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IMPLEMENTATION OF HERITAGE BUILDING INFORMATION MODELLING (HBIM) FOR CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

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Abstract

Historic Building Information Modelling (HBIM) is a process applied to existing buildings which enable the creation of a model that can simulate the actual construction of the existing building by starting up with a digital survey using laser scanner or camera for photogrammetry. The implementation of HBIM in Malaysia construction industry is relatively low. However, the studies in Malaysia regarding HBIM implementation rarely focus on the technical information in implementing HBIM. Therefore, this research is aimed to develop a guideline of implementing HBIM in Malaysia heritage building by identifying the methods of data capturing and modelling. The research method adopted was quantitative approach via questionnaire survey. The research found that terrestrial laser scanner, photogrammetry and combination of image-based and range-based method are the data capturing's method while the processing of survey data will be data cleaning, data registration, surface meshing, texturing, and creation of orthographic image. The contribution of this research is that it can serve as a reference for the heritage architect in managing the heritage building by adopting HBIM.

Keywords: Heritage Building Information Modelling (HBIM), Building Information Modelling (BIM), 3D Laser Scanning, Photogrammetry, Point Cloud

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INTRODUCTION

According to Mphil (2012), the traditional approach employed to do the survey and record of historical building structure are categorised into various different systems which are firstly, manual measurement system which may be employed by using tapes and levels while a more upgraded manual measurement system will be implemented by using optical equipment such as theodolite and level. The next method will be the image-based systems which the rectified photography or photogrammetry will be applied. However, nowadays, the traditional methods have been substituted unconsciously by the digital technologies which may provide convenient in automating the capturing and processing of measurement data such as through the use of laser scanner (Abdul Shukor et.al, 2015). With that, 3D point cloud which is a set of data points in space will then be obtained (Newsroom, 2019). Aside from these, techniques applied for generating parametric model from point clouds has also been introduced (Mphil, 2012). In short, according to Mphil (2012), Historic Building Information Modelling (HBIM) is a new device that integrates these novel developments. HBIM is a tool that enable the collection of data with the use of survey technologies such as laser scanner point clouds, 3D models, digital ortho-photo and monitoring data in order to acquire a 3D model in the form of a geo-referenced spatial information structure (Georgopoulos et.al. 2013). According to Ali et al. (2017), there are only 183 buildings that have been gazetted as national heritage by the authority in Malaysia. According to Ali et al. (2017); (Khodeir et.al. 2016; Volk et.al.2014), the common issues that the construction industries are dealing in conserving the heritage buildings are loss of information, limited documentation, lack of technology adaption and reports reliability. Therefore, HBIM should be implemented in the industry as the HBIM model enable the information of any historical building to be stored as well as allow the sharing of information among stakeholders (Khodeir et al., 2016; Volk et al., 2014). It is known that the practice of HBIM is rare in Malaysia (Ali et al., 2018). Therefore, this research is conducted to provide a guideline of implementing HBIM for Malaysia heritage building.

METHODOLOGY

This research focused on the technical information of implementing HBIM such as the methods of data capturing, processing of data captured and methods of modelling the historical structure. The target of respondents will be the architects from Kuala Lumpur and Selangor. Architect will be chosen as the respondents because they are more likely to have come across with HBIM especially in terms of modelling. The questionnaire sends through email. The primary data collection is carried out to identify the underlying information that were unexplained due to limitation in literature. A list of questions designed for the questionnaire accordingly and make sure the questions prepared can reach the research objective. To get a satisfied respond rate from the respondents, close-ended questions were prepared instead of open-ended questions. The respondents were the architects from Kuala Lumpur and Selangor. 320 sets of questionnaires have been distributed to the target respondents though email. However, there are only 61 sets of answered questionnaires being received back from the respondents. The data collected analysed by using Statistical Package for Social Science (SPSS) software.

