

# APPLICATION OF PREFABRICATED WOOD WITH AN ENVIRONMENTALLY FRIENDLY AND SUSTAINABLE APPROACH IN RESIDENTIAL PAVILION EXTENSION AT ANCOL, JAKARTA

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Submitted: July 2022, Revised: December 2022, Accepted: February 2023

## ABSTRACT

The application of prefabricated construction with environmentally friendly technology is often found in developed countries with greater practicality and sustainability. Because Indonesia has entered the era of the technologically literate industrial revolution 4.0, prefabrication has also been applied in Indonesia, although it is still rarely encountered. The fast and practical lifestyle of the community affects, including when building a residential building. The application of prefabricated construction is able to provide a faster construction time and better quality. The budget can also be adjusted to the selected materials by taking into account the scale of construction and a more flexible working time. This study aims to gain knowledge about the application of prefabricated wood implemented in the pavilion and its relationship to external conditions in the Ancol area, North Jakarta. This study uses a qualitative research method with a descriptive analysis approach, namely the description of conditions in accordance with the observations of an observation (observations), document studies, data collection, data analysis, and documentation. The application of prefabricated wood in the design of Pavilion AZ is an effective innovation when compared to conventional construction in general. The construction process is fast, practical, and more environmentally friendly because the materials used are precision measurements that are directly made at the factory using technology, so that the remaining waste generated is very little or even almost non-existent.

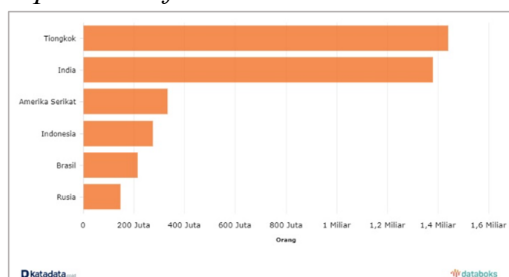
**Keywords:** Construction, environmentally friendly, pavilion, prefabricated, sustainable.

## 1. PREFACE

Indonesia is listed as the 4th most populous country in the world. The total population of Indonesia is recorded at 273,523,615 people in 2020 (Worldometers, 2020). The Central Statistics Agency (BPS) estimates that as many as 56.7% of Indonesia's population live in urban areas in 2020. This percentage is predicted to continue to increase to 66.6% in 2035 (Statistik, 2022). The increase in population in urban areas will also increase the growth of mobility, such as offices, trade, and settlements. In the end, population growth with its activities requires land for survival. Land is an absolute human need and has unique properties when compared to other aspects needed for human life (Sadyohutomo, 2008).

**Figure 1**

*Population of G20 Countries 2020*

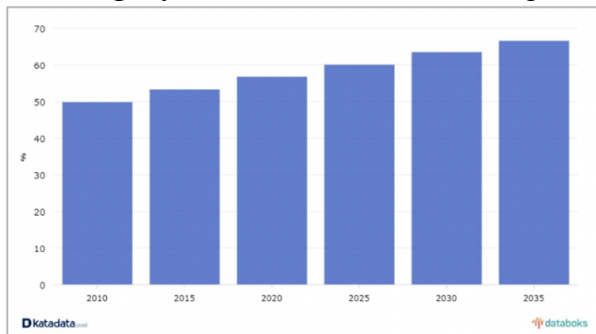


**Source:** Worldometers, 2022

The high demand for land is directly proportional to land prices that continue to increase. The increase in land prices can reach 10-20% (Figure 2) per year depending on the attractiveness of the location (Mart, 2021). This also affects the rising cost of building construction in the country.

**Figure 2**

*Percentage of Indonesian Urban Area Population 2010-2035*



**Source:** Badan Pusat Statistik, 2021

Many Indonesians are looking for ways to be able to design and build a building/house of their dreams at a more affordable price. Conventional construction techniques are the most common in Indonesia. In fact, other construction techniques also have the potential to be implemented in Indonesia. Considering that Indonesia has entered the era of the industrial revolution 4.0 which is technology literate, prefabrication is also a good solution and consideration for some people in Indonesia.

Prefabrication in the world of construction is the industrialization of construction methods in which the components are mass-produced and assembled in buildings with the help of cranes and other lifting and handling equipment (Sandewa, 2015). This prefabricated method is considered to have several advantages in the field of construction, including more efficient cost control, better material performance and quality, speed in construction, an easier approach to scalability and design flexibility, and easier project management in construction execution (Wibawa, 2016).

