



Readiness and Challenges of the Construction Industry in Implementing Building Information Modelling (BIM)

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Abstract: Building Information Modelling (BIM) is one of the innovative approaches that has been developed and widely accepted in the construction industry. In Malaysia, BIM usage is still low and not many firms have taken full advantage of its potential despite the investment in BIM being proven to be well worth the cost of implementation to organizations. Therefore, this study has been conducted to identify the current status of BIM implementation in Malaysia. This study uses a qualitative approach with an explanatory research design to explore the phenomenon of BIM implementation in the construction industry. This study was aimed to identify the readiness and challenges in BIM implementation from twelve (12) participants from consultants and contractors in Malaysia who have already implemented and not have implemented BIM where the researcher used purposive sampling technique with snowballing sampling. In obtaining the data from participants, the researcher has conducted a semi-structured interview data collection technique. The data were then analyzed using thematic analysis to identify patterns and themes among the research questions in two categories of participants. This study finds that the rate of BIM implementation in construction industry is very low and the most factors influence companies' readiness in BIM implementation from both categories of participants are client, enforcement from authority and lack of project that needs BIM. This study also found that the most challenges faced in BIM implementation are BIM exposure, cost implementation and others. In addition to that, this study proposing effective strategies for enhancing the BIM implementation in Malaysia such as introducing of BIM in university curriculum, BIM enforcement from the authority and others.

Keywords: Building Information Modelling (BIM), readiness, challenges

1. Introduction

The construction sector plays an important role in the economy of any country. According to a report published by the World Economic Forum & The Boston Consulting Group (2018), the construction industry currently accounts for around 6% of the world's Gross Domestic Product (GDP) and is expected to reach around 14.7% by 2030. According to Barbosa et al., (2017), every year, there is about \$10 trillion in construction-related spending globally, equivalent to 13% of GDP. In Malaysia, GDP from Construction in Malaysia increased to 13621 MYR Million in the third quarter of 2022 from 12929 MYR Million in the second quarter of 2022 (Statistics Malaysia, 2022), indicating its significant role in global and local economic growth. In order to enhance more rapid economic growth, most industries today have undergone evolution and various innovations that are at the core of operations to improve the quality of production and productivity in their industries (Maskuriy et al., 2019). Building Information Modelling (BIM) is one of the innovative approaches that have been developed and widely accepted in the construction industry. This is a new evolution of the design and construction

phase approach that drives the production of a virtual picture of the entire project life cycle. BIM is the process of preparing design and construction stimuli throughout the construction process.

In the construction industry, every project undertaken will usually be affected by various problems, challenges or risks that will be faced regardless of the size of the project or the willingness of a company to use a new technology such as BIM. Yet these problems and challenges need to be identified and managed systematically during the initial risk management process. Understanding the characteristics of the problems, challenges and risks faced by the construction industry is important to assess the readiness of a company to apply BIM. This is because such challenges become real factors and problems that cause less use of new technologies in the construction industry. Additionally, it is very important to identify the challenges faced by the construction industry as a basis for assessing the readiness of the construction industry in applying BIM. Based on Azmi (2019), the use of BIM in the construction industry in Malaysia is considered weak due to problems of a party and technical issues which are also known as external barriers due to a lack of trust in a new software application. This indicates that there is a relevance for the knowledge of BIM in the organization to lead the construction industry towards implementing BIM. It will also raise awareness among the construction industry on the benefits of implementation in construction projects (Shalaka Hire et al., 2021; Al-Ashmori et al., 2020; Ullah et al., 2019).

According to Azwani et al. (2018), the problem that causes the low level of use in BIM is due to doubts about the feasibility, risks and actual challenges in such use. Based on a study found by Mohammed et al. (2019), among the main challenges that provide evidence of low implementation rates for BIM in construction projects in the Gulf Cooperation Council (GCC) is the lack of awareness of BIM and the reluctance of stakeholders in accepting to change existing work practices. However, further research needs to be done to identify and analyse definitions, changes, awareness, challenges and how challenges in BIM are addressed (Liu et al., 2022). The objective of the study is very important to carry out a study. There are two main objectives that need to be achieved in this study are as follows: i. To analyse the readiness of the construction industry in implementing BIM; ii. To identify the challenges faced by the construction industry in implementing BIM. Therefore, this study aims to identify the readiness and challenges faced by the construction industry in applying BIM.

