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Contribution of bamboo materials in architecture education towards sustainable community development

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Abstract. Bamboo is one of the natural resources that are easy to find in forests, villages, and riversides area of tropical countries like Indonesia. On the other hand, architecture education in Indonesia has not focused much on bamboo as the potential architectural design material. Whereas bamboo has many potencies for many elements in architecture design. Architecture education is a possible way to explore and develop bamboo as an architectural element and introduce its potencies to the local communities. This paper is the initial desk study of multi-phase research on the contribution of bamboo materials in architecture education towards sustainable community development. The objective of this paper is to explain the gap in the vast research topics on bamboo in order to define further research on how architecture education pays attention to the significance of bamboo as a sustainable material. The result shows that research topics on bamboo material are vastly developed in some areas and on the contrary is rarely explored in other areas of research. Research in architecture education and its teaching strategies to elevate the comprehension of the students on the topic of sustainable materials such as bamboo is hardly found.

1. Introduction

Bamboo is a common and familiar building material for Indonesian people because it is easy to find and quite affordable compared to other materials. Bamboo thrives in many areas with high humidity, especially along the watershed area. In many traditional houses in Indonesia, the dominant use of bamboo resulted in a unique structure and formal expressions. Bamboo is also famous for household appliances and home decorations. It is indeed a popular material which has been used for generations in many regions.

Unfortunately, nowadays, the use of bamboo as a building material in vernacular houses is vastly being replaced by other materials such as concrete and steel. People begin to think of bamboo as a less practical, less modern, and less durable material compared to concrete and other fabricated materials. There is even an assumption that bamboo is merely a lower-middle-class material. It is indicated by the decreasing number of bamboo houses in the local communities. There is a popular assumption in the community that bamboo houses are categorized as unfit for habitation, and are only used for the poor [1].

On the other hand, even though in conceptual level architecture education seems to pay attention to the discourse of sustainable architecture, at an operational level, bamboo is often placed merely as one of the common building materials, among other materials. Not many courses or subjects in the



architecture education that offer comprehensive knowledge about bamboo and explore possibilities to develop bamboo as the potential future building material. Even in architecture design studios as the core of architecture education, bamboo is rarely considered as the primary building material in the design briefs.

These phenomena are contrary to the sustainable concept of bamboo as environmentally friendly material. Bamboo is a material that can be harvested every year for countries like Indonesia. Unlike wood, which takes decades to collect once. Bamboo can be processed into various goods and, therefore, can generate labor-intensive work for the surrounding community. With the right process, bamboo can be used for various structural and architectural elements, both exterior and interior. With all of its potentials, the socialization of the benefits, as well as the management and preservation of bamboo, needs to be carried out continuously to the local communities as an effort to conserve nature and to achieve sustainable community development. In general, bamboo is merely discussed in certain subjects and is rarely stated as one of the main issues or specific courses in the curricula.

Therefore, architecture education should be one of the media to introduce bamboo to the community as a local material that is environmentally friendly, with excellent availability and high aesthetic quality. The use of bamboo in large enough quantities and over a long period will support sustainable community development. For this reason, architects with their architectural education background have many opportunities to popularize bamboo in a more developed design and technology to society. Efforts to re-introduce and simplify bamboo in the local community required architectural innovations based on architectural education and research. The architectural innovations of bamboo can be socialized to three stakeholders, namely to students through architecture education, to architects, lecturers, and researchers through architectural research, and to the local community through community services [2]. These three interrelated aspects are seen in figure 1.

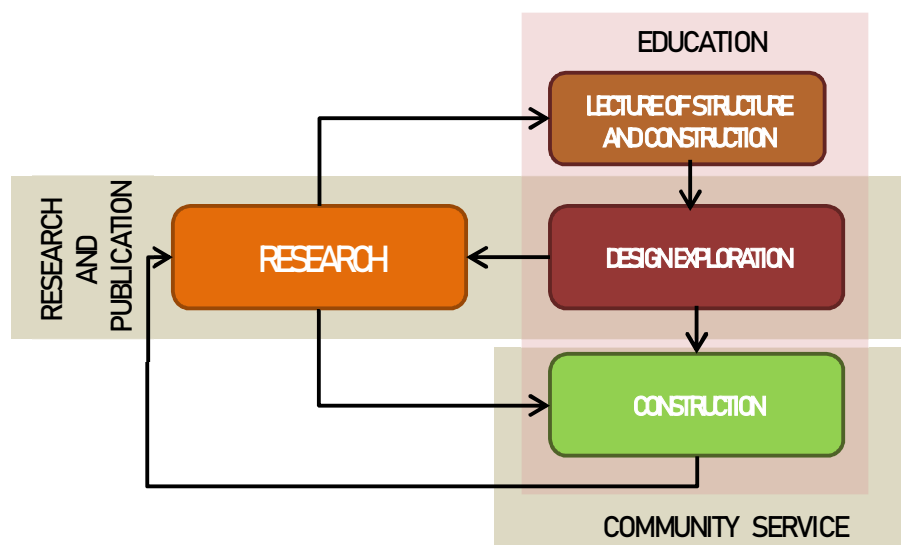


Figure 1. Integration between education, research and community service related to the socialization of bamboo material [2].

