

An Investigation Model of *Rumoh Aceh* Tectonic Assets Based on Explicit Knowledge

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Abstract: Tectonics is one of the fundamental attributes of traditional Acehnese architecture (*Rumoh Aceh*). Among the representations of the study, archives and documentation of current tectonic knowledge come from explicit knowledge. The investigation of explicit knowledge assets related to *Rumoh Aceh* tectonics aimed to rediscover the tectonic knowledge associated with this architectural object. The main objective of this article was to develop an investigation model for documenting explicit knowledge of *Rumoh Aceh* tectonics. The iteration process in developing this explicit knowledge investigation model used a qualitative approach. The chosen approach model was an exploratory sequential design through two stages. The first stage involved identifying the definition and units of tectonic knowledge, while the second stage focused on identifying the explicit knowledge of *Rumoh Aceh* tectonics. The findings of this study indicated that the current representation of archives and documentation on *Rumoh Aceh* tectonic knowledge is still incomplete. It is necessary to compile and organise the knowledge found in various literature sources to achieve a comprehensive and systematic understanding. This study made a significant contribution by developing an investigation model for explicit knowledge assets in tectonics. The development of this investigation model complemented the knowledge in documenting tectonic knowledge in traditional architecture, especially *Rumoh Aceh*. It is expected that this model will assist other researchers in revealing and documenting tectonic knowledge related to other traditional architectural objects.

Keywords: Investigation model, Knowledge assets, Explicit knowledge, Tectonics, *Rumoh Aceh*

INTRODUCTION

Rumoh Aceh is a traditional house from Aceh, one of the 38 provinces in Indonesia located at the upper tip of the island of Sumatra. As a historical artifact (Aiyub, Loebis and Pane, 2018), *Rumoh Aceh* is known for its unique tectonic characters and features which were built based on the knowledge and intuition of the community (Izziah et al., 2021). However, the study of *Rumoh Aceh* tectonics has been very limited. This is evident in the VosViewer bibliometric analysis of 27 Scopus-indexed publications from 2018–2022.

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The analysis revealed that there were no publications that focused on the tectonics of *Rumoh Aceh* during this period (as shown in Figure 1).

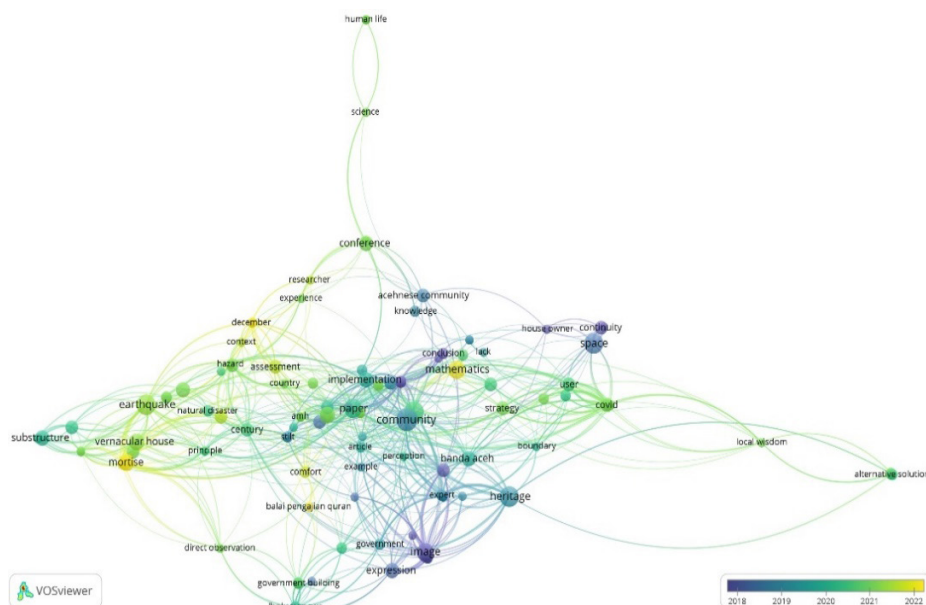


Figure 1. Analysis of VOSViewer on *Rumoh Aceh* tectonics

This phenomenon suggests that the study of *Rumoh Aceh* tectonics is becoming less popular. This aligns with the statement made by Ng and Wong (2018) that there has been a notable demise in the employment of a tectonic expression in the making of architecture. This phenomenon is observed in almost all traditional architectural objects in Indonesia, including *Rumoh Aceh*. Cultural acculturation (Hajdad et al., 1981) in *Rumoh Aceh* has led to a shift in the significance placed on emphasising the tectonic aspect as an architectural expression. Maintaining and preserving the existence of *Rumoh Aceh* artifacts poses challenges without support from the government and the community, particularly from *Rumoh Aceh* owners.

Based on the background provided, the initial hypothesis suggested that the representation of archives and documentation of tectonic knowledge of *Rumoh Aceh* was still not fully documented. This incomplete documentation of knowledge was identified as a research gap that needed to be addressed to preserve its tectonic knowledge. Therefore, it was necessary to develop an investigative methodology to document the tectonic knowledge assets of *Rumoh Aceh*. The methodology developed in this study is expected to be applied and further developed for other traditional house objects.

LITERATURE REVIEW

Knowledge assets consist of explicit and implicit knowledge (Nonaka, 1994; Nonaka, Toyama and Konno, 2000; Alavi and Leidner, 2001; Grover and Davenport, 2001; Takeuchi, 2006). The two are not dichotomous states of knowledge, but mutually dependent and reinforcing qualities of knowledge (Alavi and Leidner, 2001). Explicit knowledge is the type of knowledge that can be articulated (Nonaka, Toyama and Konno, 2000; Takeuchi, 2006). The idea of explicit knowledge is understood as a knowledge product (Ribeiro, 2013) that can be transmitted, articulated, codified and communicated (Alavi and Leidner, 2001). Explicit knowledge also refers to information generated by scientific research, such as in the form of data, scientific formulas, specifications, procedures and more (Grover and Davenport, 2001; Takeuchi, 2006). According to Polanyi (1966), explicit knowledge relies on implicit understanding and application (Tsoukas, 2004; Ribeiro, 2013).

