

New business model of flexible housing

Zairul M. M.N¹, Rob Geraedts²

¹Universiti Putra Malaysia, Department of Architecture, m_zairul@upm.edu.my

²Delft University of Technology, Faculty of Architecture, r.p.geraedts@tudelft.nl

ABSTRACT

The Open Building (OB) and the concept of flexible housing has always associated with user's ability to respond to changing demand. It is necessary that housing can adapt to changing market conditions and different users' requirements. Flexibility makes a crucial concept that one cannot ignore. However, extra investments for future flexibility are still hardly made because the early investments affect different parties that are not involved in the future adaptation thus made it unaffordable to the mass. Also, the final life-cycle costs incurred in considering alternative solutions are more important than simply investing extra money in providing for flexibility (R. P. Geraedts). Our society and economy are always changing. Nonetheless, the way we produce, the linear system that contains make-take-dispose consumption, had not changed since the started off an industrial revolution a long time ago. Thus, resulted in scarcity, depletion and waste of resources, environmental pollution, and climate change. Innovative leasing using circular economy (CE) is a recent way of looking at sustainability. The basis of CE is thinking in circular supply chains, maximizing the value of materials in which products are reused, remanufactured and recycled (MacArthur, 2013). The authors have illustrated several methods for integrating flexible housing with circular economy concept resulting in a conceptual framework of a new business model of flexible housing. Results of this study contribute to an alternative affordable, flexible housing in the market.

KEYWORDS: Flexible housing, Personalization, Circular Economy, Open Building, Life Cycle Costs

AUTHOR BIOGRAPHY: Zairul M.N is a Ph.D. researcher in Department of Real Estate, TU Delft, training as an Architect and a lecturer in Department of Architecture, Universiti Putra Malaysia, Serdang, Malaysia. His research field involved Open building and flexible housing, business model and dealing with housing issues in mass housing projects.

Prof. Rob Geraedts is co-founder and member of the International CIB Working Group W104 Open Building Implementation since 1996. He is also an Associate Professor of Design & Construction Management at the Faculty of Architecture, Delft University of Technology, The Netherlands. His research field is Open Building, the adaptability of buildings and the transformation of vacant buildings into new functions, to meet the continuously changing individual user and market demands.

1.0 Introduction

Housing preferences and personalization have become widespread and the needs for individuation because of changes in lifestyle has increased recently (Hentschke, Formoso, Rocha, & Echeveste, 2014). In result to this, house buyers are no longer interested in standard designs produced by the housing developers (Noguchi, 2003; Yashiro, 2014). However, personalization has always been associated with extra cost and can potentially increase the housing price (Barlow et al., 2003; Gann, 1996). It is often difficult to physically adapt shelter and physical modification of existing dwellings, and this often leads to many wastes and environmental burdens (Wong, 2010). Understandably, individual spaces in the house may become obsolete at times due to the changes in users' needs. Further, the way we produce, the linear system that contains make-take-dispose consumption, had not changed since the started off an industrial revolution a long time ago. Thus, resulted in scarcity, depletion and waste of resources, environmental pollution, and climate change. Current and future developments show that the demand for natural resources will increase three times in 2050 (MacArthur, 2013).

Furthermore, in the present housing situation, when the option to own a house is almost financially inaccessible for the first-time buyers, the regular renting contracts only allow little room for improvements and modifications (M Zairul, 2013). Current physical housing scenarios caused marginal options for the customers

to 'grow' and 'shrink' with the house and a better chance to fulfill their future spatial requirements (MN Zairul, 2015). The inflexibility of current housing has caused migration of the users towards other places to suit their new circumstances. As the function of housing changes from the provision of shelter to serving multiple functions, the house should be a product that has long time-span and has the flexibility to upgrade and downgrade. Each successive tenant undoubtedly makes changes to the unit to match their needs and requirements as their needs evolve over time. Therefore, a potential solution should allow the flexibility not only in term of the physical elements of the unit-envelope but also in terms of innovative leasing for the inhabitants.