This paper is the result of desk research in the preliminary phase of mix-methods research on the contribution of bamboo materials in architecture education towards sustainable community development. It reviewed various studies on bamboo as the main topic of architectural research. There are many studies on bamboo as one of the potential materials that had been done before by architecture researchers. However, from this review, one can explain which aspects of bamboo that have been, and which aspects that have not been thoroughly examined and explored through architectural research. The results have also helped the researchers to determine significant elements of architecture education, i.e.,

understanding, ability and awareness, and the importance of these aspects to introduce bamboo to architecture students, which needs to be explored further in the next phase of this whole research.

2. Studies on Bamboo Material in Architecture Research

Table 1. Time-based list of publications on various topics of bamboo as a building material.

No.	Type of publication	Title	Author(s)
1.	Modern Bamboo Structures, 235-242, 2008	Prefabricated low-cost housing using bamboo reinforcement and appropriate technology	A. Widyowijatnoko
2.	Artepolis Proceeding, ITB 2010	Experimenting Bamboo as an Architectural and Sociocultural Feature	B. Faisal; Kinasih
3.	J. Appl. Environ. Biol. Sci., 1 (11) 492-499, 2011	Research and Design of Green Tropical Architecture	AM. Nugroho
4.	Mainz, 2012	Traditional and Innovative Joints in Bamboo Construction	A. Widyowijatnoko
5.	Seminar Nasional SCAN#4: 2013 “Stone, Steel, and Straw” Building Materials and Sustainable Environment	Pengembangan Material Bambu dalam Komponen Desain Bentuk Struktur Bangunan Arsitektur Modern	GA. Setyonugroho
6.	Procedia Engineering 95 (2014) 5 – 14	Proposed bamboo school buildings for elementary schools in Indonesia	AR. Taufani; ASB. Nugroho
7.	DIMENSI – Journal of Architecture and Built Environment, Vol. 41, No. 1, July 2014, 29-36	Transitional Shelter for Disaster Victims: Bamboo Core and Incremental Houses	EK. Julistiono; BW. Maer; LS. Arifin
8.	Research Report-Engineering Science 1, 2014	Komparasi penggunaan material bambu dalam struktur ‘form-active’ dan ‘semi-form-active’ pada bangunan lengkung bentang lebar.	A. Maurina; WE. Sari; J. Krisanti; J. Adhisaksana
9.	Research Report-Engineering Science 2, 2015	Estetika Struktur Bambu Pearl Beach Lounge, Gili Trawangan, Lombok	A. Maurina; D. Christina
10.	Procedia - Social and Behavioral Sciences 216 (2016) 30 – 38	The Potential of Bamboo as Building Material in Organic Shaped Buildings	EA. Nurdiah
11.	Walailak J Sci & Tech 2016; 13(8): 631-640	Composition of Bamboo Walls and Compressed Earth Block Walls in a Simple House that Produces Energy Efficient to Heat and Embodied Energy in Indonesia	VT. Noerwasito
12.	Seminar Nasional Menuju Konstruksi Bambu Modern Masa Depan, 2016	Eksplorasi Struktur Bambu melalui Integrasi Pendidikan, Penelitian dan Pengabdian kepada Masyarakat	A. Maurina; B. Prastyatama
13.	AIP Conference Proceedings 1903, 030002 (2017)	Deployable bamboo structure project: A building life-cycle report	A. Firdaus; B. Prastyatama; A. Sagara; RN. Wirabuana
14.	EMARA Indonesian Journal of Architecture Vol 3 Nomor 1 – Agustus 2017	Bambu Sebagai Alternatif Penerapan Material Ekologis: Potensi dan Tantangannya	E. Suriani

