Exploring Circular Economy Concept in Affordable Housing Project: A Case Study on the Flexzhouse IBS Housing Business Model

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The idea of a circular economy (CE) has become more popular nowadays in the manufacturing industry. However, the concept of a circular economy in the housing industry or built environment is still at infancy. Therefore, this article explores circular economy concept in affordable housing project through 'flexZhouse' IBS housing business model. This article reported part of the thesis entitled: flexZhouse: a new business model for affordable housing in Malaysia. This article posits as the first study to suggest integrating housing industry with the circular economy. Therefore, it fills a gap in the knowledge about IBS housing. This article, which pursued the identified problems by developing a new business model (BM), will benefit the government of Malaysia, as it formulated a solution for affordable housing schemes and created an alternative business model for the housing industry.

Keywords: Circular economy; affordable housing; business model; IBS housing

1. INTRODUCTION

The concept of circular economy is nothing new in the manufacturing industry. Further, the concept has been implemented in other industries to reduce the operation cost through extending the life span of the products. (Esposito, Tse, & Soufani, 2017). Therefore, the question is: Can we reduce the price of the housing through adopting CE in the housing delivery? Achieving an affordable housing price for the customer depends on how the company or the housing developer creates revenues for its business. The price of the house could be reduced if the housing manufacturer could benefit from the economies of scale and from recurrent payments. In this article, the term affordability is being proposed and it shows how a company could reduce the cost of manufacturing and production by extending the lifespan of the products. Therefore, for the solution, this article revisited the meaning of affordability by introducing a new BM (business model) that would introduce to the market an alternative form of affordable housing. But in order to convert housing into simple and affordable products, the solution had to propose an innovative BM strategy, one that would offer innovative leasing. In this strategy, the revenue of the company will rely on the housing product and stock. This study was inspired by a circular economy strategy and logistics streams that adopt IBS housing production and focus on quality and defects control and maintenance of the products, thereby improving after-sales and the occupant's satisfaction (W. Stahel, 2008; W. R. Stahel, 2016).

One of the ways to reduce the cost of this innovation would be to develop an innovative leasing concept based on the circular economy principle for the housing components. The idea of innovative leasing is that the manufacturers or housing developers agree with the potential customers on the leasing of the housing components. The number, quality or size of the housing components increases along with the financial capability of the customers during the period of the contract. In summary, the customer is free to customize the housing unit, and thus providing the advantages of the 'ownership'. 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 association or producer and a good business strategy for long-term cooperation. At the same time, the housing producer will reduce its production costs by remodelling and recycle the components (Zairul & Geraedts, 2015).

As part of the solutions, the flexZhouse BM offers more design options in the mass housing industry, offer financial solutions to the middle-income group through innovative leasing and further improve the quality of the products through an industrialization strategy. The new BM also suggest using principles of the circular economy as part of its strategy to provide innovative leasing to the customer. This article contributes to the scientific community by combining the idea of IBS housing production with innovative leasing inspired by circular economy principles. At present, few studies have paid specific attention to the integration of flexible housing with the circular economy. Therefore, this article fills a gap in the existing knowledge of prefab housing and pursued the identified problems through the development of a new BM. This article will benefit the government of Malaysia by finding a solution for affordable housing schemes for the middle-income group (M40) and creating an alternative BM for the housing industry.

2. THE FLEXZHOUSE BUSINESS MODEL COMPONENTS

2.1. Value Propositions

The value proposition will determine the target group for the product and services offered by the company. The flexZhouse BM may require new or different types of customers. A case study on Japanese prefabricated housing shows that housing producers have always targeted high-income groups. The Japanese market has developed clever production methods and introduced aesthetics in the housing prefabrication production, thus responding to the consumer's demand for quality, but there has been less consideration regarding affordability (Noguchi, 2003). According to (Barlow & Ozaki, 2003), there is always a tendency for the customer to opt for certain basic standard design but to hope for individuation and customization. Borrowing the concept from other industries, the example of a personal computer and motor vehicle provides an example of how different needs of different target customers are processed and delivered. Depending on which groups are targeted, producing different value propositions could bring extra revenue for the company.

The flexZhouse strategy means the customer and housing provider share risks as well as rights to the property. By combining an innovative leasing model with principles of the circular economy a company can increase its focus on the efficient management of the resources. This also generates opportunities for adjusting fees according to the services and products used by the customer. The flexZhouse BM should therefore also incorporate a turnover formula, which defines the key resources needed to operate the business that later delineates the pricing of the products and services provided by the company together with mark-ups and gross and net profit margins. By combining an innovative leasing model with principles of the circular economy a company can increase its focus on the efficient management of the resources. This also generates opportunities for adjusting fees according to the services and products used by the customer.

