BENEFITS FROM ADOPTION OF BUILDING INFORMATION MODELLING (BIM) IN BUILDING CONSTRUCTION PROJECTS IN SARAWAK

ALBERT NELSON ANAK ROBERT

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ABSTRACT

Almost similar to previous research papers on BIM implementations study, this research paper presents analysis of findings of a research project, which discovers the benefits and challenges of BIM implementation in construction industry in Sarawak state area. BIM is widely known for its benefits in improving construction project process and waste minimization in terms of resources and time, by offers the users 3-dimensional modelling for construction project design. Traditional project process typically utilizes 2-dimensional drawings which will be interpreted by site project team which highly requires high expertise of technical skills from site project team to piece together the construction drawings design that are consists of architectural, mechanical and electrical, structural and civil, as well as landscaping architectural. The major findings are the five highest rated benefits and challenges, along with the suggestions from respondents on how to encourage BIM implementations in construction industry in Sarawak, from perspectives of government agencies, private organization and high learning institutes. The findings sorted the five highest rated benefits and challenges for better understanding on the main consideration factors affecting respondent's decision in adopting BIM technology. 272 respondents delivered a complete survey data for this research paper. These tabulated benefits and challenges recommended to future researchers for better understanding on the factors affecting project executives or stakeholders to consider adopting BIM in construction industry mainly in Sarawak state. The points in this research paper could be utilized by organizations to justify adoption of BIM system in their construction projects.

Keywords: *BIM, 3-dimensional drawing, 2-dimensional drawing, architectural*

MANFAAT DARI PENGGUNAAN MODEL MAKLUMAT BANGGUNAN (BIM) DALAM PROJEK PEMBINAAN BANGUNAN DI SARAWAK

ABSTRAK

Hampir mirip dengan kertas penyelidikan sebelum ini mengenai kajian implementasi BIM, kertas penyelidikan ini menumpukan analisis penemuan projek penyelidikan, yang mendedahkan manfaat dan cabaran pelaksanaan BIM dalam pembinaan di negeri Sarawak. BIM terkenal dengan faedahnya dalam menambahbaik proses projek pembinaan dan pengurangan sisa dari segi sumber dan masa, dengan menawarkan pemodelan 3-dimensi kepada pengguna untuk reka bentuk projek pembinaan. Proses projek tradisional biasanya menggunakan lukisan 2-dimensi yang akan ditafsirkan oleh pasukan projek tapak dimana ianya sangat memerlukan kepakaran kemahiran teknikal yang tinggi dari pasukan projek tapak untuk reka bentuk lukisan pembinaan yang terdiri daripada seni-bina, mekanikal dan elektrikal, struktur dan sivil, serta seni-bina landskap. Penemuan utama adalah lima faedah dan cabaran yang diberi nilai tertinggi, dengan cadangan responden mengenai cara mendorong pelaksanaan BIM dalam pembinaan di Sarawak, dari perspektif agensi kerajaan, organisasi swasta dan institusi pengajian tinggi. Penemuan ini melibatkan lima faedah dan cabaran dengan penilaian tertinggi untuk pemahaman yang lebih baik mengenai pertimbangan utama yang mempengaruhi keputusan responden dalam menggunakan teknologi BIM. Seramai 272 responded telah menghantar boring kaji selidik yang lengkap untuk kertas kajian ini. Manfaat dan cabaran yang dijadualkan ini disarankan kepada para penyelidik masa depan untuk lebih memahami faktor yang mempengaruhi eksekutif projek atau pihak berkepentingan untuk mempertimbangkan penggunaan BIM dalam pembinaan terutamanya di negeri Sarawak. Titik-titik dalam kertas penyelidikan ini dapat digunakan oleh organisasi untuk membenarkan penerapan BIM dalam projek pembinaan mereka.

Kata Kunci: *BIM, lukisan 3-dimensi, lukisan 2-dimensi, seni-bina*

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Albert Nelson Anak Robert

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INTRODUCTION

1.1 Research Background

Building Information Modelling (BIM) is a still emerging technology widely used in high profile construction industries as it can provide a platform for project engineers and managers to generate and manage building data from the conventional 2-dimensional (2D) to 3-dimensional (3D) and 4-dimensional (4D) visual interpretation which intensively elevate the accuracy of construction project design and improve awareness for tracing design discrepancies and dispute (Suzila Mohd, n.d.). BIM is currently widely applied in architectural, engineering and construction (AEC) industry since 2000 with the intention of increasing performance and efficiency of project and to minimize resources wastage (Suzila Mohd, n.d.). As the application of BIM upgraded the level of visual interpretation of the project design and requires less intensive imagination focus from users, it enables the user to communicate better and reduced down time for decision making for any design clashes (K. C. Goh et. al, n.d.).

The concepts of applying 3-dimensional digital into project design with integrated information related to the design enabled the users to interpret the information much clearer and accurate. Human error can be minimized through this effort and an overall efficient project can be achieved. The ongoing debates on the costs of implementing BIM in projects and the resources expertise required to operate the software are among the challenges that we need to face.

Although most of construction personnel are aware of the benefits of BIM in construction industry, most management failed to realize the benefits that could be gain from implementing BIM in their construction projects would outweigh the capital costs and the operation costs. Although over the years, we could observe the adoption of western project management methodology in our country such as Project Management Professional (PMP) credentials from Project Management Institute (PMI) and PRINCE certifications. These credentials offer project-oriented frame of thinking into those who studied and passed the examinations. Most importantly, these project methodology manifest on reducing wastage of construction resources and time with proper and thorough planning.

Client satisfaction in project completion is one of the significant properties that affect decision making processes and end results. However, a visual interpretation of project design presented to clients must always accompanied with costs of quality consideration. Better end-products always costs higher and with reduced wastage on times and resources, overall project cost can be brought down lower. Cost effective projects are always desired by clients as it emancipates the perceptions of peace of mind on the well-spent financial investments.