2. Methodology

Research methodology is one of the concerns in doing research. It is for needs, research, and process requirements (Snyder, 2019). This study uses a qualitative approach with an explanatory study design. Qualitative research is well suited for studies of an exploratory nature where it can delve into the problems of a research topic by reporting phenomena from various perspectives, identifying the many factors involved in the situation, and generally sketching the larger picture that emerges (Aspers & Corte, 2019). The researcher is limited to the study location where it is limited to the construction industry players in Malaysia only. Next, this study is limited to study participants in the construction industry where it is only involved consultants and contractors G7 only. In addition, the results of this study will only depend on the level of knowledge and use of BIM by study participants when answering the questions during the interview. Moreover, the limit time for this study is 14 weeks which every process already distributes according to a specific time. Every process already plans at the beginning through the Gantt Chart to get the best result and finished the study successfully. But there are some constraints while doing the research, especially when conducting the interview because Malaysia is under Movement Control Order (MCO) due to Covid-19.

However, an explanatory study design aims to explore a new universe and is mainly concerned with causes or 'why' factors about some phenomenon (Denton, 2020). Therefore, this design was chosen because it can deepen the phenomenon of BIM implementation in the construction industry in Malaysia. In the context of this study, the researcher used non-probability sampling or purposive sampling to select the study participants involved in the interview. The researcher set in advance the criteria for the participants to achieve the purpose of the study. The size sample sufficient for the explanatory research have a total of 12 study participants from the construction industry players, namely contractors (G7) and consultants were selected to achieve the purpose of the study and had divided into two categories: 4 study participants who had already implemented BIM in projects and 8 study participants who had not implemented BIM in projects.

After the interviews were completed, the researcher used snowballing sampling and asked the study participants to introduce contacts who were in the same industry and the same criteria to be selected as the next study participants until 12 study participants were sufficient.

2.1 Research Instruments

In this study, researchers have used the method of preparing interview transcripts based on interviews that have been recorded with study participants. Then, the researchers analysed the data using thematic analysis to answer the research questions. Thematic analysis is one way to analyse data with the aim of identifying patterns or finding themes through data that has been collected by researchers (Braun & Clarke, 2021). Therefore, with the availability of data analysis methods, researchers can find and organize data systematically.

In obtaining the data from participants, the researcher has conducted an explanatory study using a semi-structured interview data collection technique. The interviews were used in this study to gain a deeper understanding of the readiness and challenges faced by the construction industry in implementing BIM.

During the interviews conducted, the researcher used the instrument items that have been constructed to achieve the objectives of the study. There are 4 sections in the constructed instrument, which are sections A and B aimed to identify the participants' background while sections C & D aims to identify the research purpose. The instrument for sections A and B is the same for both categories of companies, who have already implemented and not implemented BIM but sections C and D are different. Even though there are constructed instruments during the interview, the researcher will also take into note all the information that will be provided by the study participants that is related to the study.

3. Result and Discussion

The results and discussion section presents data and analysis of the study. This section provides a narrative of the study findings and selected quotes that have been obtained from twelve (12) participants from consultants and contractors in Malaysia through semi-structured interviews that have been conducted.

3.1 Research Design

Study participants provided their opinions and views through the items of instruments that have been used to answer the research question which is the readiness of the company in implementing BIM and also the challenges faced by the company. The researcher analysed the data in two categories, the companies that have already implemented and not have yet implemented BIM.

3.1.1 Companies That Have Not Yet Implemented BIM

Based on the method of data analysis using thematic analysis, several themes have been constructed through the method to answer the research questions. The data have been obtained from 8 participants who have not yet implemented BIM in their companies. Based on Table 1, the Readiness of implementing BIM section presents data from the participants' perspectives on 4 items and instruments that have been answered during the interview session. The items instruments are software in use, BIM seminar, technological change (among staff) and company's readiness factors. Next, Table 2. Shows the challenges of implementing BIM section presents data from the participants' perspectives on 4 items instruments that have been answered during the interview session. The items instruments are challenges in early exposure, financial aspect, other challenges and company initiatives.

