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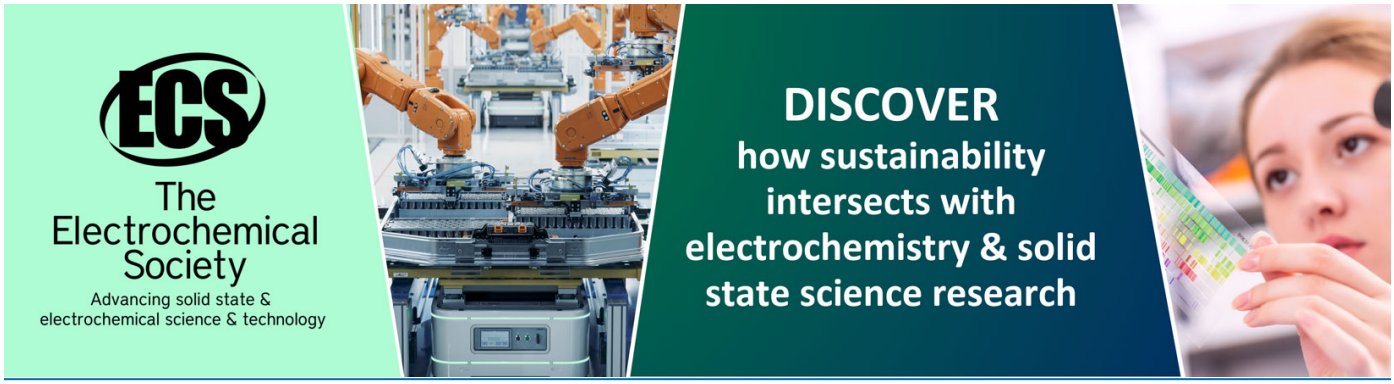

Technology 5.0 in architecture based on the understanding of environmentalism

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Abstract. Technology that developed rapidly in the late 19th century was the beginning of modern times and brought significant changes in every aspect of human life, including architecture. Starting from technology 1.0 until 5.0, technology still has a role in the field of architecture. On one side, technology offers convenience for humans to monitor buildings through the operating system and increases the value of life through its architectural style which is represented by the construction system and materials. On the other hand, technological developments also present problems. The problem that occurs due to technological development that are experienced globally is environmental damage. The purpose of this study is to determine the appropriate technology for use in buildings based on an understanding of environmental science. This study uses a qualitative method regarding the primary literature from books and journals (national and international). The results of this study concluded that through understanding the science of environmentalism, the basis for creating a design must begin with an understanding of the natural conditions of the design area. Henceforth, technology in architectural buildings is not in the form of mechanical technology that potentially increases the amount of building heat, but rather in technology that supports the natural performance inside the building in the form of wall material, new approach in terms of building openings, development of solar panel, windmills, and chimneys technology.

1. Introduction

The 19th century is said to be a period of world transition, especially architecture. The industrial revolution that occurred in the 19th century played an important role in the development of architecture. Industrial development in Europe, Britain, and America was a direct influence from the industrial activities occurred on a large scale in these three countries. Meanwhile, the architectural development in Asia was influenced by the industrial activities brought by the colonialists coming from the three industrial countries [1-4].

Technological developments are predominantly in the realm of construction and material systems development. The material that was initially projected was not planned for architecture, but rather aimed at tools or works of art. However, modernist architects explored these materials so that they could be used in architecture which then had an impact on architectural forms [5]. Materials such as glass, steel,

iron, and concrete that were discovered during the industrial revolution attracted a lot of public interest and this made modernist architects did architectural adaptations.

Starting with the industrial revolution, technological developments are always at the same starting point but operate on different paths. Starting from technology 1.0 focusing on the use of technology that is operated by nature until technology 5.0 centring on the use of electricity, current technology is in the form of electrical equipment and heavy machinery used for manufacture and construction, as well as a data system that enables humans to remotely control machines.

