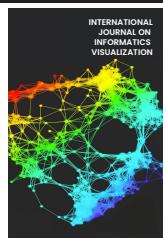




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IT-Architecture Study Literature Research Collaboration: Malay Architecture Context

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Abstract— Talking about architecture culture means talking about buildings and architecture. Architecture is a field of research that is always related to space and form. One of the exciting research topics on architecture is research on Malay architecture. Preserving Malay architecture is an important thing that must be done physically and meaningfully, positively impacting the community's development. The rapid development of information technology (IT) should be part of conservation efforts. IT supports various activities that significantly help conservation efforts. The role of IT in architecture is a significant research opportunity because of still little research on this topic. Thus, we conduct a study and analysis using a systematic literature review methodology to review IT-Architecture research, especially Malay architecture. The systematic literature review methodology consists of six stages, namely: (1) research question definition; (2) literature searching by keywords on literature sources; (3) literature assessment; (4) literature quality measurement; (5) data extraction and synthesis; and (6) research recommendation and suggestion. After going through the quality assessment process, only 37 papers were obtained that were relevant to the topic of IT-Architecture. The most discussed research themes in this literature review search were: (1) building information modeling (BIM) and augmented reality (AR) / virtual reality (VR); (2) BIM and geographic information system (GIS); and (3) BIM application and technology. However, based on literature searches, IT, and Malay architecture are still insufficient. Therefore, the topic of IT and Malay architecture still needs to be studied further in the future.

Keywords— IT architecture; Malay architectural; systematic literature review; research collaboration.

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I. INTRODUCTION

Architecture is a field that is always related to space and form. Architecture is also said to be an art or practice of designing and building structures and building construction. According to [1], etymologically, it can be concluded that architecture must meet at least two criteria, namely: that must be beautiful and strong. Meanwhile, [2], the book titled *Ten Books of Architecture*, said the same thing, that there are three principles of good architecture, namely: (1) *firmitas* (strength); (2) *utilitas* (utility); and (3) *venustas* (aesthetic).

The Malays are part of the Austronesian ethnic groups spread across Southeast Asia. The Malay community's large groups are in Indonesia, Malaysia, Thailand, Singapore, and other regions. Apart from living in coastal areas, Malay people also live at specific points and the river flow. Talking about culture means talking about buildings and architecture;

architecture makes it easier for people to understand the meaning of culture and culture itself, and a culture that has faded because of time should have been witnessed through architecture; over time, buildings also begin to disappear [3].

Architecture is the manifestation of the society and their cultural practice; it reflects the society's way of life, belief, and philosophy; all were encompassing, forming essential components in the uniqueness of culture [4]. Preserving Malay architecture is an important thing that must be done physically and meaningfully, positively impacting the community's development. Malay house, being designed with a view to the local, regional characteristics, is the embodiment of a natural design representing the congruence between the house design and environmental values [5].

Malay architecture has a lot of typologies, including the *Limas* house in Pekanbaru, the *Lontak* house in Kampar, the *Begonjong* house in Gunung Toar, *Layar* and *Sayap* house in

Sentajo, the *Malay-Peranakan* house (mixed ethnic Chinese) in Bagan Siapiapi and Selat Panjang, and some typical Malay houses in other areas [6]. In plain view, the traditional Malay house typology is a form of a stilted or classed house with high pillars as its main construction [7]. Malay house has a room with its name and function. Based on the house's geographic location, the spaces' naming is different even though they have the same function. Traditional Malay architecture symbolizes the Malay people's ingenuity in adapting to the community and their surrounding habitats physically and spiritually [8].

The existence of traditional Malay houses is starting to diminish. Malay dwellings, which were an integral part of the Malay community's civilization, eroded by the times[9]. Conservation efforts must be made, either through preservation, conservation, and restoration. Thus, in the future, the root of the Malay community's culture will still exist as learning material for the next generation[10].

The rapid development of information technology (IT) should be part of conservation efforts. IT supports various activities that significantly help conservation efforts. An example of cultural preservation using IT is digital technology [11]. With digital technology, it will provide convenience in preserving the traditional Malay house architecture. Besides, during the pandemic, we can do every activity online. Documentation activities, site visits, and studying Malay houses can all be done online. It is evident that information technology supports activities that add to knowledge.

