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Research paper

Algorithmic Inventory of Cultural Artefacts (Case Study: Rumoh Aceh of Indonesia)

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Abstract

The existence of rumoh Aceh as a cultural artifact had faced its hardest time. Aspects such as social, economic and environment were considered responsible for the problem. Firstly, within social aspect rumoh Aceh considered inappropriate to accommodate a more modern way of life of the Acehnese. Also, the scarcely available of Acehnese's carpenters who were able to construct a traditional house contribute to an even worse situation. Secondly, in term of economic aspect, budget required to build a traditional house was becoming more expensive. Lastly, nonexistent of environmentally friendly wood production was further considered to responsible for an extinct possibility of rumoh Aceh. Some efforts had been conducted to preserve the artifact in a conventional method using two dimensional working drawing system. The conventional method had not ready for the future technology, and difficult to understand for non-technical peoples. This research improved a conventional inventory model into a more sophisticated data based system utilizing algorithmic method. Further, this study integrated visual scripting of Grasshopper for the algorithmic inventory system. The algorithms was offered to store a real three dimensional data and prepare to be ready for a future production technology such as digital fabrication. As a result, this technological innovation became an alternative solution to preserve the cultural artifact of Rumoh Aceh.

Keywords: *Algorithms, Inventory, Rumoh Aceh, Cultural Artefact, Visual Scripting*

1. Introduction

As authors had observed, *Rumoh Aceh*, an elevated traditional Acehnese house, had scarcely available. Similarly, Widosari (2010) stated this ironic situation. Socially, the preference toward a modern life style had made the Acehnese to build a modern house compare to *Rumoh Aceh* (Arif, 2015). This situation contributed to the omission of traditional carpenters since lacked of request for them. Consequently, many labours forced to acquire a new skill to construct modern houses. It left few who had in depth understanding of *Rumoh Aceh's* tectonic. Economically, to build a traditional house was more expensive compare to a modern house and cost more for its maintenance (Arif, 2015). Environmentally, there were unreliable sources for timber as a main material for construction of *Rumoh Aceh.* Furthermore, Widosari (2010) explained that quality woods as building materials had been limited in Aceh. These were dominant factors that had contributed to the scarcity of the artefact.

Considering the problems, there were efforts to preserve Rumoh Aceh through conventional inventory system. For instance, in the work of Hurgronje (1906) who documented a *Rumoh Aceh* that was belong to *Teungku Anjong*. He provided house information in the form of two dimensional working drawing along with house's construction elements terminologies in Acehnese. The limitation of Hurgronje (1906) works improved by Dall (1982) where significant technical hand-drawn illustrations provided for principal detail such as joint and structural elements. Moreover, Musa, Abbas, & Yusbar (1996) and produced an inventory of the saveral houses spreading in Aceh regions. They produced a hand-drawn two dimensional drawings and three dimensional drawings with description of the building components. An upgraded inventory model found in the work of Mirsa (2013), who provided information in digital three dimensional images. Unfortunately, the three dimensional images of the Acehnese houses dedicated for the visual purpose. All of these works were found limited for visual intention and neglected information for tectonics of the house such as beam sizes. In addition, Acehnese measurement units in the earlier works were merely description and left the uncertainty when and where it was used within Rumoh Aceh. The traditional unit was significant to determine the scale of the house since all of sizes were based on the anthopometric of the owner, which was a house wife. In authors' survey, we discovered a variation in all of building component sizes between one to the other houses in different location within Aceh province.

It was obvious that the traditional inventory system unable to handle some significant information contained within the tectonic of *Rumoh Aceh*. This vurnerability contributed to the lost of certain values that resulted in inappropriate production of Rumoh Aceh for the next generations. Furthermore, since every *Rumoh Aceh* was unique in its size and character, thus, it was important to have a highly adaptable system for a rapid and accurate inventory of the traditional houses.

The current implementation of parametric method for inventory of a cultural artefact was shown in a work by Kanasaki & Tanaka (2015). Their study focused on designed and produced a joint system *tungite* and *shiguchi* within Japanese traditional architecture. They aimed at improving reconstruction of the traditional house. Grasshopper was utilized for modeling and prepared it for digital fabrication using CNCs and 3D printers. They had produced a joint system that was able to be constructed as easy as playing lego. Another advantage was the system had flexibility for verification purposes of the joints such as its sizes before construction. The *tungite* and *shiguchi* had similar principal to the nail-less joints system of *Rumoh Aceh*.