Based on technological developments and their influences on architecture, it can be seen that technological inventions are human intention to save the environment by using technology to create renewable resources that can replace the role of natural resources. However, like other common things that own good and bad sides, technological development also has drawbacks behind all of the conveniences offered, namely: (1) from economic point of view, the latest technology can only be used by the upper middle class reasoning it costs high, both from purchase price and maintenance costs, (2) in terms of the use, technology is very dependent on electricity, so if the electricity does not flow, the technology will stop operating and cause enormous losses, (3) from environmental perspective, technological developments are very damaging to the environment since technology produces radiation and gas emissions that make the earth even warmer and affect human health. These three negative impacts cause architecture to be a burden on human life and environment.

Unlike the economic impact that is experienced diversely by each individual considering the standard of living of each person is fundamentally different, the environmental impact is felt the same due to the very broad emission footprint caused by development. In architectural development process, it is known that this process provides a trace of emissions that have already started when the extraction of natural building materials such as sand, stone, and wood are carried out. The trail will expand along with how far the materials are transported. Natural materials, especially those containing metals, will release gas and heat during the delivery process, thereby increasing the carbon content in the air. Apart from gas and material heat, the carbon content also comes from vehicle fumes that are used for transporting the materials [6-9]. Therefore, development based on nature (environment) is very important to do to reduce emissions which are currently very high.

Many studies discuss architecture, environment, and technology; however, these studies are predominantly in the realm of the latest materials and technologies which are studied to determine their positive value to the environment. The difference between this study and existing studies is that this study departs from a specific scientific understanding and determines technology not by following technological developments, but leads to the selection of the right technology based on an understanding of nature and the environment.

2. Methods

This study applied a literature study approach regarding the primary literature from books and journals (national and international). The research was conducted simply by learning through literature regarding the science of environmentalism, namely Christopher Belshaw, Simon P. James, and Sahotra Sarkar. These works of literature are a fundamental concept that becomes the limiting variable in the study. Besides, these works of literature are also fundamental concepts that influence the final decision of this study.

The three concepts were selected and the preferred concepts that were suitable with modern architecture were compared with architecture based on environmentalism. Understanding the base of environment and architecture theories is very important because if the design is human-centered, the technology will only increase the environmental damage. In addition, climate that basically in high temperature and humidity will be hotter if the design is only based on mechanical technology. Based on these, the discussions were divided based on three concepts, namely environmentalism in architecture, passive design in architecture, and technology that used in the buildings.

3. Results and discussions

The architectural understanding seen through environmentalism is divided into two, namely nature and humans. There are several thoughts that the philosophy of environmental science focuses on nature and describes the cause-and-effect relationship of each variable that affects nature, especially humans. However, there are also thoughts that the philosophy of environmental science is human-centered. The occurrence of these two arguments in environmental science is inseparable from the influence of modern science, which is the basis of science that shapes environmental science, even though it is human-centered [10].

The relationship between nature, humans, and architecture can be drawn into two, namely architecture as an intermediary for nature and humans or humans as the center as it functions as a mover, controller, and creator of technology that can regulate nature in buildings [11,12]. At this time, the basis of design is more towards humans as the center and causes mechanical technology with all the conveniences offered to develop much faster than passive technology, causing the emission content in the air to be very high [13,14]. See figure 1 below.

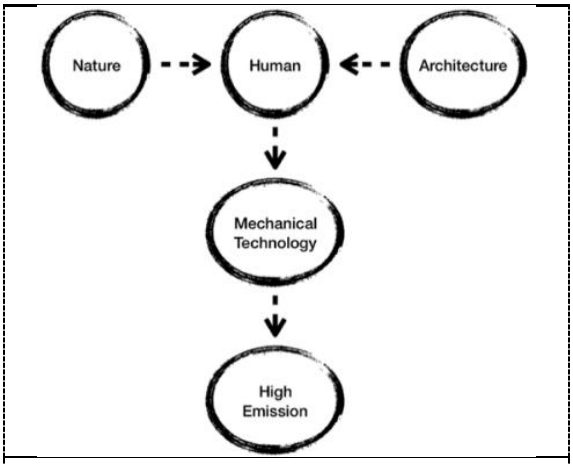

Figure 1. Human as the center and its impact.