Table 1 - Readiness of implementing BIM in companies that have not yet implemented BIM

Readiness of implementing BIM	Respondent (Participant/P)	Review	Respondent (P)
Theme 1: Software used by consultants		Software used by consultants: <ul style="list-style-type: none"> ▪ Old AutoCAD version/light design ▪ AutoCAD 2016 full version with infra ▪ ESTEEM (RC analysis and design) ▪ Prokon (analysis and design, steel structure, foundation, geotechnical for retaining wall) 	P3: Project engineer
Software in use		<ul style="list-style-type: none"> ▪ SketchUp (presentation) 	
Theme 2: Software used by contractors		Software used by contractors: <ul style="list-style-type: none"> ▪ AutoCAD & project <ul style="list-style-type: none"> ▪ Excel ▪ PowerPoint ▪ Word ▪ AutoCAD (use for shop drawing) 	P7: Project Engineer

Readiness of implementing BIM		Respondent (Participant/P) Review	Respondent (P)
BIM Seminar	Theme 1: Has attended BIM seminars	<p>Advantage attended in BIM seminar:</p> <ul style="list-style-type: none"> ▪ Can know the BIM advantages, disadvantages and potential. ▪ Can decide whether the office needs BIM or not. ▪ Can change the mode from conventional to BIM. 	P5: Owner of the company
	Theme 2: Has not attended BIM seminars	A few participants are still not sure of the extent of the use of BIM. For them, medium and small scale in this field may not be a compulsory move to it based on the current situation.	P3: Project engineer
Technological change (staff)	Theme 1: Attending seminars	You will always forget if you do not implement it	P6: Project engineer
	Theme 2: Introduce BIM to other staff	Went to the seminar and then share those things with other staff for knowledge sharing	P1: Owner of the company
	Theme 3: Providing new staff	In the future, it may be possible to provide new staff from BIM Modeller if the client employs us as an engineer at a price that is fair to have BIM implementation.	P1: Owner of the company
	Theme 4: Individual exposure	Not necessarily in the office all need to have BIM. Maybe the individual needs to be aware, and feel the need to know something about BIM.	P2: Consultant engineer
Company readiness factors	Theme 1: Client	If clients are ready to pay us expensive, we are ready to buy expensive software (back-to-back situation)	P1: Owner of the company
	Theme 2: Projects that require BIM	If there was a BIM project, so it was implemented. But if we can't get the BIM project again, then we won't invest in things we don't have.	P4: Project architect
	Theme 3: Enforcement from local authorities	They do not enforce, if the project they specified for BIM, then we will use BIM. So, if we have to use BIM, then we have to buy the software.	P3: Project engineer

Table 2 – Challenges of implementing in companies that have not yet implemented BIM

Challenges of implementing BIM		Respondent (Participant/P) Review	Respondent (P)
Early exposure	Theme 1: No one introduced	There is no way to use the software so we don't study the software partly because no one introduced us to how to use BIM	P2: Consultant engineer
	Theme 2: Disclosure from university level	BIM does not capture this subject in the university. So, the initial challenge is when we introduce BIM, a graduate engineer who takes a crucial time, people say it takes a long time to adapt because there is no exposure, and zero knowledge.	P1: Owner of the company

Challenges of implementing BIM		Respondent (Participant/P) Review	Respondent (P)
Financial aspect	Theme 1: Cost expensive	<ul style="list-style-type: none"> ▪ The cost is too expensive. ▪ If there is a lot of software, we need skilled people who are skilled in that software. ▪ There are not many skilled workers for that part, especially for new things 	P6: Project engineer
	Theme 2: Financial constraints	Have financial constraints, then we have to take care of it.	P3: Project engineer
Other challenges	Theme 1: Time	Time constraints because we move in a small group. Focus more on chasing the dateline to finish the current project. I think there needs time to move towards BIM. (New things, it takes time to adapt)	P2: Consultant engineer
	Theme 2: Have not got a project/ competition	We have not got a job yet. We have entered the tender in the consultant tender to become a lead consultant who uses BIM (government tender) but we not got it yet.	P4: Project architect
	Theme 3: Client	<ul style="list-style-type: none"> ▪ The biggest challenge is the readiness of the client and also the authority. ▪ If they do not have the tendency to accept this BIM in total, they still want us to send the paper, the drawing plan still has to print on paper, and send hardcopy/ stamp. ▪ Only half of the parties accept the system. 	P5: Company owner
Company initiatives	Theme 1: Attending seminars	<ul style="list-style-type: none"> ▪ Have to do is disclose the advantages of BIM. ▪ Provide exposure to ongoing seminars on this knowledge and also the company usually when the technology is new ▪ Make sure staff is updated knowledge but of course, we also have constraints in terms of time and money 	P1: Owner of the company
	Theme 2: Slowly develop the culture	If the project does not require BIM to have its operation, slowly develop the culture in the office environment to suit BIM but not aggressively.	P5: Company owner