Introducing mass-customization under the flexZhouse BM might pose significant challenges for the new business. However, there is anecdotal evidence that there is a growing need for mass-customization and individuation in the housing market for middle-income groups in Malaysia (Daud & Hamzah, 2012). In contrast, one might argue that the IBS housing is not the solution to the affordable, sustainable and green problems in the market caused by the barrier of entry as suggested by Ludeman, (2008). Nevertheless, the flexZhouse BM underpins the demands from the new customers in the market and therefore refined the present value propositions to its customers and to ease the process through identifying the target customers in the next section.

2.2. Target Customer

The uprising trends in the market have called for a new housing BM that is focused on flexible housing solutions. The flexZhouse BM will provide products for different customers and needs. It calls for better after-sales to maintain a healthy relationship with the customers. Hence, in this section, this section establishes the following conceptual contribution to the new BM as follows:

- The customer will have multiple design options to choose from and have the freedom to change the exterior parts, interior elements and services that match their requirements and budget.
- The customer will be more active and participate at the beginning of the development and co-evolve the design.
- The customer will be able to change or modify (add or remove) certain components after a certain period of

time.

- The services that come with the products from the company will improve the customer relationship and prolong the business of the company.

2.3. Customer Relationship

The flexZhouse provider should consider setting up several customer services as part of its marketing strategy to make maintenance work and after-sales activities more efficient and to improve service response time towards the customers. The flexZhouse after-sales services can be divided into three parts: product or design-oriented; focusing on a service support system (e.g. reducing equipment repair time) and minimizing risk (e.g. through extended warranties). For instance, the quality assurance is necessary to achieve customer's satisfaction, and this will bring return customer especially in the housing industry where the market is a customer-driven.

2.4. Revenue Streams

The innovative leasing is described as the customer choices on the products and services that suit their current financial situation. Based on the circular economy principle of Ellen MacArthur Foundation, (2015); Macarthur, (2015); W. R. Stahel, (2016), the flexZhouse BM focuses on leasing the housing components and services that enable the manufacturer to retain ownership of the housing components and resources and thus contribute to its own future resource supply. In the case of flexZhouse, the housing module is expected to adopt a remanufacturing strategy and can be upgraded based on recent technology. The technology also allows the innovation that can lengthen the lifespan of the housing module. Further, the sustainable concerns are making a debut in the construction industry in general and towards the housing industry specifically.

2.5. Key Resources

The affordability of the cost structure will be very much related to the arrangement of activities and resources, which means it will determine the price of the products. The new BM needs to change completely its way of working to match the circular economy principles. This is important because one of the factors driving the higher cost of conventional construction is the depletion of natural resources, which leads to increasing prices for cement, steel and other construction materials (Begum, Siwar, Pereira, & Jaafar, 2006). Therefore, supporting decisions on recycling and construction stakeholders' decisions regarding recycled mineral construction materials (Knoeri, Binder, & Althaus, 2011). The concept of the circular economy in flexZhouse includes reducing resource input by increasing stock and implementing the remanufacturing process.

The key resources will improve human resources and new equipment. However, investment returns are still undetermined (Amit & Zott, 2012). A lesson learnt from the Japanese housing builder is that resources play the main role in the production line. The investment by the Japanese housing builders contributed to a big manufacturing plant, show houses and a learning centre for the buyers. In these markets, companies such as Sekisui House, Sekisui Heim, and Toyota build their industries on the provision of specialized technical skills of skilled workers (Zairul, 2017; Gann, 1996).

2.6. Cost Structure

The basis for the cost structure of the products that will be offered is the resources needed to operate the business and a partnership with other companies. By this simple concept, the cost structure for the flexZhouse relies on the value propositions, partnership and resources used to operate the business. The adoption of an industrialized strategy in the housing industry will change the process of normal construction. Therefore, this change will impose a substantially different cost structure in comparison to conventional housing. Based on the revenue and innovative leasing in the previous section, the flexZhouse will introduce the closed-loop system for construction materials to reduce the operational cost by recycling and remanufacturing the housing components.

The idea of innovative leasing is, therefore, crucial for the formulation of affordable flexZhouse. The value configuration is closely related to other business elements. Changes in the value propositions lead to changes in the lifecycle cost and also impact the cost structure of the products (Mokhlesian & Holmén, 2012). flexZhouse may require completely different activities, partnerships and resources compared to the present housing industry. As a result, the flexZhouse might cost the housing manufacturer more due to its infancy. Therefore, a new strategy that involves a circular economy and

closing the loop by optimizing the remanufacturing of the components could be the solution to the problem.

The increasing popularity of the circular economy and sustainable construction in the housing industry might give an edge to flexZhouse to operate in the industry. However, flexZhouse will need support from partners and perhaps the government to realize it. The reconfiguration and remanufacturing of the components is an underpinning process for the flexZhouse BM. Take Ricoh as an example. Ricoh has adopted a long-term strategic approach to address sustainability issues and reduce prices by cutting resource consumption. Under its resource conservation programme, Ricoh pledges to reduce its operational impact through zero waste to landfill. The waste is now decoupled from turnover, and thus tonnes of waste to landfill has improved by 77%. Another strategy is to remanufacture existing products. Remanufactured products include photocopy machines, toners and printers. In the case of remanufactured machines, the old machine is stripped to its chassis and all parts are replaced and all panels are resprayed. Next, the firmware and software are modified, and then the product is completely rebranded and sold as a new product. The quality control ensures that the remanufactured products are true as new as new products. This has extended the lifecycle and provided the sustainable loop of the products (ECOPro project, n.d.). In terms of revenue, the company generates its income by reducing the consumption of resources through the remanufacturing process. The products are built to last longer and to create longer lifespan products.