With the existence of problems caused by the mindset that makes humans as the center, there needs to be a comparison mindset so that the use of technology can be limited. Architecture as an object cannot be used as the center since it will always be the result of architectural process. Based on this, the only thing that can be compared with humans is nature which leads architecture using less technology.

3.1. Environmentalism in architecture

Architecture has a system called passive design. A passive design philosophically can be understood as a concept that prioritizes nature and everything in it. The notion of nature that exists in passive design does not only exist in the form of nature in general, but also in the environment that is created by humans (area density, vegetation, and space) [15,16]. Through this, the first important thing and becomes the starting point in understanding passive design in architecture is that humans must depend on nature, not the other way around [17].

In the understanding of environmental science, human morals are used as a means of showing ethics in the environment. This is shown by at least three philosophers who discuss environmental philosophy, namely Simon P. James, Christopher Belshaw, and Sahotra Sarkar. Simon P. James defines the notion of environmental science through a human moral that is described as a reflection of the subject of environmental ethics [18,19]. It is wrong if environment is only seen through nature [20] and through human reflection based on morals as Simon considers that the problem source occurring in nature is entirely human error [21].

Christopher Belshaw basically has the same thoughts as Simon. One thing that distinguishes the two is the variable center. Belshaw focuses on human and scientific variables with the aim at knowing specific problems and patterns of resolution. Based on this, Belshaw divides the environment into two, namely the macro environment which is formed from the location of human activities and the micro environment which is formed from human activities [22,23]. Unlike Simon and Belshaw who see the relationship between the environment and humans, Sahotra Sarkar sees the environment through a conceptual approach based on quantitative things. The approach taken by Sarkar aims to ensure that the understanding of the environment have clarity and accuracy when making final decisions on any environmental problems. Sarkar's thought influenced by Aristotle provides imperatives that define diversity in environment, so that it can be deeply understood about the authenticity of problems that exist within environmental sphere [24]. Based on a brief description of the three thoughts, it can be seen that the combination of thoughts of Sahotra Sarkar and Christopher Belshaw is the right idea to be used in determining the passive design in architecture. The combination of Sarkar and Belshaw's thoughts forms two important things that are used as the basis for the formation of a passive design, namely the causal relationship used to determine the authenticity and formation of problems. Subsequently, the problem is analyzed through natural theory and architecture.

3.2. Passive design in architecture based on the understanding of environmentalism

The location where architecture stands is divided into two types, namely location with two seasons and location with four season. Even so, whereabouts architecture stands, architecture will always be influenced by the climate it consist of temperature, humidity, and wind speed [25]. The climatic characters make the development of mechanical technology related to human comfort and building operating systems develop rapidly in the tropics. Therefore, to minimize the use of technology, buildings must also have passive technology, so that there is a balance between the use of mechanical technology and passive technology.

A support for nature through architecture is by adapting the design to the microclimate and environmental conditions of the design location [26,27]. The character of the microclimate that exists at the location will affect the orientation of the building, and then it will have an influence on the building in terms of its part, shape (a whole), and the city. The building part is divided into three things, namely building materials, building elements, and building systems with nine focuses inside the building, namely floors, walls, roofs, windows, foundations, trees, ground cover materials, and lighting. The form of the building is divided into three things, namely space, spatial organization, and an intact building with four focuses, namely internal spaces, courtyards, circulation, and transition areas. Cities are divided into three things, namely elements of the city, urban planning, and the environment with four focuses, namely roads, open areas, buildings, and topography [28,29].