No.	Type of publication	Title	Author(s)
15.	International Journal on Advanced Science Engineering Information Technology; 2017	Bamboo Architectonic: Experimental Studies using Bundled-Bamboo-Split (BBS)	A. Maurina, B. Prastyatama
16.	2018 <i>IOP Conf. Ser.: Earth Environ. Sci.</i> 195 012089	Implementing bamboo research into holistic architecture design for creating a thermally comfortable interior environment in Gili Meno, Indonesia	OS. Caroline
17.	Seminar Nasional Rekayasa Desain ITENAS, 2018	Eksplorasi Material Bambu pada Bangunan Publik	A. Muhsin
18.	Reset Arsitektur (RISA) 2 (2), 2018	Knock Down Bamboo Wall Panel	VY. Santosa; A. Maurina
19.	MATEC Web of Conferences 197, 17004, 2018	A deployable structure as an active architectural structure on sports building in Bandung	H. Salamah; A. Widyowijatnoko; S. Wonorahardjo; RF. Aditra
20.	IOP Conference Series: Earth and Environmental Science 152 (1), 012005, 2018	Technological Context in Developing Bamboo Wall System for Housing in Indonesia and Philippines	NBC Auman; Widyowijatnoko; S. Wonorahardjo
21.	2018 IOP Conf. Ser.: Earth Environ. Sci. 126 012150 View	Bamboo is a sustainable material for furniture design in disaster and remote areas in Indonesia	Y. Sofiana
22.	IOP Conf. Series: Earth and Environmental Science 126 (2018) 012039	Flexible architecture: bamboo as a tool for children to play in urban kampung	D. Susanto; Widyarko; AN. Ilmiani
23.	Advances in Social Science, Education and Humanities Research, volume 197 (2019)	Laminated Bamboo as an Effort to Reduce Wood Consumption	B. Sulistyono; A. Mulyono
24.	Equity, Equality, And Justice In Urban Housing Development Volume 2019	Thermal Performance of Plastered Bamboo-Wall	F. Fadhly; A. Risnandar; S. Wonorahardjo
25.	18th International Conference on Sustainable Env and Arch, 2019	Bamboo Deployable Structural Systems: An Exploration Study in Responding to Rapid Alteration Challenges	A. Maurina; B. Prastyatama
26.	Architecture, Engineering, and Construction: Architectural design (no year)	Great Hall of Outward Bound Indonesia: a Case study of Structural Approach in Bamboo Architecture	A. Widyowijatnoko; RF. Aditra

Table 1 listed the study of bamboo material in architecture for the last decade, studies on, especially in the Indonesian context, are well developed in wide topic ranges and methods. The methods are range from a mere standard description of bamboo as a sustainable building material to the advanced experiments on specific aspects of bamboo as a potential building structure. The topics are range from bamboo as the sustainable and ecological material to its flexibility and affordability (Figure. 2). There are at least nine main topics in the published academic articles about bamboo in architecture field of study, i.e. (a) structural explorations, (b) aesthetic characteristics, (c) ecological material, (d) affordable

material, (e) transitional and flexible material, (f) thermal comfort, (g) energy-efficient and embodied energy, (h) sociocultural context, and (i) architecture education.