Some of the gaps in the earlier studies on benefits of BIM implementation is the accessibility of internet in some projects site that took place in rural areas that have very low connectivity. In Sarawak, most of the rural project such as Sarawak Alternative Rural Electrification Scheme (SARES) took place in remote communities of the state that has low internet connectivity and road access (Borneo Today, 2020)

These are only numbers of benefits proven for implementation of BIM in construction industry. Numerous studies on BIM implementations in construction industry can be accessed easily nowadays, and this paper aims to provide an overall view

of benefits that could be obtain. This paper scope will mainly comprise of the research into benefits of implementation of BIM in construction industry in Sarawak, Malaysia in depth, that can be utilized by all construction players for future projects.

1.2 Problem Statement

Malaysia construction industries constantly emerging from the past decades and a study done by Wesam Salah Alaloul et. al (2021) stated that the contribution of construction industry to Malaysian Gross Domestic Product (GDP) will triple from year of 2020 to 2050. Additional RM 131.96 billion to the national GDP from construction industry by the year 2029, increase of RM 100 billion by 2039 compared to 2020 and RM 80 billion contribution to GDP from 2039 to 2050 (Wesam Salah Alaloul et. al, 2021).

Therefore, poor performance of construction projects must be avoided at all times. In 2009, a data from Malaysia National Audit Department stated that a total of 11 government projects were incomplete contractually, either stated as unacceptable end-product quality and cost overrun (Nurul Alifah, 2018).

Through my first-hand experience in years of construction project in Sarawak, Malaysia, I faced numerous reasons for defects and delays in projects. Recurring reason for the defects and delays are the discrepancies in project design along with time and resources required to ensure all sides of project teams which are contractors, consultants and client to understand the full picture of the inquiry. Request for inquiry (RFI) is a common paperwork in construction project whereby contractors will be issued to consultants and clients to confirm on decisions or designs on particular component of a project. However, management team that are supposed to be the decision makers not all worked their way up from technical side and only present on site for few hours per week which makes it quite easy for these groups to misunderstand the RFI. Therefore, human errors tend to happen.

Other than the stated benefits of BIM that project communities already aware of such as ease of project designs and interpretations for conflict solution and effective project management, there are several other benefits that could further improve the perceptions on BIM applications in construction projects. As numerous studies on implementations of BIM in construction projects mostly proclaim on the current benefits and not into the future of construction industries. Possibilities that the construction industry can uncover after the implementations are significant and could lead to higher quality of life by those affected by project externalities.

Few seniors in project management have negative perceptions in BIM applications. Examples of the negative perceptions are BIM stated as consuming unnecessary and unrealistic planning time and resources, impractical for rural projects and many more. These views are not one hundred percent correct as these seniors have already went through numerous mistakes in their careers which costs the projects they handled financially and physically as well as the seniors depend too much on their years of experience in their careers. These attributes are almost impossible for younger generations of project executives to obtain in their first project.

Project executives with the expertise to operate BIM in construction project are quite limited as well in Sarawak, Malaysia. These are mainly due to the management key personnel reluctant to invest in their staff development and to continue with the traditional methods of construction. High profile government project does require contractors to operate and manage the project via BIM. Management key personnel are reluctant to invest in BIM implementation as they are not fully aware of the future potentials.

Numerous government effort in ensuring internet connectivity in rural places is one of the factors that the construction industry players should consider in adopting BIM in their projects. Adopting BIM parallelly development of internet connectivity in rural

projects site will be observed as beneficial for both the communities and government and the efforts can be seen as indirectly supporting the government.

1.3 Research Objective

BIM benefits in construction industry in Sarawak, Malaysia is our main focus for this paper. Various angle of perspectives in viewing the advantages after the implementations of BIM in Sarawak will be discussed in details. These advantages will not only be uncovered for the current year of implementations but projected years in the future. Perhaps one of the limitations for construction industry players to adopt BIM in their projects is that the awareness of the advantages that could be obtain after years of practice.

In initial phase of adoption of BIM in construction project, simply not all projects will be executed through BIM for few factors such as time and budget. Possibility of waste reduced and cost minimization in papers might not be accepted by some clients that has zero experience in BIM applied projects and would revert back to conventional method of project execution. This paper is aims to be projected as a basis of consideration for client's side as well for their awareness of the benefits that we could harvest from adoption of BIM in construction industry. Similar objectives are planned for contractors and consultants.

Project location required to be categorized as well to further study on the benefits awareness of project executives. These categories can be separated to either rural or urban project site. Factors that greatly affects the needs for the project site categorization is presence of access to internet and access road to the project site. Note that these two factors can be manipulated and utilized to our advantages although initially it can be seen as disadvantages. Absence of internet are huge disadvantages for BIM application along with the proper access road to project site, but these can be tackled if the personnel in

charge possessed complete information on the project and can easily refer to the BIM software. Periodic update can be sent through every once in a while, and with complete standalone models which are stored in the user's device and can be sync with BIM 360 Glue if in online modes.

Government involvement in BIM application is incremental anticipated and even now few high-profile projects have requirement of BIM operations and experiences expected from contractors and consultants. Benefits on BIM in construction project can be worked out as catalyst for government officers to gain more confidence in adopting BIM for all public projects. These efforts however, will consume years or even decades to be fully established, but first step for the full involvement would be to realize the awareness and full potentials in implementing BIM. Risks and challenges can be found in articles which are easily available online and can be referred to by the officers involved.

Socio-economic benefits analysis before and after the implementations of BIM on construction industry will also be studied and predicted. Hypothetically, the advantages would be improvement in life quality of those directly or indirectly involved and in other words, externalities. Awareness of project executives or stakeholders in the socio-economic benefits will be studied and this paper is aims to reached these categories to improve their alertness and knowledge. Contribution to the future communities will perhaps be one of the aims for current generations and the thoughts of continuous and steady improvement in project executions which indirectly benefits the externalities factors is worth to look for in the future.

