Challenges and Perspectives on Resilient Collaboration for Building Information Modelling (BIM) Education in the GCC Context

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Abstract

Building Information Modelling (BIM) is revolutionizing the construction industry and education through digitization. The construction industry expects higher institutions to create graduate students that are BIM-aware and enabled through the understanding of BIM. There are four pillars of BIM, which are people, process, policy, and technology. Less focus is given to the people dimension, as BIM is perceived as 90% technology and 10% sociology, while in reality, it is 90% sociology and 10% technology. This study would embed its focus on people, which are students in the context of the educational implementation, and on female students in the GCC region. This paper aims to identify the complexity of collaboration in BIM education for female students in the GCC region, as many educational institutions create specific atmospheres for female students aligned with the local customs of the region. The investigation focuses on identifying the challenges in BIM collaboration in education in this specific context through a multifaceted theoretical investigation with a comprehensive literature review. The findings of this paper include identifying the multivariate factors involved in the collaboration of BIM education. The recommendations involve the inclusion of resilient strategies to integrate the long-lost 'soft' attributes of people in technology in the realm of optimization and efficiency. This study would be a significant milestone in the region and a promising approach to utilizing local and indigenous tools, approaches, and contexts to meet educational excellence.

Keywords: Building Information Modelling (BIM); Higher education; Collaboration; Female students; GCC region

1 Introduction

BIM is a digital technology that may aid the construction industry in maximizing its efficiency and profitability across the whole project lifecycle by facilitating communication and coordination between project teams (Yusoff, Brahim, & Mat Yusoff, 2021). Building Information Modelling (BIM) is transforming the Architecture, Engineering, and Construction (AEC) industry and education through digitization. The construction industry expects higher institutions to train graduate students that are BIM-aware and enabled through the understanding of BIM. BIM is one of the most important technologies in the worldwide AEC industry's shift towards digitalization to boost project efficiency (Maharika et al., 2020).

BIM consists of four pillars, which are people, process, policy, and technology. Less focus is given to the people dimension, as BIM is perceived as 90% technology and 10% sociology, while in reality,

it is 90% sociology and 10% technology (Ahmad, Aliyu, & Mohammed, 2020). In spite of substantial research and development efforts in academic and professional BIM literature, there is a lack of study on BIM collaboration management (CM), particularly for BIM model production (Yusoff et al., 2021). BIM is not a stand-alone technology, but rather a technology-enabled collaborative process (Ahmad et al., 2020; Munir & Jeffrey, 2013; Saka & Chan, 2019). Most literature focuses on the technical elements of BIM use while disregarding its social and cultural applicability (Reychav, Maskil Leitan, & McHaney, 2017).