DATA ANALYSIS AND RESULT

Methods of Data Capturing

The respondents are required to rate the level of basic abilities for each of the methods of data capturing divided to three categories, laser scanning techniques, photogrammetry, and combination of image-based and range-based method. Five-point Likert scale, from “very low” to “very high” will be the rating scale and the result of the analysis has been displayed on Table 2, Table 3 and Table 4, each for different method. Table 1 shows the description for each ability. Table 2 shows the result for laser scanning technique. “LST1” got the first ranking with the highest mean value of 4.2459, followed by “LST6” with the mean value of 4.2131. “LST5” has rank the third place with the mean value of 4.1967. Both “LST3” and “LST4” are having the same ranking with the same mean value of 4.1639. Lastly, it goes to “LST2” with mean of 4.1148. The lower the value of standard deviation, the less degree of varying responses happened among the respondents. In this case, “LST1” has the lowest standard deviation with the value of 0.74511 whereas the highest standard deviation is 0.79959 which goes to “LST4”. Table 3 shows the result for the level of basic abilities for photogrammetry. In this case, “P5” got the first ranking with the highest mean value of 4.1967, followed by “P1” which got the mean of 4.1148. The third ranking is going to be “P6” with the mean value of 4.0984. This is then followed by “P4” with the mean value of 3.9836 and then “P2” that got the mean of 3.9180. Lastly, it comes to “P3”, having the lowest mean value of 3.8689. The lowest standard deviation is “P1” and the highest is “P2” which means “P1” is having the least varying degree of responses. Table 4 shows the result for the level of basic abilities of the combination method. “C5” has the highest mean value of 4.2131, followed by “C6” with the mean value of 4.1803. “C3” has the third highest mean with the value of 4.1311 and the next will be “C1”, having the mean of 4.0984. The second lowest is “C2” with the mean value of 4.0492, followed by “C4” with the lowest mean value of 3.9344. The lowest standard deviation in this case is “C3” while the highest standard deviation is “C4” which means “C4” is having the largest degree of varying responses among the respondents. In terms of median taken from three of the data capturing methods, they are all having the same median which is 4.00. It means the level of basic abilities required to be implemented on heritage building from three of the approaches are high.

Table 1: Description of the basic abilities required by each data capturing methods

Variable	Description
Laser Scanning Techniques	
LST1	Ability to capture data in a short duration of time.
LST2	Importability of the data captured into BIM platform.
LST3	Spatial accuracy of the data captured.
LST4	Degree of automation.
LST5	Applicability in existing building.
LST6	The ability of data captured (point cloud) in providing 3D geometry information.
Photogrammetry	
P1	Ability to capture data in a short duration of time.
P2	Importability of the data captured into BIM platform.
P3	Spatial accuracy of the data captured.
P4	Degree of automation.
P5	Applicability in existing building.
P6	The ability of image data captured in providing texture.
Combination of Image-based and Range-based Method	
C1	Ability to capture data in a short duration of time
C2	Importability of the data captured into BIM platform.
C3	Spatial accuracy of the data captured.
C4	Degree of automation.
C5	Applicability in existing building.
C6	Ability to complete the data missing from each other

Source: Author (2022)

Table 2: Level of Basic Abilities for Laser Scanning Technique

Basic Abilities for Laser Scanning Technique	**Level of Basic Abilities**					**Mean**	**Medi -an**	**Standard deviation**	**Rank**
	Very low	Low	Med-um	High	Very high				
LST1	0	0	11	24	26 a	4.2459 b	4.0000	0.74511	1
LST2	0	1	13	25 a	22	4.1148 c	4.0000	0.79788	6
LST3	0	1	11	26 a	23	4.1639	4.0000	0.77847	4
LST4	0	1	12	24 a	24 a	4.1639	4.0000	0.79959	4
LST5	0	1	11	24	25 a	4.1967	4.0000	0.79204	3
LST6	0	1	11	23	26 a	4.2131	4.0000	0.79822	2

Source: Author (2022)

Note:
a. Likert item with highest frequency
b. Variable with the highest mean value
c. Variable with the lowest mean value