Listed below are the summarized and simplified research objectives for this paper;

1. To identify the understanding and the level of awareness of BIM in construction industry.

2. To identify the challenges affecting the adoption of BIM in Sarawak construction industry.

3. To propose on how to face the hurdles in implementing BIM system in Sarawak construction industry.

1.4 Research Questions / Hypotheses

Compilation of benefits in implementation on BIM in construction industry are required to be in latest version for construction industry players consideration. This paper aims to provide the latest and thorough study on benefits. If more benefits uncovered for construction industry key personnel to understand, then the adoption of BIM in construction industry can be established by all parties involved. This study will specify for location of Sarawak to further identify the location-oriented differences such as cultural and technological differences.

Categorization of benefits allows us to further research in details for all factors affecting the magnitude of the possible benefits gain for all parties in construction industry. These categories are the project site location, construction firms type such as client, consultants and contractors, benefits gained by government, and interest towards externalities parties. Each category holds its own specific and special independent variables which directly affected the dependent outcomes via research and not experimentation due to financial limitations.

Project site location categorized in either rural or urban site. It can be observed and logically understood that the current projects in Sarawak mostly took places in rural areas as our government are continuously improving the facilities in areas outside cities to compensate and balance off the differences of life quality and public facility access

throughout Sarawak. Huge factors which lead to this first categorization is due to internet connectivity for BIM applications as we can fully understood that rural areas have almost zero to low internet connectivity. Main features in BIM application are intercorrelated with access to internet, basically to receive the latest model of project design and information. Problems arise in conventional project execution when there are discrepancies in project design and requires few disciplines in construction management which consumes time and resources for being standby, waiting for decision made by management. In some case, project manager on site will make their independent decision without consulting consultants and clients to avoid them from holding back the project progress. Furthermore, to be able to make this decision, group of senior personnel with sufficient experiences are required for this job, leaving very low pool of job vacancy for younger generation of engineer. Involvement of BIM in construction project, especially in rural areas enable younger generation of engineers and project executives to gain experiences as very low number of discrepancies can be found in the complete model in BIM.

Advantages that can be harvest by client, consultants and contractors are enormous as well for BIM application in their projects. Cost savings from time and resources waste minimization will enable the companies to be witnessed as an efficient construction company with high tier company profile gained from their experience and evaluation by clients. These advantages will multiply as the executives and personnel in the company gained more experience throughout the years and newly improved processes introduced lowers the resources required as in earlier stages of BIM implementation. In recent years, contractors are often nominated by the costs of project they stated in their tender during tender bidding process. However, there are no spaces for the contractor to state the projected waste minimization with application of BIM, and often, only the costs

of BIM application are being considered. Without the fair view on both costs and advantages that the BIM application propose, the consideration of rejecting contractors that applied BIM in the project are greatly imprecise.

Government can receive a fairly interesting advantages with the implementation of BIM in construction project, especially in rural projects. Implementation of BIM in construction project can be utilized as catalyst for government to put in more effort and budget in improving public facilities like internet connectivity and access road. With the demands for better internet connectivity for full utilization of BIM features, the local state government can justify these needs for more budget on facilities improvement. These supports from the government will attract attention of investors from both in and out of the country. Country revenue through taxes and technological advances are among the outstanding improvements. Presence of experts in an efficient project execution cultures will attract more focus from investors as cost of quality are expected to be high.

All of the predicted benefits stated above will eventually lead to advantages towards externalities parties. Externalities are known as parties that are directly or indirectly impacted by the project, which in this case we will focus on the positive impacts. Among the noteworthy impact is the improvement of socio-economic status of the local communities. Newly available technology and job vacancy will provide more chances for the communities to contribute to country financial. Over time, the increased in quantity and quality of project execution will provide numbers of career opportunities especially for rural areas. With the adoption of BIM, the attraction of younger generation in technological utilization for work purposes will be elevated and they will continuously look for areas to improve, either from project documentations, work scope processes or even communication procedures. Digitization of project design will eventually replace

the utilization of only 2-dimensional project design that was observed as encouraging human error.

If BIM are enforced to be implemented in construction industry in Sarawak, Malaysia, will the stated benefits be agreed upon and most importantly, will the edge emerge as positive? This paper aims to study in detail through all aspects and for long term of applications of BIM in construction industry, for referenced by all privates and government officers for their considerations in implementing BIM in construction industry.

To conclude the hypothesis, the respondents which are professionals in construction industry should be aware of BIM's benefits in assisting the industry to achieve Malaysia's "Construction 4.0 Strategic Plan", understand that the BIM application improves engineering principles collaboration, eases up the end-product hand over, improve the procurement process and most importantly proper documentation. For challenges of BIM adoption, the outcomes from the data should be more into operation and capital costs, issues in integration of new work process and time consuming for staff training. Higher learning institute, government bodies and private organization have certain responsibilities in amplifying the BIM adoption by controlling the costs for adoption and introduce the work process in the future graduate's syllabus. In short, what is the most agreed benefits and challenges of BIM implementation, and how the government bodies, private organization and high learning institute can enhance BIM implementation?

1.5 Significance of the Research

For all proposal to start, proposer have to come up with solid and valid argument and points as to why the projected proposal need to be brought forward. Similar purpose is

planned for this paper in hope that the readers find the points and argument inside this research paper to be useful for their consideration. An idea of digitizing paper work for ease of access and coordination which greatly improved engineering and management efficiency in general are the starts of an elevation of routine standard. Instead of operating project in similar method as what we have now which been known as traditional or conventional method, benefits from implementation of BIM are known in general and this paper targets to show the particular benefits for specific group of people.