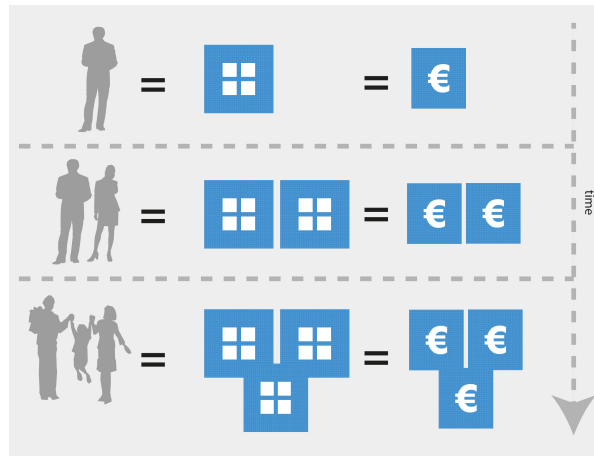


Figure 1: Changing needs and financial capability (Source: Zairul (2015))

2.0 Definitions of flexibility

Historically, the term flexibility was coined in the Netherlands since the 1980s due to changing of social household's structure and lifestyles. Flexibility also denotes the ability to change the floor plans for future needs. The changes involve by only leaving openings in the concrete wall to allow for additional rooms by adding or removing walls (Benros & Duarte, 2009). This paper inspired by the concept of infill and support started by (Habraken, 2003; Habraken & Teicher, 2000; Habraken & Valkenburg, 1972). The concept attempt to distinguish the flexible housing into two levels that are the support and the infill level. Later, it was further defined by the support being something that is non-removable, and infill is something removable and easily configured (Van Eldonk & Fassbinder, 1990). Here, the paper states that the user's ability to combine both elements can create a real solutions and accommodate flexibility according to changing needs and desires.

Barlow et al. (2003) developed a theory that the combination of standardization and personalization elements in the housing can create added value towards the housing industry. In a survey conducted in Hong Kong, to overcome the price and economics factor of the fancy design, both public and private developer have opted for a standardized layout (Wong, 2010). However, Sullivan and Chen (1997) previously argued that the standard layout prepared by the housing developers have caused more problems and unable to satisfy the different needs of occupants or the house buyers. Further, (Wong, 2010) noted that the tenants will end up make renovations to their units after they got their house keys. The additional modifications have caused wastages of valuable resources, materials, energy, time and especially money and manpower. However, this paper argues the industrialized housing can help to reduce these problems by allowing individual configurations of the layout to suits individual requirements.

In Japan, customers are given choices over the personalization of housing types, floor plans, exterior elements as well as interior and the personalization of finishes and fittings. The option for personalization has become popular recently especially in emerging countries (Hentschke et al., 2014; Kendall, 2012). We posit that the flexible housing should also have the potential to incorporate new technologies over time and the flexibility to adjust to change demographics. The flexibility of the housing system should also allow for a complete shift in the use of the building from housing to another function. Flexibility also permits the potential for relocation from one place to another. However, it was argued; several problems may stall personalization of housing that include: First, the concern of unsold customize house by third party. Second, the concern for the future value of the property. Thirdly, restricted by the long development times. Fourth, restrictions on building regulations and planning controls. Moreover, fifth, unknown construction cost (Nicol & Hooper, 1999).

The paper notices the study that support housing personalization in the literature is abundant. For example modular homes, factory manufactured, timber IBS, drywall partition and many more (Nawi, Lee, Azman, & Kamar, 2013; M. M. N. Zairul & Rahinah, 2011). Therefore, the focus of the study is on flexible homes that are modular and flexible in term of configuration. Hence, the paper starts the introduction with some definitions of flexible housing. Schneider and Till (2007) define the flexible design in housing as something that, 1) the possibility of changing layout according to owner’s preferences; 2) the potential to incorporate new technology; 3) to adjust to occupancy numbers; 4) to alter the use of the building to something else or adaptable use. Here, we add another feature that the flexible housing should also 5) able to relocate to other locations by the possibility of ‘adding’ and ‘removing’ the components and 6) adapt the changing needs of users from time to time.

Another definition of flexibility housing describes the flexibility of the structure to be adaptable according to the user’s needs (Sinclair, Mousazadeh, & Safarzadeh, 2012). Flexibility also means it should be responsive towards the environment and responsive towards users. Recently, advancing from the established foundation of Open Building (OB) group, (Sinclair et al., 2012) outlined some of the characters depicted from the ‘agile architecture’. The model of agile and adaptable explores the three categories as a stimulating mechanism; 1) spatial flexibility; 2) functional flexibility; 3) aesthetic flexibility. The model also promote that the practicing of open building and flexible design increase the high technical and technology that advanced technology and professional teams can support. In other perspectives, another definition of flexibility also means for responsive and adaptable. However, we argue that the definition of flexible is solely under the purview of the user’s satisfaction. Therefore, there must also require some restrictions.