According to Breen [12], the advanced information computer technology revolution with the accompanying digital technologies has changed the traditional context of architecture as a profession and in education. Information Technology (IT) plays an essential role in the world of Architecture, from modeling to visual rendering, so that the design work becomes more effective, efficient, and communicative in helping to create a better life for the community [13]. Also, IT plays an important role in preserving Malay architectural heritage, such as a study conducted by [14]. The study was producing a 3D model of *Rumah Tok Su*, which is a traditional Malay house. Lastly, the IT study conducted on Malay architecture is developing databases towards establishing the Malay heritage [4]. With a database, data about Malay architecture will be stored digitally and will continue to be available along with technological developments.

This paper's primary purpose is to discuss the studies or literature related to the role of IT in supporting architecture activities, especially in the Malay architectural context. To achieve this goal, it is necessary to conduct a systematic literature review [15]. Writing a systematic literature review paper review the previous studies related to the role of IT in architecture. The final result in writing this paper is a conclusion and research recommendations of IT research that can preserve Malay buildings.

II. MATERIAL AND METHOD

The methodology used in the literature review refers to the methods described by Kitchenham, which includes several steps, namely: (1) defining research question; (2) literature sources; (3) determining the keywords of literature search; (4) literature selection; and (5) extracting data and synthesis [16],

[17]. Based on the systematic literature review research methodology, this study's steps are described in Figure 1.

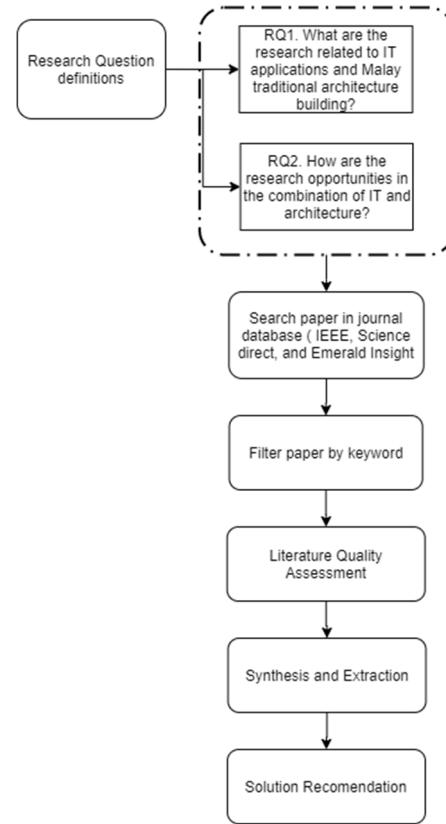


Fig. 1 Research methodology

Based on Figure 1, there are six steps to get the result. The first step is to determine the research question. These research questions will be the main discussion of this research. According to the research question, the next step is to select a suitable paper to answer the questions. The detailed steps are as follows.

A. Research Questions

The research questions that are discussed in this study are as follows:

- RQ1. What is the research related to IT applications and Malay traditional architecture buildings?
- RQ2. How are the research opportunities in the combination of IT and architecture?

B. Literature Sources and Keywords

The literature searching was carried out on the journal and conference paper databases, namely (1) IEEE; (2) ScienceDirect; and (3) Emerald Insight. In the literature searching, the literature was filtered based on keywords such as (1) Malay Architecture; (2) IT and Malay Architecture; (3) IT and Traditional Malay Architecture; and (4) IT Applications and BIM (Building Information Management).

C. Literature Assessment

The literature assessment was carried out using the inclusion and exclusion criteria to select and classify the papers, which will be discussed further at a later stage. The criteria for inclusion and exclusion are:

Inclusion Criteria:

- The contents of the literature correspond to those discussed.
- The minimum publication year is 2015.
- The literature discussed is in the form of journals or conference papers.
- The literature is written in English.
- It includes the topic criteria (Malay Architecture, IT and Malay Architecture, IT and Traditional Malay Architecture, IT Applications and BIM).

Exclusion Criteria:

- The topics discussed in the literature are not related to the topic of discussion (Malay Architecture, IT and Malay Architecture, IT and Traditional Malay Architecture, and IT Applications and BIM).
- The literature is not written in English.
- Literature was other than journals and conferences with the publication year before 2015.

D. Literature Quality Measurement

After classifying the literature at the literature assessment stage, the next step is measuring the literature's quality. Measuring the quality of the literature is carried out by considering the following points:

- The literature includes research related to the application of IT in architecture.
- If the literature concerns with the Malay architectural context, it will add literature's value.
- The method used is limited to information technology applied in the field of architecture.
- There are findings or results obtained from the research.
- There are research limitations that can be opportunities for further research.

