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A Hybrid Method of the Analysis and Synthesis Phases in the Architectural Design Process

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ABSTRACT
Learning from the experience of practicing architects in the Covid-19 pandemic era, there were many positive lessons learnt due to the current situation and condition especially in changing the way of thinking in architecture design. Health protocols require architects to work in cyber studios. The process of recording data, performing analysis, synthesis, architectural modeling and running model simulation for clients became a cyclic process that had to be done virtually in the form of drawings, measurements, calculations, and/or scientific descriptions. This paper focused on the discussion of how the analysis-synthesis process could be carried out using a hybrid method in the architectural design context. This research used literature study method. The hybrid method to perform analysis-synthesis process in design architecture would potentially solve complex problems and could manage large amount of data quickly and accurately. The design process would be transparent, easy to monitor at any time, and would involve many people or parties simultaneously to produce collaborative designs. The conclusion of the study was that the analysis-synthesis process model of architectural design using a hybrid method, which had to be automatically supported by artificial intelligence would be able to produce design criteria that would be directly beneficial to architects. However, it would be necessary to develop a machine learning for this hybrid method to properly manage the balance of human sense and machine scale.

Keywords: *Hybrid, Analysis, Synthesis, Design, Process.*

1. INTRODUCTION

The Covid-19 pandemic era taught many positive things. Learning from the experience of many practicing architects, there was a change in the way of thinking in architectural design to adapt with the current situation and condition. Health protocols force architects to work in virtual studios. As a result, architects faced various challenges especially in the process of recording data, performing analysis, synthesis and architectural modeling as well as simulating the model for clients. All these existed in a cyclic process that would, now, have to be done virtually, in the form of drawings, measurements, calculations, or scientific descriptions.

The use of machine especially in the analysis-synthesis process of architectural design would be potential to solve complex problems and could manage large amount of data quickly and accurately. With digitalization, the design process itself also would become transparent, easy to monitor at any time, and involve many people or parties to produce collaborative design simultaneously. However, the use of machine also would have its own limitations that would require human intervention.

Therefore, this paper would be focusing on the discussion of how the analysis - synthesis process could be carried out using a human-machine hybrid method in architectural design.

2. METHODS

This research used literature study method. The data was collected by the authors from various journal articles, seminar proceedings and books. The data could be in the form of quotes, opinion and/or knowledge relevant to digital architecture theme and analysis-synthesis process in architectural design. The data were then analyzed to obtain information related to how human and machine performed analysis-synthesis process in architectural design and to comprehend the limitations of human and machine thus finding hybrid

aspects that can be applied in analysis-synthesis stage of architectural design.

Moreover, the data was also analyzed to understand the working mechanisms and characteristics of human and machine in synthesis-analysis process in architectural design to differentiate the role of human and machine in synthesis-analysis process in architectural design. Therefore, a hybrid method, then, could be formulated as a concept that could be applied in synthesis-analysis process in architectural design.

3. RESULTS AND DISCUSSION

Analysis and synthesis were important stages and parts of the design process. With the influence of digitalization on the design process, Achten provided a review on a conventional design process which consisted of 5 stages that include: analysis, synthesis, modeling, simulation and evaluation. According to Achten, these five stages were separate and took place sequentially and could be simplified into 3 stages: analysis, synthesis package and evaluation [1]. The simplification was obtained by combining the synthesis, modeling and simulation stages into a single 'Design Driver' controlled package, as seen in Achten diagram shown within Fig 1.

The process of analysis would be the excavation of facts, data, contexts, references and everything related to knowledge of the situation to be changed through design. The knowledge would be collected, examined and organized into a series of information. The information that was compiled would describe the requirements, criteria or problems to be solved. The process of extracting facts relating to human feelings, spiritual and cultural, would require communication skills, sensitivity and empathy.

At the synthesis stage, design ideas would be generated. These ideas would need to meet design requirements, criteria and helped to solve problems based on information obtained in the analysis process. The excavation of design ideas at the synthesis stage would involve creative ability and spontaneity [2].

The way of thinking and the way of working during the analysis stage would be different from that of the synthesis stage in any design process. During the analysis stage, data excavation, preparation and processing would generally be thought with a linear approach or followed a certain sequence. The search for data took place rationally through logical reasoning that could be proven. A data would be partially examined by dividing the material to be analysed into small parts divergently. Thus, these small parts could be further researched to study them in more detail. The whole thinking process as described above as well as the conclusions drawn from this process took place objectively.

Contrary to the process of thinking during analysis stage that occurred logically and linearly, during the synthesis stage, the architect had to use a thinking process that might be random and in disorderly manner. Idea generation took place intuitively by relying on sensitivity of the architect's feeling and empathy. Findings that were spread and expanded divergently at the analysis stage, were then knitted and assembled into a holistically intact form through a convergent mindset in the synthesis process. The search process and conclusions drawn in the synthesis stage took place subjectively, in very specific manner and uniquely dependent on the subject itself.