The development of digital technology in architecture such as parametric technology offered potentials to be utilized as a new form of inventory for cultural artefacts. Also, it had flexibility, rapidity and accurateness to be developed to suit certain situation such as *Rumoh Aceh* cases as discussed earlier. Parametric was a method to solve design problem utilizing algorithms (Atthaillah, 2014). Further, Holst (2013) defined algorithms as instructions for computer to perform calculation and produced geometry. This research attempted to improve the inventory system of *Rumoh Aceh* into a data based system using visual algorithms of Grasshopper. The proposed system applicable for tangible aspects of *Rumoh Aceh* such as traditional measurement units and its tectonics. The system proposed within this research was highly adaptable to every *Rumoh Aceh* condition.

1.1. Limitation

Due to some technical and a year time frame, this research was limited to *Rumoh Aceh* structure and omitted building envelope. At this stage, this study was not meant to provide for digital fabrication as in the work of Kanasaki & Tanaka (2015). However, there was flexibility within the framework to be developed for its final stage that accommodated both purposes.

2. Methodology

This research employed visual algorithms of Grasshopper, a plugin under Rhinoceros, to model and stored data of *Rumoh Aceh*. This method was preferred for its high flexibility to adjust suit certain conditions such as the file size that was relatively small compare to Building Information Modeling (BIM) in general or adjust the algorithms, thus, it easily understandable and operable by non-technical users. Also, this system was able to produce a detail technical information with visualization of the objects. We used Rhinoceros version 6 and Grasshopper version 1 for our platform. Rhinoceros was used for visualization platform, meanwhile Grasshopper was utilized for visual scripting. Akos & Persons (2014) explained Grasshopper worked with Parameter, as a media for storing data, and Component as an execution tool. Further, GHPython was utilized to make some custom components that relevant for the purpose of inventory of Rumoh Aceh. Davidson (2016) explained by using GHPython it allowed users to create custom components to extend the ability of the Grasshopper.
To initiate, this study surveyed and did detail measurement to some original Rumoh Aceh, in Bireun and North Aceh of Indonesia. This area was considered to have more Rumoh Aceh, thus, allowed us for option to examine for the originality of its tectonics such as it used interlock system and nail-less construction. These criteria were significant to set up principal for algorithms. This principal controlled the flow of the framework and allowed for adaptability for different Rumoh Aceh in Aceh region. The system allowed for unlimited number of the houses to be stored in three dimensional data with a more efficient time. Figure 1 showed three Rumoh Aceh and its location as our case study.

Fig 1:Case studies, Rumoh Cut Nyak Meutia (upper left), Rumoh Tgk. Chik Awe Geutah (middle left) and Rumoh T. Hamzah Bendahara (bottom left)
Source: Authors (2018)

Beside the tectonics principal, these three objects were taken as a reference point for conversion of traditional Acehnese measurement units into international metric or vice versa. The conversion was further validated with available literature such as Mirsa (2013) and Musa et al (1996). Further, based on this data conversion of Acehnese measurement units were made for the purpose of our inventory system. The proposed framework had the ability to adapt for the changed of the measurement unit if become an issue. In addition, the Acehnese measurement unit was known as *Seunipat* (Lamjame, 2009).

3. Result and Discussion

We had three main considerations in developing our algorithms for the inventory of *Rumoh Aceh*. Firstly, geometry and orientation, *Rumoh Aceh* was symmetrical and its ridge orientated in east-west axis. It consisted of some rooms, with public area on the South, service area such as kitchen and women activities area on the North and private area in the middle. These formation dictated the house geometrically and these were significant values contained within it. Vertically, *Rumoh Aceh* divided into parts as shown in figure 2.

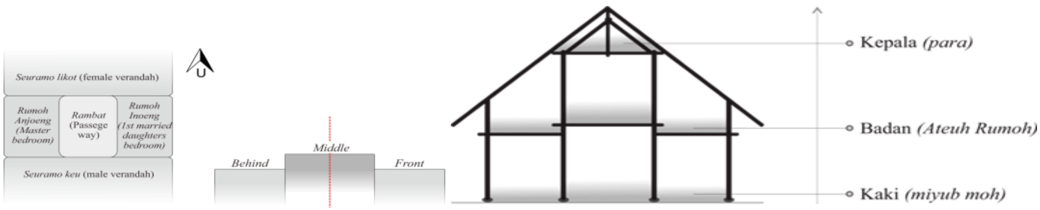


Fig 2: Horizontal and vertical division of *Rumoh Aceh*
Source: Authors (2018)

The figure illustrated three main vertical sections of the structure. From top it was called *para*, middle part named *ateuh rumoh* and bottom section termed *miyub moh.* Geometrically, there was slightly different in elevation for the middle part of the house. The significant value for each of this part was comprehensively discussed in the work of Dall (1982). In term of building elements, there were 25 (twenty five) structural elements of *Rumoh Aceh* and these elements for the first time explained in the work of Hurgronje (1906).