Discussions on compilation of benefits gained will be referred by these groups that intend on implementing BIM in their projects. Government efforts in implementing BIM in high profile public projects does initiate the demands and interest in BIM application for construction project, while private companies require consistent push and motivation for justifying their investment in implementing BIM in their companies. In order to do that, the officers involved requires proof and analysed data to present to their management and key stakeholders. With this idea moving around the communities, chainage link of other ideas will begin to tethers and this creates a continuous chain of idea which improves one another. Such as example can be seen with the relationship of BIM implementation for rural projects and the public facility improvement. One idea will lead to another and as personnel in charge for upgrading companies' profile, this idea of implementing BIM in construction project is worth the hassle.

Group of researchers in universities or high learning institute are targeted group of people for reading this paper as well since these groups are involved directly in the education of younger generation of project executives. Discovering of BIM concepts during school might not have huge effect towards the undergraduate or postgraduate frame of thinking but once they have started off their career and experiencing the difference of traditional method and BIM concepts in construction projects, then their realization will generate or

initiate their interest and idea of implementing BIM in their projects. Lecturers and professors in universities plays an important role as well in administer the idea of BIM application in construction projects in their students' state of mind. Similar exposure towards the working groups will have better impact but the earlier stage of exposure predicted to have higher impact in construction industry.

Therefore, it can be observed that this paper is not only aims group of readers from working classes but also from government and institute stages for early exposure on the next working generations frame of thinking in executing projects. Similar to the continuous improvement of project methodologies such as PMP and PRINCE which were updated almost every year by their board of panels, initial frame of thinking for all students should be altered to suit the working environment and to the targeted changes which can brought forward the benefits that we anticipated. Although this is more to long term initiatives, it would be better to start as early as possible. Needless to say the changes requires years of studying by the psychologist before any amendment or changes in today's syllabus can commence, it is still an effort worth executed.

Similar to all other new technologies that are adopted by our country such as renewable energy technology like solar energy and hydrogen energy, communities take time to fully realize the benefits and disadvantages of not possess these technologies.

1.6 Definition of Terms

Client – An organization or individual that fund the project directly or indirectly, with interest in, and have ultimate authority in the project

Consultant – An organization or individual that involves in engineering study or landscaping and architectural of the project design, and second in authority after the client in a project

Contractor – An organization or individual that agrees to execute the project under contract signed with consultants and client

Catalyst – Factor that stimulate the rate of changes from one condition to another

Deliverable – Component or parts of a project design which are subjected to be completed and delivered for approval

Digitization – An act of converting hard copy material such as paper document into digital form with text, pictures, video or sounds that can be access by computer for ease access, interpretation and communication

2-Dimensional – Visual interpretation of user on construction design that can only display length and width at one time

3-Dimensional – Visual interpretation of user on construction design that can only display length, width and height at one time

4-Dimensional – Visual interpretation of user on construction design that can only display length, width, height and durations of time for completion of a particular component at one time

Externalities – An effect, either positively or negative, on a group of people, organization or individuals from a project with direct or indirect intention

Gross Domestic Product – Total value of services delivered by projects in a country in duration of a year

Request for Inquiry – A formal document commonly used in construction project to ask for information regarding on project design or any other project related issues

Rural – An area outside of city where the population is low and most often in Sarawak, Malaysia, the quantities of public or private facilities such as school, clinic, hospital, bus station, shopping mall are low or none, often linked to lower quality of life

Socio-Economic – A branch of economic that links the social behavior to economics and how commonly, higher quality of social behavior leads to higher gains in economics for a particular area or state or country

Urban – An area located in city with high population and many available private or public facilities, often linked to higher quality of life

Gold-plating – An act of providing higher quality of deliverables and additional features or scope which are more than what required in agreed and signed contract. Often this action is not encouraged and considered as unethical

Point of diminishing returns – Refers to a point where any additional workforce or resource will not add value or increase the rate of the activity

Waterfall Project Model – A project model or methodology where process of initiation, planning, execution, control and monitoring and closing are done in process and by steps instead of concurrently, known as traditional project model as well

Agile Project Model – A project model where the process is not as rigid as Waterfall Project Model and process for making changes are understandable and practical

Change Control Board (CCB) – A department in a company where all change request in a project is being documented, reviewed, approved or rejected

Per Capita Income (PCI) – A measure of money earned for one person in a country or state