The process of analysis and synthesis in the design process would have certain characteristics. There would be processes that could be handled more efficiently and effectively with the help of digital machines, but there were also processes that would be irreplaceable and very reliant on human abilities. The use of machine in the design process could bring several benefits. Firstly, it could accelerate the design process through the automation of synthesis-analysis stage. This is because the machine could be run continuously and tirelessly, as compared to an architect's limited ability to perform it non-stop. Another benefit would be that it could improve the quality of design process through optimisation of synthesis-analysis process in order to solve a more complex problem by processing vast amount of data or information. Therefore, after receiving instruction, machines could help architects to process the analysis-synthesis stage quickly and with a larger capacity to process information [3,4].

On the other hand, digital machine also would have its own limitations. Firstly, machine might have limited ability in perceiving finger manipulation or sketch skills. Secondly, it might have limited ability to produce creative intelligence, originality or pure arts. Thirdly, it might have limited skills related to social intelligence such as perception, negotiation and persuasion. Moreover, machines would not be able to perform mental activities such as creating imagination and interpreting expression or emotion [5,6].

Machines could have the ability to become intelligent through a learning process in which an architect plays a role in teaching them. Machines could perform analysis-synthesis process, behaved intelligently and could have the ability to perceive things after they have an interaction or share experience and learning with humans. There must be communication early in the design process before the machine carries out its analysis and synthesis roles. In addition to the interpretation aspect, imagination would be another aspect that would require an architect's role and is more complicated to be transferred to a machine. In architectural design there would be a relationship between design and perception. Perception could be

formed through life experience and cultural influence. Therefore, an architect would still have important role in bridging these gaps by teaching human characteristic to machine [7].

The need for machines to learn before being able to carry out the analysis or synthesis process, resulting in machine-learning would require longer time in producing results. Synthesis analysis activities that would involve interpreting something would require intuition, the ability to sense emotion as well as the ability to generate creative and spontaneous ideas. These activities would be performed more effectively and efficiently by humans as compared to machines.

Therefore, automation in architecture in the form of automation of design methods would still provide a niche in the architect profession in the future [8,9]. The role of an architect would be as a counterbalance between human's character or personality and the machine's especially when we defined analysis and synthesis as an interactive, effective and adaptive approach in architecture [10].

As a result, a cognitive architect who could work long hours could then be achieved through the use of automation in a blending manner, a fusion between an architect and a programmer profession. This cognitive architect could be helped by machine learning in the analysis-synthesis process through a supervised, semi-supervised or unsupervised method. With all the above considerations, the impact of an uncultured machine, or architecture without an architect would not happen in the near future [11].

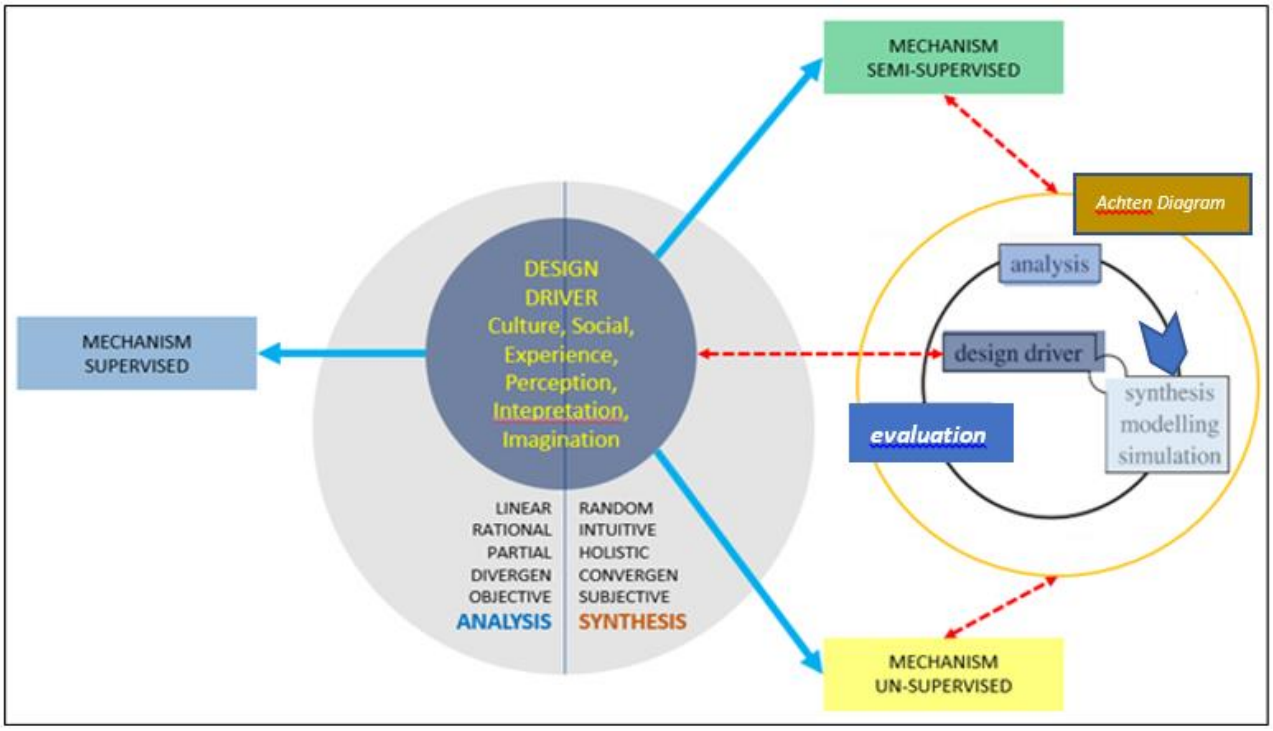

Figure 1 Hybridtecture concept in analysis-synthesis in digital architecture.

