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Research paper

The circular economy approach in a flexible housing project: A proposal for affordable housing solution in Malaysia

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Abstract

The demand for housing and affordable housing specifically will always become challenges for the government of the day. The solutions at the moment between conventional construction and IBS facing quality and costing problems respectively. In this article, it proposes the introduction of circular economy in a flexible housing project. To support the industrial revolution 4.0, this study is suggesting an alternative approach towards manufacturing the house as a commodity for the users. The idea of a circular economy is to reduce the price consumption by extending the lifespan of the housing unit. Towards the end, this article reports a design workshop conducted with the architects to produce a proof-of-concept of an affordable flexible house using CE (circular economy) principles. The flexible affordable house offers a solution to the lack of affordable housing and proposes alternative solutions to the problems. The study will benefit the government and Malaysians who opt for alternative housing in the future.

Keywords: *Flexible housing; Circular economy; Affordable housing; Industrial revolution 4.0; IBS construction*

1. Introduction

Although the government of Malaysia provides several affordable housing programs, the target group still could not access the facilities. The programs for affordable housing that are provided by the government do not truly resolve the problem of housing affordability especially among young starters in Malaysia. Therefore, it is important to analyze the needs of this group in order to find the solutions. The idea of flexible housing touches the need for 'standardized customization' in the housing construction and proposes an alternative housing system for the young starters in Malaysia. This article discusses the 'proof of concept' of the flexible housing project based on the design workshop with the architects. The demand for housing and affordable housing specifically will always become challenges for the government of the day. The solutions at the moment between conventional construction and IBS facing quality and costing problems respectively. The alternative solutions can be seen in the introduction of circular economy in a flexible housing project. To support the industrial revolution 4.0, this study is proposing an alternative approach towards manufacturing the house as a commodity for the users. The idea of a circular economy is to reduce the price consumption by extending the lifespan of the housing unit.

2. Literature Review

2.1. Affordability through Circular Economy strategy

The circular economy approach in a flexible housing project can be summarized as the ability for the customer to customize their order prior to purchase the house as to meet their current financial affordability. The flexible housing project proposes on leasing the housing components and services that allow the company to retain possession of the housing modules and properties and thus contribute to its own future resource stock (1). In addition, the housing component is expected to adopt a reconfiguration option and can be modified and upgraded based on the needs and financial capability of the customer in the future. The housing components are made from durable products to extend its lifecycle span to promote sustainability. Recently, the sustainable awareness has become essential in the construction industry in Malaysia thus this study supports the effort.

Housing tenure options in Malaysia is either renting or ownership. This article inspired by housing tenure in other countries and the reason for their inclusion. Based on a report (2), homeownership is growing in every part of the world except Germany. In most countries in the world, there is a decreasing trend of ownership. Nevertheless, affordability problems normally associated with higher house prices in the market (3). Affordability has always been the main concern in housing ownership. Therefore, this article is interested in proposing a solution to current affordable housing issues by adopting circular economy principles in a flexible housing project.

In this article, the term affordable housing is being reinvented and it shows how a business could cut the initial cost of production through the introduction of circular economy principles. The notion is that the producer or manufacturer agrees to lease the hous-

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ing modules with the potential buyer. Throughout the tenure, the components can be upgraded and replaced subject to financial capability. In short, the buyer is able to tailor their existing and future needs and therefore give the sense of 'ownership' to the product. It allows the customer to rent the housing components, but at the same time enables the unit to be flexible according to certain requirements imposed on it. Moreover, this new tenure will promote a long-term relationship with the housing manufacturer or producer and a good business strategy for long-term cooperation. At the same time, the housing manufacturer will reduce its production costs by remodelling and recycle the components.

In addition to that, the circular economy is also associated with innovative leasing which proposed the idea of co-sharing with the customer on the property rights. The circular economy also advocates on the effective management of the assets in order to expand the product lifespan (4). This business model allows the provider a chance to diversify their products according to the customer's usage (5). In short, the strategy will help to determine the pricing needed through investment in the resources used in the business and later sell it to the customer for profits.