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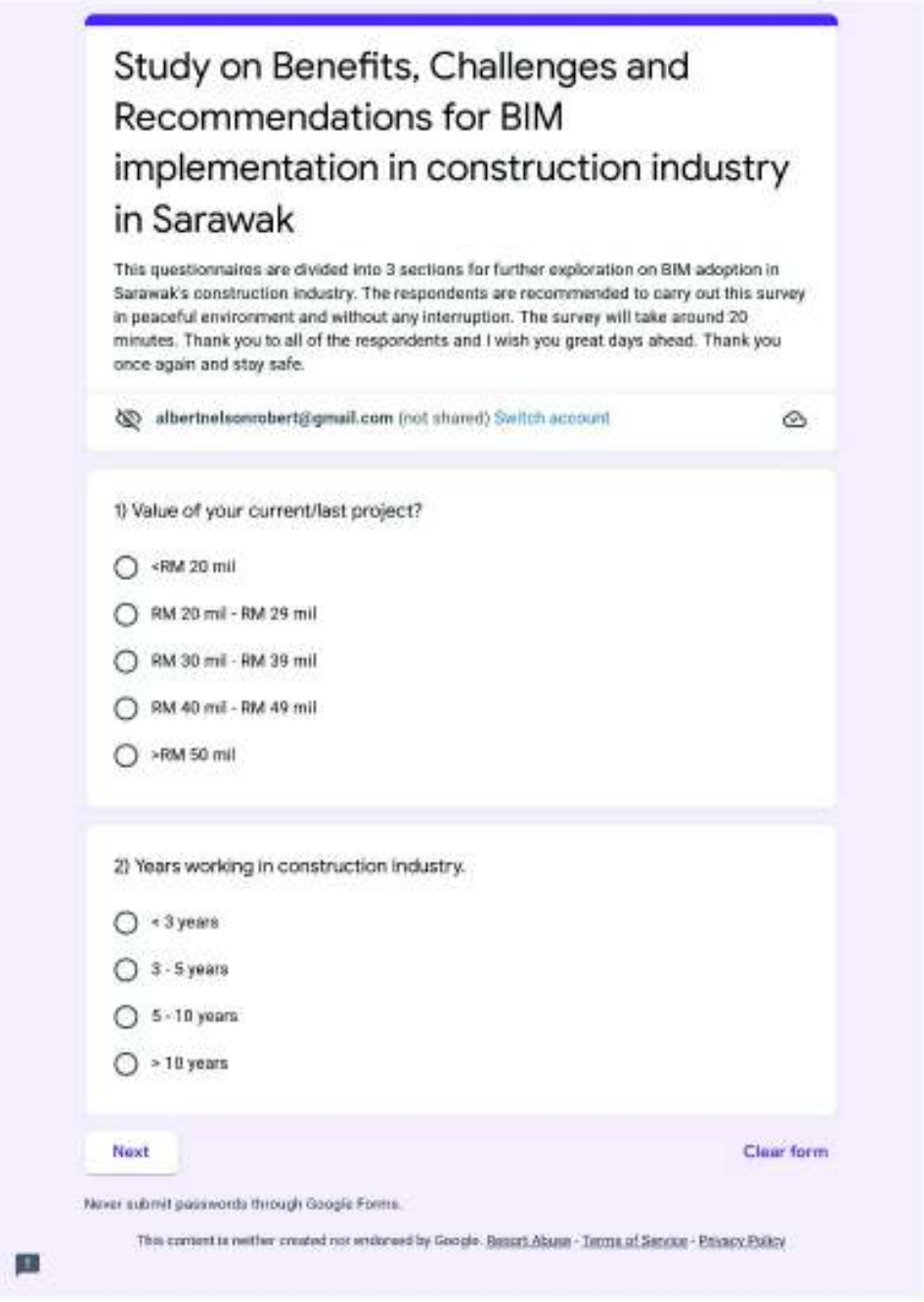
APPENDICES

APPENDIX A

Survey Form (Introduction Part)



Study on Benefits, Challenges and Recommendations for BIM implementation in construction industry in Sarawak

This questionnaires are divided into 3 sections for further exploration on BIM adoption in Sarawak's construction industry. The respondents are recommended to carry out this survey in peaceful environment and without any interruption. The survey will take around 20 minutes. Thank you to all of the respondents and I wish you great days ahead. Thank you once again and stay safe.

albertnelsonrobert@gmail.com (not shared) Switch account

1) Value of your current/last project?

- <RM 20 mil
- RM 20 mil - RM 29 mil
- RM 30 mil - RM 39 mil
- RM 40 mil - RM 49 mil
- >RM 50 mil

2) Years working in construction industry.

- < 3 years
- 3 - 5 years
- 5 - 10 years
- > 10 years

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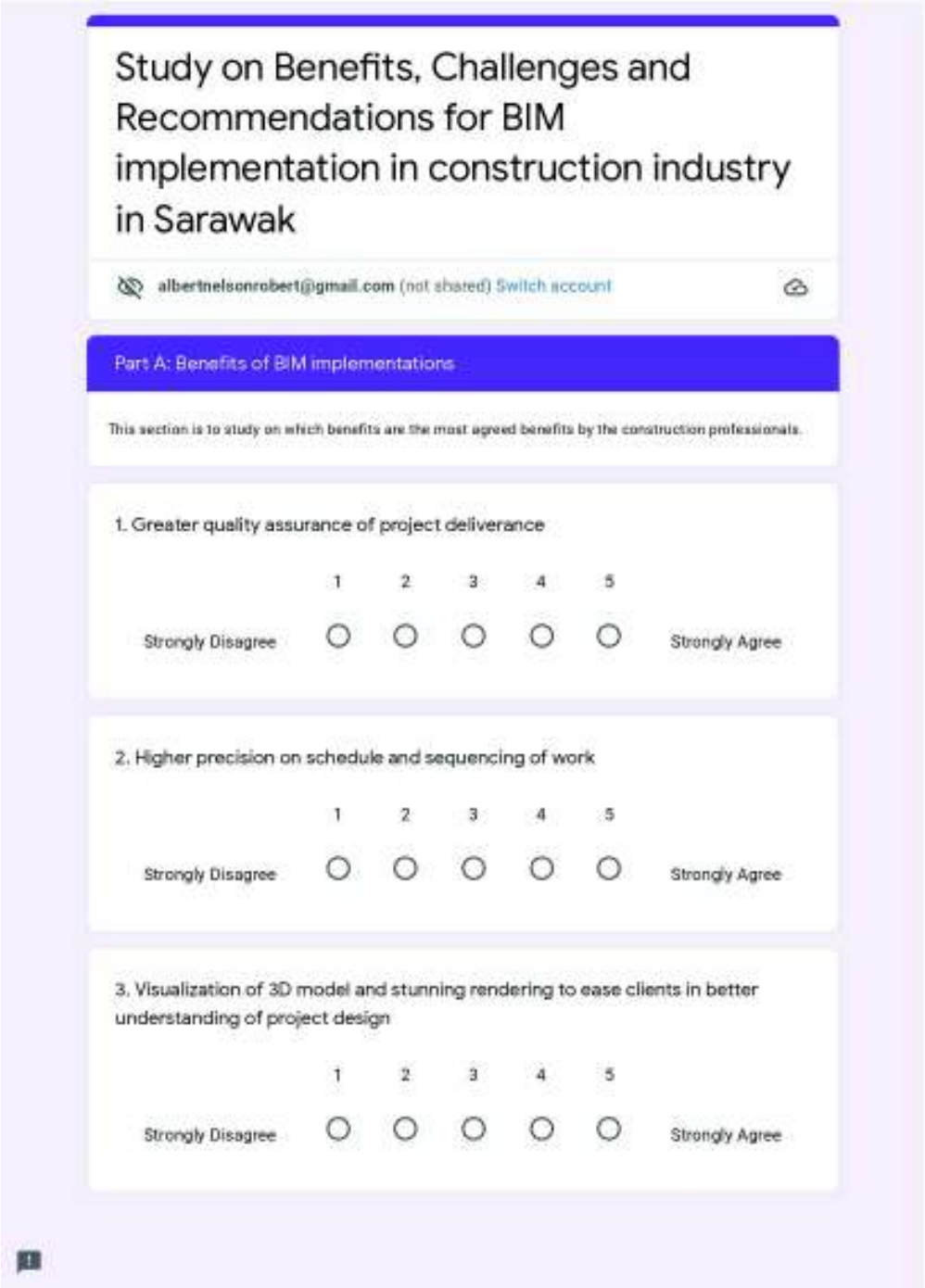
APPENDIX B

