Building Information Modelling (BIM) Implementation for Highway Project from Consultant's Perspectives in Malaysia

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Abstract: In today's world, Building Information Modelling (BIM) is not a new term in the construction industry. Although BIM has been adopted in the AEC industry for a few decades now, the BIM implementation cultivation pace between developed countries and developing countries such as many European which considered as BIM leaders and some Asian countries has still shown significant differences. In Malaysia, there are several remarkable building projects with BIM utilization but very limited in road and highways project. Despite BIM capabilities in facilitating designers during design stage, BIM implementation are still considered unfavourable within the highway design consultants in Malaysia. Many firms seem reluctant to migrate from their traditional 2D drafting centric design process to BIM design process due to several reasons such as high cost in software investment, inadequate knowledge and expertise on BIM and lack of promotion from the government or relevant authority. Although BIM can benefit the project throughout its life-cycle from preliminary to operation and maintenance stage, the coordination and integration during design stage can contributes to positive impacts in progressing towards efficient construction documentation and construction stage. BIM 3D integrated modelling during design stage (conceptual and detailed design) are deemed to facilitate a highway project in terms of optimization through early visualization, design for constructability, road safety enhancement, reduce error and time consumption during construction and early clash detection. Therefore, this paper is intended to gather preliminary outlooks and views from the present practitioners in the highway industry on challenges encounters by consultants using the current traditional design practices, BIM capabilities in transforming the current design approach and BIM adoption barriers in Malaysian highway industry. Series of interviews were conducted with the professionals involved in highway projects especially during the design stage and based on the findings from the interviews conducted, all highway design consultants from various disciplines are aware on how BIM can tackle the challenges of current traditional design practice with 3D modelling approach and collaborative working environment. Although the results showed that highway consultants are willing to migrate to BIM workflow, cost and lack of expertise, urges from government and understanding on BIM are among barriers which hinder the BIM adoption in highway industry.

1. Background

Construction industry has grown rapidly throughout the decades particularly in developing countries. Productivity, quality and value of a project can be maximized by promoting technological adoption in the construction industry [1]. BIM can be simply defined as a process or workflow with collaborations tools to design, analyze, construct and manage a project [2].

While developed countries has shown active inclination in adopting BIM, developing countries are still at the infancy phase due to several drawbacks. For instance, many European countries can be considered as BIM leaders such as Finland, Denmark, Sweden and even Singapore and Hong Kong where their BIM implementation pace has been moving rapidly. In developing countries such as Africa and Nigeria, level of BIM awareness and adoption is relatively low [3]. In Asian countries on the other hand, has also show either almost less or none in BIM implementation in some of the regions [4].

There is no doubt that the application of BIM in a building industry is expanding every day, however, the adoption in the infrastructure and transportation industry is still limited and lagging [5]. Although the construction industry and academia has consistently making effort in promoting BIM application other non-building civil infrastructure field, yet, there is lacking of comprehensive review and publication specifically focus on transportation industry. A research conducted also shows the significant increase of reviewed publication on BIM potential in infrastructure from year 2002 to 2017 [5]. Hence, it fairly can say that, nonetheless, the application of BIM in infrastructure has gathered the attention of the players in the construction industry until today.

The first highway project in Malaysia using BIM is the Pan Borneo Highway in the Malaysian State of Sarawak in Borneo Island which adopt Highway Information Modeling (HIM) which combines the Geographical Information Systems (GIS) with BIM as their main Integrated Project Management System. One of the issues encountered is the project visibility which includes physically monitoring the project progress for the whole project which transverse along highway stretch is time consuming and requires high resources. The incorporation of three-dimensional (3D) parametric model with geospatial datasets has managed to develop the Pan Borneo Highway project from the preliminary-design-construction and operation and maintenance of the highway including the highway asset management [6]. Despite the fact that there a distinctive difference in vertical (hospital, schools etc.) and horizontal (road, highway, tunnel etc.) construction in terms of the process from planning to construction, legal and contractual issues, and even cultural management, it is fair to say that by implementing BIM in the right directions at each project stage can unlock the full potential of BIM [5].

2. Literature Review

2.1. The concept of BIM

Every construction project has its own unique nature which relatively subjected to risks and uncertainties. These uncertainties have to be tackled in order to achieve the standard quality level within allocated budget and time. Poor project performance has higher tendency in leading to cost overruns and project delay. Hence, throughout the research for past years, researchers have attempted to discover various technologies with the intention of controlling these uncertainties, of these where BIM has been proven as one of the best practices.