This article promotes the idea of the circular economy in the housing industry through a flexible housing project. Through this strategy, the product and the services offer a new strategy in the building construction to promote the green and sustainable products (6). This flexible housing project might disrupt the existing housing market especially in terms of key activities, shareholders, resources and the activities in the company. Consequently, this idea might have cost more in terms of initial production. Nevertheless, the demands for sustainable construction coupled with the circular economy might give an advantage and finally provide alternative affordable housing to young starters in Malaysia. Nevertheless, the flexible housing coupled with the circular economy needs support from the government and industrial partners to make it happen. The uniqueness of this scheme is the potential of upgrading and modifying the components to suit to the user's requirement. Therefore, imperatively, this strategy could help the problems of affordable housing in the country and to meets the need of young starters in Malaysia.

Despite the noble idea, the research aware of the challenges facing the introduction of the idea in the market. Partly, the challenges to reduce the cost from the initial stage will be greater. However, the problem could be solved by increasing the level of production and by producing two or more distinct products, so that the cost could be reduced. The cost of production could be reduced through the circular economy business model. In this new plan, the components can be leased and thus saving the cost of ownership and the provider will gain from the leasing moratorium.

2. Methodology

A design workshop was conducted with the professional architects in Malaysia about the initial idea of the flexible housing project. The mission is to gain response, especially on the Uniform Building By-Laws (UBBL) and development based on the local legal aspects. According to (7) knowledge is not limited to the understanding of the concept but give feedback on the advantage and disadvantage of the design through the focus group session. Based on the responses, several inputs on the technical and authority requirements were discussed as well as technical aspects of the feasibility of the construction. The underlying reason for the workshop is to have different perspectives and empirical insights from the experts on the subject matters. Concurrently, the focus group also provide triangulation of the data sources to support the research findings.

This section will describe further on how the session was conducted to further enhance the raw idea of flexible housing. The discussion involves an educational discussion on the value propositions, business strategy and also the target customers for each product. We begin the study with a priori constructs. The criteria that we setup include a discussion on the aspect of customization, affordability and supply chain. Subsequently, we brought forward the initial code to develop categorizing and finally the final theme to answer the research questions.

In the design workshop, two professional architects, two graduate architects and a professor in Architecture have participated to give their input. The participants have professionals experienced in the design, construction and involved in the housing industry for quite sometimes. Therefore, the discussion on the design and authority aspects were fairly captured throughout the session to complement the proposal of flexible housing for the housing industry in Malaysia. In terms of sampling, the selected group was purposeful and from the sources that well versed in the subject matter (8), and from the source that the researcher can easily obtain information and utilize their knowledge and experiences (9). The session lasted for almost four hours and the findings were categorized into two parts.

In the next stage, the ideas were further developed into 3-D design using AutoCAD and to visualize the concept in 3-D. The discussion captured the pros and cons of each design and design critiques were conducted between the two groups. Based on the design brief and raw ideas, the respondents need to produce additional schemes to complement the first idea. Based on the session, the respondents conclude that the design is bound to two main aspects, which is time and user preferences. In term of time, the aspect of changing needs evolves from time to time therefore the design shall be future-proof or allow for future modifications. Secondly, in term of user preferences, the needs of target customers are essential in responding to the design, this is to avoid a design that will not satisfy the client's needs and requirements.

The findings of the workshop contribute to several options of design to support the idea of flexible housing. The basic idea of portability and mobility of the unit and the idea of infill on the main structure were discussed thoroughly. To summarize, the design workshop answered our initial code on the value propositions through the product of flexible housing.

