

D30IC: INNOVATION IN CONSTRUCTION PRACTICE

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Merdeka PNB 118 Innovative Portfolio

Student name and ID Number:
Hamza Bilal Dodhy - H00314985

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1 Introduction

The modern day provides numerous advanced ways to counter challenges faced in a mega design project. With cutting edge technologies surfacing every week, (Panel, 2021), the construction industry needs such technologies to improve the design, construction and operational phase of a building. A study suggests that the construction industry requires revolution to continue to survive after a heavy impact of COVID-19 hit the industry slowing down construction processes indefinitely affecting the global GDP. Being the most influential industry contributing to the global GDP, 13 percent the industry has to adapt to new measures to avoid further losses. (Khansaheb, 2021)

The Merdeka PNB 118 project's difficulties and dangers are discussed in this innovation portfolio along with suggestions for creative measures to help reduce the risks and a business case outlining the effects of such suggestions. These difficulties include the usage of BIM in design and construction as well as the high-risk factor of health and safety, which is a major problem in high rise buildings.

1.1. Characteristics

Merdeka 118 is a modern day building currently close to completion by 2023 in Kuala Lumpur, Malaysia. Construction initially starting in 2014, the Merdeka PNB 118 project experienced some unforeseen delays from COVID-19 which resulted in a delayed inauguration (Bernama, 2020). With a staggering height of 678.9 meters, it is meant to be the second tallest building in the world right behind Burj Khalifa in Dubai. (Anon., 2022). The following table summarizes the project details relating to Merdeka PNB 118 in Kuala Lumpur.

Project Name	Merdeka PNB 118
Location	Kuala Lumpur, Malaysia
Height	678.9 meters
Gross Floor Area	292,000 m ²
Budget	RM 5 billion (USD \$1.5 billion)
Functionality	Hotel, Offices, Residential, Retail, and Observation
Architect	Fender Katsalidis
Initial Construction Date	2014
Commencement	2023*

Table 1. Merdeka PNB 118 project details (Anon., 2022)

(*) Subject to delays from unforeseen circumstances



Figure 1. Merdeka PNB 118 (Anon., 2022)

One of the main risk involving the characteristics of the building is related to health and safety as a height of 678.9 meters imposes a risk of falling from gradually increasing construction heights of the building. Covering a fair amount of floor area in the middle of the city, the placement of the equipment required for the construction can cause obstructions in the city and further disturbance within the site.

2 Innovation recommendation

Merdeka 118, being a high-rise building, comes with unique challenges that contractors and consultants have to face. Throughout the project, from the design stage to the operational phase, numerous challenges such as, health and safety, software limitations, environmental conditions and much more.

This report will focus on the main aspects regarding the design stage and the health and safety stage of the project. Providing innovative ideas along with real world scenarios which have implemented the discussed ideas. A business case will determine the actual requirements regarding the operation of the suggested ideas.

Being crucial aspects regarding construction, it is necessary to undergo and initiate creative recommendations benefiting the project with cost efficiency, energy efficiency and health and safety.

2.1. Recommendation A (Design Stage – BIM/Digital Twins)

Innovation Context - The design stage of any project is the most crucial as it is the defining element which describes in precise details about the form and function of the building. Breaking down each aspect from the basic ideology to the final architectural drawings and the completion of the building when where its applicable to obtain usage readings.

Building Information Modelling, more commonly known as BIM, is a practice that uses computational advantages to its potential by creating and operating the specified details of a construction project from the first draft to the final project. Utilizing a set of applicable software that clearly demonstrates an informative model, preferably a 3D model which benefits the client, contractor and consultant by obtaining a visual representation of the developed ideas. The 3D model will breakdown the analysis of the building through the building itself, execution of the construction of the building and lastly handover information. (Hamil, 2021).

Using BIM, a digital twin can be designed of the planned building specifications, allowing project administrators to thoroughly view the building which includes the geometry of the design, the spatial requirements, specified materials and lighting for energy efficiency etc. Digital twins also denote the schematics of the added technologies used in the design, along with the sensors, systems and equipment. (Modabber, n.d.)

Being two of the most important innovative ideas modifying the current way a design project comes to life, it is highly favorable for high rise buildings such as Merdeka 118. As mentioned before, Merdeka 118 is a megaproject defining the skyline of high-rise buildings by defeating Shanghai Tower to the being titled as the second highest building in the world. Designing a building of this magnitude can arise challenges especially when detailing is involved for the various sections of the building. Hence stating that, BIM and creating digital twins can be utilized to their maximum potential in order to overlook the building in every aspect.