Implicit knowledge refers to highly personal knowledge that is difficult to imitate (Ambrosini and Bowman, 2001). This type of knowledge is unsystematic and difficult to formalise and share entirely (Bijker, 2011; Chennamaneni and Teng, 2011) because it is developed by individuals through their personal experiences gained over the years (Ribeiro, 2013). Therefore, understanding and utilising this knowledge is crucial as it resides within human brains (Mezghani, Exposito and Drira, 2016). The higher the level of implicitness, the more difficult it is to access. Knowledge sources with high levels of implicitness can be articulated using the appropriate knowledge management mechanisms (Chennamaneni and Teng, 2011).

Based on this understanding, the present study focused only on investigating explicit knowledge related to *Rumoh Aceh* tectonics. One of the considerations was the ease of accessibility to data sources and knowledge. An accessible source of explicit knowledge assets for *Rumoh Aceh* tectonics is information produced by scientific research documents such as journals, proceedings and books. Explicit knowledge sources are more readily available, while implicit knowledge sources can only be obtained through communication with knowledgeable individuals (Mezghani, Exposito and Drira, 2016). Accessing data sources of implicit knowledge requires a complex methodology and a significant amount of time. Implicit knowledge is essential for developing and interpreting explicit knowledge (Alavi and Leidner, 2001). Therefore, investigating the implicit knowledge of *Rumoh Aceh* tectonics would naturally be a subsequent study to complement the results of the current research investigation.

Tectonics is a fundamental attribute in architectural design (Lakkala and Pihlajaniemi, 2021; Theodossopoulos, 2022). Tectonic theory develops along with the development of architectural theory (Chen et al., 2010) and continues

to evolve (Schwartz, 2015). Physical entities (carpentry) have shifted to a more comprehensive idea of construction (Al-Alwan and Mahmood, 2020). The term tectonics describes the issues of aesthetics, materiality and representational aspects behind construction solutions (Riskiyanto, Yatmo and Atmodiwirjo, 2021). Tectonics can be interpreted in various ways, depending on the context (Phattanawasin, 2007). There is no specific definition of the tectonics of *Rumoh Aceh*. Therefore, in the process of investigating the knowledge of *Rumoh Aceh* tectonics, it was necessary to refer to literature studies on tectonics. This literature review aimed to gather knowledge units and definitions of tectonic knowledge that are contextual to the traditional architectural object of *Rumoh Aceh*.

In general, there are two typologies of traditional house buildings in Aceh, namely *Rumoh Aceh* and *Rumoh Santeut* (Husin, Chairani and Syafrizal, 2003; Nursaniah, 2022). The characteristic of *Rumoh Aceh* is that it has varying floor heights in the middle (as shown in Figure 2). Meanwhile, *Rumoh Santeut* has a flat floor (Husin, Chairani and Syafrizal, 2003), as shown in Figure 3. The red dotted box shows the approach to the floor characteristics.



Figure 2. Typology of *Rumoh Aceh*



Figure 3. Typology of *Rumoh Santeut*

Rumoh Aceh has a high level of tectonic culture and art (Arif, 2015a). One of the unique features of *Rumoh Aceh* lies in its strength and sturdiness. The construction elements and their connections did not require any nails (Nurdin, 2015; Izziah et al., 2020; Saskia, Susanto and Suganda, 2020), as they solely relied on a peg-bound system (Leigh, 1989). The construction process carried out by the community in the past was closely tied to the principles of traditional values. As a cultural heritage, *Rumoh Aceh* has a lot of local

wisdom that can be adapted and applied in the current context. Therefore, it is necessary to explore and re-examine the tectonic knowledge of *Rumoh Aceh* to document it properly and comprehensively.

One of the attempts to preserve the knowledge of *Rumoh Aceh* tectonics is to reinvestigate the “scattered” explicit knowledge. The findings of this investigation can be compiled into a comprehensive and systematic body of knowledge. Given the importance of this knowledge, an investigation model was required to identify and manage knowledge assets related to *Rumoh Aceh* tectonics.

METHODOLOGY

Data analysis is conducted using JMP Pro version 16 (JMP Statistical Discovery LLC, Cary, North Carolina, United States). The iterative process used a qualitative approach to develop this explicit knowledge investigation model (Neuman, 2014; Creswell and Creswell, 2018; Efron and Ravid, 2019). The chosen approach model was the exploratory sequential design which involved collecting and analysing data sequentially. The investigation of explicit knowledge assets on *Rumoh Aceh* tectonics was conducted in two stages (as shown in Figure 4).

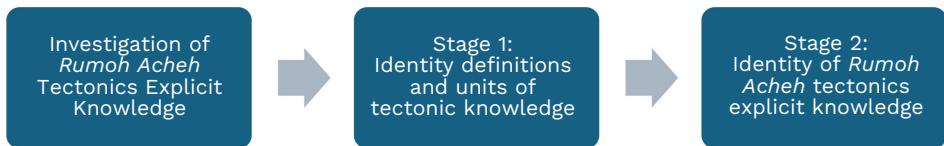


Figure 4. Research stage framework

The initial stage in exploring knowledge is to identify the sources of knowledge (Ribeiro, 2013). In this study, the first stage was to identify the tectonic knowledge units and their definitions. The identification process was conducted through a literature review on tectonics in architecture using an exploratory qualitative approach. This stage involved four steps (as shown in Figure 5): (1) identifying tectonic taxonomy according to experts, (2) validating based on relevant literature review using the summative content analysis method, (3) identifying tectonic knowledge units using the content analysis method and (4) justifying and determining tectonic knowledge units. The expected outcome of the first stage is to define tectonic and its knowledge units.