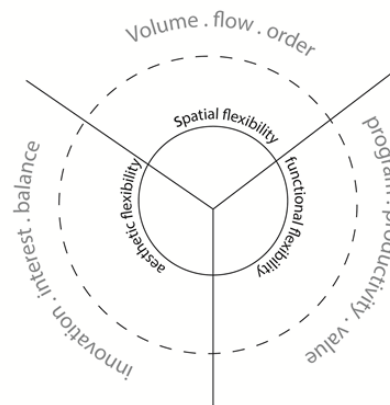


Figure 2: Integrative agility framework (sources: (Sinclair et al., 2012)

The research summarizes the description from the above model into the table below based on (Sinclair et al., 2012) for the agile framework that transcribe as follows:

Spatial flexibility	The ability to control space by the users. The users have the power to configure the space that they desire
Aesthetic flexibility	It promotes building with sense of character and quality of expression
Functional flexibility	It allows different activities to unfold with minimum amount of difficulty, demolition, and disruption

Table 1: Integrative agility framework (sources: Sinclair et al., 2012)

To summarize this section, we define **the flexible housing as housing that can adapt to the changing needs of users. Flexibility gives option and possibility of choosing different housing layout prior to the existing need as well as the ability to adjust to future needs.** The paper definition of flexibility involves the following

equilibrium; 1) towards the users; 2) towards the design and 3) towards the structure. What we mean by flexibility towards users are the choices that the flexibility design in housing offers towards them. Secondly, the design gives the flexibility of choosing different types of design and accessory for the aesthetic reason. Moreover, thirdly, the structure, displays the flexibility of the structure through an advance mechanism that will utilize the technology today. The flexibility of the structure supported by the advancements in knowledge and sophisticated techniques.

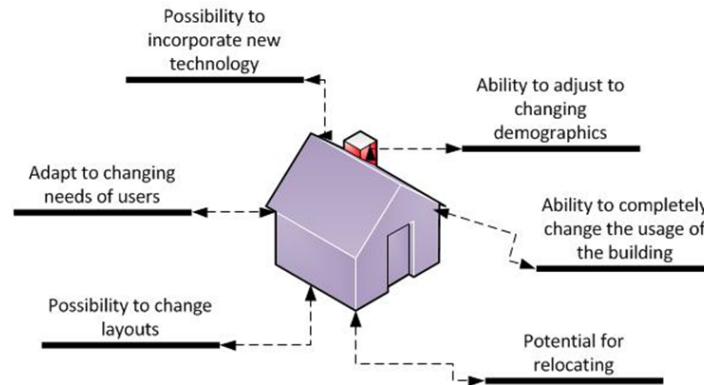


Figure 3: Characteristics of flexible housing (sources: Zairul (2015))

2.1 Adaptive capacity of flexibility

The need for flexibility is also motivated by the adaptive capacity (R. Geraedts et al., 2014). According to adaptive capacity, the flexibility in the building /housing unit is further characterized as; 1. **Organizational flexibility**: the capacity of an organization or user to respond adequately to changing demands of the built environment; 2. **Process flexibility**: the capacity to react to changing circumstances, wishes or demands during the initiative, the design and the construction phase; 3. **Product flexibility**: the capacity of a building (the product) to respond to changing circumstances, wishes or demands during the use phase of the building (see figure 4).

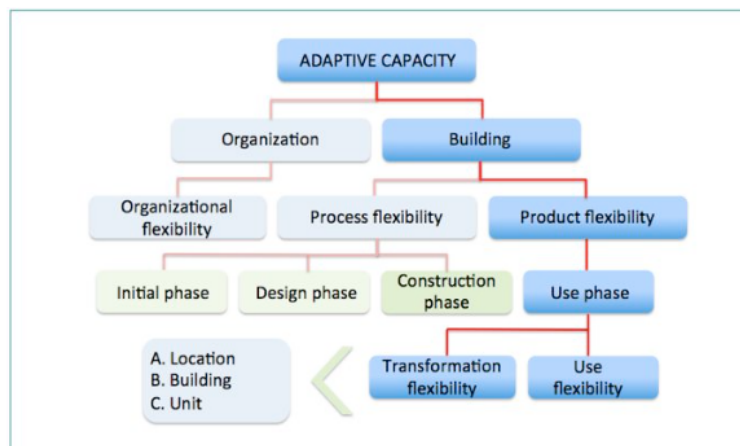


Figure 4: Several appearances of flexibility related to the adaptive capacity of buildings (R. Geraedts et al., 2014).

