities
- special infrastructural and network adjustments are needed, which are challenging for some organizations, especially in developing countries.
- Contrary to the local construction industry related research, it was found that most of the studies were about the technologies in general and its importance to be adapted by the education process itself or the education curriculums.
- the-state-of-the-art technologies have two orientations in the educational research. As some studies were oriented towards the technologies as a tool to be used in the education process itself and the other some oriented towards these technologies as an integrated curriculums into the education

2. points related to the construction industry researches

- Construction industry is moving towards the digitalization due to its benefits and it is important to deal with that shift.
- BIM is the most popular and required technology in the construction market. but still needs studies on how the firms can implement it efficiency.
- BIM not only can be integrated with many technologies, but also important for adapting most of the construction technology.
- Construction industry is in a critical need to enhance the education system and curricula to keep with the market needs.
- Including the BIM education into the curriculums is important to provide BIM experts to solve one of the obstacles facing the implementation at all BIM levels.
- most of the studies related to the state-of-the-art technology in Egypt were about BIM either stand alone or integrated with other technologies contrary to the global situation there were balance in the different technologies research and the BIM system one.

finally, through analyzing the common findings and recommendations the problem of the research can be stated as shown in Fig 9 the problem started with not meeting the construction market requirements with architectural engineering education output.



**Fig 9. The research problem statement and the positive effect of solving it**

As the construction market is in a critical need to implement and adapt the different technologies due to its benefits regarding the efficiency and productivity enhancing especially the BIM system as it can integrate with most of these technologies, but it

was found that although the benefits related to the technology's adaption, it is still facing some obstacles. One of these is there is not Enough inclusion of these technologies into the education.so if it successfully integrated into the education curriculums and process, which would facilitate the adaption in the construction market as an utmost aim, which would increase the desire of learning these technologies. And as it shown That would close the loop that started at the education and ended at it.

## 6. Conclusion.

Due to the importance of modern technology in all areas of life, most sectors are moving towards digitization. construction industry as an important sector of the economy seeks to improve efficiency, increase productivity, reduce cost, and save time to meet its increasing requirements. Therefore, the adoption of digital technology has become one of the most important requirements of the construction industry. the studies emphasized the importance of including this technology in educational curricula and improving the educational process in general to provide the market with a generation capable of achieving its requirements in the era of digitization. On the other hand, computer visualization techniques have yet to be adapted by the industry in Egypt compared to developed countries, so the situation in Egypt needs to be studied in the context of the previous obstacles. Therefore, the research aimed to evaluate the Egyptian education outputs according to the new requirements of industry in the age of digitalization. Also highlight some steps on the way of connecting the education and the market to a common point. To achieve that, the current situation has been studied through this literature review for each of construction market, and education institutes in Egypt and compared with their counterparts globally to form a comprehensive vision for this matter by studying the needs, challenges, and trends. the research emphasized the importance of developing the curriculums and an educational process to keep pace with the challenges of digitization in the construction market. It also clarified the gap between the global and Egyptian situation in this regard. Finally, this literature review presented a base ground to be built on in this research and for those who are interested in education development issues and assessing its performance globally and in Egypt.

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