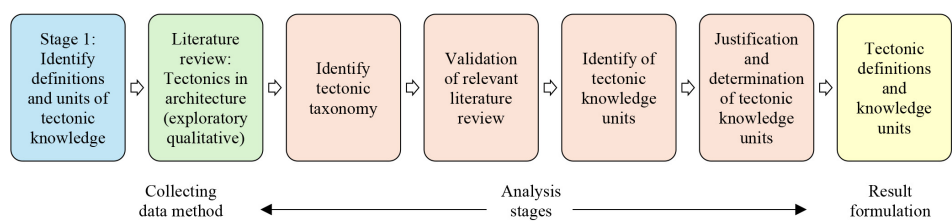


Figure 5. Research methodology framework phase I

As tectonic theories continue to develop (Chen et al., 2010; Schwartz, 2015), it is necessary to revalidate the expert tectonic taxonomy (as shown in Figure 6). This validation aims to examine the development and understanding of tectonic knowledge. The validation of the expert tectonic taxonomy was carried out through a review of relevant literature. The knowledge units established at this stage would be re-traced based on a broader literature review. The literature review selected consisted of scientific articles published within the past 5 years (2018–2023). This aimed to determine the percentage of the terminology usage from these knowledge units in the latest research.

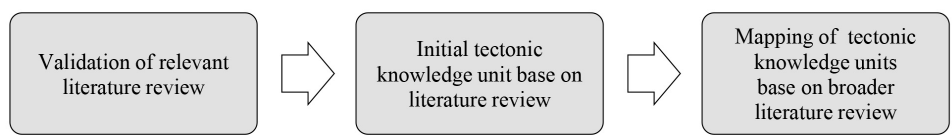


Figure 6. Tectonics knowledge unit taxonomy validation framework

The mapping of knowledge units in the previous stage was then justified for determining the final knowledge units (as shown in Figure 7). The first step involved tracing the definition of each knowledge unit through literature studies. The second step involved justifying the combination of knowledge units that had similar definitions and meanings. The third step was to determine the knowledge units and formulate a definition of tectonics. These tectonic knowledge units served as the reference in exploring the explicit knowledge of *Rumoh Aceh* tectonics.

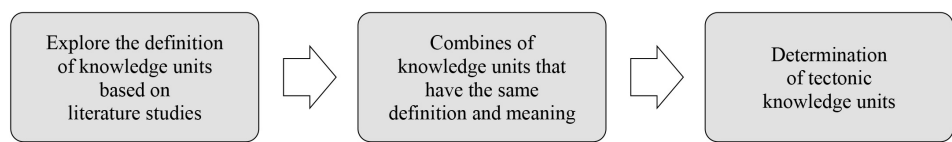


Figure 7. Framework for determining tectonic knowledge units

The second stage involved identifying explicit knowledge about *Rumoh Aceh* tectonics. Explicit knowledge can be found in written knowledge or artifacts. In this study, relevant literature served as the primary data source. The identification process was based on tectonic knowledge units from the first stage. This stage consisted of four steps (as shown in Figure 8): (1) conducting literature studies on *Rumoh Aceh* using exploratory qualitative methods, (2) identifying literature studies on *Rumoh Aceh* tectonics based on topics and abstracts using the summative content analysis method, (3) identifying explicit knowledge of tectonics using the inductive coding method and (4) compiling explicit knowledge of tectonics.

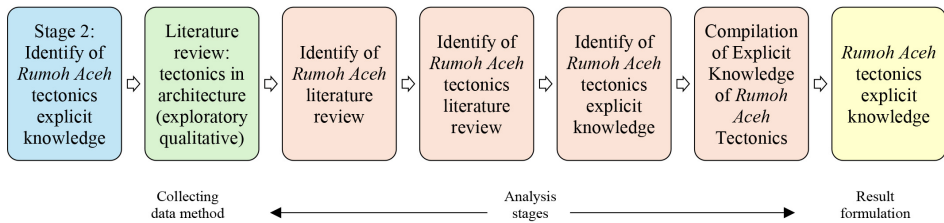


Figure 8. Research methodology framework phase II

The literature review of the architecture of *Rumoh Aceh* was collected from various sources consisting of journals, proceedings, book chapters and books. The identification of the literature review on *Rumoh Aceh* tectonics was conducted by identifying tectonic knowledge units from topics and abstracts (as shown in Figure 9).

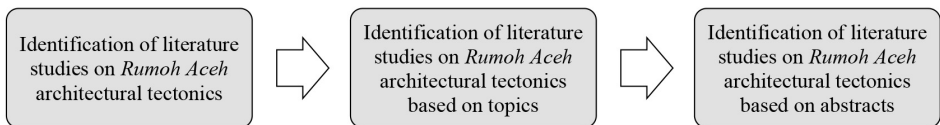


Figure 9. Identification framework for the *Rumoh Aceh* tectonics literature review

The explicit knowledge identification stage of tectonics was conducted using qualitative data analysis methods. This involved inductive coding to extract meaning segments, codes, subcategories and categories from the text data (as shown in Figure 10). The text data were obtained from literature reviews conducted in the previous stage. The selected text data include information or knowledge that is relevant to the tectonic knowledge unit.

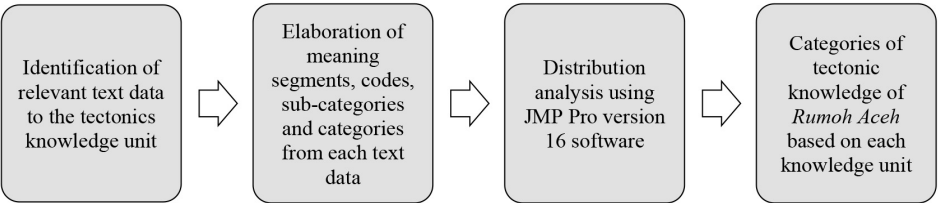


Figure 10. Explanatory knowledge identification framework of tectonics

The text data were translated into meaning segments. Meaning segments are pieces of information or knowledge extracted from the text data. Each meaning segment was then assigned a code. The code could include words that are present in the meaning segment. The code could also include words outside the meaning segment but represent related segments. Codes that share similarities were grouped into subcategories. Subcategories that share similarities were then grouped into categories (as shown in Figure 11). In a specific knowledge context, one meaning segment could consist of several codes, subcategories and categories. The coding process can be iterated repeatedly to identify appropriate and relevant words. In this study, the coding process was conducted based on each unit of tectonic knowledge.