3.1.2 Companies That Have Implemented BIM

Based on the method of data analysis using thematic analysis, several themes have been constructed through the method to answer the research questions. The data have been obtained from 4 participants who have not yet implemented BIM in their companies. Based on Table 3, the Readiness of implementing BIM section presents data from the participants' perspectives on 4 items and instruments that have been answered during the interview session. The items instruments are BIM tools currently in use, the time period taken in implementing BIM, BIM implementation factors, and benefits and advantages of using BIM. Table 4 shows the challenges of implementing the BIM section and presents data from the participants' perspectives on 4 items and instruments that have been answered during the interview session. The items instruments are the initial challenge, technical difficulties, other challenges, and company initiatives.

Table 3 - Readiness of implementing BIM in companies that have implemented BIM

Readiness of implementing BIM		Respondent (Participant/P) Review	Respondent (P)
BIM tools currently in use	Theme 1: Software used by consultants	Software used by consultants:	P9: Company owner
		Revit ArchiCAD (not broken, mechanical, structural, what is everything you can do in one. It is one software for all types of thread)	

Readiness of implementing BIM	Respondent (Participant/P)	Review	Respondent (P)
	Theme 2: Software used by contractors	Software used by contractors: CAD	P9: Company owner
The time period is taken in implementing BIM	Theme 1: More than 12 years	Start implementing BIM at the end of 2018. Before that, we already have Revit since 2010.	P9: Company owner
BIM implementation factors	Theme 1: Clients	We are serious in 2018 because people have given us the mandate to finish it.	P9: Company owner
	Theme 2: Go into the market	We try to get into the market because everyone has mentioned BIM.	P10: BIM Manager
Benefits and advantages of using BIM.	Theme 1: Early problems can be detected	When we implement BIM, we have a term we call VDC, Visual Design Construction. So, in 3D we can see our model, a structure model with M&E. If there are any problems that will occur on the site, we can detect them early. Based on ideal practice.	P10: BIM Manager
	Theme 2: Save time	Construction issues can be detected early. When making Revit, when we implement BIM from the same model, we can accept drawings. So, we've saved time. Can reduce work twice.	P10: BIM Manager

Table 4 - Challenges of implementing BIM in companies that have implemented BIM

Challenges of implementing BIM	Respondent (Participant/P)	Review	Respondent (P)
Initial challenge	Theme 1: Complex software	In terms of the software, the first or two years, it was a bit of a hustle, and a lot of experiments, even now, there are still things that we still experiment with because not all the things that other people make are okay near people's projects, if we can, we want to suit, right, with the office having standards, there will be problems.	P10: BIM Manager
	Theme 2: Staff	The problem is we can't hold on to this BIM modeler for a long time because he is already good at it, people offer him to other places.	P9: Company owner
	Theme 3: Willing to pay for BIM equipment	Must get ready to pay the amount for the expensive license.	P9: Company owner
Technical difficulties	Theme 1: Problems with drawing	The technical problem is when we got the drawing, the drawing draws another size, but in the specification used another size. So, if our staff wants to make BIM, you have to have the exact size, you cannot in drawing draw another size, but in the specification used another size. End up, if you enter the actual size that follows the specification, you will face many problems	P9: Company owner
	Theme 2: Limitation of software	In technical terms, Revit is software, so many of us cannot be achieved near drawing because the software has limitations. So, we	P10: BIM Manager

Challenges of implementing BIM		Respondent (Participant/P) Review	Respondent (P)
		have to find a way of how the object must be presented in the drawing.	
	Theme 3: Challenges during the project	The project is ready so when the BIM comes in late, the challenge is how to keep up with the project dateline.	P10: BIM Manager
Other challenges	Theme 1: Challenge of getting a project	The challenge is to get a job because it has not yet expanded that the client needs BIM. Because the client does not see the advantages and the client does not want to spend extra money for the consultant to prepare BIM for them.	P9: Company owner
Company initiatives	Theme 1: Give exposure to clients	Most of the time a lot of clients don't see the value for the money. They don't want to because when you make BIM, that is manpower involved, time involved, so you have to deal with your client for that extra manpower than extra time.	P9: Company owner