As part of emerging technology which has been globally employed in the construction industry to date, there are still many misperceptions in understanding the accurate definition of BIM. According to National Building Information Modelling Standard (NBIMS), BIM can be defined as

"An improved planning, design, construction, operation, and maintenance process using a standardized machine-readable information model for each facility, new or old, which contains all appropriate information created or gathered about that facility in a format useable by all throughout its lifecycle". [7]

Generally, it is not a piece of software but more of a way of working throughout the whole process. According to Azam Haron N et al. (2017) also outlined diverse definitions of BIM which generally concluded BIM as a software model which can be used throughout project life-cycle and can benefit project stakeholders to ensure project success [8].

2.*2. Causes of Delays in Highway Project*

There are several studies and researches worldwide that has been conducted in indicating the factors that leads to a successful highway project throughout its project life-cycle from planning to construction stage. A project completion without time and cost overruns as well as satisfying the required quality standard can be considered as a successful project [9]. However, the defiance of these successful factors

will cause negative impacts on the project progress and performance e.g. delays, cost overruns, poor quality, variation orders which are shown in Table 1 based on several studies conducted.

Table 1. Summary of causes of delays in highway project based on countries.

Country	Summary of Causes of Delays in Highway Project	Sources
Saudi Arabia	Change orders by owner during construction, consultant's and contractors' performance, delay of progress payment by the owner	[9]
Thailand	Incomplete drawings, contractor's incompetency in terms of resources and financial, and delay in original infrastructure structures relocation	[10]
Pakistan	Competency of project management team, effective site management, involvement from all parties within the project and also the proficiency of the design team	[11]
Malaysia	Workflow for the design process, competencies of project managers, availability of workforce, availability of materials	[12]

Both academia and practitioners has been investigating on topics related to infrastructure and highway transportation field. Based on these researches, it is apparent that designers or consultants play one of the major roles during design stage towards a successful highway project. According to Cooperative Research Centre (CRC) for Construction Innovation (2007), BIM for road and highway projects are capable to foresee the project performance prior to construction, faster communication on design changes, design optimization, visualization and simulation of the whole project, and also high quality and efficient construction documentation [13]. Hence, it is essential to explore the challenges and disputes faced by the consultants during design stage which influenced to poor performance in a highway project in Malaysia and how BIM can facilitate the challenges.

2.3. BIM Adoption in Transportation Infrastructure (Roads & Highways)

As BIM implementation is not restricted only to structural design, the road and highways industries shall also be benefited from the advantages of BIM implementation. Each level of stakeholders shall be able to experience the full potential of BIM from preliminary design to operation and maintenance stages of a roads or highways project. Although BIM has widely been utilized in building industry, the technology has shown huge potential in advancing transportation infrastructure [5].

One of the significant examples of successful infrastructure project in adopting BIM is by the Wisconsin Department of Transportation (WisDOT) is now has led the movement towards implementing 3D modeling as their core approach in roadway construction. Among their successful projects involved BIM adoption are the Zoo Interchange, west of Milwaukee (1.7 billion project) and Mitchell Interchange. Zoo Interchange which was completed in year 2018, the use of parametric 3D models has provided a firm foundation for the project to move forward in using 4D modelling (staging and scheduling), 5D (cost information) and also 6D (as-built, operation & maintenance). Another significant benefit gained through 3D modeling is the clash detection which helps in reducing the future change orders and design issues [14].

On the other hand, originally WisDOT have developed the design of Mitchell Interchange through traditional 2D CAD design. However, near completion of the project, they have generated the 3D models in order to investigate the potential impact on design modelling versus the cost saving. They have concluded that the project could have saved up to $9.5 million if 3D modeling has been implemented during the preliminary stage. [14]

2.4. Benefits of BIM in Highway Construction Project: Design Stage

In line with the aim of this paper, further evaluation will be given to assess the benefits of BIM adoption during design stage. Based on previous researches and studies, highway construction industry can gain similar benefits from BIM adoption in building construction.

Referring to subsection 2.2, it is quite clear that design phase in a highway construction can be considered as vital stages which can contributes to smooth and effective project progress. According to Anderson. R (2010), he has outlined the comparisons between traditional design approaches versus designing using technological advance such as BIM workflow through "MacLeamy Curve" as shown in Figure 1 [15]. This curve indicates that the by shifting to BIM workflow, the highest level of effort, effect and time shall be given during the detailed stages. This approach will impact the project performance at higher level and the cost of overcoming design changes is low. Therefore, it is costly and time-consuming to make design changes after the construction documentation started. Figure 1 also clearly shows why it is important to emphasis on efficient and coordinated design stage and how this approach can affect the overall project progress.