During the usage of buildings, the translation of demand into transformation and use dynamics on three different levels: location, building and unit (see Figure 4). **Use dynamics**: allow the users to formulate the demands. The building must be flexible to change in time with these (changing) needs. **Transformation dynamics**: this concerns the requirements for a building that should be able to accommodate entirely different user groups or various functions shortly. Transformation dynamics leads to specific demands for rearranging the spaces for various user groups.

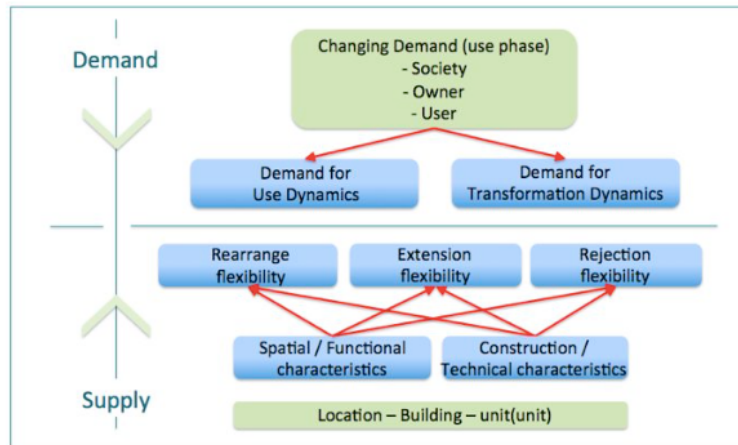


Figure 5: Framework for the demand (for use and transformation dynamics), and the supply (of rearrange, extension and rejection flexibility) on three different levels: location, building and unit (R. P. Geraedts 2014).

Within this framework (figure 4), the flexibility of the supply is translated into three spatial/functional and construction/technical characteristics. They determine if a building can meet the requirements: rearrange flexibility, extension flexibility and rejection flexibility: 1. **Rearrange flexibility**: to which degree the location, the building or the unit can be rearranged or redesigned. 2. **Extension flexibility**: to which degree the area, the building or the unit can be extended; 3. **Rejection flexibility**: to which degree (part of) the area, the building or the component can be rejected.

2.2 Framework for flexible housing

Next, how does the flexible housing helps to provide affordable housing? We understand the flexible housing needs support from many attributes, especially in the production field. The paper asserts that the flexible terms itself connotes the idea of prefabrication, installation rather than construction, easy delivery and concern on the customer's requirements. Here, we try to establish a link between existing theories in the respected fields and presuppose the history and current canon of the attributes; every departure from conventional understandings must be explained and justified.

The paper further discusses customer satisfaction in housing services. Various researchers have assured that producing a more customer economic-centric has become a priority in many industries (Itard & Meijer, 2008). Moreover, a house is the biggest investment in one's life. It is a place for socializing, gathering and bonding activities among the family members. It is also an investment of physical, psychological, social and financial (Forum, Housing, & Initiative, 2002). Hence, it is necessary if the house to be build, according to the need of the end users. The concept of customer satisfaction has been developed in the service industry. Research in the service industry has shown that there is a high correlation between customer satisfaction and intention of returning to the same service provider. Moreover, that satisfied customers' brand loyalty has positive impacts on business (Holm, 2000; Mokhlesian & Holmén, 2012; Sullivan & Chen, 1997; Wong, 2010). In the current housing industry, it is found that there is a considerable length of time between customer-supplier interactions (Nicol & Hooper, 1999). Thus, makes customer's brand loyalty weaker in the house building industry (Barlow et al., 2003). Furthermore, the fact the location is the important factor in purchasing a new home, may also restrict the persons to remain loyal to the same housing company.

The opportunity to enhance customer satisfaction and increase market has become more popular lately. It is against the conventional system where the housing developers purchase a plot of land and build a standard design. The housing customers nowadays know their rights and demanding a unique style that reflects their lifestyle (Daud, Hamzah, & Adnan, 2012). The paper suggests the concept of personalization is believed to be the answer to address customer's satisfaction. Personalization can be defined as changing or allocating product and services according to the customer's needs and requirements (Schoenwitz, Gosling, Naim, & Potter, 2013; Schoenwitz, Naim, & Potter, 2012). A recent study by Kendall (2012) highlighted that the prefabrication of housing was considered as a process of mass customization (Hentschke et al., 2014; Piroozfar & Piller, 2013) and proven previous remark from Sinai and Souleles (2005) stressed that market demands can only be addressed if the housing industry adopted the industrialized and appropriate manufacturing concept (Pelizzon & Weber, 2009). However, the paper also notices that there are also problems if the house assumed total

customization. In term of client access to design, this would require the housing supply to be changed radically. Sufian (2008) mentioned that there are limits to the application of such strategies in the case of house-building products, especially if the products are highly customized. Therefore, as suggested by (Schoenwitz et al., 2013), we assert that the **flexibility is not necessary freedom of choice but also making a choice out of given options.**