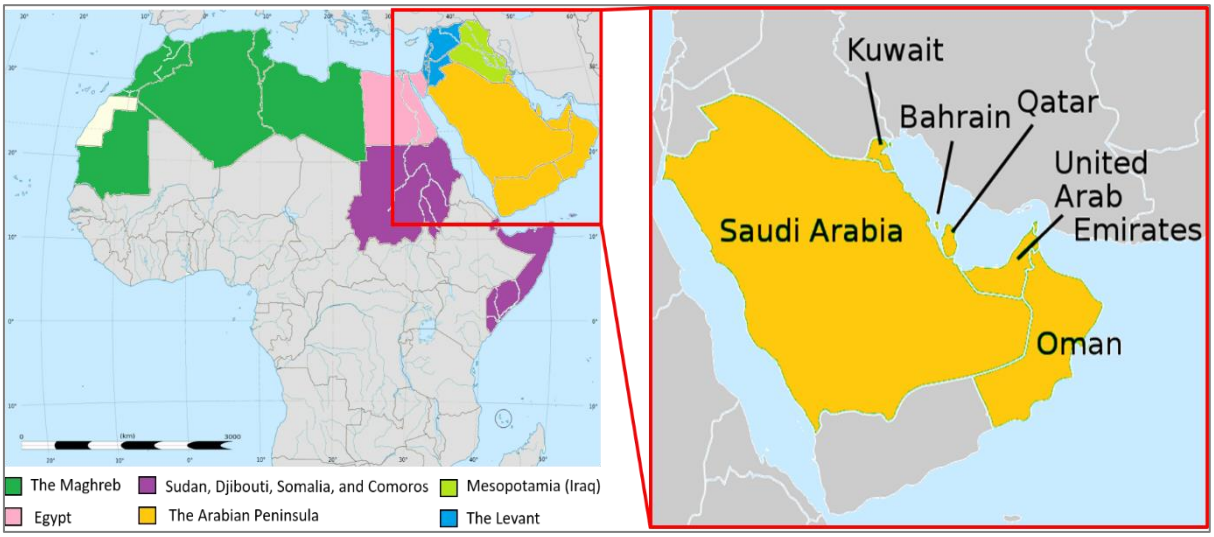


Fig. 1: Location of Research Study Scope. Source: Authors after World Map

This paper aims to explore the limitations observed in BIM-based Education in the GCC context and the limitations' impact on BIM-based collaboration. To do this, understanding the nature of BIM and its components was essential in order to know the angle and point of view this research is taking, and while the data and literature obtained in this study are not limited to addressing the GCC context, the incorporation of various sources was important as this topic is continuously expanding and has a multifaceted nature. Additionally, this study gives the results of a thorough review of the implementation of BIM education from 2019 onwards as well as reviewing literature before 2019. It provides a summary of BIM's current teaching techniques and highlighted collaboration problems. This document also serves as a resource and introductory guide for universities and educational institutions in the GCC areas that are new to BIM education or in the process of introducing it. Knowing that the Arab world and the MENA region consists of multiple cultures ranging in different geographical locations, as shown in Figure 1. The scope of this research will focus on the Arab Peninsula, the GCC region in specific as it constitutes of similar cultural context, aiding this research's target.

2 Methodology

Finding answers to the research questions was done by literature review. Many studies used the bibliometric analysis method (Ali, Alhajlah, & Kassem, 2022; Jin, Guo, Adamu, Kangwa, & Chohan, 2021; Küçük-Avci, Topal, & stanbullu, 2022; Saka & Chan, 2019). A detailed map of a certain study area can be provided through a manual review of literature (Ali et al., 2022). Particular attention must be paid to the requirements of the local industry (Boton, Forgues, & Halin, 2018), which can be done by observing the local context, theorise the context into logical patterns that are able to be understood universally, and creatively find solutions that are responsive to the specific case of the context. The methodology used for

this study can be seen in Figure 2 below.

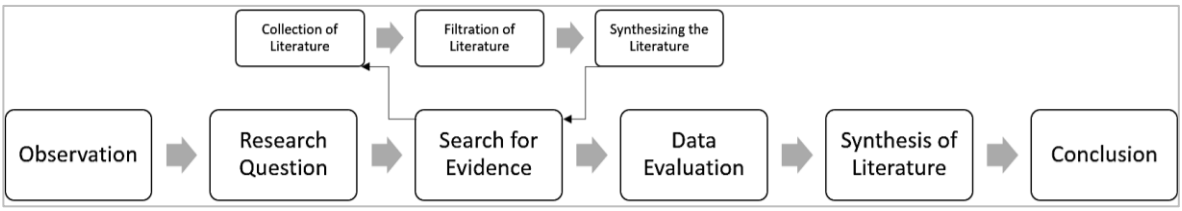


Fig. 2: Study Methodology. Source: Authors, adopted from *(Abdulazeez Abdulmumin, B. K. Bolo, Y. G. Musa Haddary, & Chindo, 2021)*

Many scientometric and bibliometric literature reviews position and analyse the scientific data into clear distinctions in a quantitative manner. However, not many critical reviews were done. The level of detail of this study is quite broad as it is a first step as a pilot study that describes the current situation regarding BIM collaboration within the specific context of GCC as a case study. The filtration process used to collect and include the literature used for this study can be seen in Figure 3 below.