Table 3: Level of Basic Abilities for Photogrammetry

Basic Abilities for Photo-grammetry	Level of Basic Abilities					Mean	Medi-an	Standard deviation	Rank
	Very low	Low	Medi-um	High	Very high				
P1	0	0	14	26 a	21	4.1148	4.0000	0.75495	2
P2	1	4	13	24 a	19	3.9180	4.0000	0.97117	5
P3	0	6	13	25 a	17	3.8689 c	4.0000	0.93942	6
P4	0	4	13	24 a	20	3.9836	4.0000	0.90354	4
P5	0	2	10	23	26 a	4.1967 b	4.0000	0.83306	1
P6	0	3	12	22	24 a	4.0984	4.0000	0.88891	3

Source: Author (2022)

Note:
a. Likert item with highest frequency
b. Variable with the highest mean value
c. Variable with the lowest mean value

Table 4: Level of Basic Abilities for Combination of Image-based and Range-based Method

Basic Abilities for Combination of Image-based and Range-based Method	Level of Basic Abilities					Mean	Median	Standard deviation	Rank
	Very low	Low	Medi-um	High	Very high				
C1	0	0	15	25 a	21	4.0984	4.0000	0.76822	4
C2	0	4	11	24 a	22	4.0492	4.0000	0.90233	5
C3	0	0	14	25 a	22	4.1311	4.0000	0.76323	3
C4	2	3	12	24 a	20	3.9344 c	4.0000	1.01438	6
C5	0	0	13	22	26 a	4.2131 b	4.0000	0.77706	1
C6	0	0	13	24 a	24 a	4.1803	4.0000	0.76394	2

Source: Author (2022)

Note:
a. Likert item with highest frequency
b. Variable with the highest mean value
c. Variable with the lowest mean value

Processing of Laser and Image Survey Data

The respondents are required to rate the level of necessity to carry out the particular actions so that to know whether to be included into the data processing. Likert scale from 1 to 5 which indicates "very unnecessary" to "very necessary" will be used and the result for this section has been tabulated in Table 6. The descriptions of the actions to be taken for data processing have shown in Table 5. By looking at the mean value, it can be known that "DR1" will be at the first placing with the highest mean value of 4.4426. It is then followed by "DC1" with the mean value of 4.2459. Both "DC2" and "SM1" are having the same placing with the same mean value of 4.0656.

Table 5: Description of actions taken for data processing

Variable	Description
Data Cleaning and Resampling	
DC1	"Noise" such as moving persons, vehicles, tress, etc. have to be removed from the survey data.
DC2	Reduce the density of data for overly dense point clouds.
Data Registration	
DR1	Combine two or more point clouds taken from different scanning positions.
Surface Meshing	
SM1	Connect the series of random points in the point cloud into a consistent polygonal model to create a surface on the point cloud.
SM2	Modify the surface of the point cloud by filling the holes and correcting the edges.
Texturing	
T1	Map the correspondence image data onto the point cloud for more accurate identification of the surface's texture and features.
Orthographic Image	
O1	Create the orthographic image from point cloud so that the image and geometric data can be exported for modelling.

Source: Author (2022)

Table 6: Level of necessity to carry out the respective actions for data processing

Actions to be taken for data processing	Level of Necessity					Mean	Median	Standard deviation	Rank
	VU	U	N	Nc	VN				
DC1	0	1	11	21	28 a	4.2459	4.0000	0.80944	2
DC2	0	2	13	25 a	21	4.0656	4.0000	0.83404	3
DR1	0	0	6	22	33 a	4.4426 b	5.0000	0.67143	1
SM1	1	1	13	24 a	22	4.0656	4.0000	0.89198	3
SM2	1	1	13	27 a	19	4.0164	4.0000	0.86587	6
T1	0	3	12	25 a	21	4.0492	4.0000	0.86460	5
O1	1	7	9	25 a	19	3.8852 c	4.0000	1.03438	7

Source: Author (2022)