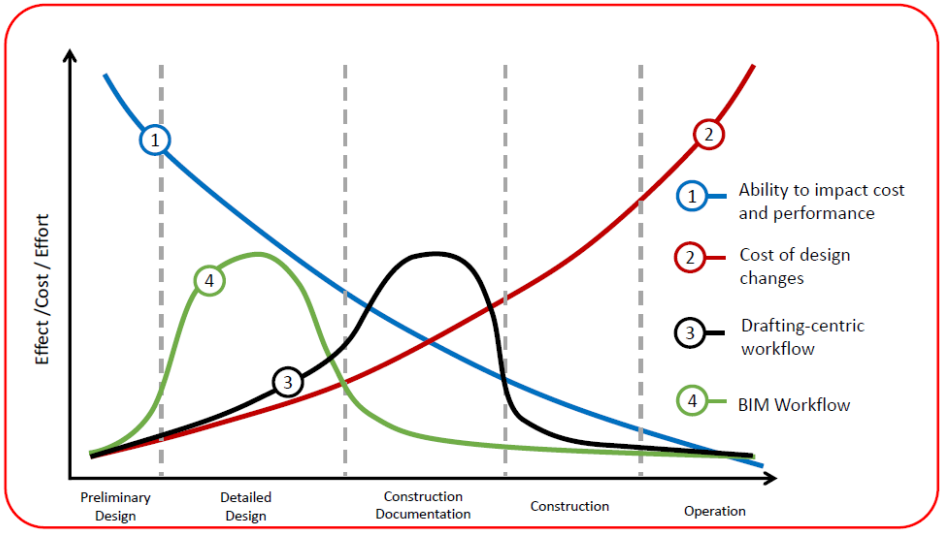


Figure 1. 'MacLeamy Curve' on BIM workflow [15].

2.4.1. Optimization through Early Visualization. During preliminary or planning stage, different alternatives will be evaluated and assessed in order to achieve the optimum alignment. Shetwi et al. (2015) has demonstrated from their research on the Champlain Bridge in Montreal, Canada which uses three levels of BIM: 3D visual, 4D schedule, and 5D cost estimations [16]. The editable realistic rendered 3D model has been used as the basis for visualization which helps the owners, engineers and even the contractors to decide on the form and aesthetics of the project. As most of the proposed highway in the city or urban area nowadays are elevated, visualization through 3D model is useful to envision the alignment as well as helps with early judgement on the pier's location and land acquisition evaluation.

2.4.2. Design for Constructability. BIM allows designers to design for constructability which helps to reduce the mistake before it become a problem [17]. An example of design for constructability is determined by [18] where they have integrated the Bridge Information Modeling (BrIM) with a hybrid model in order to locate the suitable location for mobile cranes placement during bridge construction. Additionally, the constructability and mobility plan of interfacing between two highways can also be tackled by BIM implementation.

2.4.3. Road Safety Enhancement. Another important aspect in highway designs is the road safety features. Passing and stopping sight distances is one of the crucial elements in highway designs. The visual obstruction and horizontal layout can be assessed through interactive visualization and sight distance simulation. Thus, further safety measures can be taken into considerations as well as ensuring the road geometry satisfying the critical safety parameters [17].

2.4.4. Reduce Error and Time Consumption during Construction. As 3d modelling in BIM results with a model with rich attributes and functional datasets associated, any changes can be made at earlier stage for instance halfway through the project, the alignments need an adjustment in vertical profile, and hence by adjusting the profile in the 3D model, all related elements will be updated automatically. Designers will be able to see the impact of the adjustment for example to the cut-and fill as well as the right of way [17].

2.4.5. Earlier Design Clashes Detection. Another key value of BIM adoption is the ability to detect clashes from all the integrated disciplines through model coordination. Clash detection process helps to resolve design issues prior to construction stage and contributes to cost-saving value to the project [19]. Despite the significant and noteworthy capabilities on how BIM can change the game of transportation and infrastructure industry based on the previous studies researches, the number of available literatures which specify on BIM adoption in highway industry are still lacking. Hence, it is crucial to gain the insights on the current situation on BIM implementation in Malaysia particularly from the practitioners in the actual highway industry perspective.