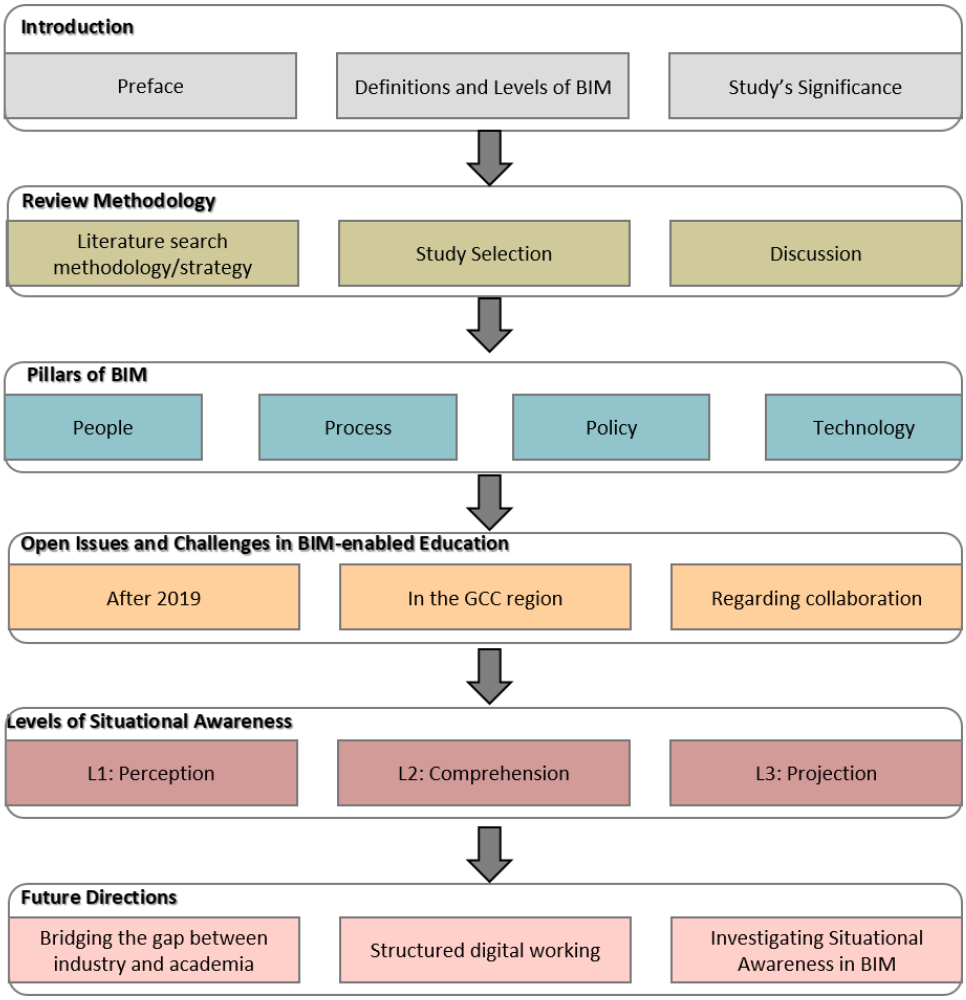


Fig. 3: Literature Review Scope: BIM-Collaboration Dimensions. Source: Authors

The methodology was initially adopted from (Jin et al., 2021). This research began with a comprehensive literature evaluation of the current situation of Building Information Modelling (BIM) in the education sector. The literature search was not confined to undergraduate level education, but

included all activities linked to teaching and learning. However it was limited to specific disciplines such as Architecture, Construction, and Engineering. The scope of the analysis was intended to include the following topics: collaboration and integration.

3 Literature Review and Analysis

According to a study done by (Ali et al., 2022), greater attention was paid to documents that included cooperation and collaboration in 2020, whereas in 2017, 2019, and 2021, increased emphasis was placed on risk, integration, and uncertainty. The result of that systematic literature review found that there are only 88 publications out of 650 that were directly associated with collaboration in building information modelling. Still, there has been a definite upward trend in their number over the last several years owing to the topic's significance, especially in 2019 with a trend of 20 published studies, 2021 with 19 studies, and 2020 with 17 published studies (Ali et al., 2022).