Utilizing BIM and Digital Twins in the Merdeka 118 project can be beneficiary to the numerous parties involved in many ways which mainly include:

1. **BIM Collaboration:** Several parties can witness live updates to the existing design at the same time, delaying any time lost between real hand created designs (Anon., 2021). Merdeka 118 team can achieve a better outcome by completing initial planning work more quickly, avoiding unnecessary delays that the project has already suffered.
2. **Cost Efficient:** Utilizing BIM prior to any actual onsite construction may settle any

disagreement that emerges between parties, causing adjustments to be placed into the design file rather than actual onsite alterations, which can be quite expensive (Reyes, 2020). A building of Merdeka 118 caliber can use this by ensuring that all party criteria are completed before construction begins.

3. **Waste Management:** Contractors that use BIM may gain a detailed understanding of the design's material needs, hence decreasing on-site waste and expense (Devarajan, 2019). Merdeka 118's location in an urban area may cause difficulties in the logistics of getting the material on site. As a result, understanding the material requirements ahead of time might aid in making proper logistical investments
4. **Performance:** Digital Twins determine opportunities to improve the systems of the implied design to reduce energy consumption and carbon loads along with outlining how the building performs comparing with real world data and overviewing the performance of the building in specified environmental conditions such as rain, humid etc.

CASE STUDY – Museum of the Future, Dubai

Museum of the Future is one of the most recent projects unveiled in the United Arab Emirates back in the first quarter of 2022. A modern day building with a stainless-steel façade showcasing a wonderful mixture of beauty and simplicity blending into the appealing skyline of Dubai.

The complex structure of the building shown in *Figure 2* was designed entirely on BIM. This allowed the parties involved to gain an overall understanding of where the building stands in design, construction and in the operational phase. BIM was utilized to deliver maximum optimization of the various technologies used within the building to achieve the LEED certification. (Montjoy, 2022)



Figure 2. Museum of the Future (Keogh, 2022)

Merdeka 118 is deemed a megaproject, needs utmost priority for design, implementation, construction and operational aspects. Applying a similar project path can benefit the project by detailing and designing the using a BIM software to gain a substantial understanding of the technical side of the building.

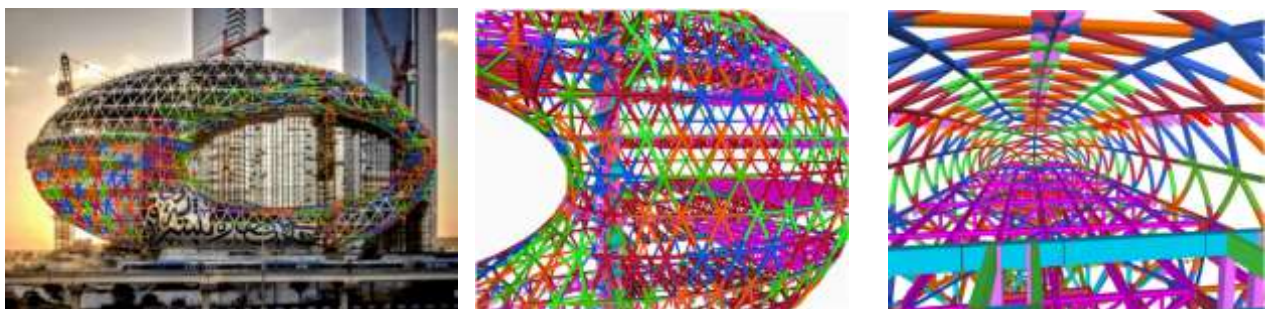


Figure 3. (left) Combination of BIM design and real-world design (middle and right) Image taken from BIM software (Montjoy, 2022)

Using the likes of Tekla Structures, a BIM software, the museum was detailed and designed according to the specifications with the proper technologies that were to be used in the building. The stills from the modelled design are as follows.

Business Case

Implementing BIM can aid in the understanding of the project better, with attention to details of every aspect regarding the project being easily digested by the contractors and clients. (Anon., 2022). From easy communication between the parties to the waste management of the construction site, future project management can save time by calculating each aspect of the project collectively instead of individually. Improving skillsets by understanding the modern solutions regarding the design stage.