3.0 New business model for affordable, flexible housing

Previously, we mentioned that the flexible concept need support from a financial aspect through innovative leasing. In this section, we try to adapt the circular economy into the flexible housing concept. We use the following components to differentiate between the existing model and our new business model. The CE components were modeled after the performance economy characteristics by Stahel (2010). The new innovative leasing of the building/housing involves the following;

- 1) value propositions;
- 2) liability;
- 3) payment;
- 4) work sequence;
- 5) property rights;
- 6) Advantages;
- 7) customer disadvantages;
- 8) marketing strategy;
- 9) the notion of value

3.1 Value propositions

Value propositions describe the value to the customer the company offers. Some also reflected the meaning with the ability for personalization (Anderson & Wynstra, 2010) and also the integration and activities between the customer and the service providers (Helander & Möller, 2008). For this reason, this research is focusing on providing services and the goal of value propositions towards customer choices and satisfaction. The paper proposes the category shall include the interactions between customers and the manufacturers during the early stage of design and also the option for the customer to have access to the product information and to personalize their needs.

3.2 Liability

Liability for physical damage arising from the dangerousness of the product from customer's perspective (Keeton, 1973). In the housing segment, liability can be caused by the defects of the products, construction defects and maintenance and care of the products. In this case, the new IFH shall focusing on providing quality services throughout the tenure and, therefore, the liability could be the pervasive characteristic of it.

3.3 Payment

In contrast to the standard ownership model (rental and hybrid) new innovative leasing of flexible housing providing an amount that is pro rata and accumulated when the manufacturer delivers the service. It includes several options for payment, electronically or manually. Apart from the monthly payment, it is also concentrated on pay-for-what-you-use.

3.4 Work sequence

Work sequence elaborates on the stages and process that involves in its operation. Often for a typical ownership model, the work sequence involves a very long and tedious works and many actors from start to the end. Therefore, for this new IFH, the research is looking into the process of work that can be produced locally, products that can be stored and restock. The utilization of semi-skilled workers in the country instead of using foreign labors.

3.5 Property rights

Most people still value ownership simply because of the property rights. Therefore, for the new innovative leasing, the research is looking into the possibility to reduce the price of the ownership through transferring the rights of property to the manufacturers. However, there is also an option for purchase for loyal customers.

3.6 Advantages for customers

There are certainly advantages to all models. People opt for ownership since they have an ultimate right over the property and to a possible increase in the property value. For a short commitment person, the rental model might be an ideal choice just because they do not want further involvement with financiers. For the hybrid model, there seems a similar benefit with the ownership. However, for the new innovative leasing, the paper suggests customer ability to have high flexibility in terms of design, do not require that much of technical knowledge, able to move in or move out when time serves and the flexibility of the payment according to one's capability rather than one size fits all solution.

3.7 Disadvantages of customers

Every single model has its weaknesses. For example, the ownership and hybrid model produces standardized design and renovation cost often involves extra money. Ownership also means further commitment with the mortgage system. In contrast, a rental model gives no right for the tenant to modify or change the physical of the house. Changing in social status or adding the family means tenant needs to move out to a new place or bigger places to suit changing needs. However, for the new innovative leasing, the main disadvantage could come from no right to a possible increase in the value.

3.8 Marketing Strategy

The standard ownership model works with marketing strategy if the housing developer has a proven track record. However, not all housing developers use the same teams for every project. Therefore, the approach is almost impossible to maintain. Further, publicity such as advertising in the newspaper and marketing brochures are some of marketing strategies for most ownership and the hybrid model. The new innovative leasing suggests customer services and display houses to let the potential customer have awareness on the products so they can feel the real tastes of living in the same house.

3.9 Central notion of value

The current ownership and the hybrid model provide a high short-term exchange value at the point of sale. The value of the houses is subject to the market value, inflation, and many other factors. Nevertheless, for the new innovative leasing model, the value is derived from the long-term utilization period.