E. Data Extraction and Synthesis

Data extraction is carried out to obtain accurate and consistent information. The literature criteria included in this data extraction include (1) identification; (2) the author's name; (3) publication year; (4) source; (5) references; (6) data collection methodology; and (7) data analysis and concepts. The search for additional literature can also be obtained from the primary literature reference, which is the basis for this literature review. Synthesis is carried out by classifying literature discussion themes that can be used to map IT research in the architectural field, especially in the Malay architectural context.

F. Research Recommendations and Suggestions

Based on the results of the synthesis obtained in the previous stage, literature findings related to IT's application within the architecture scope will be accepted. The literature obtained can then be formulated as a recommendation or suggestion of research opportunities that can be carried out in the future.

III. RESULTS AND DISCUSSIONS

A. RQ1. What is the research related to IT applications and Malay traditional architecture buildings?

Research collection is based on keywords and predetermined criteria. In Figure 2, the research statistics

related to the specified keywords have always increased from year to year. This indicates that the multidisciplinary research topic (IT and Architecture) has been an increasingly exciting topic and has experienced many developments. In 2018, the number of studies decreased slightly from the previous year. However, the number of studies significantly increased in 2019.

In Figure 3, each journal database (IEEE, ScienceDirect, Emerald Insight) changed the number of research-related keywords. There were the fewest studies on the IEEE, but on average, the number of studies increased from year to year. In the Emerald Insight database, the number of related researches increased each year except in 2020. The ScienceDirect database had the most research related to keywords. Each year related research in the ScienceDirect database increased except in 2018. In figure 4, it can be seen that the keywords that have the number of related researches are IT applications and BIM.

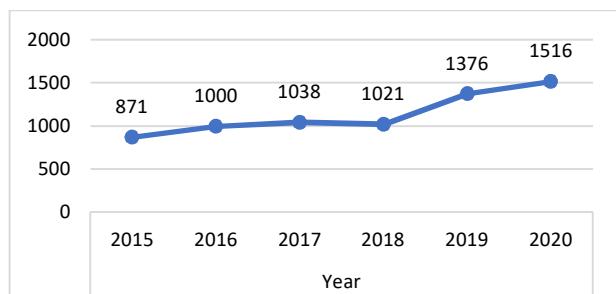


Fig. 2 Total literature search from journal database (18/11/2020)

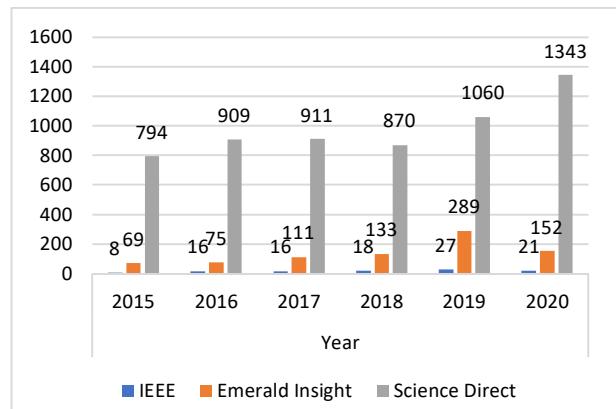


Fig. 3 Total literature search based on database and year (18/11/2020)

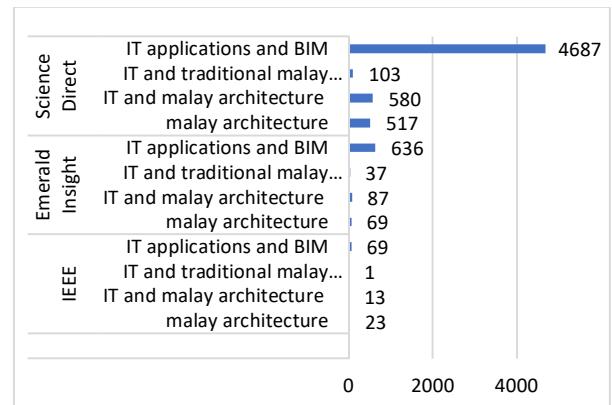


Fig. 4 Total literature search based on keyword from 2015-2020 (18/11/2020)

After screening through keywords, the next step is research filters related to themes based on abstracts (Figure 5). From the results of the screening obtained, 25 studies (IEEE), 11 studies (Emerald Insight), and 38 studies (ScienceDirect) were obtained. Based on keyword filtering, the most frequent were IT applications and BIM keywords (Figure 6). This indicates that the keywords used are particular to the theme to be discussed.