There are different levels of BIM, ranging from Level 1 to Level 4. This study will be generic and will not focus on certain levels specifically. According to (Ali et al., 2022), collaboration in the development of BIM models presents many crucial practical concerns, such as inadequate management systems for collaborative work, difficulty in successfully handling BIM model conceptualization issues and revisions, difficulty communicating and detecting pertinent alterations with connected BIM engineers, inefficiency in controlling BIM model generation self-inspections and findings, and an inability to properly regulate BIM model build versions throughout a process where the BIM model must be regularly altered and updated.

Collaboration and standardization are the pillars of BIM procedures in industry (Besné et al., 2021). Where BIM installations and BIM collaborative work are enabled by a number of standards increasingly used by public agencies (Besné et al., 2021). It is important to investigate whether the GCC context has what makes it unique from international contexts, specifically in education and BIM-enabled education. As challenges facing BIM in education could be universal in most cases, but also context-specific whenever the socio-cultural dimension comes into play.

Educators need to develop effective learning environments when using new technology such as Building Information Modelling (BIM), as it can be argued that in BIM-based collaboration, peer pressure promotes student learning (Zhao, 2021).

According to (Bishop & Verleger, 2013; Boton et al., 2018) with the crisis in education, the combination of two linked movements is transforming engineering education:

- "*The technological movement (to overcome related information flow and the physical barriers).*
- *The ideological movement (to remove the man-made and artificial barriers).*"

The competitive spirit between Gulf nations and even between various states within a country is a significant obstacle. This rivalry restricts cross-border or inter-institutional research collaboration (Badry & Willoughby, 2016). Additionally, colonial education and ethnology were instruments of power that served to define identities in order to sustain dominance relationships (2010). In this context, finding solutions relevant to the context of GCC would be a way to decolonize knowledge and learning approaches.

The worldwide Covid-19 epidemic has brought about enormous disruptions in higher education, especially the built environment (BE) industry (Jin et al., 2021). The Coronavirus produced a sense

of urgency and a matter of survival, which expedited the speed of research and invention and facilitated cooperation (Adnan et al., 2022). Uncertainty over the nature and limits of current collaboration models was associated with collaboration-related issues (2020).

Building on the previously mentioned pillars of BIM, which are People, Process, Policy, and Technology (Ahmad et al., 2020)**,** (Abdulazeez Abdulmumin et al., 2021; Boton et al., 2018) introduced a categorization of BIM education to be based on the following pillars:

- Technologies, Organisations' Infrastructure and Curriculum, as in data management as a technical pillar.
- Organization and Integration, as in team collaboration as a procedural pillar.
- Policies and Implementation, as in risk management for regulatory topics.

Using these pillars as a cornerstone in categorizing the phenomena and issues observed and related to this study's scope would contribute to linking multidisciplinary and interdisciplinary concepts into the research problem and therefore become a theoretical model in which recommendations would be provided.