Nevertheless, the uncertainty caused by the immaturity of the new BM is a concern, as it may lead to extra costs for either the manufacturers or the partners. However, there are ways to ensure the cost structure could provide customers with affordable prices. One way is to determine the economies of scale and the economies of scope. The cost of producing the components is expected to be reduced by the introduction of the circular economy and innovative leasing. In this new strategy, the customer leases the components for a certain period and is only allowed to buy the units after a moratorium period. Because of this, the high costs of the production could be prolonged, and the manufacturer will benefit from the leasing fees and the customers will save on the cost of ownership.

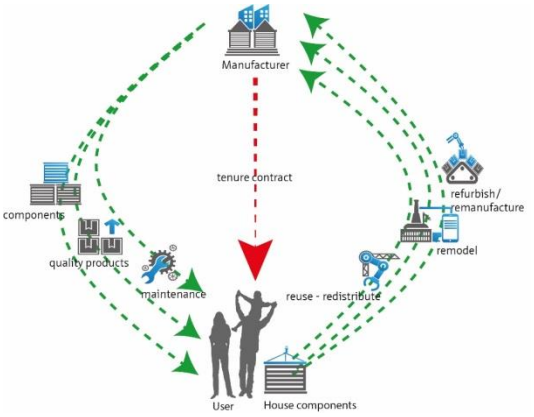

Figure 1: The 'prolonged' concept of housing manufacturer in flexZhouse. Source: Zairul (2017)

In closing the loop of housing production, manufacturers will have to change their mindset from being the sellers of the housing products and become the emancipators, provided by long-lasting upgradeable products of housing components. Their goal now will be to sell results rather than products, that is, performance and satisfaction rather than how many units of houses. Instead of purchasing the house, the middle-income group could lease it, paying a monthly fee based on how long they used their housing component.

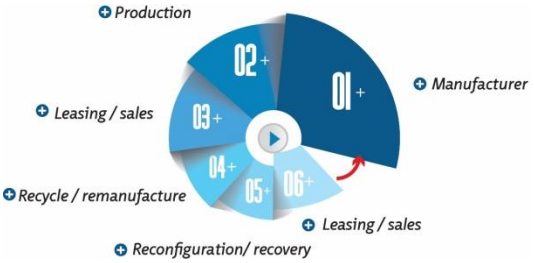

Figure 2: The loop for flexZhouse production. Source: Zairul (2017)

2.7. Partnership

Japanese prefab housing manufacturers as described by Barlow & Childerhouse, (2003) in his case study of Japanese prefab houses have shown that there were significant lessons to be learnt before the industry could move forward. It was reported that the factors that contribute to the successfulness of the Japanese housing industry are the size of the market itself, coupled

with increasing demands from the population. The maintenance of the current rigid housing is seen to be costly, needs a special craftsman and sometimes caused difficulty on-site (Schmidt & Eguchi, 2014). Therefore, it will be necessary to examine closely the potential of partnership involved in the process of the production, and key resources required to support the key activities. The complexity of the housing industry presents a challenge to monitor along with the supply chain. A survey on the adoption of the industrialized systems showed that quality can be achieved through better supervision in the factory and the thorough inspection of the product before it leaves the factory and is installed on-site (Abas, Hanizun Hanafi, & Aswad Ibrahim, 2013; Bari, Abdullah, Yusuff, Ismail, & Jaapar, 2012; Bildsten, 2014). However, the value of cross-industry learning does not stop at the techniques but also applies to the knowledge transfer. Therefore, the idea tends to focus on the supply chain management strategy within the housing industry and reveal the opportunities to improve the time leads and the quality of the product.

2.8. Channels

The supply chain includes a wide range of process from the inception of the projects (raw materials) through the production stage in the factory, the delivery and installation of the components through a systematic distribution process and marketing. Therefore, channels explained the continuous improvement of processes and relationship available to help the delivery of the product.

The advent of technology and electronic commerce has further improved how the channels could reach the potential customer. At the early stage, the awareness of the product can be created by organizing and communicating information through social media, for example, Facebook and Twitter (Tucker, Mohamed, Johnston, McFallan, & Hampson, 2001). More traditional approaches to improving interactivity may also be used, for instance, show houses and learning centres (Peterson, Balasubramanian, & Bronnenberg, 1997). Channels include ways people can pay and perform the necessary transactions; this will further reduce paperwork and unnecessary complexity (Peterson et al., 1997). And improving the flexibility of the communications through the means of internet and web browsing for the customers. In our case, the flexZhouse will need to make use of the internet to increase the awareness, to promote the products and services, and to spread information regarding the products.