Survey Form (Part A)



Study on Benefits, Challenges and Recommendations for BIM implementation in construction industry in Sarawak

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Part A: Benefits of BIM implementations

This section is to study on which benefits are the most agreed benefits by the construction professionals.

1. Greater quality assurance of project deliverance

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

2. Higher precision on schedule and sequencing of work

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

3. Visualization of 3D model and stunning rendering to ease clients in better understanding of project design

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

4. Better clash detection and coordination between AEC

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

5. Digital documentation that is kept in cloud storage can make updating and compilation work much convenient

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

6. Faster and more accurate management for construction payment claim

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

7. Higher accuracy for cost estimate as cost is estimated based on 3D model components that has been generated

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

8. Streamlined Facility Management and can strengthen building handover

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

9. Cost-saving through waste minimization

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

10. Can reduce rework resulted from mistakes of design coordination

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

11. Enable asset information to be shared with other organizations and for historical record e.g., procedures, previous errors for deterrent

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

12. BIM 360 offers proper documentation as in construction as lots of documents are required to be sorted in respective categories

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

13. Can improve communication by enabling notifications on changes in real time

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

14. Improve collaboration between engineering discipline with clash detection

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

15. BIM implementation is aligned with "Construction 4.0 Strategic Plan", which is to equip Malaysia's construction industry with digital technologies

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

16. Better level of safety on site as work sequence improved

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

17. Enhance the procurement performance with improvement of work sequencing and schedule

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

18. Can provide more time for suppliers and contractors to finish their work since thorough plan on construction materials and equipment can be done prior

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

19. Risk mitigation with work sequencing and 3D modelling

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

20. Lower numbers of RFI (Request for Inquiry) during project execution

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

21. More opportunities for pre-fabrication and modular construction that are aligned with IBS and SOP from SDMC

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

22. Wider tolerance range of skills and experience level for project executives required especially for rural project since most of the work plans are prepared in detail

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

23. Increase competitiveness between construction organizations

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

24. With rapid development of public facilities, life standard of local communities in that particular area will be increased as well

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

25. Can attract local and foreign investors

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

26. More high-tier job opportunities can be created, which will result to higher Per Capita Income (average income of citizens in the area)

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

27. As a catalyst to produce more manpower that can be competitive on international level

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

28. Faster public project completion, which can empower the current government's campaign

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

29. Can encourage the adoption of new technology software among the public or agencies with the current BIM successful implementation

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

30. More Information Technology (IT) tools to be incorporated in project management, which is appropriate with the current computer-literate generation

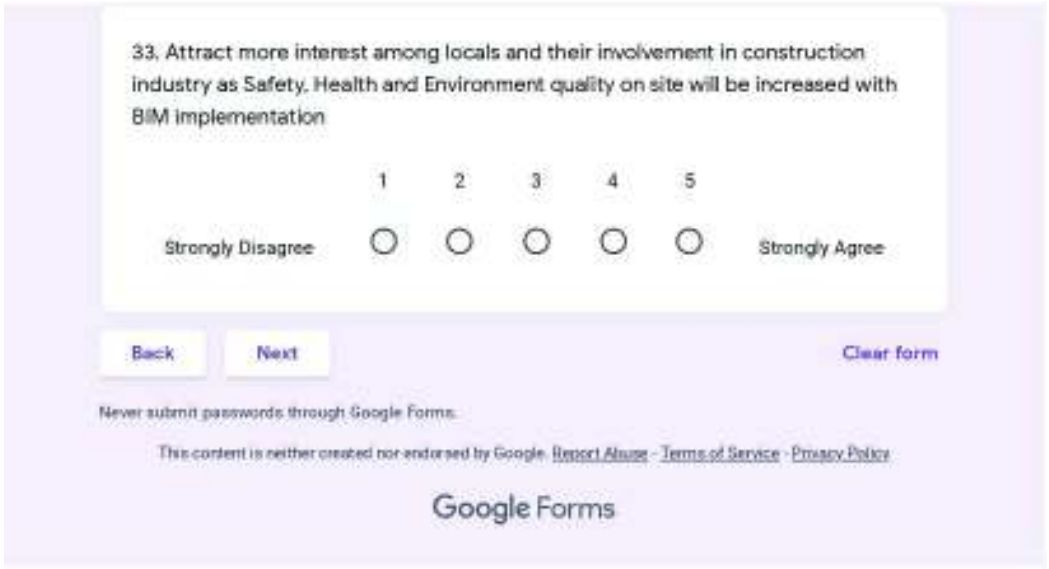
	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

31. Lower rate of construction waste generation as recommended by NREB (Natural Resources and Environment Board Sarawak)

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

32. Catalyst for government to have more effort and financial investment in improving basic facility in rural area e.g., telecommunication and access road