4. Discussion

Based on the themes that have been obtained in each instrument item from interviews conducted with 8 participants who have not implemented BIM, for the company readiness to implement BIM, it was found that they are ready to use the software and one step further toward using BIM tools. As for BIM exposure, there are some companies that have been exposed to BIM knowledge by attending seminars but not all of them in the company had been involved due to time constraints and so on. Based on the CIDB Report 2016-2020, there is a program organised by CIDB through the my-BIM Centre program which is committed to developing and nurturing BIM in the construction industry in Malaysia. Also, there are also companies that have not yet participated in the BIM seminar. In preparation for the technological change that involves staff in the company, most of them are ready in terms of knowledge among staff where they have attended seminars, introduced BIM to other staff, and also made exposure to individuals. There are also companies that think they will provide new staff when implementing BIM in the future. Next, the participants gave the view the factors they would implement BIM in the future such as clients, projects that require BIM, and enforcement from the government. This shows that they are willing to use BIM if there are parties who request and support it.

Furthermore, for the part of the challenges faced by companies to implement BIM, it was found that among the challenges at the initial exposure, stage involving no party introducing BIM and also no BIM exposure at the university level. According to Kleiner & Schaefer (2022), the interdependence between universities and industry is increasing as it relies on the intellectuals of students from the university. In addition, most of the participants agreed that they have challenges in the financial aspect which involves the cost expensive of BIM and also financial constraints in the company (Shin et al., 2018). According to Noor Akmal Adillah Ismail et al (2021), the use of BIM will cause a company organization to make a large investment financially because only large organizations can afford the high cost of technology. Next, study participants also provided information on other challenges they faced namely time, not yet getting a BIM project, and clients. Finally, the participants provided insights on the initiatives that have been taken by the company to overcome the challenges, namely attending continuous seminars and also slowly accepting new cultural changes.

Based on the themes obtained in each instrument item from interviews conducted with 4 participants who have implemented BIM, for the readiness part of companies implementing BIM, it was found that the software they always use is Autodesk Revit for consultants while for contractors, although they have been involved in BIM projects, they are only involved in project development and do not use any software. The only software they use is AutoCAD and other basic software. According to Alasmari et al. (2022), among the BIM tools that have been introduced in various types and functions is one of them is Autodesk Revit. Next, the companies took another time to start implementing BIM and mostly started implementing BIM in projects starting in 2016 even though the Government of Malaysia started to introduce BIM technology in 2007. Next, among the reasons this company has implemented BIM is on client factors and go into the market. They say if they don't try in the market, they will be left behind. In addition, the study participants also provided insights on the benefits and advantages of using BIM that is, early problems can be detected and can save time.

For the part of the challenges faced by companies to implement BIM, it was found that among the challenges faced initially, they faced challenges of the complex software, challenges in terms of skilled workers, and company willingness

to purchase BIM equipment. Next, the company faces technical problems namely on drawings, software limitations in carrying out the work, as well as challenges during the BIM project. Among the other challenges mentioned by the study participants where they faced challenges to get the project. This is because, they have invested to buy BIM, so they have to face to find a project that requires BIM so that it is more worthwhile (Farouk et al., 2023). The participants also gave an insight into the initiatives taken by the company in facing these challenges to give exposure to the client because the client is the paymaster who needs BIM in the project.

Therefore, the researcher gives suggestions that can be taken to resolve these issues to disclose the university level, providing in-depth disclosure to the client, suggesting that enforcement in the use of BIM be done in stages by the government and the government should give some initiative seminars so that all companies can be exposed to BIM.

5. Conclusion

In conclusion, this study was conducted very well according to the set duration and fulfilled the objective of the study stated at the beginning of the study. This study has revealed the readiness of companies to implement BIM and has delved deeper into what causes companies to implement BIM. Similarly, for the second research question, this study has delved into the challenges faced by the company whether the company has implemented BIM or not because it has given a different view from the point of BIM implementation. Suggestions to certain parties have also been made by the researcher in the discussion section where the researcher hopes that this issue can be resolved quickly and all parties can work together so that more projects in Malaysia use BIM which brings many benefits to users. In addition, future studies can also address the bigger sample size and the scope of discussion towards readiness and challenges of the construction industry in implementing BIM.

