

CIRCULAR ECONOMY BUSINESS CASE STUDIES IN SOUTHEAST ASIA

WEGE

-  Jakarta, Indonesia
-  Construction
-  modular.co.id
-  Analysis period: 2018-2024

Modular: Future for Sustainable Construction

Business Spotlight

PT Wijaya Karya Bangunan Gedung (WEGE) is specialised in prefabricated, prefinished volumetric construction (PPVC) – a construction method by which free-standing three-dimensional modules are completed with internal finishes, fixtures and fittings in an off-site fabrication facility, before being delivered and installed on-site. This method is modular in that it deploys standardised modules into a larger building. The modules are prefabricated at an industrial facility with higher efficiency and quality and less waste. Compared to conventional construction, modular construction can save up to one-third of use of raw materials (i.e. steel, concrete, cement, bricks), reduce greenhouse gas (GHG) emissions, and minimise waste at the construction site. The modular method saves total construction time as activities can be carried out in parallel. Modular buildings can be disassembled, moved and reassembled at another location, which is particularly useful for buildings with a short expected useful lifetime.

The building modules can be shipped in different ways (semi-assembled volumetric units or flat-packed roof, floor and wall panels) and assembled and stacked in different ways to construct different buildings (low rise, mid-rise, commercial, public facilities). During the period 2020–2023, WEGE built several prominent projects using the modular

method, including COVID19 hospitals in Jakarta and Batam, the pit building for the Mandalika Street Circuit in Lombok, and housing for workers at Nusantara, Indonesia's new capital.

WEGE is committed to further develop modular construction as a sustainable building practice. It therefore collaborates with stakeholders, including government, architects, research companies and material producers. WEGE teams up with waste-management researchers and material producers to explore the recovery and reuse of material from construction waste and other untreated waste for its modular panels. Following the milestones of implementing the modular method for low-rise (up to four floors) and mid-rise building (five to eight floors), the company is aiming for high-rise (more than eight floors) implementation in 2025.

 **Keywords**

Modular building, Prefabricated, Prefinished, Building reuse

 **Innovation**

Product/service design, Manufacturing, End of life management, Resource circularity, Resource efficiency

Analysis of PT Wijaya Karya Bangunan Gedung (WEGE)

Context and baseline

Buildings consume large quantities of materials, and the production of these materials generates GHG emissions, particularly, but not limited to, emissions from cement, concrete and steelmaking. Construction activities on the building site also generate air and noise pollution from the heavy-duty construction traffic and left-over construction waste. Moreover, it is generally a challenge to carefully control the quality of construction activities that take place in the open at project locations.

Recognising this state of affairs, WEGE began specialising in prefabricated prefinished volumetric construction (PPVC) after 2018 for better project management and building quality with reduced impacts on the environment. While modular buildings had been around for years in Indonesia, they were used mainly for temporary project offices, since they can be easily installed, dismantled, and moved. WEGE set out to develop modular construction as a full alternative for buildings intended for long-term use.

WEGE's team developed modular prototypes that are feasible for commercial use with feedback from researchers, architects, and structural engineering consultants. The company also works with waste managers and materials producers to explore alternative material from recycled waste (construction and general) to replace raw materials for the module panels in their modular constructions.

Innovation

WEGE set out to dematerialise, or light-weight, permanent buildings through innovations in building design, construction methods and logistics. First, the buildings are modular in design, meaning that they are composed of standardised units ('modules') rather than any customer or project specific shape. Modules in turn, are then optimised for minimum material use for floor-, ceiling- and wall-panels. Second, these modules are fabricated in a workshop which allows for deployment of material efficient hybrid panels, compared to solid walls and floors constructed on site, while controlled prefabrication can be fully optimised for minimal materials use, compared to construction in the open under only partially controlled conditions. The modules are furthermore prefinished at the factory with mechanical, electric and plumbing (MEP) furnishings. Finally, modules are supplied to the project site so as to minimise transport, logistics and installation requirements (and associated emissions and waste), through innovative flat packing (panels for one module are stacked and

reassembled into the three-dimensional building modules on site).

Using the building modules reduces the total weight of the building, meaning that smaller foundations suffice to support the building, leading to additional savings on steel and concrete for the foundations of the building.

The principles and techniques of prefabricated, prefinished building construction are known in the building sector, and WEGE optimized design, fabrication and associated processes for innovative product offerings meeting specific market segments in Indonesia. The flat packed modules consist of light steel frames, GRC (Glass Reinforced Concrete) for flooring, sandwich panel walls, and mechanical, electrical and plumbing (MEP) supporting equipment. A typical flat pack has a dimension of 13 m², is 3 metres high, weighs about 1.5 metric tonnes, and can be stacked four storeys high for public and commercial buildings. The dimensions of 'modular lite' are 18 m² and weighs 900 kg; it can be assembled into one-storey (residential) buildings without the use of a crane. The walls and floors of the volumetric modules are assembled at the factory, and can be stacked up to 12 storeys high, with a typical module size of 28 m².

Research and development at WEGE continues in order to make improvements on its modular products. In early 2024, in collaboration with Recycle and Waste (RAW) Lab, WEGE produced a prototype modular lite panel made with diverse waste materials, such as waste plastics (Saint Gobain waste packaging) and general waste (coffee grounds, used medical masks and fishing nets). WEGE also collaborates with the Polish construction company Design Manufacture Deliver (DMD) to develop modular designs for high rise buildings.



Circular Economy impact

Construction with the use of prefabricated modules contributes to circular economy, particularly through more efficient use of materials (resource efficiency) while also enabling opportunities for circular use of materials (resource circularity).