Prefabrication is underdeveloped in developing countries (Omid Reza Baghchesaraei, 2016), as is the case in Indonesia. This is very unfortunate because prefabrication can provide many advantages that other construction techniques do not have, because prefabrication has very close benefits in terms of economy, speed of time, and its environmentally friendly nature (Tharaka Gunawardena, 2014). This aspect supports the realization of a sustainable design. This has always been a big challenge for the construction industry in this modern era to continue to be developed and implemented in Indonesia. Therefore, efforts to create design innovations in order to achieve a sustainable concept need to continue (Tharaka Gunawardena, 2014).

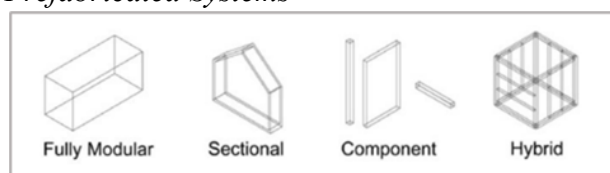
There are several types of prefabricated systems (Huang, 2006), namely:

**Table 1**  
*Prefabricated Systems*

	Description
Modular System	All components are assembled and manufactured at the factory. This system requires only simple connections to the foundation and main structure. However, the size of the modular units is limited by road laws/shipping constraints.
Intersection System	Makes it easy to transport intersected but not complete modules. Requires complementary components/processes once they arrive on site.
System per Component	Pre-designed and planned building components can be assembled in a variety of ways.
Hybrid System	The combination of prefabricated columns and beams to form the fundamental structural system in the building.

**Source:** Huang J.C, Krawczyk R.J, 2006

**Figure 3**  
*Prefabricated Systems*



**Source:** Huang J.C, Krawczyk R.J, 2006

According to the Continuing Education Center, there are two methods of wood prefabrication in the assembly industrialization approach, namely (News-Record, 2019):

- (a) Building Kits (Kit of Parts): In this method, prefabricated units that have been built at the factory are transported and assembled to the site. Prefabricated units include roof panels (roof panels, fascia, and gutters), roof structures (decks and beams), glass (windows and entrances), and building structures (wall panels, beams, columns, floors). This method can reduce framing time by up to 90% with timely delivery and installation with the help of a crane;
- (b) Finishing Modules: In this method, the entire building is constructed, then shipped and assembled on site. Buildings are stacked and placed side by side according to their layout. 85% completion can be achieved using this method.

Its modular nature is also its main attraction. Easy to disassemble and move to different locations. The structure is also very flexible and can be renovated by adding space in it. This study aims to identify prefabricated timber construction at Pavilion AZ in Ancol, North Jakarta and its relationship to external conditions and efficiency in terms of processing time and price.

### Related Work

According to the application of prefabricated wood with an environmental friendly and sustainable approach, we divided the existed work into one category.

“Lumenensia Pendant Lamp” Sustainable Design Millennial Decorative Luminaire. Keesah Pendant Lamp, the final result of the sustainable design of a decorative luminaire product from the lighting design course in the Interior Design Study Program at Tarumanagara University. This luminaire has successfully entered the Top 14 Indonesian Fashion and Craft Awards 2021 or commonly referred to as IFCA which is a national design competition that aims to produce talented young designers who have a vision of Sustainability in the Craft and Fashion fields (Adi Ismanto, 2021).

This design was made to be a solution to one of the world's problems, namely plastic waste. Plastic waste is not new in terms of sustainability issues. With the current global pandemic conditions, the use of plastic has actually doubled in line with online activities during the Large-Scale Social Restrictions or PSBB based on survey data conducted by the Indonesian Institute of Sciences in 2021 (Nurhati, 2020).

**Figure 4**  
*Molding Process*



In the manufacturing process, components are molded using molds that are made according to the desired shape in the design. In general, the printing and molding process are similar to the design of the Pavilion AZ. In this lamp, we use small-scale printing and molding of components in the form of luminaires (Adi Ismanto, 2021). While in the design of Pavilion AZ on a large scale, which is more complex in the form of wood-sized that is tailored to the site, the needs and desires of designers and clients and there are structural calculations on it.