Following the idea of innovative leasing for the new business model, the research captures some of the criteria that can support our arguments and our proposal for an innovative leasing for industrialized flexible housing. Based on the discussion earlier, the research formulates a table that provides the characteristic of the new IFH as follows:

Table 2: Comparison current type of tenure vs. flexible housing+ circular economy

	Ownership Model	Rental model	Hybrid model	New business model (Flexible housing + circular economy)
Value propositions	Housing product	Unit, services	Housing product	Services, customer satisfaction
Liability	Construction defects	Maintenance of the property	Construction and the maintenance of the quality	Quality of the service
Payment	Payment due on the transfer of property rights	Payment due monthly	Payment due monthly and at transfer of property rights	Payment is due pro rata and when the services are delivered
Work sequence	Extended supply chain, many actors, not centralized, often sequentially produced	Not relevant	Extended supply chain, many actors, not centralized, often sequentially produced	Producing work in local, products can be stored, re-sold, recycle, reproduce, remodeling
Property rights	Buyer holds property rights and liability	Property rights remain with the landlord	Property rights stay with the financiers until property transfer	Property rights remain with the infill suppliers and have options for ownership
Advantages for customers	Ownership Customers have the right to a possible increase in value	Able to move out when times serves; Short commitment	Financial flexibility; Ownership; Customers have the right to a possible increase in value	New model has high flexibility in design; Little technical knowledge necessary; Able to move out when times serves; Flexibility to change terms of payment
Disadvantages for customers	Standardized design, No cost guarantee; Renovation often caused higher price; Long commitment with mortgage	No option for modifications; Have no rights to a possible increase in value; No rights over property	Standardized design, No cost guarantee Renovation often caused higher price; Long commitment with mortgage	Have no rights to a possible increase in value
Marketing strategy	Publicity, sponsoring, advertisement	Housing agency	Publicity, sponsoring, advertisement	Customer service
Central notion of value	High short-term exchange value at the point of sale	Constant utilization value over long-term utilization period	Great short exchange value at the point of sale	Constant utilization value over long-term utilization period

4.0 Feasible Study

In the present linear housing production, there are significant costs involved in the supply chain. The development frequently requires; 1) preliminary phase of construction (design development, tendering process, authority, planning approval); 2) construction phase (construction and sales) and finally 3) handover and defects liability period (maintenance). It is also common, various costs are involved from the inception stage until the completion of the project. For a conventional housing project, the cost and benefits are seen to be linear and adopting the cradle to grave concept. The standard business model typically ends with the possibility of demolition or renovation of the old projects. Either way, the developer or the provider has to stimulate the company and start the life cycle chain all again for every project they produce. The industry is also known as highly fragmented and create one-off nature. It separates design from production thus creates several issues and unnecessary deficiencies caused by the traditional procurement (Cooke & Williams, 2013).

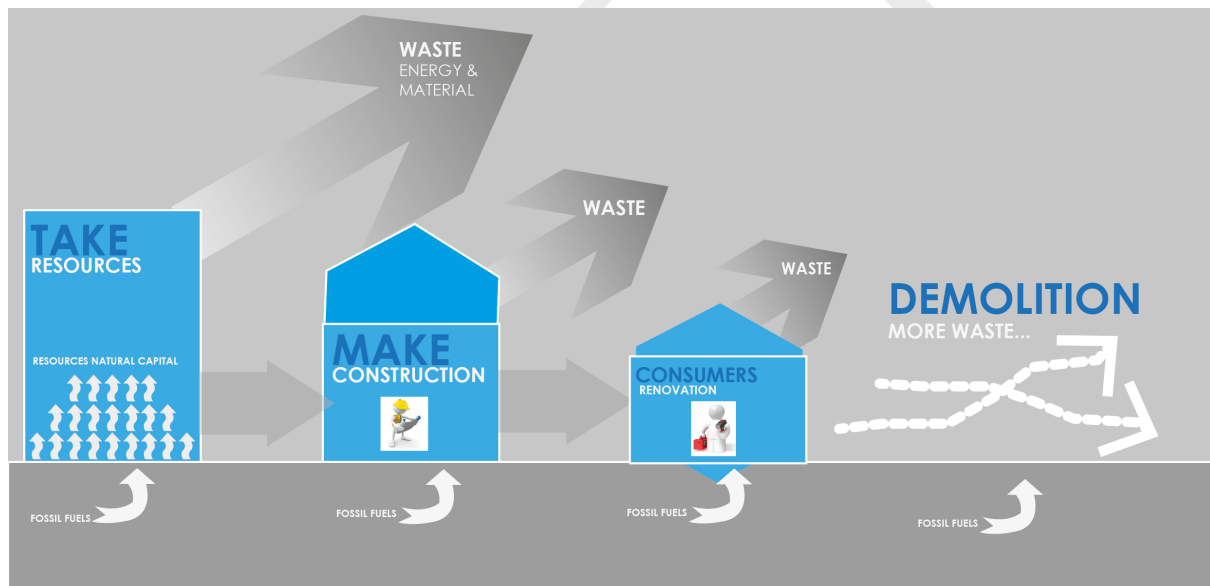


Figure 6: Linear housing construction (Zairul, 2015)