2.9. Key Activities

Literature supports industrialization attempts in the building sector with various objectives including reducing onsite activities (Vrijhoef & Koskela, 2000), flexibility in design (Habraken, 2003), concurrent engineering (Chimay J, John M., & Anne-Francoise, 2007), modular design (Gann, 1996), lean construction (Barlow & Childerhouse, 2003) and different understanding in a different context. Rinas & Girmscheid, (2010) presented nine aspects to describe industrialized production, namely 1) the use of mechanical means and technologies, 2) the use of high-tech systems and tools, 3) production in a constant process, 4) continued development of productivity, 5) standardization of products, 6) prefabrication, 7) rationalization, 8) modularization and 9) mass production. Further, Yashiro, (2014) divided the framework of the industrialised building (IB) system in Japan into several categories, including IBS houses of the 1940s, mass construction, component-based, mass customization, platform-oriented and service providing. Therefore, flexZhouse is the sums of everything mentioned earlier. It connotes the idea of new IBS house that embodied the characters of manufacturing products and at the same time imitate its sisters in automobile.

This article argues that different categories have different supply chain maturity. This is supported by Ali, Kamaruzzaman, & Salleh, (2009). There are barriers to implement the system mainly related to operating cost and financial barriers (Kamar, Alshawi, & Hamid, 2009). Several studies have argued that using an industrialized solution could increase the cost of the whole project and therefore discourage the utilization of the system (Abdul-rahman, Wang, Wood, & Khoo, 2012). Despite the barriers, Japanese housing manufacturers are investing heavily to improve the flexibility of the housing design to meet their customer's new requirements and to achieve customer satisfaction. The old market of standardization has been changed to a more flexible one in terms of design. By the 1970s, the production of prefabricated housing units prefabricated had reached new levels of quality and resulted in satisfied customers. The customers were more

prepared to accept factory-made housing and the provider increased its efforts to satisfy customer's quality expectations. Therefore, it is crucial for the flexZhouse to adopt customer preferences oriented through the idea of customized standardization as being implemented by Sekisui Homes.

In Japan, the new concept of IBS housing by Japanese housing providers offered many benefits in the planning and coordination of resource allocation and minimizing time-consuming on the site. In comparison to conventional housing, the Japanese manufactured housing industry managed to shorten the period of conventional construction from 120 days on-site to only 40 days on-site, which includes the preparation of foundation works, to the building work, the interior and finally up to inspection stage (Zairul, 2017). The new approach needs a new management decision in several fields. It is anticipated that some of (but not only) the following features will be part of that setup:

- The operating plant for manufacturing and remanufacturing will have to be located as close as possible to the development area. This will allow small repair and after-sales activity more efficient.
- The product needs to be designed for disassembly and technology improvement.
- Designers need to think of a product that will utilize the raw materials efficiently and durable over a long period of time.
- A new job specification will arise, and this will boost operation and management specialization.
- The users will learn how to take care of the product to enjoy the privilege of consuming the product, and any misuse will lead to penalties.
- The production will reduce the operational cost by recycling the stock.
- The company will focus on the efficient management of the resources, creating money and wealth through the recurring money from the leasing activities, and adjusting fees according to the services and products used.

3. THE CONCEPTUAL MODEL OF FLEXZHOUSE

Previously, this study related innovative leasing to the problems of the linear economy and how depleting materials resources has led to an economic downturn and expensive housing stock. The production of housing product in a conventional way has caused significant loss of renewable resources and created more wastage. Here, innovative leasing has introduced a different BM that creates a sustainable loop of lifecycle chain that gives future house buyers a better option in the form of the new concept of housing 'ownership'. The new concept of housing ownership has changed the paradigm to the long-term (rental) income for the housing producer and the housing producer is now responsible for the product, which includes risk and cost of waste. In a nutshell, the housing producer will take responsibility for its own actions.