In the prefabrication process on this luminaire, first, the cleaned HDPE PLA plastic waste is chopped using a chopping machine. Then, it is put into molding (according to the shape) with a color composition that has been adjusted to the desired color of the finished product. Then, the components are pressed using a machine. This process does not emit toxic fumes, pollution, and is safe [4]. Through this design, the author wants to develop a prefabrication process from a small scale to a larger scale by implementing it into the Pavilion AZ's project.

### **Our Contribution**

The contribution to be achieved from this paper is the application of prefabricated wood with an environmental friendly and sustainable approach through the same approach and process in related research at the "*Lumenensia Pendant Lamp*" sustainable design millennial decorative luminaire. the difference lies in the project scale as an architecture- interior design, which is more complex and the character of its users. Wood as a sustainable material that used for a Pavilion AZ design, which is located in Jakarta and is in a strategic location of Ancol beach clarifies the user desires and needs to be solve by designers. This paper can also be

recommended for designing residential and can be used as a reference regarding the process design, technique and application of prefabricated material such as wood with an Environmentally Friendly and Sustainable Approach.

## Paper Structure

The rest of the paper is organized as follows. Section 2 the methods used in this paper, which include the design process phase and output. Section 3 presents findings and discussion about the application of prefabricated wood with an environmental friendly and sustainable approach. Section 4 concludes the paper and presents a direction for future research.

## 2. RESEARCH METHOD

The design method used is Design Thinking from Rosemary Kilmer, W. Otie Kilmer (Rosemary Kilmer, 2014) which was then developed and adapted to the goals and concepts as an efficient design solution for the design of Pavilion AZ. This method has 8 stages, namely commit, state, collect, analyze, ideate, choose, implement, and evaluate. The research was conducted with qualitative methods. This method is carried out through research procedures that produce all information, both oral and written, even in the form of images or photos, that contribute to answering the research problem as stated in the problem formulation or research focus (Rahardjo, 2011). This study aims to examine the object and the expected results by analyzing primary data through the stages of informal interviews and direct field observations and secondary data with supporting theories obtained through library reviews and online observations that can be obtained through books, e-books, and e-journals.

The following table covers the method that researchers have done:

**Table 2**

*Design Method of Pavilion AZ*

Commit	Create a schedule for meetings with clients, contractors, and related vendors and create a project timeline.
State	Make notes and accommodate the needs and desires of the client.
Collect	Conduct field surveys and site measurements, as well as search for related literature data.
Analyze	Collect and analyze survey data.
Ideate	Create schematic concepts and moodboards to be submitted to clients.
Choose	Provide alternative layouts, concepts, and 3D designs, so that 1 layout, concept, and 3D design are selected to be developed prior to the contractor.
Implement	Implementing the design results into the real world, supported by the manufacture of custom furniture from AlvinT.

## 3. RESULT AND DISCUSSION

On the rooftop of Forest House AZ, there is 1 small unused pavilion. The interior wants to be redesigned according to the needs without changing the facade of the existing pavilion. The client wants to add pavilions to the left and right of the main pavilion as seen in the Figure 4 below.



**Figure 5**

*Pavilion AZ Addition Sketch*

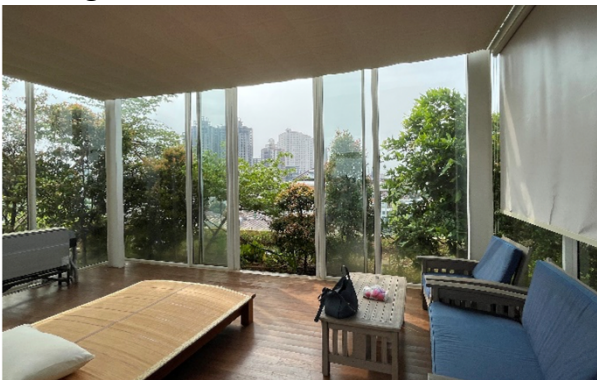


**Source:** Author, 2022

On the rooftop of the Forest House, there is a small, unused pavilion. The interior wants to be redesigned according to the needs without changing the facade of the existing pavilion. This main pavilion will be used by guests, co-workers, clients from abroad, friends, and even family who want to stay overnight. The client wants to add pavilions to the left and right of the main pavilion. The red line is the new pavilion plan, the blue line is the existing main pavilion (Figure 5).