3. Research Frameworks and Methodology

The objectives of this paper are to gather preliminary outlooks and views from the present practitioners in the highway industry on;

- Challenges encounters by consultants using the current traditional design practices
- BIM capabilities in transforming the current design approach
- BIM adoption barriers and future in Malaysian highway industry

3.1. Methodology

Extensive literature review through current publications and sources will be executed in emphasizing the benefits of BIM adoption in highway project. Most of the data were collected from various sources such as books, journal articles, international conference papers, and materials available on the Internet.

However, semi structured interviews also were conducted in order to gain deeper information and perspectives from the highway industry practitioners from various disciplines in achieving the research objectives. A series of questions were outlined in order to get their insights based on the research objectives. All data gained were recorded, transcribed, and analyzed using content analysis and representation through text, images, as well as expressions.

3.2. Research Frameworks

The first steps taken was by outlining the structure of this paper. Figure 2 shows the basis of this paper on achieving the research objectives.

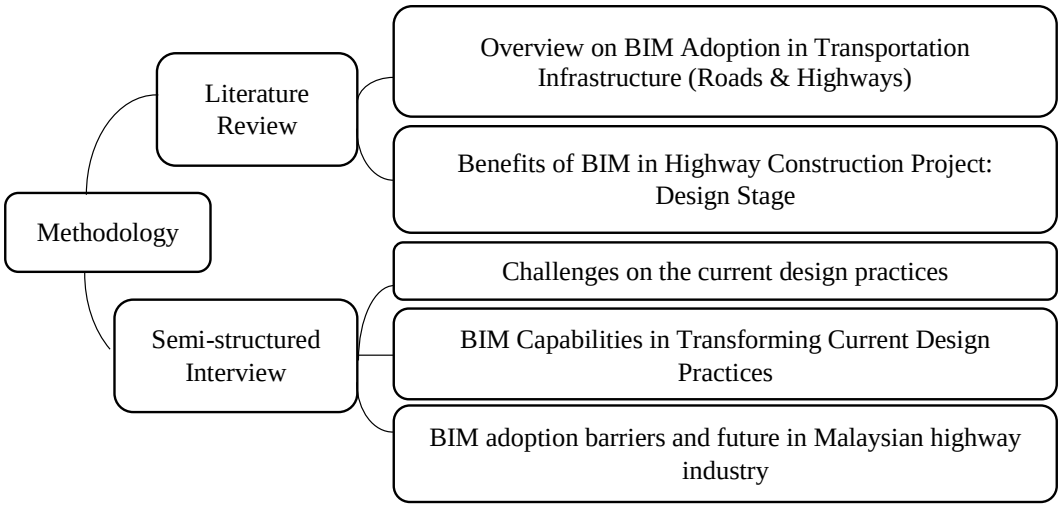


Figure 2. Proposed research frameworks.

As part of the one of the main intentions is to evaluate how BIM can change the paradigm of the current design practices in a highway project, it is crucial to understand how each discipline involves in a highway project deliver their design practices as well as ensuring precise, integrated and satisfactory information can be established in the final design as their approach and tools or software may vary.

In the United States of America (USA), Findley et al. (2015) indicates that their current design practices allow for flexibility in applying the design principal which varies by region, agency and individual. Additionally, Findley et al. (2015) also indicated that the existing highway design practices are not formally documented and typically inherited from earlier generations accumulated with the knowledge from the industry [20].

However, in the United Kingdom (UK), the design manuals and standards does not indicate how to design highways but the information highlighted are rather explained on the general quality assurance (QA) principles related to highway design, roles and responsibility and the procurement of quality plans and records. The manual [21] also indicated on the requirement on pavement design, geometric design, geotechnical design, landscape and road furniture.

Figure 3 illustrated below has been developed in presenting the typical workflow involving the general multi disciplines involved in a highway project from conceptual stage to production of tender or construction documents. This typical workflow was developed based on the information provided from [22-23] and also expert reviews from some of practitioners in highway industry in Malaysia. In order to gain deeper insights from the respondents, Figure 3 will be used part of the interview as basis in obtaining respondent's views on identifying the gaps or challenges on the current design approach by consultants in highway project.