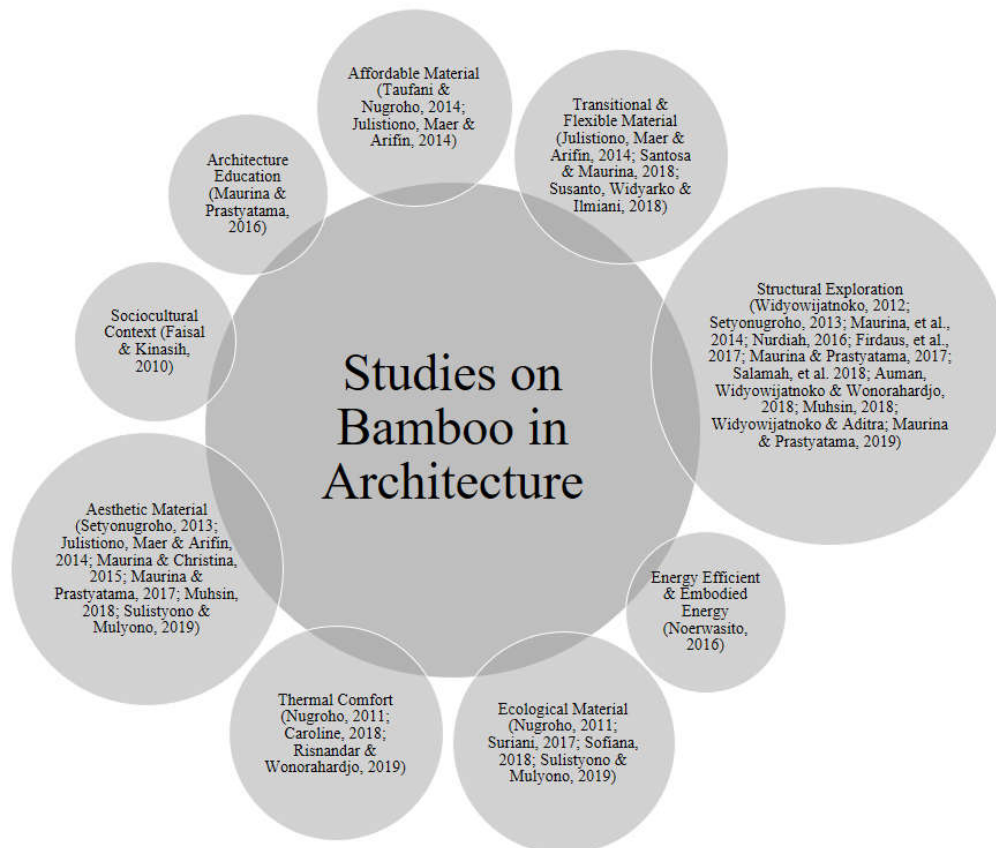


Figure 2. Range of topics in the architecture studies on bamboo material.

Structural exploration and aesthetic characteristics of bamboo material are two dominant topics studied by many researchers. However, among those researchers, only a few that had their studies focused mainly on bamboo material, e.g. A. Maurina and A. Widyowijatnoko, with more than five publications within the recent years, especially on bamboo structural explorations. Within this range of topic, the development of bamboo technology as a deployable structure and its ability to obtain wide span buildings are the most attracting theme for the researchers [3-12]. Meanwhile, the studies on aesthetic characteristics of bamboo as building material were also conducted by other researchers [4, 8, 11, 13-15].

Another popular topic is related to building environmental science, such as the characteristic of bamboo as green and ecological material [1, 15-17], including its ability to maintain thermal comfort [16,18-19] as well as to keep optimum embodied energy in the buildings [20]. The use of bamboo as a building material such as laminated and plastered bamboo walls and their impacts on the building environments are the most studied theme in this range of topics.

On the other hand, the development of bamboo in architecture education is among the least topics studied by the researchers. An article written by Maurina and Prastyatama [2] is an exciting example of how three aspects of the higher education (i.e., teaching, researching, and serving the communities) can collaborate together to raise awareness and familiarity of the architecture students towards the unique characteristics of bamboo material as the structural, as well as non-structural elements of buildings. This article shows that research in architecture education and its teaching strategies to elevate the

comprehension of the students on the topic of sustainable materials such as bamboo is a potential field of study. Many innovative ideas generated by the collaborations between the students and the lecturers/researchers resulted in the applicative designs relevant to the community [2].

Unfortunately, there are not many similar academic publications that documented and reported the impact of the exploration of bamboo projects within those three aspects of architecture education. Even though there are many related activities of the teaching, researching, and serving the communities, the documentations often ended up merely in the form of unpublished reports of research and community services. Furthermore, there is also a lack of further research on the positive and negative impacts of the activities implementations towards the community and the students as well as the lecturers themselves. Despite the lack of publications found, this topic's relevance to the environmental and social contemporary issues and their close relationship with architecture education make it important to reconsider this topic as one of the main research topics nowadays.

However, the positive impacts explained in Maurina and Prastyatama's article were only based on their observations of their students, fellow lecturers, and the community. Their research has not explored precisely which aspects of awareness, ability, and understanding were raised significantly through their collaborative activities. This is an opportunity for other researchers to determine the positive impacts more measurably. Therefore, the next phase of this research is to investigate the effects of architecture education on the awareness, understanding, and ability of architecture students related to bamboo explorations during college. Nine main topics that are frequently raised in architectural research will be used as a basis to arrange questions in each architecture education aspects. The further step of this research will be the investigations of the impacts of the architecture education towards the awareness of the community where the architecture students were conducting the academic projects.

3. Conclusion

Studies on the exploration of bamboo as the significant material for architecture during the last decade are highly diverse in the topics and methods. The research topics on bamboo material are vastly developed in some areas, and on the contrary, are rarely explored in other areas of research. The gaps in the research topics explained in this paper, one of which is bamboo within the context of architecture education, along with some considerations on significant issues related to environmental and social contexts in architecture have made this topic interesting to be explored further through architectural research. These research gaps provide a full opportunity to study unexplored issues related to architecture educations and their impact on the community to improve the quality of our architecture education and its relevance to sustainable community development. Therefore, the state of the art of this whole research will be its comprehensive and measurable approach to explore the understanding, awareness, and ability of architecture students on each of nine main topics related to bamboo as a sustainable building material in the practice of architecture education.

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