**Figure 6**

*Existing Interior Main Pavilion*



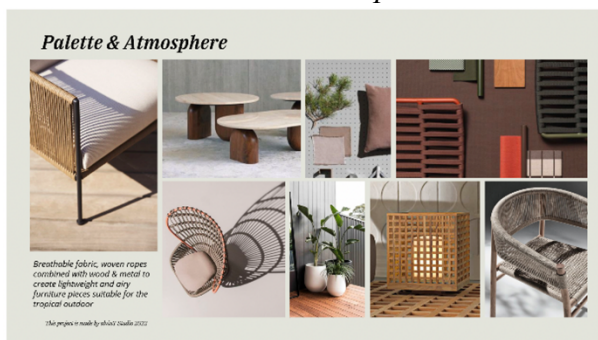
From the results of meetings and interviews with clients, information was obtained that the client wanted to redesign the interior in the main pavilion. The client also wants to add buildings to his left and right in the form of a pavilion. The right outdoor area is made as an outdoor lounge to relax, chat, and there needs to be a dining table to eat outside or it can also be used for casual meetings with guests. Need a canopy also for sun shade. The left outdoor area is filled with various kinds of herbs and fruits that will be planted directly by the client. There needs to be an outdoor shower that will be used by guests because in the existing bathroom there is only a sink and a closet, as seen in the (Figure 6) below.

**Figure 7**  
*Existing Interior Bathroom Area*

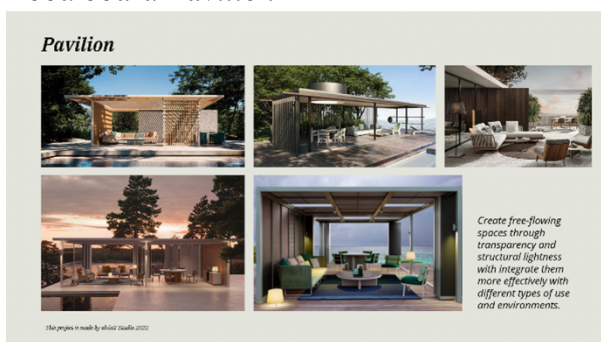


In this study, information is analyzed into a concept in the form of a mood board (Figure 7) to help the thinking process towards a 3D model (Figure 8).

**Figure 8**  
*Mood board Palette & Atmosphere*



**Figure 9**  
*Mood board Pavilion*



After that, 3D layout drawings and designs were made for Pavilion AZ. The concept and design image leads to modern contemporary. In the lounge, there is a dining table and lounge area. The left side of the dining table is intentionally not partitioned to take advantage of the existing view. In the main pavilion, the position of the bed becomes the main point in the room, considering the position of the pavilion is on the rooftop where in front of it there is a view of the capital city of Jakarta and Ancol beach that can spoil the eyes (Figure 9). Also equipped with custom loose

furniture from alvinT which was made especially for this project which gives an exclusive impression for the user experiences and concepts such as villas that are more flexible and not bulky. In the outdoor shower, curved is made which is limited by a lattice so that it is not stiff.

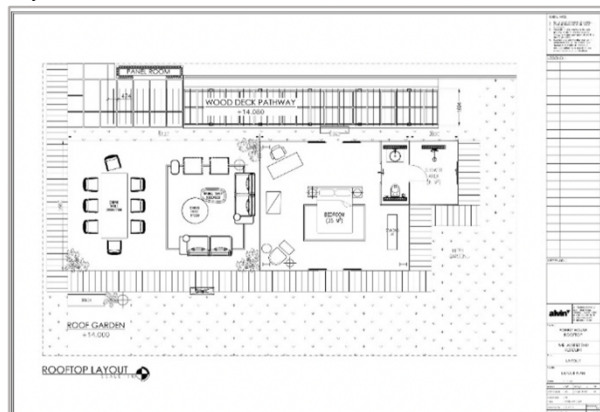
**Figure 10**  
*Moodboard Environment Setting*



There is direct access from the bathroom inside out so that users do not need to leave the pavilion first to use the outdoor shower. In front of the outdoor shower, there is a plant void as a sweetener for the pavilion as seen in the layout plan Figure 10.