In the case of a new business model of flexible housing, the research suggests a flexible, off-site production and more flexible approaches in the production and supply chain of the products. The assumptions of the flexible housing with the circular economy would cause a significant investment at the very beginning. However, the paper also denotes the return investment that the company could make in the long term. The new IFH is expected to create a 'loop' of benefits established by the recurring products and services provided by the company. The productivity will be the main aspects of the new business model to improve the housing industry and also to support cradle to cradle and sustainable mantra in its daily operation.

However, the idea of integrating flexible housing into the circular economy are looking for deeper analysis and involves several components that crucial for the cost and benefits. The analysis requires more study on; resources that requires physical and human; construction materials, authority submission fees/requirement, land development cost, fees for the consultants and contractor and benefits that it may obtain from the key

activities.

4.1 Current linear housing production

The existing housing construction involves a long process (Berhad, 2013). It is possible to include the following as contributing value to this situation. The paper assumes the key activities for the housing developer is selling the properties, but the investment cost started from the acquisition of land until the defect liability period for the housing project. For an average project, construction often takes 18 to 24 months period to be completed. However, the selling starts as early as the inception phase when the company is launching the project.

Here, the paper illustrates a sample project. For an example, the project is a development of 10-storey apartment complex with commercial lots on the lowest floor. The land size can accommodate 17,000 m² of residential units and commercial lots, producing 14,000 m² of net residential units for rental and 3,000 m² net floor space of shop premises. The projected development period is expected to be 24 months. The first six months have been allowed before building works start to take into account of schematic design, estimation, tender and submission to authority. Construction costs have been estimated at RM 1,000 per m² (residential) and RM 1,500 m² (commercial).

T1

$$C_T = \sum C_{r(p+h)} + C_m + C_a + C_c + C_l + C_{c+c} + C_{ma}$$

$$B_T = \sum S_p$$

Assuming, project two at different location

T3

$$C_T = \sum C_{r(p+h)} + C_m + C_a + C_c + C_l + C_{c+c}$$

$$B_T = \sum S_p$$

Assuming, project three at different location

T5

$$C_T = \sum C_{r(p+h)} + C_m + C_a + C_c + C_l + C_{c+c}$$

$$B_T = \sum S_p$$

Equation 1: Project estimation (linear housing production)

C_T = total cost

$C_{r(p+h)}$ = Resources (physical + human)

C_m = construction materials

C_a = Authority

C_c = Consultant cost

C_{c+c} = Construction + Contractor fees

C_l = Land cost

C_m = maintenance cost

B_T = total benefits
 S_p = Property sales

4.2 Flexible housing + Circular economy

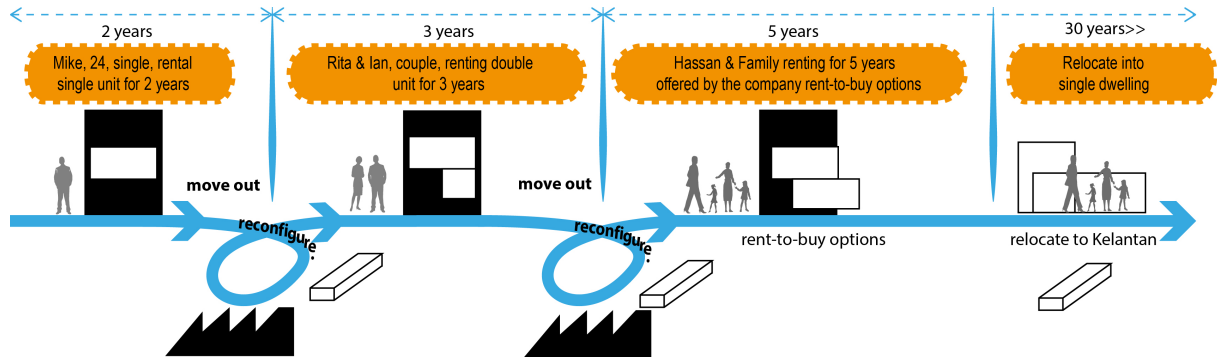


Figure 7: Flexible housing + Circular economy lifecycle (Zairul (2015))