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree


33. Attract more interest among locals and their involvement in construction industry as Safety. Health and Environment quality on site will be increased with BIM implementation
1
2
3
4
5
Strongly Disagree
Strongly Agree
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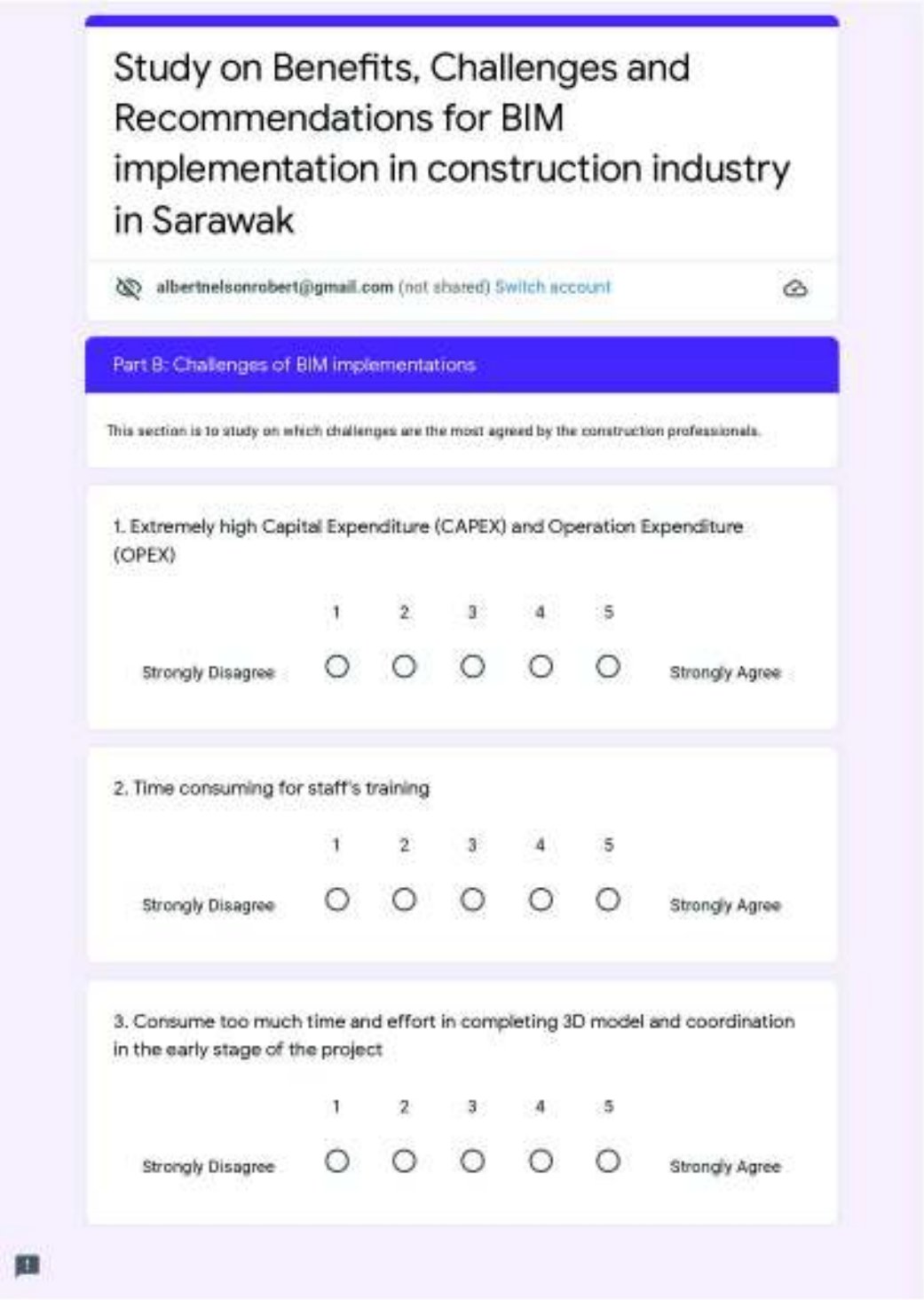
APPENDIX C

Survey Form (Part B)



Study on Benefits, Challenges and Recommendations for BIM implementation in construction industry in Sarawak

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Part B: Challenges of BIM implementations

This section is to study on which challenges are the most agreed by the construction professionals.

1. Extremely high Capital Expenditure (CAPEX) and Operation Expenditure (OPEX)

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

2. Time consuming for staff's training

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

3. Consume too much time and effort in completing 3D model and coordination in the early stage of the project

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

4. Risk of losing the tender along the process due to time consuming activities in early stage

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

5. Clients or consultants have no confidence on contractors to involve BIM system in their project

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

6. Resistance to change to the current way of working

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

7. Not enough computers with BIM license which can disrupt the collaboration of personnel-in-charge

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

8. Doubt on cost effectiveness for small-scale project

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

9. Copyright protection for ownership of data since data transfers are easy

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

10. Problematical in integration and transition of conventional systems with BIM system since not all computers will be equipped with BIM system

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

11. Lack of training for BIM system as myBIM centre is only available in West Malaysia. Only "BIM Concept And Theory â€" Online Course" is available online