In the facade structure, the researcher proposed using the prefabricated method considering the faster processing time and the position of this pavilion on the rooftop. For this project, the researcher collaborated with PT. Kayu Lapis Indonesia, where they are responsible for the construction and are the producers of the prefabricated wood that will be used.

**Figure 11**  
*Layout Pavilion AZ*



Previously, the researcher proposed a column with a size of 16x16 cm. However, after being calculated and consulting with the contractor, the size is too small and risky, considering the position of this pavilion is on the rooftop of the Ancol area where the weather changes are very extreme and the wind is relatively strong. With a windload calculation of 75 km/hour, the contractor provides a column size recommendation with a minimum of 20x30 cm.



**Figure 12**

*Outdoor Bathroom Pavilion AZ*



**Source:** Author, 2022

Before entering the working drawing stage, an estimated working time is made with a structured preparation plan from Pavilion AZ (Figure 12, 13 and 14).

**Figure 13**

*Bedroom Main Pavilion AZ*



**Source:** Author, 2022

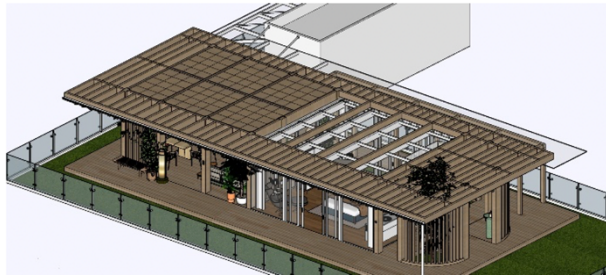
**Figure 14**

*Lounge Area Pavilion AZ*



**Source:** Author, 2022

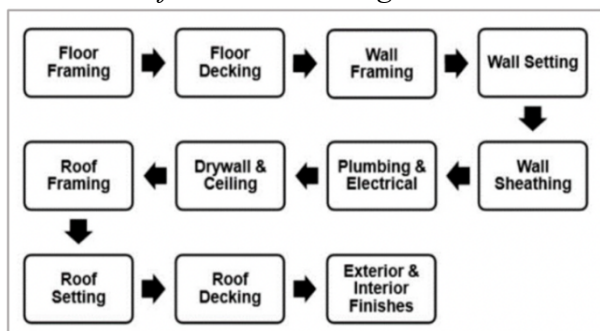
**Figure 15**  
*3D Facade of Pavilion AZ*



**Source:** Author, 2022

Estimated construction work time (Table 3) using the prefabricated method starting from the ordering process time, production, delivery to product installation. The estimated construction time is calculated directly and adjusted to various aspects such as the size of the pavilion to be built, the number of workers, the assembly position, and the surrounding environmental conditions. This illustration of the estimated time of construction work as seen in the Table 3, with the prefabricated method is proven to provide a more effective time. If this pavilion is built with conventional construction, the estimated time is only 2 months for the construction phase, not counting the preparation of building materials.

**Figure 16**  
*Pavilion Prefabricated Arrangement Plan*



**Source:** Author, 2022

On-site assembly provides less noise, dust and generally less harmful impacts on the local environment during assembly, and at the same time, construction time is much faster. In addition, with factory prefabrication, higher levels of precision are achieved thanks to better trained workers, modern equipment mated with high quality technology, higher safety standards and safer construction processes.

This means that fewer mistakes are made, which results in less waste in the construction process and can be easily integrated with eco-friendly technologies and adopting energy-friendly construction principles. The following are sustainable indicators in the design process of Pavilion AZ with wood prefabrication techniques (Table 4). It's the same with one of the projects in Alam Sutera, Buranchi which uses the same prefabrication technique as Pavilion AZ. The construction process took only two weeks and left no waste, no adjustments on site, and also no noise pollution

**Table 3**

*Illustration of Estimated Work Time of Prefabricated Construction Method for Pavilion AZ*

	Estimation	Description
Stages of custom wood production in the factory	2 months	- The printing process will be processed to the waiting list after 50% DP payment is made - Product delivery time can range from 8-15 days
Installation and assembly stage	3 weeks	- Include exterior & interior finishes

**Table 4**

*Sustainability Indicators with Prefabricated Techniques*

Sustainability	Yes/No	Description
Environment	Yes	- Reduce noise/ air pollution - Adjustable - Minimum waste - Easy to integrate with eco-friendly technology
Economics	Yes	- Save on costs and installation services
Social	Yes	- Fast work, efficient in time - Guaranteed worker safety standards - Almost anyone can do development

#### 4. CONCLUSIONS AND RECOMMENDATIONS

The use of environmentally friendly refabricated materials is one of the important sustainable issues in the field of architectural and interior design, from small to large scale. an example of the use of recycled materials such as plastic, can be refabricated into a use product such as a lamp. in the case of larger and complex projects such as residential design or architectural buildings, refabricated wood materials can be used as an Environmentally Friendly and Sustainable Approach.