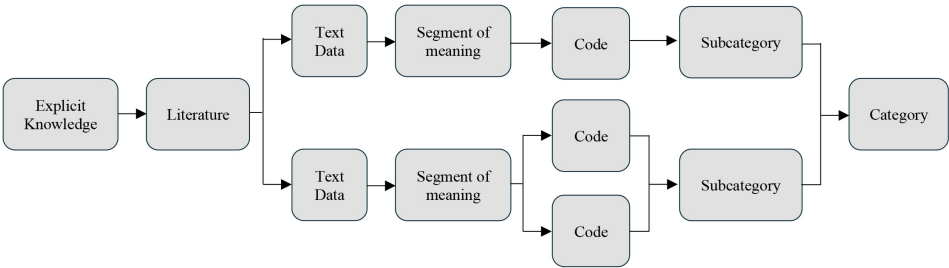


Figure 11. Explicit knowledge coding stages framework

RESULTS AND DISCUSSION

This study focuses on investigating explicit knowledge of *Rumoh Aceh* tectonics. Therefore, it was necessary to first identify the taxonomy of tectonics itself. In its development, tectonics was divided into classical tectonics and digital tectonics (Al-Alwan and Mahmood, 2020). Classical tectonics is related to the poetic value of buildings and construction with a focus on materials and structures. Digital tectonics provides an understanding of new architectural forms from a tectonic perspective. The study of tectonics in this study was limited to classical tectonics, as it was specific to the architectural object of *Rumoh Aceh*.

Stage 1: Tectonics Knowledge Unit Investigation Model

This stage consists of four sub-stages as described in the following explanation.

Identification of tectonic taxonomy according to experts

According to Karl Botticher (1806–1889), tectonics is the relationship between ontology (*kernform*) and representation (*kunstform*). Gottfried Semper (1803–1879) argued that the keywords of tectonics are the use of hands and cultural expression. In the other hand, according to Edward Sekler’s (1920–2017) perspective, tectonics is the expressive value of structure and construction while Kenneth Frampton (1995: 387) describes tectonics as “poetic construction” (as shown in Figure 12).

Gottfried Semper (1803–1879)	:	Material	+	Handicraft	=	Cultural Expression
Karl Botticher (1806–1889)	:	Ontology	+	Representation	=	Architectonic Sense of Place Natural Organic Form
Edward Sekler (1920–2017)	:	Construction	+	Structure	=	Empathy
Kenneth Frampton (1930)	:	Cultural Science	+	Art Technology	=	Tectonic Culture Poetic of Construction

Figure 12. Concept of classical tectonic theory according to experts
Source: Adapted from Al-Alwan and Mahmood (2020)

The important factors of classical tectonics can be categorised into three main aspects: technique, culture and material (Al-Alwan and Mahmood, 2020). The concept of this tectonic theory is illustrated in Figure 13.

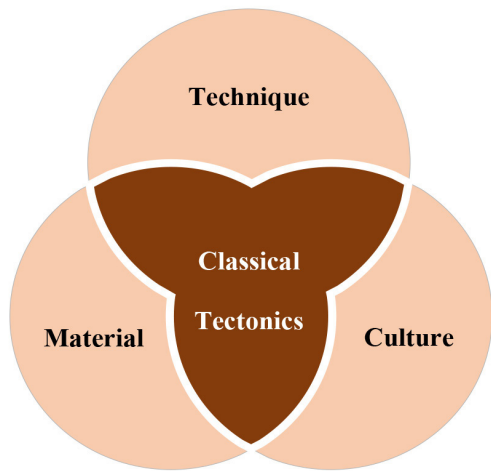


Figure 13. Classical tectonics essential factors

Source: Adapted from Al-Alwan and Mahmood (2020)

Validation through relevant literature review

There are several literatures explaining the aspects or definitions of tectonic theories. The aspects or definitions are derived from various histories and contemporary thoughts. Frampton proposed seven factors describing important tectonic elements in architecture (Mahmood and Al-Alwan, 2023). These factors include objects, details, joints, materials, construction, structures and interactions. According to Schwartz (2017), there are seven aspects of tectonic theory: anatomy, construction, details, place, representation, space and atectonics. Similarly, Liu and Lim (2006) identified at least seven factors in tectonic analysis: joints, details, materials, objects, structures, construction and interactions.

Based on the compilation of past literature, it can be concluded that classical tectonic knowledge units consist of objects/anatomy, construction, structure, details and joints, materials, places, representations, ornaments, space, interactions and atectonics. However, of all the existing aspects, the cultural aspect was not explicitly mentioned. Therefore, the compilation of aspects of tectonic theory needs to be further validated through a more comprehensive literature review. The analysis of additional literature includes 24 journal articles and proceedings from the past five years (2018–2023). The distribution of tectonic units is described in Table 1.