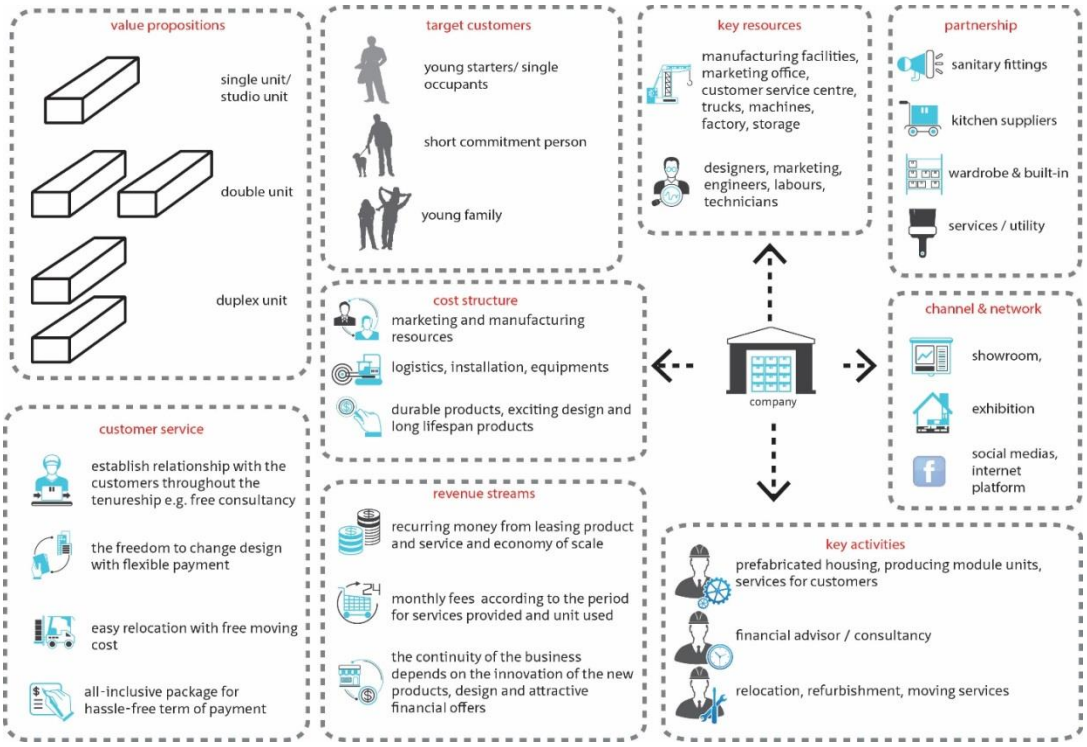

Figure 3: The conceptual framework for flexZhouse business model. Source: Zairul (2017)

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In the flexZhouse BM concept, the company will emphasize on customer satisfaction not only on the selling part. The main revenue will come from the recurrent fees based on the leasing activities, coupled with maintenance activities. The next idea is to introduce usage fees based on the component included in the package prepared by the company. The flexZhouse BM shifts to a new skill that promote 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 contribute to a long-term relationship with the company. From the company standpoints, this approach will benefit from the reduction of resource consumption-investment and increase their revenues at the same time. In relation to that, the flexZhouse BM contributes to the sustainability cause in the local housing scene and helps to reduce carbon footprints caused by conventional housing construction.

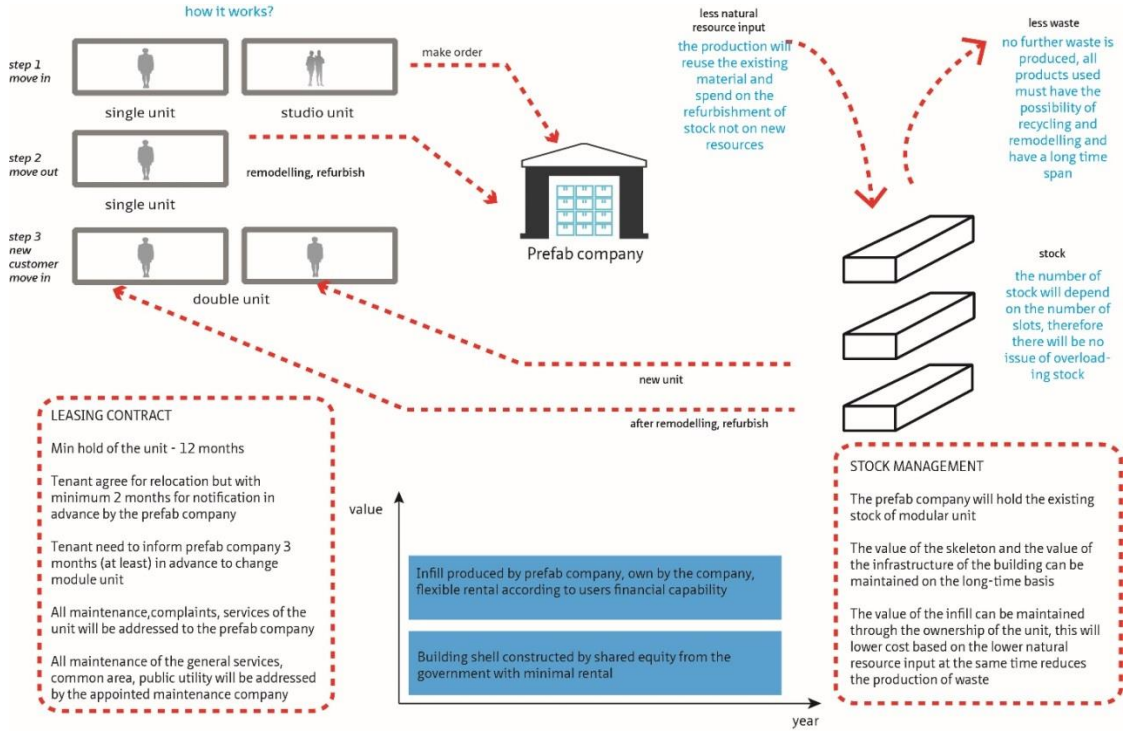

Figure 4: The conceptual lifecycle chain framework for flexZhouse business model. Source: Zairul (2017)