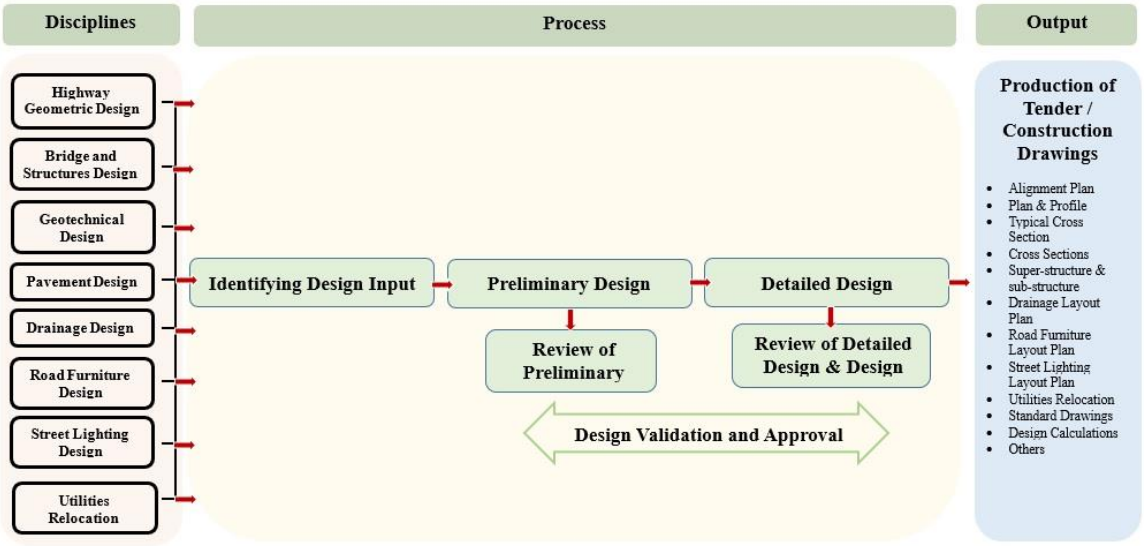


Figure 3. Summary of typical design practices in highway project in Malaysia.

4. Results and Analysis

The results and findings from the semi-structured interview conducted will be further discussed in this section and it shall provide an overview on the current BIM situation in Malaysian highway industry from consultant's perspective. Results and findings from the interview were categorized into four (4) subsections as follows:

- Respondent's profile and background
- Challenges on the current highway design practices
- BIM capabilities in transforming the current highway design practices
- Limitations and barriers on BIM implementation for highway design companies

The results from this exercise are deemed to be valuable in understanding the current BIM situation especially in highway industry in Malaysia and encouraging highway consultants in transitioning to BIM-based design workflow.

4.1. Respondent's Profile and Background

The respondent groups for the interview were divided in two (2) categories: A) design consultants who are yet to utilize BIM and B) design consultants with experiences utilizing BIM in any road or highway projects. Align with the objectives of this study, the respondents were selected based on their involvement within the general disciplines involved in a highway project during design stage. For each group, three (3) respondents were selected and interviewed for their insights and respondent's demographic are summarized in Table 2.

Table 2. Respondent's demographic.

Category	Respondent	Position in Organization	Experience in Highway Industry (years)	Experiences with BIM (years)
A	1	Engineer	7	-
	2	Senior Engineer	20	-
	3	Director	> 30	-
B	1	BIM Modeller	6	< 1
	2	BIM Coordinator	8	3
	3	BIM Consultants	6	9

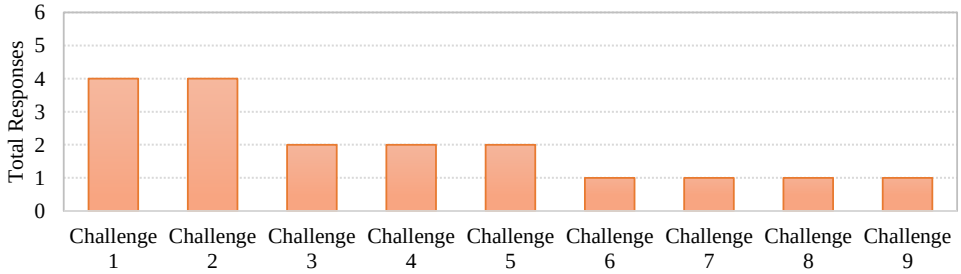
Based on Table 2, all respondents from category A and B possessed experiences and involvement in a highway project from various disciplines with experiences in highway industry ranging from 7 years to more than 30 years. As level of BIM implementation for highway project in Malaysia are very low, respondents' experiences in using BIM specifically for highway project from category B is considered still very limited where it only ranges from less than 1 year to 9 years. The experiences possessed on BIM by respondents from category B generally involved in building projects or other infrastructure project such as mass rapid transit project (MRT) and only limited experiences on BIM for highway project. It is significant to perceive the respondent's input from different highway background as it will shows different level on BIM awareness, understanding and adoption.