Autodesk Revit is a BIM software covering every aspect of design and building services along with Rhino which has similarities with Revit in 3D modelling and engineering analysis. These specific software's simply the workload on specialists and the many parties involved within the project.

Autodesk Revit costs around \$2,800 annually with a Revit specialist can be hired for around \$150 per hour according to upwork.com or other opportunities arise in architectural engineering firms which provide an overall workload analysis. Rhino provides a single payment of around \$1000 with similarities to Revit in access to expertise.

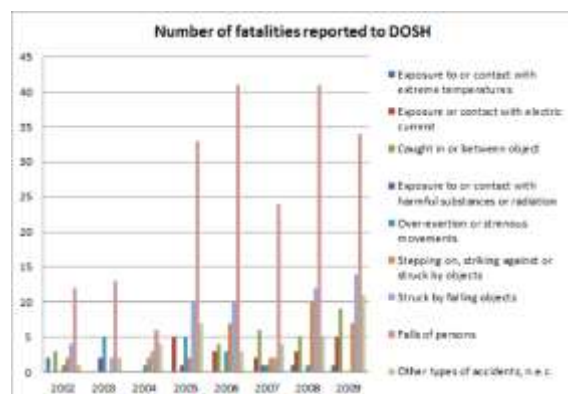
2.2. Recommendation B (Construction Stage – Virtual Reality)

Innovation Context - Virtual reality is a modern-day technology which allows a user to explore a simulated 3D environment. Replicating an idealized environment for a user to experience and interact with the world without physically interacting in the real world. Due to the fact that the simulated world is indeed a virtual reality, a user can experience and enter the 3D simulation remotely or in the work place via virtual headsets and handheld controllers.

Virtual reality can be implemented into a construction site, especially that of Merdeka 118. Being a high-rise building comes with its tests, mainly including health and safety. According to The United Nations' International Labor Organization, a staggering amount of around 2.8 million deaths are reported from construction site related aspects alone. Moreover, the highest number of fatalities have been reported by falling from heights (Warrier, 2019). It can be stated that this circumstance is based on the fact of not understanding the value of risk involved within a construction site. Going back to Merdeka 118, high rise buildings impose an even greater risk which exponentially increases as parts of the construction are completed hence, virtual reality can be implemented to properly understand the value of risk.

High rise buildings are exposed to higher risk levels due to extensive work and irregular shift timings during the day. The following are examples of the risks involved in Merdeka 118 from the most fatal to the least:

1. Falling from the high-rise floors of Merdeka
2. Electrocution from loose equipment cables
3. Crush Injuries by poorly maneuvered equipment
4. Caught between injuries from poor management in Malaysia (Syafiqah, 2018)
5. Crane collapse from poor placement and obstructions from neighboring sites around Merdeka
6. Fires from equipment such as welding on the Merdeka 118 site



7. Cancer causing particles originated from on-site asbestos generation mixing with humidity levels of Malaysia
8. Slips and trips from unorganized equipment by
9. Exhaustion by overworked laborers and hot climate issues in Malaysia
10. Heat Strokes from high humidity levels in Malaysia

Figure 4. Statistics of construction site accidents from 2002-2009 from DOSH, Malaysia (Abas, 2020)

All of the risks mentioned above are based from the United Nations International Labor Organization due April 2019. (Warrier, 2019)

Business Case

Construction workers and supervisors can be trained and briefed using virtual reality simulators. Walking around the virtual environment can assist labor in understanding and having an overview of the hazards, as well as how to decrease the risks properly. Having an onsite representative can help the labor and the many parties involved by providing a general understanding of the physicality of the danger.

The Innovation Technology Company (NNTC) is a UAE based company which provides modern solutions for virtual reality for health and safety in the construction industry. The company is a partner to globally recognized companies such as Helwet Packard Enterprises, Intel, VisionLabs etc. These global leading companies provide NNTC with top-of-the-line technologies which indefinitely improve the simulators.

The NNTC provides statistical field analysis on how the simulators benefit the construction industry in the health and safety department. It has been stated that 30% of the engineers have improved their speed and quality of work after undergoing training and briefing using the virtual reality simulators with 75% of management retaining their trust in the product provided proving the impact the health and safety department had from virtual reality. Statistics also prove that users have experienced a 96% accuracy rate from the simulators, suggesting that the awareness and understanding of the risk involved was accurately established. (Anon., n.d.)