Initially, it is suggested that the government becomes the first party to initiate the project by acquiring the land and subsidizing the construction of the structure. The government under its housing agency will then construct the structure at the selected area or target area that has the potential for the scheme. Next, the government will invite tenders for the infill (housing units) and then the selected suppliers will produce and apply the concept on the site. The housing units or components will be leased to the potential customers and will have to be returned to the housing producer after the customer moves out. In the original contract, it is suggested that the minimum contract term for the units should be 12 months, and tenants should agree to give a minimum of 2 months' notice before relocating. In the event of changing the module, the tenant will be required to inform the suppliers three months in advance that he or she wants to change the module unit. All maintenance of the general services, common area and public utilities will be handled by the maintenance company appointed by the company providing the infill.

In this framework, it is suggested that the monthly commitment for the users will be based on their financial capability and based on the 30% of income rules. The payment will consist of the rental payment for the structure, the infill and the maintenance of the building. The business life cycle shows the potential of the circular economy through the remodelling and refurbishing of the existing unit/module for the next customers.

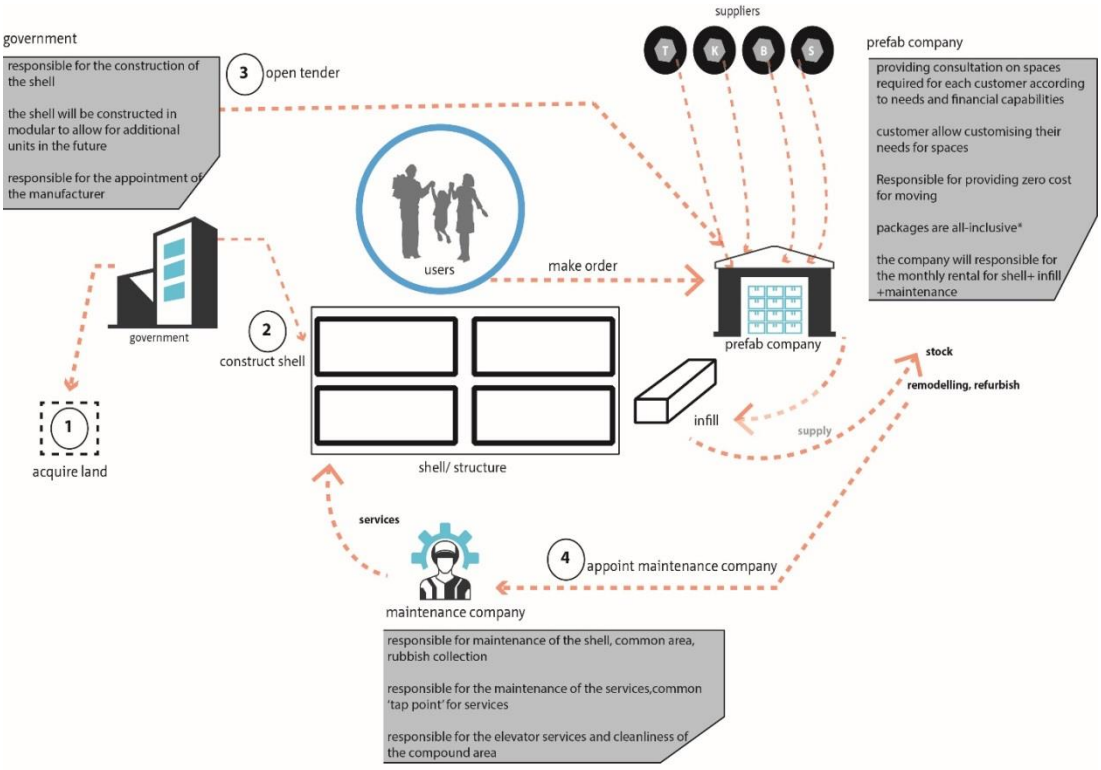

Figure 5: The conceptual supply chain for flexZhouse business model. Source: Zairul (2017)

In summary, this study aims to offer an innovative BM and a way to provide middle-income group in Malaysia with housing that is affordable and flexible in terms of design and offers. At the same time, this study aims to provide housing that improves the bureaucratic process and provides quality housing.

4. A WAY FORWARD

This article has presented a conceptual design for the flexZhouse. A future study could look into details concerning the construction of the products and further clarify the technology that is available on the market, especially mechanisms for moving the units in and out of the structure. Further study on the technical aspects of the products will help in terms of finalizing the production costs and the price of the unit to be sold on the market. flexZhouse requires strong technology support. New skills require technology transfer from other countries. Awareness of the new technology and training should be given as part of the development of skilled and semi-skilled workers to operate the new BM. Given the current technology in the IBS system in Malaysia, the flexZhouse will need a new paradigm to shorten the supply chain cycle. Lessons learnt from Japanese house builders on key resources are necessary to support the flexZhouse.