In architectural digital method, the digital machine could be used as a tool to increase the capacity and speed of the architect's thinking process in the analysis and synthesis stages. However, the digital machines did not have experience and things related to psychological and socio-cultural aspects, unless they had been taught.

For the analysis stage, it could be more precisely assisted by digital machines with supervised mechanisms. This would because this process would be extracting the main data from clients or humans. So there would be still a supervised mechanism as a result of fully human thinking especially in translating human thought patterns during discussion with clients.

The synthesis stage would be more likely to use a semi-supervised mechanism. In this stage, the machine would perform the synthesis process in random but the architect would provide guideline to this random process. The positive side of the unsupervised mechanism carried out by the machine would be that it would give an alternative concept beyond the limits of human architectural experience, which could then be evaluated for its suitability with the client's expectations.

So, based on the aforementioned results, we developed a 'Design Driver' system that would be based on Achten Diagram while factoring in digital machine as part of analysis-synthesis process. This modified design driver could act as regulator that would provide space for humans to intervene the un-supervised process through a set of algorithm so that the mechanism could

change from unsupervised to semi-supervised or vice versa. This modified 'Design Driver' would be a meeting place for 'Man-Machine' in the analysis-synthesis stage of architectural digital design methods. Design drivers that have been modified to accommodate the man-machine also change the Achten diagram to be simpler. The position of the analysis moves to synthesis (Fig. 1) so that the designing process can be accelerated without neglecting the human aspect.

4. CONCLUSION

In conclusion, the architectural design analysis synthesis process model using a hybrid method, which had to be automatically supported by artificial intelligence, would be able to produce design criteria that would be directly beneficial to architects. By applying the concept of hybrid-tecture at the analysis and synthesis stage in the architectural design process, it would allow design activities to take place faster, covering a wider scale and solving more complex problems. The design process would also involve more parties, enabling transparency and producing high-quality designs while still adopting a human touch.

Furthermore, it would be necessary to develop a machine learning of hybrid method to properly manage the balance of human sense and machine scale.

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REFERENCES

[1] H.H. Achten, “Experimental Design Methods – A Review”, International Journal of Architectural Computing, Issue 04, vol. 07, pp. 505, December 2009.

[2] E.S. Abowardah, O. Manal, “Design Process & Strategic Thinking in Architecture”, in Conference: Proceedings of 2016 International Conference on Architecture & Civil Engineering (ICASCE 2016) At: London, March 2016.

[3] S.K. Boguda1, A. Shailaja, “Maximizing Digital Transformation Innovation – Design Thinking”, International Journal of Engineering Research & Technology (IJERT), Vol. 8 No. 05, May-2019.

[4] M.A. Hassan, Q.M. Rizvi, “Computer Vs Human Brain: An Analytical Approach And Overview”, International Journal of Engineering Research & Technology (IJERT), Vol. 06, No. 10, Oct’ 2019.

[5] J. Guszcza, M.A. Lee, B. Ammanath and D. Kuder, “Human values in the loop: Design principles for ethical AI.” Deloitte Review, 2020.

[6] I. As, S. Pal and P. Basu, “Artificial intelligence in architecture: Generating conceptual design via deep learning”, International Journal of Architectural Computing, SAGE Journals, November 2018.

[7] J.M. Laurens, “Imaji Dan Peran Media Desain Dalam Proses Desain Arsitektur”, Dimensi Teknik Arsitektur Vol. 31, No. 1, pp. 1-8, July 2003.

[8] M.G. Gunagama dan N. F.Lathifa, “Automatictecture: Otomatisasi Penuh Dalam Arsitektur Masa Depan”, Jurnal Arsitektur NALARs, Vol. 16, No.1, pp. 43-60, Januari 2017.

[9] M. Parsaee, P. Motealleh and M. Parva, “Interactive Architectural Approach (Interactive Architecture): An Effective and Adaptive Process for Architectural Designacademic Research Paper on "Mechanical Engineering", Housing and Building National Research Center, 2015.

[10] C. Belém, L. Santos and A. Leitão, “On the Impact of Machine Learning Architecture without Architects?”, in CAAD Futures 2019, Seoul, South Korea, 2019.

[11] P. Satwiko, “Arsitektur Digital”, E-Book, Yogyakarta, Penerbit Universitas Atma Jaya, 2010.