Secondly, morphological transformation, the current state of *Rumoh Aceh* had evolved into several stages. At its earliest state, the house rather small which consisted verandah and interior spaces arranged longitudinally from front to back. Next, as activities within the house changed overtime and made the building expanded sideways including its roof. As the result of projected roof, it made the expanded area lower than the middle part and made it uncomfortable for internal activities, thus, it forced to lower the floor level in each sides of the house to accommodate the extended activities. Figure 3 and 4 illustrated the overall transformations of the artefact. At its final stage, *Rumoh Aceh* only expanded longitudinally in east-west axis. Also, this stage's transformation was what we recognized and understand as *Rumoh Aceh.* The final stage was the basis for our algorithms as we merely found the *Rumoh Aceh* in that shapes during our research timeframe.

Finally, the seunipat, In Aceh's culture, the traditional house was dedicated to a woman, specifically a house wife, as the owner. This was a reason for a housewife in Acehnese called peurumoh, which was defined as the owner of the house (Bakri, 2015). For the reason, majority of activities within the house were dedicated for women. In addition, the house was tightly bounded by ergonomic of house owner to suit some activities as shown in figure 5. These activities were applied as the basis for seunipat, the Acehnese traditional measurement units for constructing a Rumoh Aceh.

For our case study, the seunipat was aligned with earlier discussion and it showed variation in each of our case study. Yet, some units were similar when converted into international standard measurement unit which was centimeter in our case. According to Iman (2017), an Acehnese curator, since utoh, an Acehnese carpenter, based the measurement on peurumoh, variations in sizes for each structural component of the house was inevitable. Consequently, it affected the overall size of Rumoh Aceh. Figure 6 illustrated the seunipat and the range of each measurement unit in centimeters for our case studies.

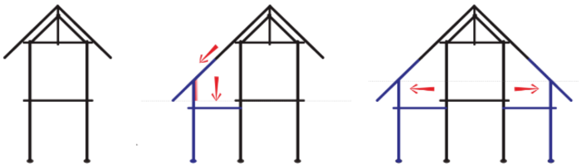


Fig 3: *Rumoh Aceh* transformation (a) earliest stage, (b) middle stage, (c) final stage
Source: Authors (2018)

Fig 4: Evidence of *Rumoh Aceh* Transformation, earliest, middle and final stage (left to right)
Sources: Arcengel (2010), (Sanjaya. D, 2012) and Authors (2018)

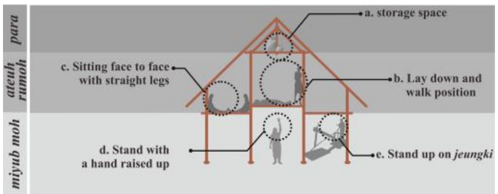
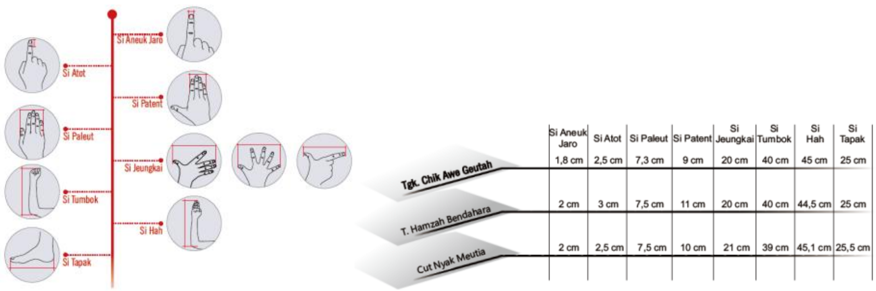


Fig 5: Type of activities within the house
Source: Authors (2018)

Based on our case studies we did the average for each measurement unit for the purposed of measurement input data for our algorithms. As explained earlier, the high adaptability of the framework was adjustable to suit certain changed due to new conversion unit for Rumoh Aceh.