Table 1. Mapping of tectonic knowledge units

Source	Material	Structure	Construction	Detail	Joint	Technique	Technology	Form	Space	Culture	Poetic	Aesthetics	Ornament	Function	Atectonic	Stereotomic	Elements/Anatomy	Place/Context	Interaction
Hildayanti and Wasilah (2021)	✓	✓	✓	✓	✓		✓	✓				✓	✓						
Herwindo, Dwisusanto and Nirwan (2023)	✓	✓	✓	✓			✓	✓	✓	✓		✓	✓						
Mahmood and Al-Alwan (2023)	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓					✓
Santosa, Rachmawati and Noerwasito (2023)	✓	✓	✓		✓		✓		✓	✓									
De-Los-Aires-Solís and Gonzalez-Quintial (2023)			✓	✓			✓									✓			
Schultz (2023)	✓	✓	✓			✓	✓	✓		✓	✓	✓						✓	
Lucchini and Urban (2023)	✓	✓	✓							✓	✓	✓				✓	✓	✓	
Theodossopoulos (2022)	✓	✓	✓		✓		✓	✓									✓		
Akgün, Erkarslan and Kavuncuoğlu (2022)	✓	✓	✓	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	✓	✓	
Hematang and Ikaputra (2022)	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Karmoose (2022)	✓	✓	✓	✓	✓		✓		✓	✓		✓	✓		✓	✓	✓	✓	
Riskiyantoand Anandhita (2022)								✓	✓										
Ibnu et al. (2021)	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓						✓
Riskiyanto, Yatmo and Atmodiwirjo (2021)	✓	✓	✓			✓	✓	✓	✓	✓		✓	✓	✓				✓	✓
Lakkala and Pihlajaniemi (2021)	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓						

(Continued on next page)

Table 1. Continued

Source	Material	Structure	Construction	Detail	Joint	Technique	Technology	Form	Space	Culture	Poetic	Aesthetics	Ornament	Function	Atectonic	Stereotomic	Elements/Anatomy	Place/Context	Interaction
Widjaja, Prijotomo and Dwisusanto (2021)	✓	✓	✓	✓		✓	✓		✓	✓		✓	✓	✓				✓	
Safley (2021)	✓		✓	✓	✓		✓												
Harahap (2021)	✓	✓	✓	✓				✓	✓					✓			✓		
Al-Alwan and Mahmood (2020)	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓			✓	✓	✓
Shi et al. (2020)	✓	✓	✓				✓					✓							
Jensen et al. (2019)		✓	✓			✓			✓		✓	✓							
Weber (2018)	✓		✓	✓						✓	✓								
Ng and Wong (2018)	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓		✓			✓	
Lakkala and Pihlajaniemi (2018)	✓		✓		✓		✓	✓	✓	✓	✓								
Total	21	19	23	14	14	7	19	13	14	15	9	15	10	7	3	5	7	9	4

Identification of tectonics knowledge units

The mapping results using the content analysis method in the previous stage revealed that there were 19 units of knowledge related to tectonics (as shown in Figure 14). Among these 19 units, the knowledge units pertaining to tectonic construction, materials, technology and structures had a higher distribution percentage compared to other knowledge units.

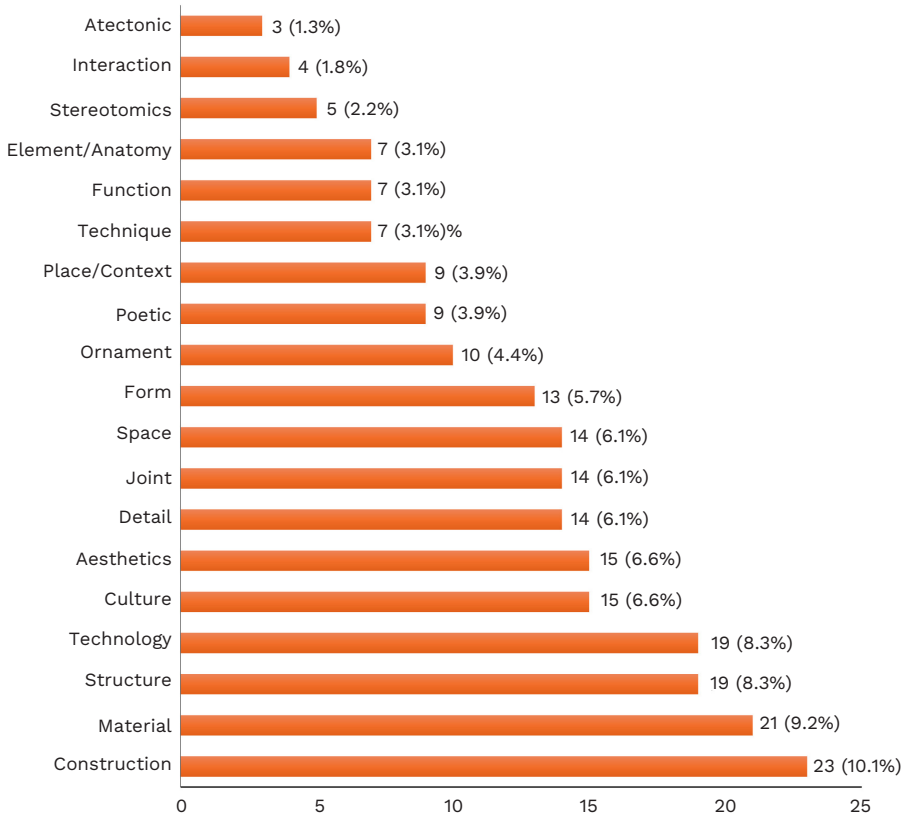


Figure 14. Compilation of tectonics knowledge units

The results of more comprehensive identification and analysis indicated that certain aspects of classical tectonic theories introduced by experts (Gottfried Semper, Karl Botticher, Edward Sekler and Kenneth Frampton) remain relevant today. When developing an investigative model, these units of knowledge would serve as the foundation for examining explicit and implicit knowledge.

Justification and determination of tectonic knowledge units

Based on the justification results, it was determined that there were 10 selected tectonic knowledge units: materials, construction, structure, details and joints, space, culture, elements, place/context, ornament and representation and atectonics. The knowledge units of function, form, interaction, technique and technology were not selected because they were similarly related to the aforementioned 10 knowledge units.

Based on the investigation of the knowledge units mentioned above, the definition of tectonics was understood as the integration of engineering, materiality and cultural elements in construction. The engineering aspects included construction, structure, details and joints, anatomy and atectonics. The materiality aspect related to the use and expression of materials, while the cultural aspect included space, ornamentation and representation and place/context. Tectonics can be used to reveal the essence, understand components, analyse systems and evaluate the quality of a building.