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

12. Limited numbers of BIM suppliers in Sarawak

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

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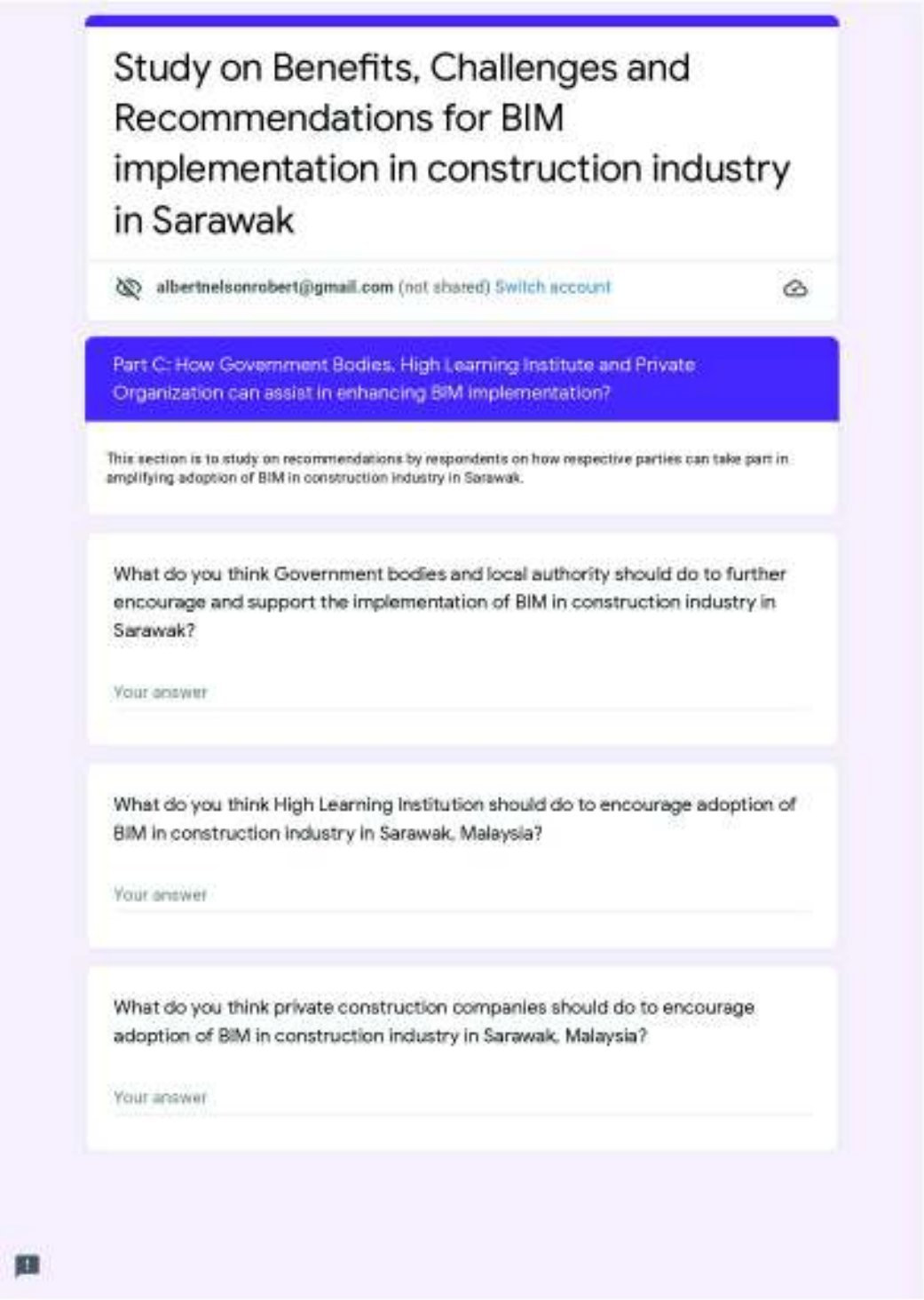
APPENDIX D

Survey Form (Part C)



Study on Benefits, Challenges and Recommendations for BIM implementation in construction industry in Sarawak

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Part C: How Government Bodies, High Learning Institute and Private Organization can assist in enhancing BIM implementation?

This section is to study on recommendations by respondents on how respective parties can take part in amplifying adoption of BIM in construction industry in Sarawak.

What do you think Government bodies and local authority should do to further encourage and support the implementation of BIM in construction industry in Sarawak?

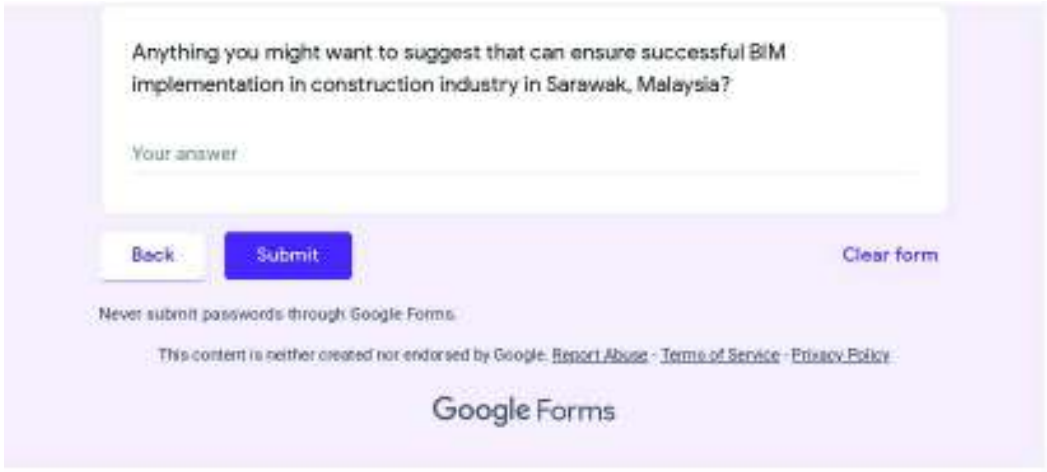
Your answer

What do you think High Learning Institution should do to encourage adoption of BIM in construction industry in Sarawak, Malaysia?

Your answer

What do you think private construction companies should do to encourage adoption of BIM in construction industry in Sarawak, Malaysia?

Your answer


Anything you might want to suggest that can ensure successful BIM implementation in construction industry in Sarawak, Malaysia?
Your answer
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