	Si Aneuk Jaro	Si Atot	Si Paleut	Si Patent	Si Jeungkai	Si Tumbok	Si Hah	Si Tapak
Tgk. Chik Awe Geutah	1,8 cm	2,5 cm	7,3 cm	9 cm	20 cm	40 cm	45 cm	25 cm
T. Hamzah Bendahara	2 cm	3 cm	7,5 cm	11 cm	20 cm	40 cm	44,5 cm	25 cm
Cut Nyak Meutia	2 cm	2,5 cm	7,5 cm	10 cm	21 cm	39 cm	45,1 cm	25,5 cm

Fig 6: Aceh's measurement unit illustration and range for seunipat in our case studies
Source: Authors (2018)

The inventory data that was input into algorithms was based on surveyed data from our object studies. The earlier three considerations acted as principle for the arrangement of our algorithms, thus, we were able to produce a prototype of the inventory framework. Figure 7 showed the flow for constructing our algorithms.

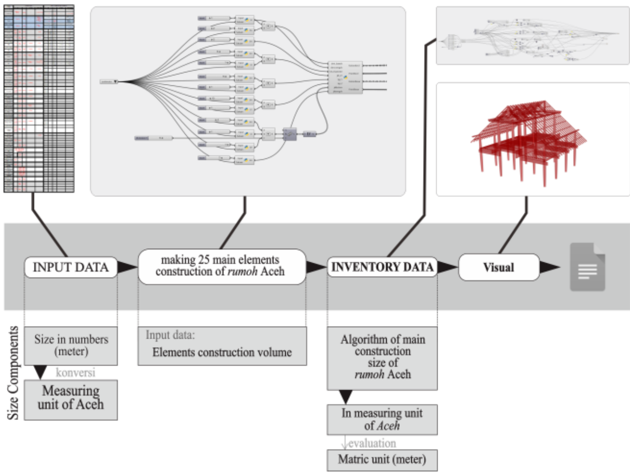


Fig 7: Workflow of algorithms
Source: Authors (2018)

In our algorithms, GHPython played significant role in order to create Grasshopper custom components to suit Rumoh Aceh conditions. For instance, the measurement unit that was able to do conversion from Aceh unit into international unit or vice versa. The component was important to define overall algorithms flows. It was able to accept input from Aceh traditional measurement unit or international system. If input for international was given than the component converted it into Aceh measurement unit or either way. Figure 8 illustrated conversion unit was able to be altered if new data were found. When it changed the entire system adjusted to the new reference number of the measurement unit. This model was applicable to all Aceh seunipat discussed earlier.

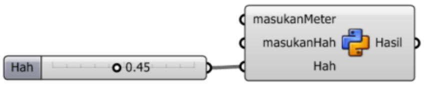


Fig 8: Ghpython components for making seunipat of Rumoh Aceh
Source: Authors (2018)

Fig 9: Overall Rumoh Aceh inventory algorithms
Source: Author (2018)

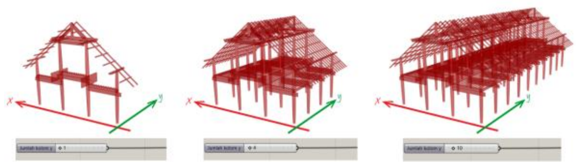


Fig 10: The transformation of Rumoh Aceh longitudinally
Source: Authors (2018)

Overall algorithms were grouped based on Rumoh Aceh structural components as shown in figure 9. This made easier to validate the algorithms if necessary for future developments. Since the development of Rumoh Aceh mainly possible longitudinally and had regular in sizes and patterns repetitively, the development was able to be modeled and visualized by altering one slider. This capability was shown in figure 10. The algorithms were highly adaptable to be used for inventory of every Rumoh Aceh available in the province. By using this algorithms as an inventory tool, the process of preserving the cultural artefact was more innovative, flexible, efficient and effective. Of course, at this stage our algorithms limited to structural components and systems inventory of Rumoh Aceh.

4. Conclusion

This research had introduced a new inventory system for the Acehnese tangible cultural artefact which was Rumoh Aceh. The inventory system had innovated the previous two dimensional drawing and three dimensional images for visual intention into data based system using algorithms. By utilizing the data based systems, it had allowed to store data of Rumoh Aceh that synchronize for modeling and visualization purpose. Further, data based system allowed for a more dynamic way of preserving the cultural artefact. Also, the system opened possibility to be integrated into future digital fabrication system for reconstruction of the artefact. This was possible since the nature of parametric technology that orientated to future development. Even, this study limited for structural system of the house, yet, it was able to be flexibly developed into the finished system of Rumoh Aceh.

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