Note:
VU – Very Unnecessary; U – Unnecessary; N – Neutral; Nc – Necessary; VN – Very Necessary
a. Likert item with highest frequency

b. Variable with the highest mean value
c. Variable with the lowest mean value

Next will be "T1" and "SM2" with the mean value of 4.0492 and 4.0164 respectively. The lowest mean value of 3.8852 will go to "O1". For the ranking of standard deviation, "DR1" is having the lowest standard deviation value of 0.67143, followed by the second lowest which is "DC1" with the value of 0.80944. Next will be "DC2" and "T1" with the value of 0.80944 and 0.86460 respectively. It is then followed by "SM2", having the value of 0.86587 and "SM1", with the second highest value of 0.89198. Therefore, the highest value of 1.03438 will go to "O1" which indicates that this variable is having the most varying degree of responses among the respondents while "DR1" is having the least. In terms of median, aside of "DR1" which has the value of 5.00, the value for other variables are under 4.00. This means that "DR1" is the action that is very necessary to be conducted for data processing.

Methods of Modelling

The respondents are required to rate the level of acceptability towards the limitation of each modelling methods in order to determine the method that can be included into the guideline. Likert scale from 1 to 5 which indicates "very unacceptable" to "very acceptable" has been used and the result has been tabulated in Table 8. The description of the limitations for each methods of modelling have been shown in Table 7.

Table 7: Description of Limitation for each methods of modelling

Variable	Description
	Mapping of Vectors into Point Cloud
Vectors1	Creation of orthographic image and segmented point cloud is required to enable the mapping of vectors.
Vectors2	It is largely manual and comparatively time consuming than parametric modelling.
Vectors3	Vectors do not reveal as much details behind the object's surface as parametric objects.
	Parametric Modelling Manually
PMM1	Creation of orthographic image & segmented point cloud is required to enable the mapping of parametric objects.
PMM2	There is a high possibility to create a plug-in library of parametric objects that can incorporate with the irregular shapes of the historical structure.
PMM3	It is time consuming as number of steps required to manually map the parametric objects onto the point cloud are high.
	Parametric Modelling Semi-automatically
PMS1	It is only feasible to automatic modelling of point clouds that represent plane surfaces or primitive geometries.
PMS2	It will generate inaccurate results when trying to represent irregular geometries.
PMS3	The reading and interpretation of the qualitative data of a space or object such as the types of materials used, is difficult to be conducted.

Source: Author (2022)

Table 8: Level of acceptability towards the limitation for each modelling methods

Limitations for each methods of modelling	Level of Acceptability					Mean	Median	Standard deviation	Rank
	VU	U	N	A	VA				
Vectors1	0	6	17	23 a	15	3.7705	4.0000	0.93797	3
Vectors2	11	20 a	18	12	0	2.5082	2.0000	1.01033	6
Vectors3	11	23 a	16	11	0	2.4426	2.0000	0.99204	7
PMM1	0	3	13	24 a	21	4.0328	4.0000	0.87497	2
PMM2	0	3	12	25 a	21	4.0492b	4.0000	0.86460	1
PMM3	1	7	13	25 a	15	3.7541	4.0000	1.01087	4
PMS1	4	13	17 a	17 a	10	3.2623	3.0000	1.16764	5
PMS2	25 a	24	12	0	0	1.7869c	2.0000	0.75531	9
PMS3	13	22 a	18	8	0	2.3443	2.0000	0.96411	8

Source: Author (2022)

Note:
VU – Very Unacceptable; U – Unacceptable; N – Neutral; A – acceptable; VA – Very Acceptable
a. Likert item with highest frequency
b. Variable with the highest mean value
c. Variable with the lowest mean value