In the context of traditional architectural tectonic research, the cultural aspect is an important unit of knowledge. Culture expresses identity, values, traditions and beliefs (Frampton, 1995). In the context of this research, the taxonomy of tectonics needed to be re-elaborated to obtain specific and contextual knowledge units that align with the topic and objectives of the research.

Stage 2: Explicit Knowledge Investigation Model of *Rumoh Aceh* Tectonics

This stage also includes four sub-stages described as follows.

Identification of literature studies on architecture of *Rumoh Aceh*

The literature used in this study comprised journals, proceedings, book chapters and books related to the topic of the architecture of *Rumoh Aceh*. A total of 124 literatures were selected from various sources (as shown in Figure 15).

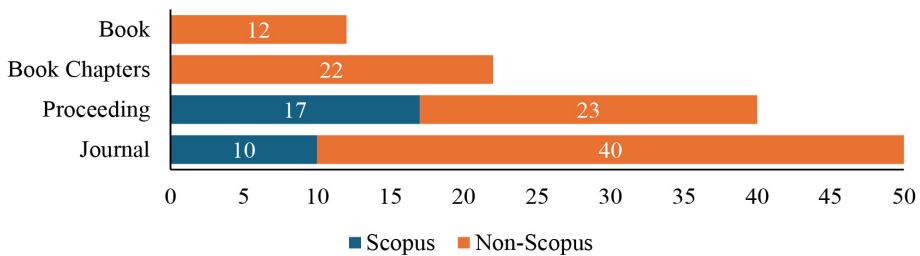


Figure 15. Architecture of *Rumoh Aceh* literature data

The collected literature consisted of 10 Scopus-indexed journals (8.1%), 40 non-Scopus journals (32.3%), 17 Scopus-indexed proceedings (13.7%), 23 non-Scopus proceedings (18.5%), 22 book chapters (17.7%) and 12 books (9.7%).

Identification of literature studies on *Rumoh Aceh* architectural tectonics

From the literature reviewed in the previous stage, there were 59 sources related to tectonics (as shown in Figure 16). These sources were chosen based on their relevance to the tectonic knowledge unit, which was identified by analysing topics and abstracts in the initial stage. These sources include 3 Scopus-indexed journals (5.1%), 17 non-Scopus journals (28.8%), 6 Scopus-indexed proceedings (10.2%), 13 non-Scopus proceedings (22.0%), 8 book chapters (13.6%) and 13 books (22.0%).

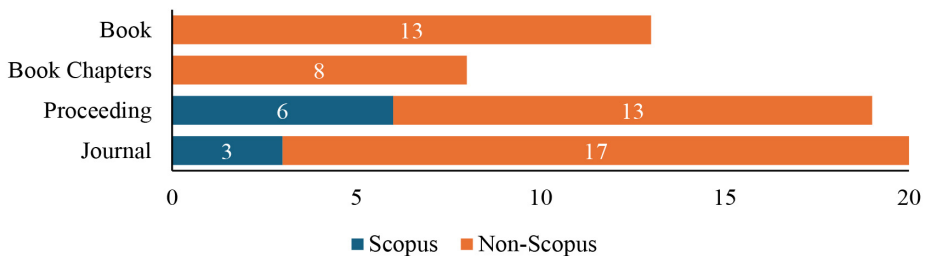


Figure 16. *Rumoh Aceh* tectonics literature data

Identification of explicit knowledge of *Rumoh Aceh* tectonics

The identification results showed that there was no literature studying tectonics completely based on its knowledge units (as shown in Table 2). Out of the 59 identified literatures, 2 literatures have 9 units of knowledge (3.4%), 5 literatures have 8 units of knowledge (8.5%), 11 literatures have 7 units of knowledge (18.6%), 11 literatures have 6 units of knowledge (18.6%),

2 literatures have 5 units of knowledge (3.4%), 5 literatures have 4 units of knowledge (8.5%), 8 literatures have 3 units of knowledge (13.6%), 4 literatures have 2 units of knowledge (6.8%), 7 literatures have 1 unit of knowledge (11.9%), and 4 literatures do not have any tectonic knowledge unit at all (6.8%).

Table 2. Distribution of explicit knowledge of tectonics of *Rumoh Aceh*

Source	Material	Construction	Structure	Details and Joints	Space	Culture	Elements/Anatomy	Place/Context	Ornament	Atectonic	Total
Nursaniah et al. (2022)		✓	✓	✓							3
Atthailah et al. (2019)		✓				✓	✓				3
Dhuhri (2018)			✓	✓		✓			✓		4
Rahmi, Sahputra and Yuliar (2023)	✓	✓		✓	✓	✓	✓		✓		7
Andeska and Ghifari (2022)									✓		1
Liesandra (2022)	✓	✓	✓		✓	✓		✓	✓		7
Andeska and Rahmawati (2021)											–
Natasya (2019)	✓	✓		✓	✓		✓		✓		6
Hamzah (2018)											–
Maulana et al. (2018)		✓			✓		✓		✓		4
Hairumini et al. (2017)	✓		✓			✓					3
Meutia (2017)	✓	✓	✓	✓	✓	✓	✓				7
Fakriah (2015)	✓							✓			2
Irwansyah et al. (2022)									✓		1
Fathiyyah, Idris and Huzaim (2021)	✓	✓	✓	✓			✓				5
Nabila et al. (2022)		✓		✓	✓	✓	✓		✓		6
Sahputra and Edytia (2021)									✓		1
Hendra (2021)					✓	✓		✓			3
Maulin, Zuriana and Lindawati (2019)		✓				✓					2
Sabila, Antariksa and Handajani (2014)		✓			✓	✓					3
Sabaruddin et al. (2022)	✓	✓	✓		✓						4
Kevin et al. (2021)	✓	✓						✓			3
Sawab et al. (2021)	✓	✓			✓	✓		✓	✓		6
Saskia et al. (2020)	✓	✓	✓	✓			✓				5
Azzahra and Sahriyadi (2020)	✓	✓			✓		✓				4