Three aspects that involve technical capability and technology were discussed concerning the appropriateness and the type of facilities that are suitable for the flexZhouse (technical aspects, available technology and mechanisms). As mentioned, this research just provides a guideline about the new technology and how it can support the flexZhouse. It will be important in future studies to discuss such aspects as the type of machines, equipment, infrastructures and mechanisms that will be required to operate flexZhouse BM. Attention should be paid to novel techniques in the new system. The market must be aware of the new technology and how it can improve the existing problems to create a market that continues to support the new BM. The strategy must take into consideration the aspects of sustainability that are emphasized in government policy.

In terms of economies of scale, it is necessary to distribute the network of the suppliers into a larger market. As discussed in the partnership components, the involvement of SMEs and

subcontractors can dispel the mistaken perception that the flexZhouse is an expensive product, as well as reduce the problems associated with the presence of unskilled foreign workers in the country. Nevertheless, the scepticism of representatives of the industry concerns the skills required to operate such a new system, the technology and the way of working. This will definitely need time, capital and more resources at the beginning of the operation. Changing the way of working creates serious resistance to the flexZhouse, as the current housing developers will not be keen to change how they work. Sourcing skills workers from outside definitely will cause more to their daily operations. However, some investment is necessary to achieve a successful business. As the financial implication creates the biggest obstacle, the initial investment is also necessary to help the business reap profit in a feasible time.

During the early stage of the operation, the factory needs to be built in a suitable location since the logistics of the units is one of the main aspects of flexZhouse. It should be located closer to the main highways and to make it easier to transport the units to the site. The model of flexZhouse will resemble a car manufacturing plant. The housing units will be produced off-site and transported to the desired location once they are ready. Later, the units will be brought back to the factory for remanufacturing and reconditioning. Therefore, the biggest obstacle is the technology and skills required to operate flexZhouse. Another obstacle is a financial one: convincing financial institutions to finance the project, which does not have any precedents in the case of Malaysia.

5. CONCLUSION

The materials presented in this article is part of the author's thesis named: flexZhouse: a new business model for affordable housing in Malaysia that focused on the shortage of affordable housing for young starters in Malaysia. Although the research emphasized the lifecycle chain of the mass housing development, it did not address the procedures for securing land or applying for planning permission. This means that although the flexZhouse provides proof of concept for the new BM, the notion is still in a preliminary stage of conceptual ideas. Introducing flexZhouse implies a radical change in the housing market. It is a new strategy, one that the housing industry in Malaysia needs because many previous proposals have proven unable to deliver affordable housing that offers flexibility and good quality housing to users. Furthermore, the proposed BM will support the government's mission to provide more affordable housing for urban dwellers especially the middle-income group along with more housing options for future customers.

Finally, the flexZhouse will provide an alternative way for young Malaysians to own their own homes. The flexZhouse will add a new dimension to prefabricated housing and, as its name suggests, offer flexible options right from the beginning of the purchasing process. In contrast to the conventional housing system, the flexZhouse 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 flexZhouse BM will be an alternative to current affordable housing and help to meet the needs of the population, especially young starters.

6. REFERENCES

Abas, A., Hanizun Hanafi, M., & Aswad Ibrahim, F. (2013). Competencies Factors of Malaysian Architectural Firms Towards the Implementation of Industrialized Building System. Middle - East Journal of Scientific Research, 18(8), 1048–1054. https://doi.org/10.5829/idosi.mejsr.2013.18.8.12471

Abdul-rahman, H., Wang, C., Wood, L. C., & Khoo, Y. M. (2012). Defects in Affordable Housing Projects in Klang Valley, Malaysia. Journal of Performance of Constructed Facilities, 28(2), 272–285. https://doi.org/10.1061/(asce)cf.1943-5509.0000413

Ali, A. S., Kamaruzzaman, S. N., & Salleh, H. (2009). The characteristics of refurbishment projects in Malaysia. Facilities, 27(1/2), 56–65. https://doi.org/10.1108/02632770910923090

Amit, R., & Zott, C. (2012). Creating Value Through Business Model Innovation. MIT Sloan Management Review, 53(53310), 41–49. Retrieved from http://sloanreview.mit.edu/article/creating-value-through-business-model-innovation/

Bari, N. A. A., Abdullah, N. A., Yusuff, R., Ismail, N., & Jaapar, A. (2012). Environmental Awareness and Benefits of Industrialized Building Systems (IBS). Procedia - Social and Behavioral Sciences, 50(July), 392–404. https://doi.org/10.1016/j.sbspro.2012.08.044

Barlow, J., & Childerhouse, P. (2003). Choice and delivery in housebuilding: lessons from Japan for UK housebuilders. Building Research & Information, (December 2012), 37–41.