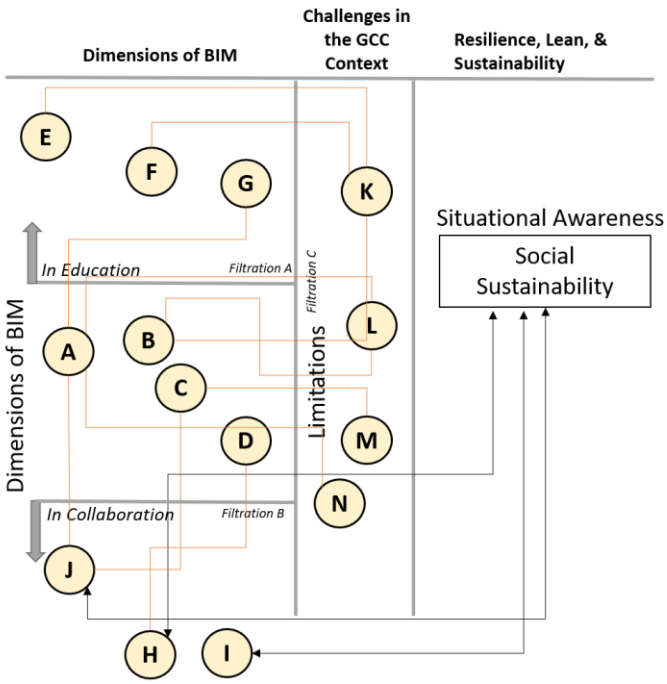
4 Discussion

4.1 Situational Awareness

Some scholarly references refer to BIM as a 'disruptive' approach (Boton et al., 2018) as it resulted in significant modifications to the design, management, and execution of construction projects. Diverse manifestations of identity are associated with sociocultural sustainability (Reychav et al., 2017; Wu, Fan, & Chen, 2015).

What has been noted for the literature review is that successful implementation of BIM collaboration was found to be most dependent on social aspects in an organization, which shows that the need for a perspective that includes social sciences is evident when incorporating technology within an organization. Based on the input of a workshop titled *When Social Science Meets Lean and BIM*, the fragmentation in the BIM implementation could be a challenge for social scientists to explore. The context of the current situation shows that there are specific challenges in the GCC region, especially for female students, where predefined gender roles continue to dominate the culture in which educated women function (Levers & Brock, 2007). Another challenge is that in the Arab nations, distance and open education are little established (A. Badran, Baydoun, & Hillman, 2018).

There many aspects and dimensions of BIM, such as Technology, Time (stage of the project), People, Document Management Collaboration (Shafiq, Matthews, & Lockley, 2013), and many more. Categorized aspects of BIM can be seen in Figure 4 and Table 1 below, which shows the relations between different aspects of BIM and its potential contribution to the concept of social sustainability and Situational Awareness (Adamu, Emmitt, & Soetanto, 2015) as a potential solution to this research problems, where the term 'Situational Awareness' is in fact a concept that has a developed a theoretical model provided by (Endsley, 1995) and could serve as a theoretical guideline in mapping and categorizing issues observed in this study's specific context. For this, the figure below serves as a map in categorizing each aspect related to the research problem and understanding how it connects and relates to finding a solution towards social sustainability and resilience in BIM-education collaboration within the GCC context.



Label	Aspects of BIM	Source
A	Process	(Ahmad, Aliyu, & Mohammed, 2020)
B	Policy	
C	People	
D	Technology	
E	Curriculum	(Abdulmumin, Bolo, Haddary, & Chindo, 2021)
F	Integration	
G	Implementation	
H	Cloud Computing	(Adamu, Emmitt, & Soetanto, 2015)
I	Optimisation of group efforts and Task Delegation	
J	Real-time visual Consensus and consent	
K	Culturally-specified roles for certain Educational Programs	(Levers & Brock, 2007)
L	Limited interdisciplinary collaboration between colleges	(Jabbour, Yamout, Giacaman, Khawaja, & Nuwayhid, 2012)
M	Limited skills and expertise	(Abdalla, 2016)
N	Gap Between Industry and Academia	(Abdalla, 2016)

Fig. 4: Left: The application of BIM elements in Education and Collaboration towards Social Sustainability within the GCC Context. Right: General Dimensions of BIM in Education – Collaboration. Source: Authors.

4.2 Paradigm Shift

There is a need for a shift in working processes across the industry. This applies to educational institutions. The construction industry expects higher institutions to graduate students that are BIM-aware and enabled through the understanding of BIM. Four distinct forms of architectural education were formed by the prior historical approaches to architecture: academic, craft, technological, and sociological (Salama, 2022).