Using the above information, a project like Merdeka 118 could implement this innovative idea to minimize the risk of fatalities and injuries. NNTC provides a virtual reality simulator for working at heights (*Figure 4*) which can be utilized in such projects for training purposes. The laborers can undergo this training to understand the basic risks involved and any potential risks that they can be exposed to within the construction site. The program can also provide solutions to the risks and how to minimize those risks.



Case study

Objective: Find a training solution for reducing injuries when working at heights and lifting operations, a compact and user-friendly instrument for testing knowledge and training workers in the field

Solution: Pre-project assessment and development of a VR simulator for training and testing safety knowledge on working site

Outcome: The simulator enabled effective training and testing of workers' knowledge at construction sites

Figure 5. Image taken straight from NNTC website showcasing the simulator to prevent fatalities from falling from heights. Left image shows the virtual reality environment used for training. (Anon., n.d.)

After discussing how to minimize the risk for the highest number of fatalities in the construction

industry, the Merdeka 118 project can also utilize the virtual reality simulator for working with electricity (*Figure 6*) to undergo training to prevent risk of electrocution being the second most fatal cause of injuries and fatalities. Merdeka 118 is home to many modern-day solutions requiring electrical works to take place within the construction site, hence a simulation training for working with electricity is deemed necessary to prevent unwanted injuries.



Case study

Objective: Find a more effective training solution for electric staff training

Solution: Pre-project assessment, development of functional and technical requirements, simulator feasibility study, VR simulator development and testing

Outcome: The project showed to the company's top management that such VR simulator will boost the electrical engineering training efficiency and, if scaled to multiple locations, will cost much less than its physical alternative

Figure 6. Left image showcases the actual simulation in which laborers can undergo training of working with electricity. (Anon., n.d.)

Virtual reality in a construction site can prove to be beneficial for future projects before starting construction works. Adding value to the project by taking initiative in health and safety of the parties involved. Virtual training simulators will improve the understanding of laborers of the various risks involved in the site and how to counter them.

Future projects implementing virtual reality can experience an increase in communicating and awareness skills on site, leading to higher quality work outputs. Implementing virtual reality can cause time constraints as training laborers takes time however, it can be deemed as an investment for further projects.

Limitations

Cost considerations include a minimum expenditure of \$20,000 and a maximum of \$150,000 or even more. Hourly charges for constructing a simulator from a professional with industry knowledge might range from \$200 to \$300/hour. Despite having a strong capital base, the building sector, parties participating in a design project may decide not to use such technology due to the dangers associated. Workers taking this kind of training may struggle to learn and comprehend the simulator, which may reduce their productivity at work. Time management is crucial, especially in a tall structure like the Merdeka 118, and ineffective training practices might cause unwanted delays. (Day, n.d.)

These constraints are not overwhelming and can be overcome with a strong project management team and advance planning on how to deal with such scenarios.

3 Conclusions

To conclude the discussion relating innovative ideas for the Merdeka PNB 118 project, it can be stated that the provided solutions are step into revolutionizing the whole construction industry.

Using BIM and Digital twins to create a project within a software to simulate real world scenarios to determine the chosen technologies for the building function accordingly. Adding value by obtaining accurate readings pathing the way to develop and construct the building appropriately. It also helps the parties involved gain a technical understanding of the way the project has the potential to be a success.

Stepping into virtual reality to improve health and safety conditions to counter fatalities and severe injuries. After discussing the most fatal type of injuries, virtual reality simulators can aid site supervisors to examine the site for any risk for injuries and modify accordingly. The laborers can be trained on how to keep safety as a top priority when it comes to construction. Providing a healthy workplace satisfying every party by reducing any risk for injuries, moreover, reducing the risk of legal issues such as lawsuits.

Practicing such strategies can impose reflections of professionalism and allow more projects to adapt to such strategies. This can lead to more technologies for the construction industry especially in the health and safety department.