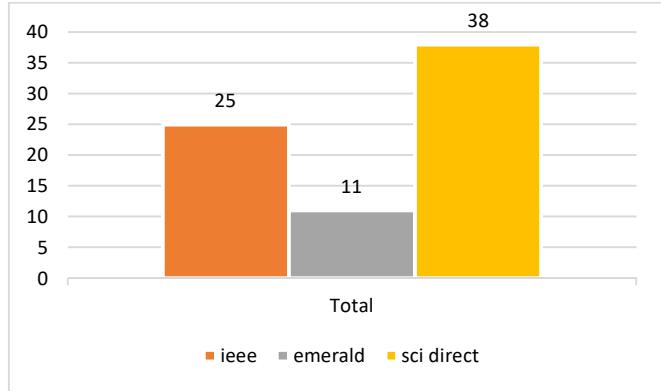


Fig.5 Literature cluster based on research themes.

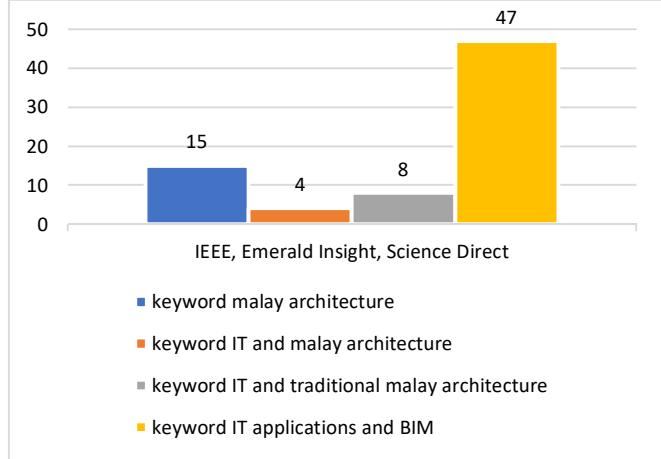


Fig. 6 Literature cluster based on keywords

Based on the paper quality testing, 37 papers were obtained, which became the main papers in the literature review discussion. It can be seen in table 1 that the most used papers are from the ScienceDirect database. This is similar to the previous results; the journal on the ScienceDirect database has the most amount of research related to keywords and abstract content.

TABLE I
FINAL LITERATURE SEARCH

Database	Total
IEEE	12
Emerald Insight	7
ScienceDirect	18
Total	37

B. RQ2. How are the research opportunities in the combination of IT and architecture?

Based on the classification results on the 37 papers obtained, IT-Architecture research themes can be classified as

to be shown in table 2. Based on Table 2, 11 research themes can be used for IT-Architecture research. The most discussed research themes in this literature review search were: (1) BIM and AR / VR; (2) BIM and GIS; and (3) BIM application and technology (Fig. 7). Therefore, based on the most discussed research themes, we recommend that studies be carried out.

TABLE II
RESEARCH OPPORTUNITIES ON IT-ARCHITECTURE

IT-Architecture Research Theme	Sources
Building information modeling (BIM) and Project Management Application	[18], [19], [20], [21], [22]
BIM and Augmented Reality (AR) / Virtual Reality (VR)	[23], [24], [25], [26], [27], [28]
BIM and Geographic Information System (GIS)	[29],[30],[31],[32],[33],[34]
BIM and Big Data	[35], [36]
BIM and Radio-frequency identification (RFID)	[37]
BIM application and technology	[38], [39], [40], [41], [42], [43]
BIM and Knowledge Management Systems	[44], [45]
BIM and data mining	[46], [47]
BIM and Semantic	[48], [49], [50]
BIM and Artificial Intelligent	[51], [52]
BIM and Cloud	[53], [54]