The relationship between the microclimate and the building can be seen through the influence of the microclimate which initially affects the building part first. The layout of the walls will then affect the placement of the openings which determine the thermal comfort of the interior. Then, after the part of the building is organized, the inner building will be determined according to the function of the space, so that the intact building will form an urban area. Based on this, it is known that the passive design seen through the understanding of environmentalism is located in the building part since the building part is the first and foremost thing that is directly related to the microclimate and environmental conditions of the design location. In addition, the part of the building also determines the direction of natural motion that occurs in a city. See figure 2 and 3 below.

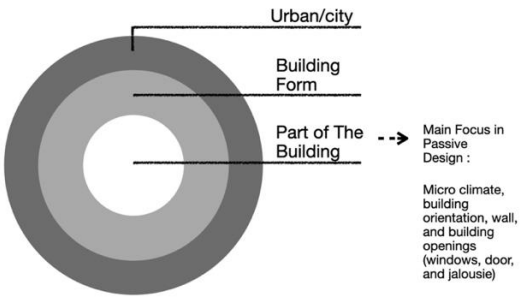

Figure 2. Focus in architecture from environmentalism thought.

Source: https://www.yourhome.gov.au/passive-design/orientation (c)

Figure 3. Wall and openings (a), door (b), building orientation and openings in building (c)

3.3. The journey of technology in architecture

Technology in architecture is always evolving. In technology 1.0, technology in architecture uses natural resources as an existing building operating system in the form of windmills, waterwheels, openings, and chimneys [30,31]. Technology 2.0 is the early age of technology used totally in architecture. The use of renewable materials such as glass, cement, and concrete which are dominant in buildings, the use of technology that accelerates construction time, and the invention of high-rise building systems are common in this era. Technological developments that occurred in the 2.0 era, in fact still happened up to technology 3.0. The difference is the production system. In technology 2.0, technology production is still carried out by humans, while in technology 3.0, some of the production has been done by machines. In the era of technology 4.0, in addition to the development of material production, technological developments in this era are building operating systems that exist in the form of cloud technology, and big data. Based on the development of technology 1.0 to 4.0, the development of technology 5.0 in architecture is a technology development that will complement the technology 4.0 system, such as sensors, robotics, and artificial intelligence.

3.4. Results

Based on the literature analysis of environmentalism, passive design in architecture, and the journey of technology, it can be seen that technology is not only in the form of materials but also in building systems. If these developments are viewed based on an understanding of environmentalism, then the development of technology 5.0 must be the technology that supports natural performance in buildings. Understanding of Environmentalism focuses itself on parts of buildings such as walls, openings, and building orientation. The part of the buildings is believed to be the main factor in the establishment the natural performance of an area. Therefore, the development of technology 5.0 in architecture is in the form of a new approach to wall materials and types of building openings. In addition, the developments of mechanical technology is in the form of the development of solar panel, windmills, and chimneys technology.

4. Conclusion

Apart from having a positive impact, technological developments also have negative impacts that predominantly harm the environment. This occurs as a result of all human-centred development. In architecture, humans are the centre of creating buildings that is deemed unfriendly to the environment as its design does not include nature as its starting point. Based on science, understanding nature in architecture can be derived from Sarkar and Belshaw's thoughts. Based on them, architecture can be analysed through the causes and effects that occur among nature, humans, and architecture. This makes architecture must have a focus on nature both in its design and the choice of technology. Based on several literatures, it is stated that technology 5.0 used in architecture is technology that supports natural performance in buildings, including wall material, new approach in terms of building openings, development of solar panel, windmills, and chimneys technology.