(2743 Words)

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Bibliography

- Abas, N. H., 2020. *Accident statistics (based on types of accidents) in construction industry reported to DOSH for the year 2002-2009 -Fatality..* [Online] Available at: https://www.researchgate.net/figure/Accident-statistics-based-on-types-of-accidents-in-construction-industry-reported-to_fig1_342353090 [Accessed 31 03 2023].
- Anon., 2014. *Falling from heights in construction - to be prevented.* [Online] Available at: <http://digitalforest2014.blogspot.com/2014/03/falling-from-heights-in-construction-to.html> [Accessed 30 03 2023].
- Anon., 2021. *BIM collaboration: how BIM helps a project from concept to operations.* [Online] Available at: <https://biblus.accasoftware.com/en/bim-collaboration-how-bim-helps-a-project-from-concept-to-operations/> [Accessed 30 03 2023].
- Anon., 2022. [Online] Available at: <https://thetowerinfo.com/buildings-list/merdeka-pnb-118/>
- Anon., 2022. *How BIM Is Changing The Construction Industry For The Better: My Views on The Future of Architecture and Engineering.* [Online] Available at: <https://plannerly.com/how-bim-is-changing-the-construction-industry/#:~:text=Improved%20Coordination%3A%20One%20of%20the,working%20towards%20the%20same%20goal.> [Accessed 31 03 2023].
- Anon., n.d. [Online] Available at: <https://nntc.digital/health-and-safety-trainings-in-vr/>
- Bernama, 2020. *Merdeka 118 project back on track after MCO delays.* [Online] Available at: <https://www.nst.com.my/news/nation/2020/10/635092/merdeka-118-project-back-track-after-mco-delays> [Accessed 28 02 2023].
- Day, N., n.d. *Cost Of Custom Virtual Reality Training: Full VR Price, Cost Factors, And Benefits* [2022]. [Online] Available at: <https://roundtablelearning.com/cost-custom-virtual-reality-training-full-vr-price-cost-factors-benefits-2022/> [Accessed 28 02 2023].
- Devarajan, S., 2019. *How BIM Reduces Waste ?.* [Online] Available at: <https://www.linkedin.com/pulse/how-bim-reduces-waste-sandya-devarajan/> [Accessed 30 03 2023].
- Editorial, C., 2022. *Save The Date: Architecture Projects Unveiling in 2022.* [Online] Available at: <https://www.cobosocial.com/dossiers/design/save-the-date-architecture-projects-unveiling-in-2022/> [Accessed 28 02 2023].
- Hamil, S., 2021. *What is Building Information Modelling (BIM)?.* [Online] Available at: <https://www.thenbs.com/knowledge/what-is-building-information-modelling-bim> [Accessed 25 02 2023].
- Keogh, L., 2022. *Dubai's Museum of the Future: how to visit and get tickets.* [Online] Available at: <https://www.timeoutdubai.com/news/dubai-museum-of-the-future-visit> [Accessed 28 02 2023].
- Khansaheb, A., 2021. *The construction industry needs a revolution to survive.* [Online] Available at: <https://www.arabianbusiness.com/opinion/comment/468916-the-construction-industry-needs-revolution-to-survive> [Accessed 28 02 2023].
- Modabber, H., n.d. *Digital Building Twins.* [Online] Available at: <https://www.boschbuildingsolutions.com/x/en/news-and-stories/digital-building-twins/#:~:text=A%20digital%20building%20twin%20is,components%20and%20implement%20new%20services.>

[Accessed 26 02 2023].

Montjoy, V., 2022. *Overcoming Design Challenges with Technology: Museum of the Future in Dubai*. [Online]

Available at: <https://www.archdaily.com/983458/overcoming-design-challenges-with-technology-museum-of-the-future-in-dubai>

[Accessed 28 02 2023].

Panel, E., 2021. *13 Cutting-Edge Technologies That May Soon Be Making A Big Impact*. [Online]

Available at: <https://www.forbes.com/sites/forbestechcouncil/2021/02/04/13-cutting-edge-technologies-that-may-soon-be-making-a-big-impact/?sh=4eb06b4e8ae8>

[Accessed 24 03 2023].

Reyes, N., 2020. *Top 5 Benefits of BIM Construction*. [Online]

Available at: <https://hmcarchitects.com/news/top-5-benefits-of-bim-construction-2020-05-13/>

[Accessed 30 03 2023].

Syafiqah, S. N. A., 2018. *Impacts of poor management on construction project in Malaysia*. [Online]

Available at: <http://malrep.uum.edu.my/rep/Record/my.ump.umpir.27692/Details>

[Accessed 31 03 2023].

Warrier, R., 2019. *Top causes of global construction fatalities, and how to avoid site risks*. [Online]

Available at: <https://www.constructionweekonline.com/people/training/255830-top-10-causes-of-construction-deaths-and-how-to-prevent-site-accidents#:~:text=Falls%20are%20among%20the%20most,scaffolding%2C%20ropes%2C%20or%20ladders.>

[Accessed 26 02 2023].