When departments are structured along disciplinary lines, interdisciplinary cooperation and involvement may be challenging, particularly in teaching (Jabbour, Yamout, Giacaman, Khawaja, & Nuwayhid, 2012). Successful implementations have been dependent on social factors such as teamwork and the corporate environment, demonstrating a strong need and potential for a social science approach in this setting. Such as situational awareness as it was a recommendation of a previous study (Adamu et al., 2015).

4.3 Appreciative Inquiry

Appreciative inquiry has the power to decolonize the curriculum's content and the manner in which knowledge is generated and reproduced (Salama, 2022). Finding solutions to the current context of the GCC can be quite challenging yet vital for sustainable development measures. This proposal and recommendation includes multi-school collaboration within the GCC while keeping their cultural values as a form of cultural resilience and social sustainability. In this sense, investigating the model of Situational Awareness and its contribution to delivering a sense of collaboration, in the context of BIM-enabled education in the GCC context could be a promising approach to utilizing local and indigenous tools, approaches, and contexts to meet educational excellence.

Table 1: BIM Collaboration issues in the Educational Context in GCC and the Hypothesis Presented on its Relevance and Impact on the Model of Situational Awareness. Source: Authors

Label	References	Education Limitation in GCC	BIM Collaboration context	Relevance to the model of Situational Awareness (Largely Affected, Mildly Affected, Not Affected) [Hypothesis; to be tested in further research]
K	(Levers & Brock, 2007)	Culturally-specified roles for certain Educational Programs	BIM as a model that depends on interdisciplinary work in the engineering field, may be affected by the fact and reality that some educational programs are specified for female students whereas some are for male students	Perception: Largely Affected Comprehension: Largely Affected Projection: Largely Affected
L	(Jabbour et al., 2012)	Limited interdisciplinary collaboration between colleges	Apart from previously-mentioned barriers, students of a certain department need continuous contact in order to collaborate on a BIM-enable education level	Perception: Mildly Affected Comprehension: Largely Affected Projection: Largely Affected
M	(Abdalla, 2016)	Limited skills and expertise	BIM as a method that adapts emerging technologies, need enough time and expertise in multiple regions in the world, including the GCC	Perception: Largely Affected Comprehension: Largely Affected Projection: Largely Affected
N	(Abdalla, 2016)	Gap between Industry and Academia	According to a survey done in the UAE regarding BIM collaboration (Abdalla, 2016), 61.5% of respondents in the AEC academia agreed that a gap exists and therefore affects BIM collaboration	Perception: Mildly Affected Comprehension: Largely Affected Projection: Largely Affected

4.4 Interdisciplinary Approaches

Learning theories about the phenomena can be quite contrasting when getting an in-depth understanding of the phenomena's behaviour (Salama, 2022). BIM as an interdisciplinary object-oriented three-dimensional model (Boton et al., 2018), can include many risk factors, as multidisciplinary team works include "*communication barriers, accessibility and availability of resources, group size, and accountability*" (A. e. Badran, Baydoun, & Hillman, 2022).

The most popular teaching approach in the BIM educational framework in the publications between 2010 to 2017 is the one that considers a cross-disciplinary and multidisciplinary module, it was a topic of many publications in this research field, covering 54% of research topics about BIM educational framework and teaching approaches (S. K, Osman, Razak, & Shazwan, 2019), which stresses the need to include a social sciences perspective within investigating BIM challenges, especially when people are involved through collaboration. The concept of Situational Awareness as a solution to the research problem could be further analysed through more in-depth research in the future.

5 Conclusion and Recommendations

Future research advancement would need to perform a study that addresses specifically the Gulf environment using expert opinions and survey studies, including a quantitative research

methodology, where more analysis of the case study would be done via collecting quantitative data to investigate the inquiry of whether post-Covid scenario has an influence on the need to work digitally, facilitating BIM implementation and collaboration. Additionally, it is vital to find ways to bridge the gap between industry and academia, which would facilitate collaboration on many levels, as well as promote interdisciplinary and multidisciplinary approaches in learning, teaching, research, and overall knowledge production that gives space to structured digital working to ensure collaboration starts from a bottom-up approach, sprouting from the depth of the rich context it is in.

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