4.2. Challenges on the current highway design practices

As Figure 3 was used as a basis in representing the typical workflow between multi-disciplinary involved in a highway project during design stage, respondents were asked if they agreed on the figure illustrated. All respondents agreed that Figure 3 exemplified the typical approach used in their workflow during design stage of a highway project based on the nature of their organizations and experiences.

Based on the interview, the main challenges faced during the design stage of a highway project is the non-collaborative working environment between disciplines as highway projects generally involved input from various disciplines as shown in Figure 4. The process which described by Strafaci (2010) as "siloed" where the steps from preliminary design to detailed design to construction documentation only starts once each step completed with minimal collaboration [17]. This followed by the likelihood of design changes in highway project are higher.

Design changes are also one of the most common issues which caused conflicts and disputes between disciplines which are then led to further delays in overall project progress [9-12]. Respondent A3 also mentioned that as horizontal construction such as highway project typically transverse across different site conditions such as various types of terrain, requirement for land acquisitions, etc. thus, multiple design changes typically due to client's or relevant authority request may affects most of the disciplines design progress. Other challenges are summarized in Figure 4. Based on the findings from the Figure 4, it fairly apparent that there is the need to improve and transform the traditional highway design process towards efficient and sustainable process

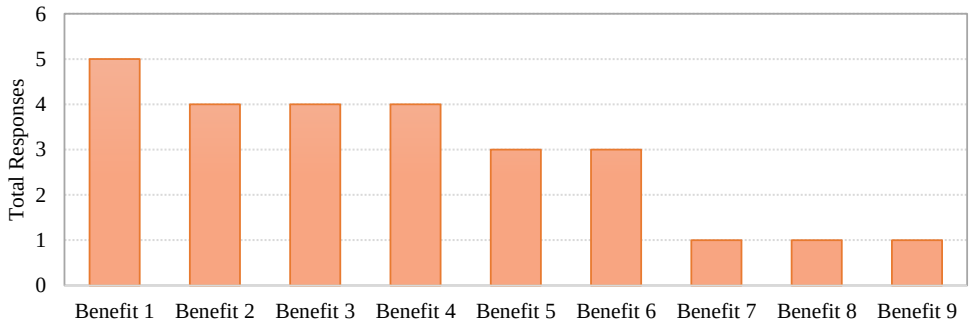


Challenge 1 - Non-collaborative workflow between disciplines
Challenge 2 - Likelihood of design changes during construction are higher
Challenge 3 - Risks of design conflicts in between disciplines are higher
Challenge 4 - Information on any design changes and updates from other disciplines are easily missed out
Challenge 5 - Lack of design integration and constructability between disciplines
Challenge 6 - Ineffective and non-integrated information sharing process between disciplines
Challenge 7 - Too many amount of paper printing
Challenge 8 - Manual drafting is more error-prone
Challenge 9 - 2D drawings provide insufficient information

Figure 4. Summary of challenges on the current highway design practices.

4.3. BIM capabilities in transforming the current highway design practices

As BIM is widely known as technological advancement in construction nowadays with several successful implementation in road and transportation projects across the globe, BIM it deemed to be capable in transforming the current highway design practices.



Benefit 1 - 3D model provide better visualization and understanding for all stakeholders
Benefit 2 - Coordinated and collaborative working environment between disciplines
Benefit 3 - Design optimization can be done earlier to avoid design changes during construction
Benefit 4 - Risks of design conflicts can be reduced through clash analysis
Benefit 5 - Design constructability prior to construction stage
Benefit 6 - Automated correction within the 3D model software
Benefit 7 - Centralized and efficient information sharing and accessibility between disciplines
Benefit 8 - Project members able to keep updated on any design changes through shared model
Benefit 9 - Less paper printing

Figure 5. Summary of BIM capabilities in transforming the current highway design practices.

Figure 5 shows the summary of BIM capabilities in transforming the current highway design practices. Based on the interview, the first BIM capabilities in highway design corresponded by almost all of the respondents are the 3D modelling application in providing better visualization and understanding of the projects to all project's stakeholders followed by the collaborative working environment between disciplines and preliminary design optimization to avoid design changes. Generally, the responses from the interview are streamlined with the BIM capabilities highlighted in the previous study [5,17].