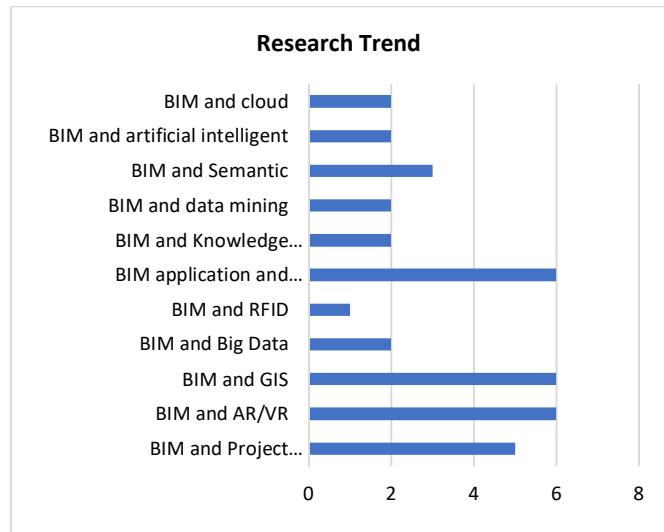


Fig. 7 Trend Research IT and Architecture theme

The combination of BIM with AR / VR is the most comprehensive research based on the classification results. A study conducted by [23], used AR applications as geometric information in BIM modeling to make it more accurate. This information is undoubtedly useful for various stakeholders. Architectural visualization using AR applications on BIM 3D models was also tested by [24] by using a type-1 Fuzzy Logic System (T1FLS). Research conducted by[25] and [26] integrated BIM and mobile AR. This study's research opportunity is to adjust the BIM requirements with the features available in AR [25]. Improving the proposed system in the form of using more effective hardware and also by then conducting user studies [26]. The integration of AR and BIM

is a topic that needs to be explored a lot to make it easier for all stakeholders in designing buildings [28].

BIM with GIS integration is also a popular research topic. The use of GIS in mapping the location of buildings and the building area's environment is needed [31]. Thus, to find the right place and design according to the BIM application is very easy for practitioners. Research that deals specifically with applications related to traditional Malay house architecture were conducted by [18]. This study presents a useful platform for promoting adaptive reuse for heritage and conservation purposes through effective planning using BIM and its simulation tools. However, the research that was reviewed did not discuss the object or case study in the form of a traditional Malay house. This shows the lack of IT-Architecture research in the Malay architectural context.

C. Discussions

The literature searches on journal and conference databases show an increase in the number of topics discussed from year to year. This shows a positive trend due to the increasing number of research, specifically in Malay architecture. Based on the number of topics from each journal and conference database, it can be seen that the keyword search results in ScienceDirect still produce a large number of papers but are not specific. This is quite contrary to IEEE, where the search results are few, but many research papers are relevant to the topic.

Based on the keywords search, the keyword "IT applications and BIM" contributed the most literature search. However, this is contrary to the keyword "IT and traditional Malay architecture," which was the last search result. This proves that the Malay traditional architecture still needs to be explored more deeply because there is still a lack of literature on this topic. The topics listed in the above research (Table 2) offer a variety of research opportunities.

The topic of BIM and AR in the case of traditional Malay houses is a topic that has a significant contribution. This is because there has been no specific research on the integration of AR and GIS with BIM applications. Integrating AR, VR, and GIS with BIM will undoubtedly fulfill the needs of architectural practitioners. The use of AR can realistically depict the interior and exterior of a traditional Malay house. This can be useful for practitioners, academics, and people working in tourism.

Meanwhile, the GIS application in a traditional Malay house can provide a map of the location of a traditional Malay house using the location barcode. This location map makes it easier for travelers to access cultural assets scattered in various regions. Data mining, cloud storage, databases, and big data can provide ornamental references for architects in building modern houses but still provide traditional elements.

However, based on a discussion of IT-Architecture research opportunities, research that discusses IT in the context of Malay architecture is still insufficient. It is exciting to explore IT in Malay Architecture because Malay architecture with an IT approach still needs to be studied further. This will support new research in the Malay architectural context to level up through the IT approach (e.g., database and data dictionary of Malay house). The existence of an IT approach will enable Malay architectural research to be compared with other cultural houses such as the Chinese

house, Arabic house, Indian house, and others. Finally, an IT approach will also play a significant role in digitizing data to preserve Malay culture.

IV. CONCLUSIONS

The writing of this systematic literature review paper has been conducted through a systematic literature review research methodology. A review of IT-Architecture's topic is obtained, especially on the topic of the Malay Architectural Context. After going through the quality assessment process, only 37 papers were obtained that were relevant to the topic of IT-Architecture. Based on the classification paper, 11 topics could be future research. The combinations of BIM and VR/AR, BIM and GIS, BIM application, and technology are exciting topics to be explored further. However, based on literature searches, IT, and Malay architecture is still insufficient. Therefore, the topic of IT and Malay architecture still needs to be studied again in the future.

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