(Continued on next page)

Table 2. *Continued*

Source	Material	Construction	Structure	Details and Joints	Space	Culture	Elements/Anatomy	Place/Context	Ornament	Aeteconic	Total
Rizky, Loebis and Pane (2018)		✓			✓						2
Afriadi, Dharsono and Guntur (2020)		✓			✓	✓	✓	✓	✓		6
Meutia and Izziah (2019)	✓	✓	✓	✓	✓	✓	✓	✓	✓		9
Sahputra, Edytia and Mirza (2018)									✓		1
Novita et al. (2017)									✓		1
Nichols, Fong and Avey (2016)											–
Sahputra, Ekomadyo and Indraprastha (2013)									✓		1
Meutia (2011)	✓	✓	✓		✓		✓		✓		6
Meutia et al. (2020)		✓		✓		✓	✓				4
Sahputra et al. (2020)	✓	✓		✓	✓	✓	✓		✓	✓	8
Junaidi and Riyani (2017)											–
Mutia et al. (2016)	✓	✓		✓	✓	✓	✓				6
Arif, Zainuddin and Sawab (2016)	✓	✓		✓	✓	✓	✓	✓			7
Arif (2015a)	✓	✓	✓	✓	✓	✓	✓	✓	✓		9
Attaillah et al. (2020)	✓	✓	✓	✓	✓		✓			✓	7
Meutia (2015)	✓	✓	✓	✓	✓	✓	✓				7
Nurdin (2015)	✓	✓		✓	✓	✓	✓		✓		7
Arif (2015b)	✓	✓		✓	✓	✓	✓	✓	✓		8
Nas (2003)	✓	✓			✓	✓	✓	✓			6
Tammar et al. (1996)	✓	✓			✓	✓	✓	✓	✓		7
Putra and Ekomadyo (2022)	✓	✓	✓	✓	✓	✓	✓	✓			8
Farsyah (2021)		✓					✓		✓		3
Ibrahim et al. (2018)		✓			✓						2
Herman (2018)	✓	✓		✓	✓	✓	✓		✓		7
Hasnawati et al. (2016)	✓	✓			✓	✓	✓		✓		6
Mirsa (2013)	✓	✓		✓	✓	✓	✓	✓			7
Husin, Chairani and Syafrizal (2003)	✓	✓	✓	✓	✓	✓	✓		✓		8
Museum Negeri Provinsi Daerah Istimewa Aceh (1992)	✓	✓			✓	✓	✓		✓		6
Leigh (1989)	✓	✓		✓	✓	✓	✓	✓	✓		8

Table 2. *Continued*

Source	Material	Construction	Structure	Details and Joints	Space	Culture	Elements/Anatomy	Place/Context	Ornament	Atectonic	Total
Hajdad et al. (1981)	✓	✓			✓	✓	✓	✓	✓		7
Hasjmy (1983)					✓						1
Hurgronje (1906)	✓	✓				✓					3
Total	35	44	15	23	37	34	34	18	28	2	

The distribution of the most frequently used tectonic knowledge units (as shown in Figure 17) were construction (15.7%), space (13.2%), material (12.5%), culture (12.1%), elements/anatomy (12.1%), details and joints (11.8%) and ornaments (10.0%). The least mentioned tectonic knowledge units were place/context (6.4%), structure (5.4%) and atectonic (0.7%).

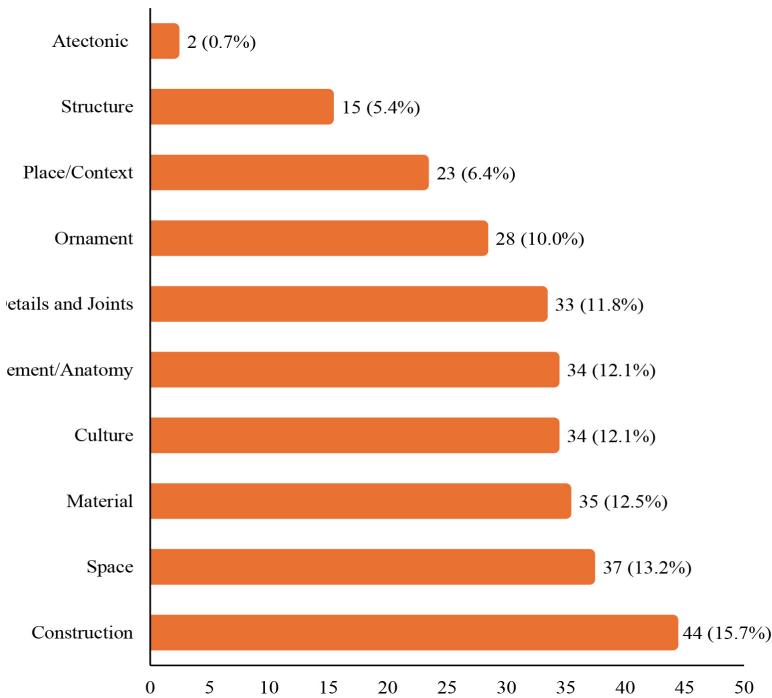


Figure 17. Percentage distribution of explicit knowledge units of *Rumoh Aceh*

These identification results confirmed the hypothesis that the representation of archives and documentation of *Rumoh Aceh*'s tectonic knowledge was not fully documented. The knowledge distribution in each literature needed to be compiled to create comprehensive and systematic knowledge.

Compilation of explicit knowledge of *Rumoh Aceh* tectonics

The coding results revealed categories that can be classified as attributes of each *Rumoh Aceh* tectonic knowledge unit (as shown in Figure 18). The material knowledge unit displayed four knowledge attributes: material type (43.4%), material function (35.3%), material form (13.8%) and material characteristics (7.5%). The construction knowledge unit exhibited six knowledge attributes: construction method (37.1%), construction typology (18.3%), construction stages (15.2%), construction equipment (12.4%), construction characteristics (9.3%) and measurement method (7.6%). The structure knowledge unit had two knowledge attributes: structural performance (73.8%) and structural system (26.2%). The details and joints knowledge unit had three knowledge attributes: connection method (73.0%), connection type (13.5%) and connection system (13.5%). The space knowledge unit displayed four knowledge attributes: space function (57.9%), space zoning (22.2%), space characteristics (15.7%) and space properties (4.2%).