3. Results & Findings

The design workshop has contributed to several design options for the flexible housing projects. The decision to involve architects is to obtain the design input together with authority and UBBL requirements. Apart from that, the knowledge on Industrialised building system (IBS) was also debated and transferred into the flexible housing ideas. There were basically two teams: The first group proposed (types A & B). While the second group proposed type C.

The first group proposed the potential of a lightweight structure as part of the mobile unit. The potential of the structure to be modular and extended as requires in the future. One of the respondents stated

With so many technologies that are available nowadays. It is good if the structure could multiply and become flexible to allow additional unit and expansion in the future. (design workshop)

There are also concerns about the building services (electrical and water services) supply to this building.

It is important to consider how the change of the house configuration would affect the services layout of the house. (design workshop)

In response to this, some examples were showed during the workshop (10) on the grey water and electrical piping from a fit-out system. To support the technology, the respondents suggested a good logistics would be crucial to ensure the product can be delivered to the site accordingly.

The first thing that came to my mind is, this business model needs a sound network to support the logistics. It must be closer to the factory or, at least, accessible to highways for the crane and trailers to transport the unit to the site. (design workshop)

Plot ratio for this type of building was raised by one of the respondents. As mentioned, the plot ratio will be subject to local authority requirement. Subsequently, the discussion was referred to Chapter 1, Section 2 - Akta 267, Akta (Perancangan) Wilayah Persekutuan, 1982 which describe plot ratio as a ratio between gross floor area of buildings divided by a total site area (common law/development requirement). In normal circumstances, the higher the plot ratio, the more gross floor area can be allocated to the site. Plot ratio determines the optimum density of the development or how many units can be built on site. Logically, the higher the developer can go, the higher profits they can make. Nevertheless, the plot ratio will be determined by the location of the unit:

I think the height of the buildings could be determined by the location later on… but maybe at this point, it is important to take note of the requirement of the plot ratio. (design workshop)

Alternatively, the next group (team 2) proposed a 'slot-in design" adding that this design will increase the unit on each floor. The justification is that it can create more design and thus increase the revenue for the developer. It is common during the discussion, the respondents act as a potential client. Some responses proposed additional facilities and accessories to choose from:

If you want to offer freedom of customization, we must be able to include the choices of different treatments for the facade and the ability to change the usage of the open areas. (design workshop)

Towards the end, the session contributed to several designs for the flexible housing ideas. Nevertheless, the respondents were challenged to produce atypical housing scheme which beyond their normal typical home design. One of the challenges is to produce a house that flexible enough to be upgraded and downgraded. In contrast, a conventional housing would be difficult to be modified due to its inflexibility and fixed in nature. Nevertheless, the session was conducted successfully and manage to provide conceptual design as being described in the next session.

4.1. Type A

The suggested size of type A is 2.4 m x 12 m, which formulated from the typical ISO container permissible on Malaysian highways. The typical height for each unit is 2.5 m (interior) / 2.9 m (exterior). Each unit is equipped with a living area, kitchenette with a wrap-up dining space and a small bathroom. The unit is supposed to be standalone or have an embedded structure. The unit is mobile and can be transported from one location to another. For the type A1, the unit is suitable for a starter due to its condense space. The module can be installed parallel to the building as to maximize the view from the sideways. As usual, the unit can be an add-on for further expansion. In the A2 design, the potential of the extension was demonstrated in the design. Further, in the type A3 and A4, the potential to combine three units together was demonstrated and the additional accessory such as balcony was demonstrated in the type A4. AS mentioned earlier, this type allows more sunlight into the building.