Barlow, J., & Ozaki, R. (2003). Achieving "Customer Focus" in Private Housebuilding: Current Practice and Lessons from Other Industries. Housing Studies, 18(1), 87–101. https://doi.org/10.1080/0267303032000076858

Begum, R. A., Siwar, C., Pereira, J. J., & Jaafar, A. H. (2006). A benefit–cost analysis on the economic feasibility of construction waste minimisation: The case of Malaysia. Resources, Conservation and Recycling, 48(1), 86–98. https://doi.org/10.1016/j.resconrec.2006.01.004

Bildsten, L. (2014). Buyer-supplier relationships in industrialized building. Construction Management and Economics, 32(February 2015), 146–159. https://doi.org/10.1080/01446193.2013.812228

Bin Mohd Noor, M. Z. (2017). FlexZhouse: New business model for affordable housing in Malaysia. In A+BE Architecture and the Built Environment (Vol. 2).

Chimay J, A., John M., K., & Anne-Francoise, C.-D. (2007). Concurrent Engineering in Construction Projects (C.-D. Anne-Francoise, ed.). New York: Taylor & Francis.

Daud, M., & Hamzah, H. (2012). Examining the potential for mass customisation of housing in Malaysia. Open House International, 37(1), 16–27. Retrieved from http://umexpert.um.edu.my/file/publication/00007664_76462.pdf

ECOPro project. (n.d.). How does Ricoh bring its vision on sustainability into practice?

Ellen MacArthur Foundation. (2015). Circular economy system diagram.

Esposito, M., Tse, T., & Soufani, K. (2017). Is the Circular Economy a New Fast-Expanding Market? Thunderbird International Business Review, 59(1), 9–14. https://doi.org/10.1002/tie.21764

Gann, D. (1996). Construction as a manufacturing process? Similarities and differences between industrialized housing and car production in Japan. Construction Management & Economics, (December 2012), 37–41. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/014461996373304

Habraken, N. (2003). Open Building as a condition for industrial construction. International Journal on Automation and Robotics in Construction, 3, 37–42. Retrieved from http://www.iaarc.org/publications/fulltext/isarc2003-81.pdf

Kamar, K. A., Alshawi, M., & Hamid, Z. A. (2009). Industrialised Building System: The critical success factors. I9th International Postgraduate Research Conference, 29–30.

Knoeri, C., Binder, C. R., & Althaus, H. J. (2011). Decisions on recycling: Construction stakeholders' decisions regarding recycled mineral construction materials. Resources, Conservation and Recycling, 55(11), 1039–1050. https://doi.org/10.1016/j.resconrec.2011.05.018

Ludeman, C. (2008). Prefab is not the answer to affordable, modern, and green homes. Jetson Green Website, 1–17.

Macarthur, E. (2015). Circular Economy. https://doi.org/10.1038/531435a

Mokhlesian, S., & Holmén, M. (2012). Business model changes and green construction processes. Construction Management and Economics, 30(September), 37–41. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/01446193.2012.694457

Noguchi, M. (2003). The effect of the quality-oriented production approach on the delivery of prefabricated homes in Japan. Journal of Housing and the Built Environment, 18, 353–364. https://doi.org/10.1023/B:JOHO.0000005759.07212.00

Peterson, R. A., Balasubramanian, S., & Bronnenberg, B. J. (1997). Exploring the Implications of the Internet for Consumer Marketing. Journal of the Academy of Marketing Science, 25(4), 329–346. https://doi.org/10.1177/0092070397254006

Rinas, T., & Girmscheid, G. (2010). Business model of the prefab concrete industry - a two-dimensional cooperation network. CHALLENGES, OPPORTUNITIES AND SOLUTIONS IN STRUCTURAL ENGINEERING AND CONSTRUCTION, 677–682.

Schmidt, R., & Eguchi, T. (2014). Mediating Change: A Japanese Perspective on Adaptable Architecture. Architectural Design. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/ad.1731/abstract

Stahel, W. (2008). The performance economy: business models for the functional service economy. In Handbook of Performability Engineering. Retrieved from http://www.springerlink.com/index/R2630P3T636Q1578.pdf

Stahel, W. R. (2016). Circular Economy. Nature, 531, 435–438. https://doi.org/10.1038/531435a

Tucker, S. N., Mohamed, S., Johnston, D. R., McFallan, S. L., & Hampson, K. D. (2001). Building and Contruction Industries Supply Chain Project (Domestic). In Report for Department of Industry, Science and Resources. Retrieved from http://www.industry.gov.au/assets/documents/itrinternet/BC-SCMReport.pdf

Vrijhoef, R., & Koskela, L. (2000). The four roles of supply chain management in construction. European Journal of Purchasing & Supply Management, 6(3–4), 169–178. https://doi.org/10.1016/S0969-7012(00)00013-7

Yashiro, T. (2014). Conceptual framework of the evolution and transformation of the idea of the industrialization of building in Japan. Construction Management and Economics, 32(1–2), 16–39. https://doi.org/10.1080/01446193.2013.864779

Zairul, M. N., & Geraedts, R. (2015). New business model of flexible housing and circular economy. In ETH (Ed.), Open building (Vol. 44). https://doi.org/10.3929/ethz-a-010581209