The culture knowledge unit exhibited four knowledge attributes: customs and culture (28.5%), religious values (28.5%), social values and status (17.2%), rules (15.9%) and beliefs (9.9%). The element/anatomy knowledge unit displayed five knowledge attributes: construction elements (46.6%), construction element functions (20.9%), construction element dimensions (15.9%), construction element shapes (10.0%) and number of construction elements (6.6%). The place/context knowledge unit had two knowledge attributes: adaptive (94.9%) and environmentally friendly (5.1%). The ornament and representation knowledge unit exhibited five knowledge attributes: ornament motifs (42.2%), ornament location (35.8%), ornament function (16.1%), ornament processing equipment (3.7%) and ornament types (2.3%). Meanwhile, the atectonic knowledge unit had no attributes.

The compilation of knowledge has shown that the explicit knowledge of *Rumoh Aceh* tectonics is very complex (as shown in Table 3). In general, knowledge from each literature source complements each other. However, there is also a need to revalidate certain pieces of knowledge due to differences in nomenclature, dimensions of elements and other factors. This explicit knowledge validation step could be done through investigations into artifacts and their implicit knowledge. This stage is recommended for further research in documenting the tectonic knowledge of *Rumoh Aceh*. Additionally, conducting correspondence analysis between subcategories, categories, or between knowledge units may reveal other phenomena.

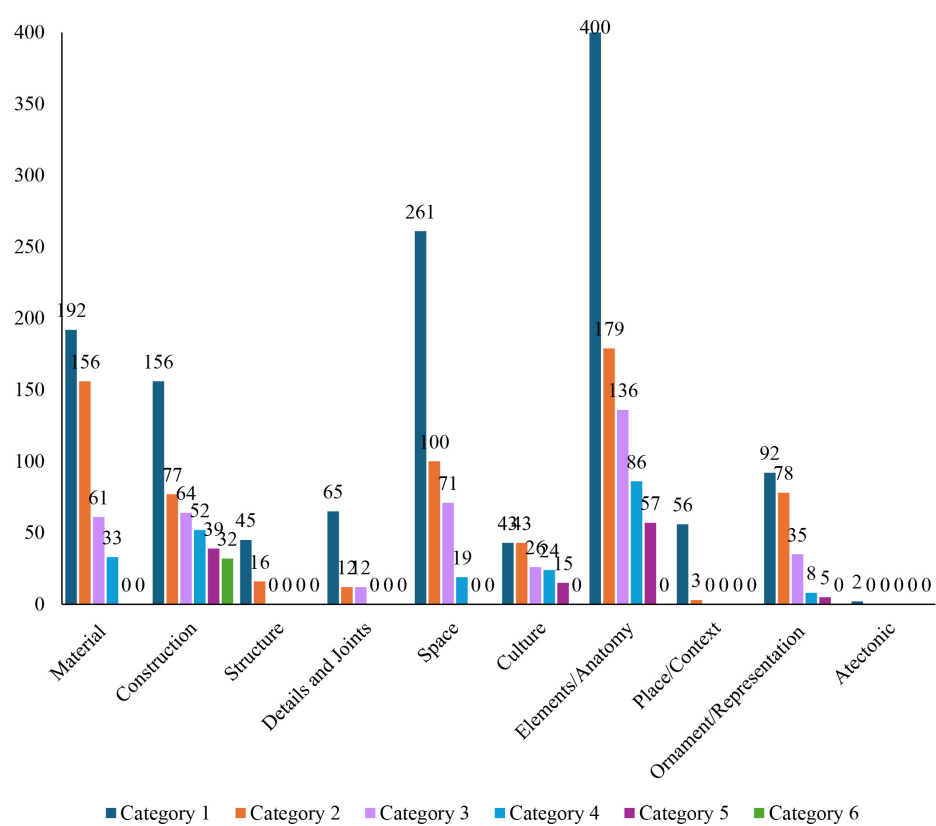


Figure 18. Unit and attributes of tectonic knowledge of *Rumoh Aceh*

Table 3. Distribution of the tectonic knowledge units number

Tectonics Knowledge Category	Tectonics Knowledge Units Number	%
Elements/Anatomy	858	31.2
Space	451	16.4
Material	442	16.1
Construction	420	15.3
Ornament/Representation	218	7.9
Culture	151	5.5
Details and joints	89	3.2
Structure	61	2.2
Place/Context	59	2.1
Atectonic	2	0.1

CONCLUSION

There were two stages in developing an investigation model of the explicit knowledge assets of *Rumoh Aceh* tectonics: identifying tectonic knowledge units and identifying explicit knowledge of *Rumoh Aceh* tectonics. The results indicated that the existing representation of archives and documentation of *Rumoh Aceh*'s tectonic knowledge has not been fully documented. The distribution of knowledge in each literature needs to be compiled to complete and systematise knowledge. Each unit and attribute of identified tectonic knowledge needs to be managed for sustainability. These units and attributes of knowledge can serve as a basis for developing tectonic knowledge in current Acehnese architecture.

This study has made a significant contribution to the development of an investigative model of explicit tectonic knowledge assets. The development of this investigative model complements the body of knowledge in documenting tectonic knowledge in traditional architecture, especially *Rumoh Aceh*. This model is expected to assist other researchers in uncovering and documenting tectonic knowledge in other traditional house objects. The method framework developed in this research can be used as the basis for developing further research. Further research opportunities could include investigating explicit knowledge of other objects such as artifacts and implicit tectonic knowledge of *Rumoh Aceh*.

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