It can be concluded that the application of prefabricated wood construction for Pavilion AZ in the Ancol area, North Jakarta provides advantages in terms of processing time which is 50% faster than conventional construction, cheaper prices because the need for wood molds is produced according to assembly requirements which is environmentally friendly. because the waste generated is very little or even almost non-existent. On-site assembly also provides less noise, dust and creates a safe and healthy work environment. This is also related to the creation of efficiency and productivity in carrying out project work.

#### Acknowledgement

Many thanks to all involved parties who has given the opportunity to me and trust me to hold some interior project during my internship.

#### REFERENCES

- A. Wibawa, "Enam Keunggulan Data Center Prefabrikasi. Kompas Cyber Media.," Kompas, 2016. [Online]. Available: <http://www.klasika.kompas.co.id> . [Accessed 1 May 2022].
- B. P. Statistik, "Persentase Penduduk Daerah Perkotaan Indonesia (2010-2035)," Badan Pusat Statistik, Indonesia, 2022.
- E. News-Record, "Designing Sustainable, Prefabricated Wood Buildings.," Enginerring News-Record, 2019.

- H. L. A. B. Omid Reza Baghchesaraei, "'Behaviour of Prefabricated Structures in Developed and Developing Countries'", *Bulletin de la Societe des Sciences de Liege*, vol. 85, pp. 1229-1234, 2016.
- I. S. P. Nurhati, "Peningkatan Sampah Plastik dari Belanja Online dan Delivery Selama PSBB, Survei LIPI," LIPI, 2020.
- J. K. R. Huang, "Mass Customizing Prefabricated Modular Housing By Internet- Aided Design," *Illinois Institute of Technology*, 2006.
- M. A. Adi Ismanto, "'Lumenensia Pendant Lamp'" Sustainable Design Millennial Decorative Luminaire," in *Book chapter Seri Publikasi Ilmiah Untar 2021, Sebuah Gagasan Milenial dalam Desain: Transformasi Desain Interior Menuju Era Pasca Pandemi*, vol. I, Jakarta, LPPI UNTAR (UNTAR Press), 2021.
- M. Rahardjo, *Metode Pengumpulan Data Penelitian Kualitatif*, Malang: UIN, 2011.
- M. Sadyohutomo, *Manajemen Kota dan Wilayah Realita dan Tantangan*, Jakarta: Bumi Aksara, 2008.
- M. Sandewa, "Prinsip Konstruksional pada Konstruksi Prefabrikasi," *Arctofia*, 2015. [Online]. Available:  
<https://www.arctofia14.blogspot.com/2015/07/prinsip-konstruksional-pada-konstruksi.html> . [Accessed 1 May 2022].
- Mart, "Tanah Kaveling Jadi Incaran di 2022, Podomoro Park Optimis dengan Produk Land Bank Miliknya.," *Podomoro*, 2021. [Online]. Available:  
<https://www.podomoropark.com/en/article/tanah-kaveling-jadi-incaran-di-2022-podomoro-park-optimis-dengan-produk-land-bank-miliknya> . [Accessed 1 May 2022].
- T. D. N. P. M. L. A. Tharaka Gunawardena, "Sustainable Prefabricated Modular Buildings," in *International Conference on Sustainable Built Environment*, Kandy, Sri Lanka, 2014.
- W. O. K. Rosemary Kilmer, *Designing Interior*, New York: John Wiley and Sons, 2014.
- Worldometers, "Jumlah Penduduk Negara G20 (2020)," 2020. [Online]. Available:  
<https://databoks.katadata.co.id/datapublish/2022/01/20/jumlah-penduduk-indonesia-ke-4-terbanyak-di-negara-g20>. [Accessed 1 May 2022].