Respondent A1 stated that the application of 3D model will helps project teams to obtain clearer picture on the project and also for better comprehension on the highway impact especially to the relevant authorities and public during preliminary stage as also mentioned by respondent A3 and B3. As a highway project especially, urban highway has higher tendency to transverse across developed and populated area, it is crucial for project team members to be able to tackle the public resistance and convince all the affected authorities. In comparison to the current approach of presenting the alignment in 2D CAD drawings, 3D models of the project are easier to be understand and comprehended including for those with limited proficiency in interpreting 2D drawings [24]. Visualization will also help designers to improve road safety features such as road geometric, sight distance and road furniture positioning which sometime may be overlooked through 2D drawings [24]

Secondly, most of the respondents also agreed that another valuable BIM attributes for highway project are the ability of all disciplines to work in coordinated and and collaborative working environment. Respondent B3 and B2 specified that by implementing BIM in highway project, all disciplines can work in a single streamline and communicate on single platform. Hence, any required changes or information can be accessed and delivered at rapider pace.

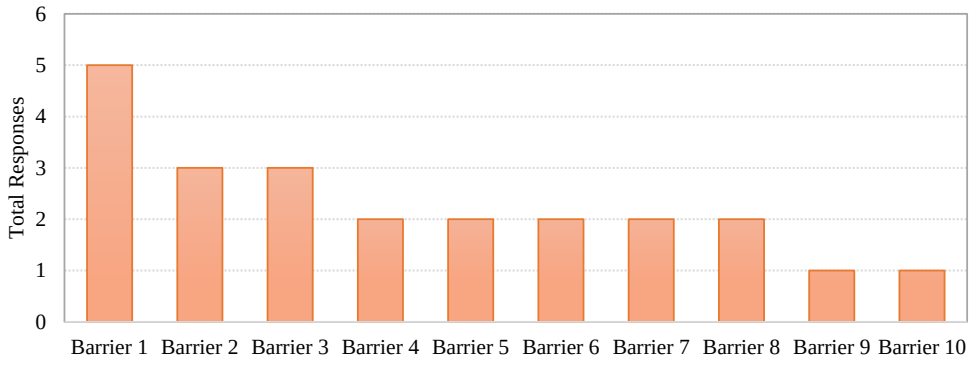
This attribute also relatively corresponded to the BIM ability in transforming one of the most crucial issues in highway design which is design changes as mentioned in previous section. Application of BIM technology can reduce design changes during construction stage can be reduced by executing design optimization earlier during design stage. Tackling design issues in earlier stage will facilitate the project team to firm up the conforming design which shall lead to lesser design changes during construction. This is also in line with the MacLeamy curve shown in Figure 1 which signifies the significance of focusing on design stage can results in time and cost-effective construction delivery [17].

Another prominent BIM attribute corresponded by majority of the respondents is the ability to carry out clash analysis which can lessened the risks of design conflicts especially between disciplines. Respondent B2 also mentioned that the 3D model integration can also provide better presentation of the clashes. Similarly, in order to undertake amount of design changes, BIM capabilities in conducting clash analysis and design optimization during the design stage as agreed by the respondents are seen as one of the effective ways to reduce design changes especially once the construction commenced. This somehow will reduce additional cost incurred and contributes to smoother and on-time project delivery.

Moreover, BIM also is deemed to facilitate highway design stage by accelerating time consumption for design changes by automated correction within 3D software model and also through design constructability prior to construction stage as it enables consultants to construct the highway virtually with data rich and intelligent 3D model [25].

4.4. Limitations and barriers on BIM implementation for highway design companies

Parallel with the findings from study conducted by several researches on factors contributing to impediments of BIM adoption in construction industry Malaysia [1, 26-27], the results from interviews conducted likewise reveals quite similar results. Results are illustrated in Figure 6 below which summarized responses on the limitations or barriers in implementing BIM for highway project from highway design consultant's perspective.



Barrier 1 - BIM software and hardware are too costly
Barrier 2 - High investment on resources and manpower
Barrier 3 - Limited urges and initiatives from the government and relevant agency
Barrier 4 - Lack of expertise and skills in highway industry
Barrier 5 - Lack of understanding on BIM concept and capabilities
Barrier 6 - Minimal involvement from all project members
Barrier 7 - Organizations reluctant to provide trainings due to high tendency of trained team members leaving the organisation
Barrier 8 - Transitioning to BIM technology may takes longer times
Barrier 9 - Lack of commitment for extensive trainings and seminars
Barrier 10 - Unwillingness to shift from current workflow