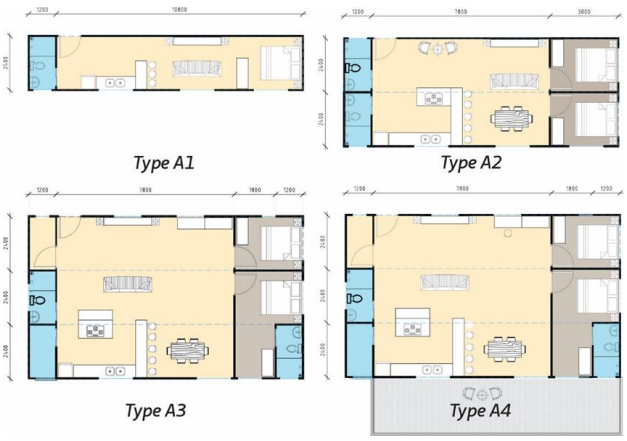


Figure 1. Proposal for type A

For obvious reason, type A allows more sunlight to penetrates into the building:

As we can see, both type A3 and type A4 have long windows opening on both sides. It helps with the positioning of all the main systems: power supply, water and waste recycling. (design workshop)

Nevertheless, the weakness of this scheme is the potential of the heavy structure caused by the width and the length of the unit. The location of the opening (doors and windows) will create potential problems in the future since the module is lengthy and thin. Therefore, extra consideration is needed when the unit is lifted to the desired level.

The module is long and narrow. Therefore, it needs extra care during lifting. (design workshop)



Figure 2: Typical layout for type A

4.2. Type B

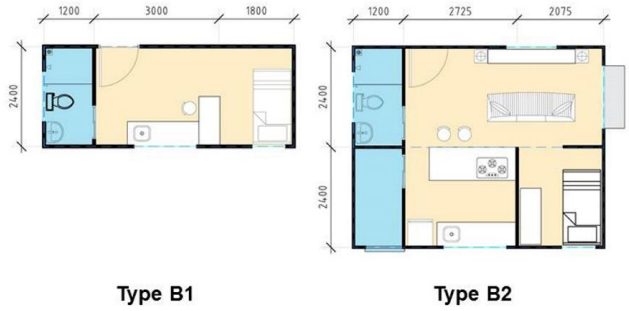


Figure 3. Proposal layout for type B

For type B, the size is measured 2.4 m x 6.0 m (approximately 14 m²). This module comes in two sizes. Type B1 is appropriate for a starter (one person). It comes together with a single bed, a kitchenette and a bathroom. Typically for type B2, the module is a combination of type B1. The B2 type offers the seamless connection between the bedroom and the living area for a compact living.

The advantage of this unit is it gives more light and ventilation, and at the same time, it is practical for the logistics and easy to manage. (design workshop).

This option allows the user to add on their units in sideways, thus offers a multiple to the existing unit. This type allows for the expansion and adds on the accessory that allows space for gardening, open balcony and rooftop garden for anybody who keens to have additional spaces for outdoor activities. This unit would appeal to young starters simply because it starts from a small unit and can be multiplied according to future needs.

This type fairly offers something in the middle, it is not that wide and can be easily transported and a right size for the young starters to begin with. (design workshop).



Figure 4. Typical layout for type B

4.3. Type C

In contrast, type C offers a different arrangement compared to previous units. The unit will be attached or 'slot-in' from the short part of the unit. The non-load bearing wall can be adjusted according to the spatial requirements and the dimensions are. are 7.2 m (l) x 2.4 m (w) x 2.5 m (h).

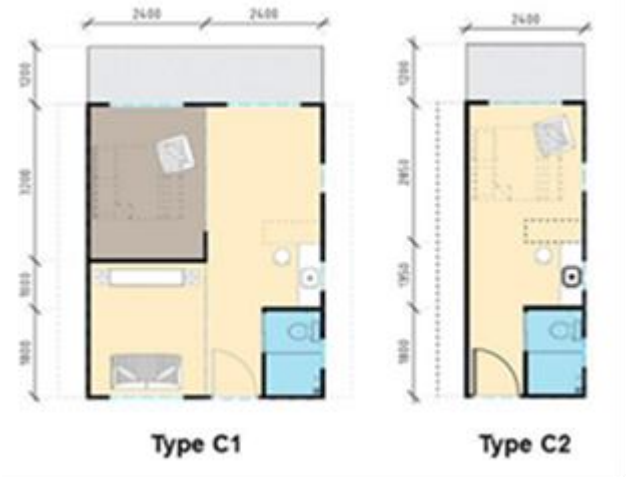


Figure 5. Proposal layout for type C

The skin of the unit is preferably suited to the climate of Malaysia. Although metal and steel are the main structure for the unit, the unit can be insulated to achieve optimum comfort according to Malaysian standards. From the layout, the basic unit can accommodate a single or double bed, a small bathroom and a kitchenette. The unit is also expandable and can be multiplied to form bigger units.