Based on Table 8, it shows that "PMM2" has the highest mean value of 4.0492, followed by "PMM1" with mean value of 4.0328. Next will be "Vectors1", "PMM3" and "PMS1" with mean value of 3.7705, 3.7541 and 3.2623 respectively. "Vectors2" come right after "PMS1" with the value of 2.5082, followed by "Vectors3", having the mean value of 2.4426. The second lowest of the mean will be "PMS3" with the value of 2.3443. Finally, 1.7869, the lowest value of mean goes to "PMS2".The ascending order of the standard deviation will start from "PMS2", with the lowest value of standard deviation which is 0.75531. This is then follow by "PMM2", "PMM1", "Vectors1", "PMS3", "Vectors3", "Vectors2" and "PMM3". The highest standard deviation will go to "PMS1" which is 1.16747 which means it has the highest degree of variation of responses whereas "PMS2" has the slightest variation of responses among the respondents as it has the lowest value of standard deviation. In respect of median, "Vectors2", "Vectors3", "PMS2" and "PMS3" are having the value of 2.00, which means most of the respondents found the limitations arise from the above methods unacceptable. On the other hand, only "PMS1" has the median value of 3.00, which indicates that most of the respondents found the limitation either acceptable or unacceptable. Lastly, "Vectors1", "PMM1", "PMM2" and "PMM3" have the median of 4.00. It means the respondents found the limitations arise from those methods are acceptable.

DISCUSSION

Methods of Data Capturing

It has been indicated that all the methods rated above mean of 3.00, which means they posed high level of abilities needed to conduct data capturing for heritage building. In terms of laser scanning technique, the ability to capture data in a short duration of time placed the first ranking. Laser scanning technique is a rapid technique in acquiring point clouds that describe the building's information in 3D forms with detail down to millimetre (Megahed, 2015). The second ranking for the abilities of laser scanning technique is the ability to capture data that can provide 3D geometry information. Laser scanner such as terrestrial laser scanner (TLS), aerial laser scanner (ALS) and so on can generate an accurate geometric reproduction of an object in the form of point clouds with geometric coordinates (x, y, z) (Lopez et al., 2018). The third ranking of the ability is the applicability of the method in existing building. As shown in the analysed data, laser scanning technique also provide high spatial accuracy as it can generate 3D point clouds with the accuracies of the measuring angles and distances up to millimetre (Lopez et al., 2018). The data captured is importable to BIM platform to carry out modelling that can contain intelligent data (Murphy et al., 2013). Laser scanning technique also has higher degree of automation as compared to conventional method which required the use of measuring tape (Ali et al., 2018b). In terms of photogrammetry, the first ranking is the applicability of the method to be used in existing building. Megahed (2015), Murphy et al. (2017), Lopez et al. (2018) had included the usage of photogrammetry as one of the surveying methods. The second ranking goes to the ability to capture data in a short duration of time. The ability to capture data that able to provide texture goes for the third ranking.

According to the analysed data, photogrammetry has high spatial accuracy, degree of automation and the data captured is importable into BIM platform. Photogrammetry not only able to provide texture, it also able to provide geometry with high accuracy and have moderate degree of automation with the data being captured able to be imported into BIM platform (Megahed, 2015). In respect of combination of image-based and range-based method, the first ranking of the ability goes to the applicability in existing building. This can be shown the case study of Nasif Historical House in Jeddah, Saudi Arabia (Baik, 2017) and Royal Castle in Bedzin (Klapa et al., 2017), where surveying of data has been conducted by using both laser scanning techniques and photogrammetry. The second highest ranking is the ability to complete the data missing from each other. This means whatever data missing from laser scanning technique can be acquired through photogrammetry or vice versa. As mentioned by Oreni et al. (2014), in the combination method, area will be reconstructed through image-based method when laser survey data unable to provide sufficient level of detail (LoD) or the data acquired is completely lacking. The third highest ranking will be the spatial accuracy of the data captured. As mentioned above, the combination method can complete the data missing from each other, therefore, the data acquired will have comparatively high accuracy as compared to the single method. The analysed data also shows that this method has high ability to capture data in a short duration of time, importable to BIM platform and has high degree of automation. This is because this combination method consist of both laser scanning technique and photogrammetry technique where those abilities also included in the respective method. According to Megahed (2015), this method enable the 3D model to be quickly generated. Having reviewed back the data analysed for the three methods, it shows that spatial accuracy of data captured and applicability in existing building have always been in the three highest ranking from the respective methods.