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References

- Al-Ashmori, Y. Y., Othman, I., Rahmawati, Y., Mugahed Amran, Y. H., Abo Sabah, S. H. & Aminu Darda'u Rafindadi, M. M. (2020). BIM benefits and its influence on the BIM implementation in. *Aim Shams Eng. J.*, 11(4), 1013–1019.
- Alasmari, E.; Martinez-Vazquez, P.; Baniotopoulos, C. A. (2022). Systematic Literature Review of the Adoption of Building Information Modelling (BIM) on Life Cycle Cost (LCC). *MDPI Buildings* 2022, 12, 1829.
- Aspers, P., & Corte, U. (2019). What is Qualitative in Qualitative Research? *Qualitative Sociology*, 42(1), 139–160.
- Azmi, N. (2019). *The Implementation of Building Information Modeling in Malaysia Construction Industry* (Issue January).
- Azwani, I., Ya, M., Azli, F., Rahim, M., & Zainon, N. (2018). *Risk in Implementing Building Information Modelling (BIM) in Malaysia Construction Industry : A Review*. 03002, 1–9.
- Barbosa, F., Woetzel, J., Mischke, J., Ribeirinho, M. J., Sridhar, M., Parsons, M., Bertram, N., & Brown, S. (2017). Reinventing Construction: A Route To Higher Productivity. *Mckinsey Global Insititute, February*, 20. <http://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/reinventing-construction-through-a-productivity-revolution>
- Denton, A. (2020). Why Do Most Small Businesses in Liberia Fail? *Open J. of Business and Mngmnt.*, 8, 1771–1815.
- Department of Statistic Malaysia. (2022). Malaysia GDP From Construction. Department of Statistics Malaysia Official Portal. https://www.dosm.gov.my/v1_/
- Farouk, Abdelrahman & Zulhisham, Ahmad & Lee, Yong & Rajabi, Mohammad Sadra & Rahman, Rahimi A.. (2023). Factors, Challenges and Strategies of Trust in BIM-Based Construction Projects: A Case Study in Malaysia. *MDPI Infrastructures*.8.13.
- Kleiner-Schaefer, T., Schaefer, K.J. (2022). Barriers to university–industry collaboration in an emerging market: *Firm-level evidence from Turkey*. *J Technol Transf* 47, 872–905. <https://doi.org/10.1007/s10961-022-09919-z>
- Liu, H., Zhang, R., Zhang, H., Jiang, H., & Ju, Q. (2022). Identification and Analysis of Key Barriers of BIM Application for Small- and Medium-Sized Fire Protection Enterprises. *Journal of Environment and Public Health*, 2022.
- Maskuriy, R., Selamat, A., Ali, K. N., Maresova, P., & Krejcar, O. (2019). Applied sciences Industry 4 . 0 for the Construction Industry — How Ready Is the Industry ? *Applied Sciences*, 9(14), 2819.
- Mohammed, A., Hasnain, S. A., & Quadir, A. (2019). Implementation of Building Information Modelling (BIM) Practices and Challenges in Construction Industry in Qatar. *Journal of Engineering Research and Reports*, 9(1), 1–9.

Noor Akmal Adillah Ismail, Mohd Nazareth Mohd Yousof, Hamimah Adnan (2021). BIM Adoption in Managing Construction Risks Amongst Malaysian Quantity Surveyors: Current Practice and Challenges. *Journal of Sustainable Construction Engineering and Technology*. Vol. 12 No. 3, p. 166-175. DOI:

Shalaka Hire, Sayali Sandbhor, Kirti Ruika & C. B. Amarnath. (2021). BIM usage benefits and challenges for site safety application in Indian construction sector. *Asian Journal of Civil Engineering*, 22, 1249–1267.

Shin, Min & Lee, Hye & Kim, Hwan. (2018). Benefit–Cost Analysis of Building Information Modeling (BIM) in a Railway Site. *Sustainability*. 10. 4303. 10.3390/su10114303.

Snyder, H. (2019). Literature review as a research methodology : An overview and guidelines. *Journal of Business Research*, 104(July), 333–339.

Ullah, K., Lill, I., & Witt, E. (2019). *An Overview of BIM Adoption in the Construction Industry : Benefits and Barriers*. 2, 297–303.