Nevertheless, some of the comments made about the unit include:

This concept definitely needs a lot of consideration about the ventilation of the intermediate unit... and to avoid being a stuffy unit. (design workshop)

The units were proposed to be based upon the ISO container and unanimously agreed by all respondents. As being discussed earlier, although the size was taken from the ISO container size, the real size might be taller and bigger in comparison to the actual container. For the flexible house, the unit will be equipped with all necessary services such as water and electrical ready to be connected to the main source once delivered to the site. Both the roof and the walls will be made from manufactured metal panels clad with sheets of acrylic and fabric to insulate against the tropical climate of Malaysia. The session with the architects provides a variety of design options for the flexible house concept. In the actual thesis, the design will be taken into consideration and to be analyzed the advantage and disadvantages of each unit.

contribute to a long-term relationship with the company. From the benefit from the reduc-



Figure 6. Typical layout for type C

5. Conclusion

In summary, we proposed potential solutions for affordable housing in Malaysia through flexible housing projects. Currently, the conventional housing construction has created more wastages and damages to the environment through the linear economy. Therefore, through this new strategy, flexible housing offers benefits of a doubt to a new innovative scheme that integrates circular economy as its principle. The new idea of circular economy passing the responsibility of maintaining and keeping the product back to the manufacturer. In return, the manufacturer reaps the profits from the leasing activities and continues leasing activities on their product.

The new idea of affordable housing with a circular economy principle will bring the housing products to another level in the IBS products and technology. In this new strategy, the housing manufacturers will invest more at the beginning and hold ownership of the products and reduce wastages in the housing construction. The housing production will be more responsible on their own products and take responsibility for the quality and durability of the products.

In this new concept, the company will become the emancipator and promote leasing as the main revenue coupled with maintenance activities. The next idea is to introduce usage fees based on the component that included in the package prepared by the company. The proposal brings a shift to a new skill that promotes a durable product for the housing component. The value creation expected to be delivered through customer satisfaction rather than high sales. This can be done through the prudent use of the energy, resources and a high-quality housing component. In this case, the customer will have peace of mind and satisfy with the product and source consumption-investment and increase their revenues at the same time. In relation to that, the project contributes to the sustainability cause in the local housing scene and helps to reduce carbon footprints caused by conventional housing construction.

Part of the content in this article is taken from the author's thesis named: flexZhouse: a new business model for affordable housing in Malaysia (11) that focused on the shortage of affordable housing for young starters in Malaysia. Introducing a flexible house with circular economy principle suggests a disrupt innovation in the housing market. It is a new strategy, one that the housing industry in Malaysia needs because several solutions at the moment have proven incapable to deliver affordable housing that offers flexibility and good quality housing to users. Furthermore, the proposal will support the government's mission to provide more affordable housing for urban dwellers especially the young starters along with more housing options for future customers.

Finally, the flexible house solution will provide an alternative way for young starters to own a house which not only customizable but also fit their current financial capability. The proposal will add a new dimension to the IBS system and, as its name suggests, offer flexible options right from the beginning of the purchasing process. In contrast to the conventional housing system, the flexible house will offer customers a choice of both interior and exterior housing design. The industrialized production will assure the quality of the housing and give customers peace of mind. The proposal will provide an alternative to current affordable housing and help to meet the needs of the population, especially young starters.

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