Processing of Laser and Image Survey Data

Based on Table 6, the mean for all the variables are above 3.00, which indicates all the actions proposed are necessary to be carried out for data processing. The actions will be categorised into data cleaning and resampling, data registration, surface meshing, texturing, and creation of orthographic image. The actions that obtained the first ranking goes to the combination of two or more point clouds taken from different scanning positions, which is under the category of data registration. There will be point cloud data from several different positions as it is normally impossible to be able to capture the whole building structure only from one scanning position with no blockage existed (Lopez et al., 2018). Therefore, data registration has to be conducted to merge the point clouds from different observation points into a coordinate system (Murphy et al., 2017). The second and third ranking, which are to eliminate "noise" from survey data and reduce density of data, come from the same category of data cleaning and resampling. The survey data will always be clouded with erroneous data due to reflection from the scan through object, hence data cleaning will be carried out to remove the irrelevant points (Mustafa et al., 2019). There is a circumstance where the point cloud is too dense due to altering range to the object's surface when capturing data. The remaining actions which under their respective category of surface meshing, texturing and creation of orthographic image have also been rated as necessary to be carried out with the mean for the creation of orthographic image slightly lower than the rest. One of the actions under surface meshing has also been rated as the third highest, being described as: connect the series of random points in the point cloud into a consistent polygonal model to create a surface on the point cloud. This can be known as polygonal surface meshing with the points being joined in triangular networks (Mphil, 2012). Surface meshing also need to carry out the function of smoothing just like what being mentioned in "SM2", fill the holes, correct the edges and optimise the data. According to

Table 6, the data analysed shows that texturing is also necessary to be carried out and this action normally need to go along with the image data as the texture is arise from the mapping of image data onto the point cloud data. Even the mean for the creation of orthographic image is slightly lower than the others but it is still more than 3.00 (neutral). In a nutshell, all the actions have the mean values higher than 3.00 (neutral), which indicates the data processing might include all the categories.

Methods of Modelling

The overall result shows that the second limitation for parametric modelling semi-automatically (PMS2) has the mean value lower than 2.00 (unacceptable) which means the limitation is more than just unacceptable. Meanwhile, there are three limitations with the mean value lower than 3.00 (neutral) but higher than 2.00 (unacceptable), which are the second and third limitation for vectors mapping method (Vectors2 & Vectors3), and the third limitation of parametric modelling semi-automatically (PMS3). There are also three limitations with the mean value lower than 4.00 (acceptable) but higher than 3.00 (neutral), which are the first limitation for vectors mapping method (Vectors1), third limitation of parametric modelling manually (PMM3) and first limitation of parametric modelling semi-automatically (PMS1). Lastly, the remaining two limitation of parametric modelling manually (PMM1 & PMM2) have the mean value higher than 4.00 (acceptable) respectively. For the first methods of modelling, which is to map the vectors onto point cloud, it consists of limitations such as the necessity to create orthographic image and segmented point cloud so that the vectors can be plotted onto the correct surface (Vectors1), it is largely manual (Vectors2) and it is unable to provide detail behind the object's surface such as the type of material and construction method (Vectors3) Murphy et al., 2013). Except for "Vectors1", the other two limitations have the high possibilities for not being accepted as their mean value is lower than 3.00 (neutral). In terms of parametric modelling manually, which is a method used to map the parametric object, an intelligent object onto point cloud, the limitations are the necessity to generate orthographic image and segmented point cloud so that the parametric objects can be mapped precisely on the surface (PMM1), the necessity to create the library of parametric objects for historical building as the library in current BIM platform is meant for conventional building (PMM2), it is a time consuming method as there are a lot of preparation steps that have to be taken before starting with the modelling (PMM3) (Murphy et al., 2017; Murphy et al., 2013). All three limitations have high possibilities to be accepted as their mean value are above 3.00 (neutral) especially with "PMM1" and "PMM2" which have the mean value more than 4.00 (acceptable). In regards of parametric modelling semi-automatically, which is a method that can automate the creation of BIM geometries from point clouds but not entirely as it still need to incorporate with manual method in some circumstance, and with this it leads to the first limitation. This method is only suitable for point clouds that represent primitive geometries and plane surfaces (PMS1), this is because this method will provide incorrect data when being used on building with complex geometries (PMS2) and this will be the second limitation as most of the historical buildings are of irregular geometries. The next limitation will be the difficulty of this method to interpret the qualitative data of an object (PMS3) as there is still lacking of any "smart algorithm" that is able to perform this function (Lopez et al., 2018). In this case, "PMS2" is totally unacceptable as its mean value is already lower than 2.00 (unacceptable) while "PMS3" has the high possibilities of not being accepted as the mean value is lower than 3.00 (neutral). "PMS1" might be accepted as the mean value is higher than 3.00 (neutral) but lower than 4.00 (acceptable). In a nutshell, two out of three limitations of the vectors mapping technique might not be accepted, all the limitations for parametric modelling manually might be accepted and lastly two out of three of the limitations of parametric modelling semi-automatically might not be accepted.