Figure 6. Limitations or barriers in implementing BIM for highway project

Figure 6 shows that higher cost for BIM technology, resources and manpower, limited initiatives from government and relevant agency, lack of BIM expertise and lack of understanding on BIM concept are the top five challenges agreed by the respondents. The limitation and barriers agreed by the respondents are also correlated with the study conducted by Roslan et al. (2019) and Yaakob et al. (2016) which classified the factors which contributes to hindrance of BIM adoption in Malaysian construction industry into four (4) general categories: i) People, ii) Technology, iii) Process, and iv) Policy [28-29]. It can be observed that the challenges faced by industry player in shifting from their

common practices into new technological advance constantly revolves around these four main factors including the highway industry.

The results from the interview are consistent with the recent study by Yung et al (2020) which also reveals similar challenges in BIM adoption for road industry in Malaysia [30]. BIM adoption requires upgrading of IT system with BIM enabled software as well as providing relative resources and training. Thus, this would greatly impact the cost and company's return of investment (ROI) will be re-evaluated. BIM incentives such as free training shall be further enhance for highway project which is deemed to increase the level of awareness and intensifies the adoption rate [30].

Respondents has also agreed that limited urges from the relevant authorities are among the BIM adoption challenges for highway project in Malaysia. Public Work Department (PWD) PWD has mandated BIM for any public construction projects worth more than RM 100 million value [31]. However, the requirement for private projects is still lagging as it is commonly depending on client's demand. Thus, this has reasonably contributed to the slow adoption rate as industry players are still reluctant to invest as it is not wholly compulsory yet as per implemented in other BIM leading countries like USA, UK and European countries [32]. Therefore, it is significant for the government and authorities to look into these challenges and further developing a strategic planning in promoting BIM for highway industry.

It is also important for industry players and professionals from all level to understand the concept of BIM and its capabilities in transforming the highway design. In year 2014, Malaysia's authority like Jabatan Kerja Raya (JKR) has established Garis Panduan dan Piawaian BIM JKR and Garis Panduan Pengunaan Template JKR which can suit several of projects. Malaysian Highway Authority (MHA) has also started to look into BIM application for highway project and the midst of data collection but yet to execute any further initiatives. As BIM is relatively new for highway project in Malaysia, there is also the need to introduced more pilot projects to invite more participation from private sector as what has been done in Singapore and Hong Kong [33]. For instance, currently Pan Borneo Highway is one of the projects that has set a benchmark in leveraging the BIM adoption for highway project. Thus, this approach will somewhat gradually increase the numbers of expertise in the field as well as expand the exposure to BIM capabilities among designers. Sinoh et al. (2020) has also recently indicates the roles of government as one of the solutions in undertaking the impediments factors of BIM adoption through expanding BIM competency in the industry, promoting BIM awareness and also BIM deployment in higher learning education [34].

5. Conclusions

This paper reveals that BIM capabilities in changing the direction of highway industry from the highway design consultant's perspective. As the adoption in highway industry is considered quite new, the numbers of consultants who are using BIM tool and software in designing highway projects are very limited. Based on the findings from the interviews conducted, all highway design consultants from various disciplines are aware on the BIM technology and willing to migrate from their current design practices towards BIM design workflow.

The results shows that the top three challenges of the current highway design practices are non-collaborative workflow between multi disciplines, higher likelihood of design changes during construction and risks of design conflicts between disciplines. BIM technology on the other hand has the capabilities in transforming the current highway design process towards providing better visualization through 3D modelling, coordinated and collaborative workflow between multi-disciplines, and ability to perform design optimization and clash analysis prior to construction phase. However, BIM adoption in highway industry in Malaysia from consultant's perspective has been hindered due to the high cost of BIM enabled software and hardware as well as high investment on resources and manpower and limited urges from the government and relevant authorities. These data are deemed to be the significant in understanding the current BIM implementation aspects among highway designers.

In summary, although the utilization is not very common within the highway industry in Malaysia with diverse limitations and barriers, players in the industry are now has starting to recognize its

potentials and slowly has steering the industry towards more technological and digitalization advancement. As highway projects nowadays has become more challenging and complex, relevant authorities has also begin to initiate the BIM adoption in for highway projects in Malaysia. Hence, this study is deemed to be as a basis towards further research on BIM strategic implementation planning for highway industry

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Acknowledgements
Sincere thanks to Universiti Teknologi Malaysia for financial support from High Impact Research Grant (HIR) Q.J130000.2451.04G54 as well as the consultant's participation in this study.