The key contribution of modular construction to the circular economy is its more efficient use of materials. The use of both materials and energy is reduced, along with associated waste, GHG and other emissions during manufacturing, and transporting of construction materials, in particular steel, concrete and cement, which are energy intensive to manufacture and cause both energy and non-energy related GHG emissions. The reduced weight of the buildings can be supported by lighter foundations, which saves additional materials.

The scale of materials reduction is specific to the building design and size. As an example, the 2,400 m² COVID19 hospital that WEGE built using modular construction weighed only about 208 metric tonnes, and used about 480 m³ of concrete for the foundation. Based on WEGE estimations, if a similarly sized and equipped hospital had been built with traditional techniques as a full concrete building, the building would have weighed 1400 metric tonnes and required around 720 m³ of concrete for the foundation.

The modular construction method can facilitate recovery and reuse. First, at the end of its useful life, the modular building can be disassembled, moved somewhere else and reassembled for a second use, avoiding both the need for new materials and construction as well as for demolition and its waste generation. For example, several modules of the COVID19 hospital in Jakarta were moved and reassembled as class rooms for a university, while others were deployed to Nusantara, the capital city-to-be for Indonesia, for use in a small housing projects. The temporary buildings at Gelora Bung Karno Jakarta Stadium have been reused as offices in various other WEGE projects, while temporary buildings at Soekarno Hatta airport have been frequently reused for various supporting facilities within the airport premises.

Second, as modular units are comprised of sandwich panels (instead of solid concrete/bricks in traditional construction), secondary materials can be utilised as filler material, as has already been successfully piloted for plastic waste and coffee grounds.

Business and market impact

Since its commercial implementation in 2019, the WEGE's revenue from modular construction is still fluctuating while showing an overall upward trend. In 2019, modular construction generated IDR 36 billion

in revenues (around EUR 2.1 million) and it was used to set up temporary facilities at Stadium Gelora Bung Karno Jakarta and Soekarno Hatta Airport. Revenues rose to IDR 96 billion (around EUR 5.6 million) in 2020 when WEGE built four COVID19 hospitals with 6400 m² of space, and it climbed again to IDR 226.5 billion (around EUR 13.3 million) in 2022 with a housing project for 16,000 workers for the construction of Nusantara capital. Meanwhile, modular construction revenues reached IDR 127 billion (around EUR 7.4 million) in 2023, with amongst others the new Dhoho regional airport with a total of 18,000 m² of space. With increasing market awareness of sustainable construction, the company is optimistic about securing more contracts in the years ahead. They are looking for the opportunity to build high-rise buildings (higher than 8 floors) in 2025.

The modular construction also benefits the company in terms of shorter construction times. The modules are prefabricated off-site, which allows the site preparation and foundation laying to be done in parallel with the fabrication of the modules in the factory. The handling and assembly of modules at the construction site may present a challenge, that is being addressed with advanced planning and strict project management, including calculating the most efficient delivery and deployment methods. Such project management enables more rapid completion, requires less heavy equipment on site and eliminates having to set aside land for inventory-holding on the construction site.

The company organisation is also growing with the development of modular construction. WEGE formed a new division for modular construction, which oversees the subdivisions of research and development, planning, marketing, and production.



Stakeholders

Architects and research institutions are among the most critical and significant contributors to the development and promotion of modular construction. They understand the magnitude of the problem and have the know-how for developing and implementing modular construction. For example, in February 2024, WEGE signed an MoU

with Surabaya Institute of Technology for a high-rise modular construction to be used as a student dormitory. WEGE's collaboration with RAW Lab and Saint-Gobain took centre stage at the 2024 ARCH.id¹, a prominent annual architecture exhibition and conference in Indonesia.

Implementation

WEGE's main challenge is to convince stakeholders including public, government, and businesses to accept modular construction as an alternative for conventional construction for buildings that are intended to last. Continuous awareness-raising and information are needed, that will focus on the demonstrated performance and qualities of modular buildings as well as their environmental advantages. WEGE actively holds meetings and discussions, participates in public events, and collaborates with strategic partners who share the same vision on 'lean' construction. WEGE gained a momentum to promote modular construction during the COVID19 pandemic, when there was a need for fast but also good quality construction. From there, WEGE further promoted the benefits for resource efficiency and associated reductions in GHG emissions.

Customers in Indonesia are known to be price sensitive. The scale of modular construction is not yet sufficient to capitalise on economies of scale. In promoting modular construction, WEGE emphasises the added financial benefits for customers. For instance, if modular is intended for commercial purposes, the shorter construction time will enable the customer of the building to generate income quicker.

1 <https://arch.id/>

Modular technology innovation is still in the development stage for applications in high rise buildings, which require structural testing and certifications to ensure conformity with building codes, proof of building safety through evidence, and cultivating customer and investor confidence. The current modular designs still have a monotonous appearance, and further variation is needed to accommodate trends and a variety of site layouts. These reasons explain why the company is committed to supporting research and development, both internal and in collaboration with partners.

Takeaways

The transition from traditional site-based construction to construction with factory-prefabricated modules has clear circular economy advantages because of the significantly increased material efficiency and the opportunity for circular use and reuse of buildings and inclusion of waste materials from other sectors. At the same time, the market and stakeholders' perceptions and acceptance of these new practices are blocked by unfamiliarity and uncertainties about construction quality and durability. Thus, a comprehensive policy and strategy for increased uptake of modular construction is needed, involving government, planners and architects, investors, builders, and building users. WEGE is paving the way to such a policy through its commitment to communicate transparently on the opportunities and benefits in modular construction, as well as through development of industry and research partnerships for the further development and optimisation of modular construction designs and fabrication methods.

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