Proposed Guideline for HBIM Implementation

After analysing the data, two of the methods for modelling have been eliminated from the HBIM implementation guideline while the rest of the content such as the methods of data capturing, and processing of laser and image survey data still remain in the guideline (Figure 1). This is because the result obtained shows that the methods of mapping vectors onto point cloud and parametric modelling semi-automatically are unlikely acceptable among most of the respondents.

CONCLUSION

This research serve as a "reminder" that HBIM can be practiced within Malaysia heritage building. HBIM can be used to cope with the problem of lack of relevant documentation, details and information of the heritage buildings that are required to carry out the conservation works. This research indicates that HBIM can solve the problem of limited information in a heritage building by performing data capturing and transfer the data into BIM platform which enable the parametric objects, intelligent objects that enable the storing of graphical or non-graphical information, to be formed in regards of the historical building. This research also serves as to raise the awareness of practicing HBIM in Malaysia.

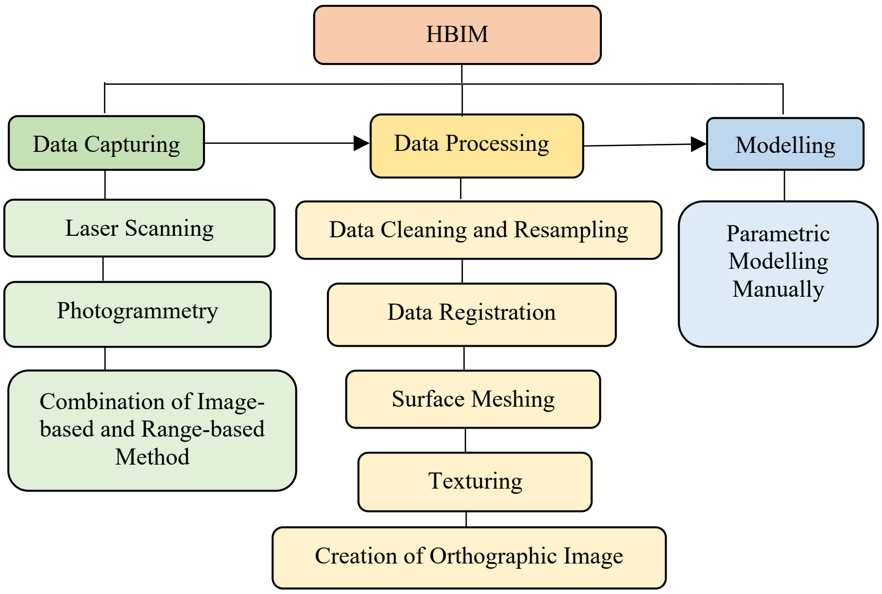

Figure 1: Proposed Guideline of HBIM Implementation

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