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References

[1] Hoppit J 2011 The Nation, The State, and The First Industrial Revolution Journal of British Studies pp 307-331
[2] Brolin C B 1976 *The Failure of Modern Architecture* (New York: Van Nostrand Reinhold Company) p 7
[3] Crouzet F 1996 *The Industrial Revolution in National Context: Europe and the USA* (Cambridge: Cambridge University Press)
[4] Corbuzier L 1931 *Towards A New Architecture* (New York: Dover Publications, Inc.) pp 7-8
[5] Brolin C B 1976 *The Failure of Modern Architecture* (New York: Van Nostrand Reinhold Company) pp 14-15
[6] Frick H and Suskiyatno F X B 2007 *Dasar-dasar Arsitektur Ekologis: Konsep Pembangunan Berkelanjutan dan Ramah Lingkungan* (Yogyakarta: Kanisius) pp 49-50
[7] Fritsch B 1993 *Mensch-Umwelt-Wissen*. Evolutionsgeschichte Aspekte de Umweltproblems (Zurich: VDF) p 176
[8] Frick H and Suskiyatno F X B 2007 *Dasar-dasar Arsitektur Ekologis: Konsep Pembangunan Berkelanjutan dan Ramah Lingkungan* (Yogyakarta: Kanisius) p 85
[9] Krusche 1982 *Oekologisches Bauen* (Wiesbaden: Bauverlag) p 226
[10] Juniper T 2019 *The Ecology Book* (London: DK Penguin Random House) pp 160-161
[11] Yeang K 1995 *Designing with Nature: The Ecological Basis for Architectural Design* (New York: McGraw-Hill)
[12] Widodo J 2019 Human, Nature, and Architecture *ARTEKS : Jurnal Teknik Arsitektur* **3**(2) 127-30
[13] World Meteorological Organization 2008 *Climate Change 2007: Synthesis Report* (Switzerland: The Intergovernmental Panel on Climate Change) p 5
[14] World Meteorological Organization 2015 *Climate Change 2014: Synthesis Report* (Switzerland: The Intergovernmental Panel on Climate Change) p 88
[15] Lippsmeier G 1980 *Bangunan Tropis* (Jakarta: Erlangga) p 6
[16] Brown G Z 1994 *Matahari, Angin, dan Cahaya* (Bandung: Intermatra) pp 92-100
[17] Bauer M, Mosle P, and Schwarz M 2010 *Green Building-Guidebook for Sustainable Architecture* (Heidelberg: Springer)
[18] James P S 2015 *Environmental Philosophy: An Introduction* (United Kingdom: Polity Press) pp 9-11
[19] Warren K 1990 *The Power and Promise of Ecological Feminism: Environmental Ethics* pp 125-146.

[20] James P S 2015 *Environmental Philosophy: An Introduction* (United Kingdom: Polity Press) p 12
[21] Curry P 2011 *Ecological Ethics: An Introduction* (United Kingdom: Polity Press) pp 7-8
[22] Belshaw C 2001 *Environmental Philosophy: Reason, Nature, and Human Concern* (New York: Routledge) pp 18-20
[23] Department of Environment 1970 *British Government White Paper: The Reorganization of Local Government*
[24] Sarkar S 2012 *Environmental Philosophy: From Theory to Practice* (United Kingdom: John Wiley&Sons) pp 13-14
[25] Nugroho A M 2019 *Rekayasa Ventilasi Alami Untuk Penyejuk Bangunan: Sebagai Wujud Kecerdasan Dasar Arsitektur Nusantara* (Malang: UB Press) p 28
[26] Rafi'I S 1995 *Meteorologi dan Klimatologi* (Bandung: Angkasa) pp 26-27
[27] Tjasyono B 2004 *Klimatologi* (Bandung: Penerbit ITB) p 251
[28] DeKay M and Brown G Z 2014 *Sun, Wind, Light: Architectural Design Strategies* (New Jersey: John Wiley & Sons) pp 16-65
[29] Brown R 2010 *Design with Microclimate: The Secret to Comfortable Outdoor Spaces* (Washington: Island Press)
[30] McDowall D 1996 *Richmond Park: The Walker's Historical Guide* pp 10-11
[31] Wikander Ö 2000 "The Water-Mill" in Wikander Ö (ed.), *Handbook of Ancient Water Technology, Technology and Change in History,2* (Leiden: Bril) pp 371-400