In the case of the new industrialized housing business model, the company is assumed to invest in key resources (KR) at the very beginning. The setting up of the factory, investing in the technology, machines, transportation, and equipment are crucial to the business operation. As reflected the cost incurred at T1. However, the return is also obtained through a leasing program, services and rental on components. In T2, the equation shows the savings on the costs produces by the company in term of land cost and structure cost (main building). Further in T5, the savings include additional return on selling of the unit based on the loyalty program that offered by the company. The value of the savings increases as the time moving. However, the maintenance of the units also included after 24 months and reflected at T5.

T 1

$$C_T = \sum C_{r(p+h)} + C_m + C_{c(s)} + C_l + C_{lo}$$

$$B_T = \sum R_p + R_s + R_c$$

T 2

$$C_T = \sum C_{r-rm} + C_{m-r} + C_{lo}$$

$$B_T = \sum R_p + R_s + R_c$$

T 5

$$C_T = \sum C_{r-rm} + C_{m-r} + C_{lo} + C_m$$

$$B_T = \sum R_p + R_s + R_c + S_u$$

C_T = total cost
 $C_{r(p+h)}$ = Resources (physical + human)
 C_m = construction materials
 C_{m-r} = construction materials – recycling stock
 $C_{c(s)}$ = structure cost + utility services
 C_{lo} = logistic cost
 C_c = Construction cost (structure)
 C_l = Land cost
 C_{u+l} = Utility + crane cost
 B_T = total benefits
 S_p = Property sales

Equation 2: Project estimation for new business model (Flexible + Circular economy)

Table 3: Illustration of profits making

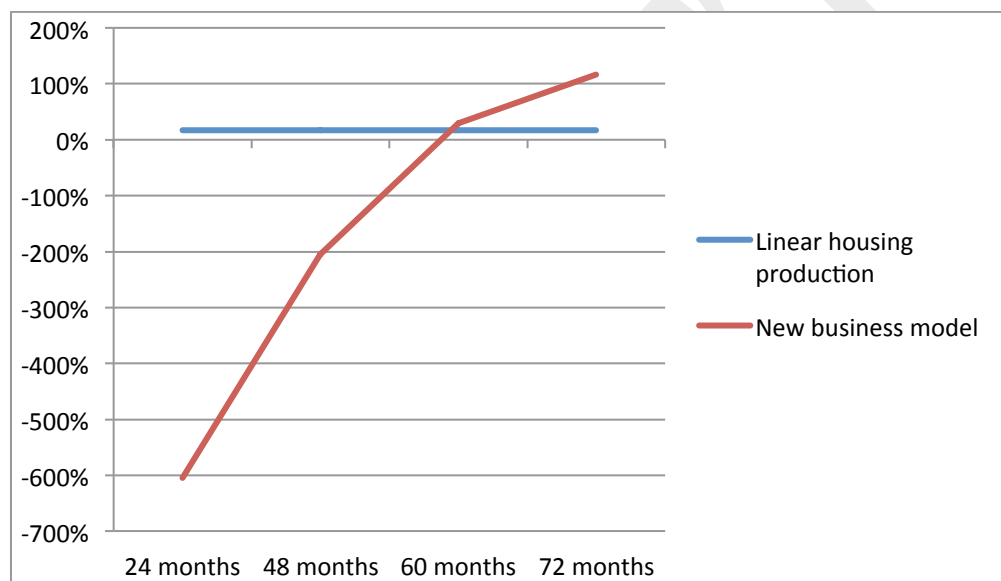


Table 3 illustrates the total development costs that both productions can influence. We assume the typical linear housing production involves a same procedure at the very beginning and remain the same for the profit making throughout different projects assuming the scale of the project remains the same. However, in the flexible housing and circular economy, we illustrate the beginning cost of operation involves an enormous investment for the company, however, along the process the return of investment is seen increasing. In the new model, the profit is growing especially at T5 caused by selling activities of the unit. The new business model resembles a good strategy of investment for the future.

5.0 Way forward for the new business model

The study described the preliminary estimation and assumptions on the new model. Since the new business model involves a relatively new manufacturing strategy, the study needs support from business model components to identify the supply chain, stakeholders, resources and activities to support the idea. Therefore, it is recommended to conduct follow-up studies. Several case studies on existing prefabricated housing models, feedbacks from the users through focus group studies and expert opinions could provide insight for this new business model of industrialized flexible housing.

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