

Designing Strategies to Anticipate Circular Economy Barriers in Furniture Industry

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Abstract

Circular economy is a new concept that improves the traditional concept of linear economy, which produces with the model of "take-make-distribute-consume-dispose" to "take-make-distribute-consume-return". When the product has reached the final stage, the product will not be disposed, but will returned in a form or quality that is different from the initial product. This return process considers the 6R principle of reduce, reuse, recycle, recovery, redesign, and remanufacture. In its implementation, circular economy experiences various barriers. This study aims to identify and analyze barriers to the implementation of circular economy in the furniture industry and create a strategy to anticipate these barriers. Respondents in this study are 75 furniture entrepreneurs in Central Java. Questionnaire are processed with the AHP (Analytical Hierarchy Process) method with the help of Expert Choice software to assess the importance weight of 5 barriers and 17 sub-barriers. The results of this study, the barrier with the highest weight is Financial with a value of 0.355. Based on the results of interview with some respondents, to overcome these barriers, the furniture industry must have a business model that is in accordance with the principles of circular economy. The most suitable business model is Product Life Extension.

Keywords

Circular Economy, 6R, Furniture Industry, Barriers, and AHP.

1. Introduction

The furniture industry as one of the growing industrial sectors in Indonesia plays an important role as a source of foreign exchange for the country because product enthusiasts are not only domestically but also foreigners. The need for furniture products make the need for wood as the main raw material increases because the furniture gives the impression of a luxurious interior design and aesthetic value that can provide comfort and can support various activities. Massive logging done continuously with little effort to reforestation so that the number of trees as the main raw material decreases and ultimately impacts on environmental damage. If the use of wood can be reduced and wood production waste can be reused, then it can minimize the environmental damage. Circular economy is a new concept that improves the traditional concept of linear economy, producing with the model of "take-make-distribute-consume-dispose" to "take-make-distribute-consume-return" (MacArthur et al. 2016). When the product has reached the final stage, the product will not be disposed of but will be returned in a form or quality that is different from the initial product. This return process considers the 6R principle of reduce, reuse, recycle, recovery, redesign, and remanufacture (Kircherr et al. 2017). However, in its implementation, the circular economy also experiences various barriers. Many companies (both small and large) that actually still consider the circular economy as something that is too expensive and risky to implement (Tonelli and Cristoni 2018)

This research has two objectives. The first objective is to identify and analyze barriers in the circular economy in the furniture industry. The second objective is to develop a strategy to anticipate these barriers. The step taken in assessing the level of importance of barriers to the adoption of circular economy in the furniture industry is by distributing paired comparison questionnaires to related parties. The results of the questionnaire will be calculated by the Analytic Hierarchy Process (AHP) method. AHP method is used for weighting the variables used. The weight are then sorted from the highest to the lowest. The highest rating represents the most important barrier, and so on until the

lowest ranking represents the least important barrier. The results of this study are analyzed in order to create further strategies to overcome those barriers.

2. Literature Review

The Concept of Circular Economy

McArthur et al. (2016) states that circular economy promotes restorative and regenerative models of production and consumption through a design. Circular economy changes the concept of "end-of-life" with the concept of recovery which aims to eliminate waste. According to Geissdoerfer (2017) circular economy is a regenerative system where input of resources and waste, emissions, and energy leakage are minimized by slowing, closing, and narrowing the energy and material loops. This can be achieved through design, maintenance, repair, reuse, remanufacturing, and sustainable recycling processes. (Kirchherr et al. 2017) added that the design was also designed to improve resource efficiency and involve the 6R principle (reduce, reuse, recycle, recovery, redesign and remanufacture (Jawahir and Bradley 2017). Thus, the circular economy focuses on the process of recycling materials, limiting the taking of material from its source, and reusing inputs (materials), and using waste as a resource aimed at reducing the consumption of primary resources. There are at least three requirements to transition to a circular economy from linear economy concept (MacArthur et al. 2016). The first is the importance of reusing standardization and modularization of components. Product design is also made in such a way so that its easier to disassembly. The second is disposal sector must be considered, at least of all discarded items that can still be reused. For example, there may be a market emerging to collect components and resell them. And the third is re-innovating business models. There will be a shift from "product ownership" to "product usage".

Circular Economy Business Model

There are 4 categories of business models that are adequate for CE implementation according to (Tonelli and Cristoni 2018). The first one is Net-Zero Innovation. This business model involves the operation of environmentally friendly production processes, with inputs and final products carrying a negligible or no ecological footprint, if a net positive impact on the environment is not achievable. The second model is Servitization. Servitization is an innovative business model where the ownership of the equipment is not transferred to the customer. Instead of selling a product, the company charges the user for the service delivered by the asset itself. Customers are provided PSS (Product Service System) as an alternative solutions (Tukker 2015). The third model is Product Life Extension. This business model focuses on creating products that last longer and remain economically useful; hence, its emphasis is on designing products for easy re-use/repair/refurbishment/re-manufacturing and on establishing reverse cycles for their treatment. There are 4 types of product designs used in this business model: Design for Ease of Maintenance and Repair, Design for Upgradability and Adaptability, Design for Standardization and Compatibility, Design for Dis-assembly and Reassembly (Bocken et al. 2016) And the fifth model is Product Residual Value Recovery. This model is talking about exploiting the residual value of a product, through its further treatment (recycling), when this cannot be re-marketed or has reached the end of its life cycle. Being the CE still in its infancy, most companies are currently exploring one single business model – generally considered to be the best fit for the core activities of the firm. This is particularly true for established companies that have been operating in the linear economy for decades and for which the transition to more circular practices will inevitably require greater efforts than a start-up. However, the four CE business models can be leveraged in combination and this seems to be the preferred approach by new business ventures.

Major Barriers to Adopting Circular Economy, In expert's opinion and extensive literature reviews the important barriers to adoption and implementation of CE practices in furniture industry. Those barrier were identified and enlisted in Table 1.

Table 1. Identification of Barriers to adopting CE in Furniture Industry

Variables	Sub-variables	Code	References
Socio-Culture	Urgency of application	A1	(Pheifer 2017)
	Recycle materials demand	A2	(Forrest et al. 2017)
	Second-hand products demand	A3	(Forrest et al. 2017)
	Business orientation	A4	(Tonelli and Cristoni 2018)
Company Regulation	Guidelines for post-use products	B1	(Mont et al. 2017)
	Internal integration	B2	(Mont et al. 2017)
	Value chain constrains	B3	(Mont et al. 2017)

Table 1. Identification of Barriers to adopting CE in Furniture Industry (cont.)

Variables	Sub-variables	Code	References
Financial	Repair & Recovery cost	C1	(Forrest et al. 2017)
	High investment value	C2	(Mont et al. 2017)
	Financial focus	C3	(Pheifer 2017)
	Labor cost	C4	(Kisling et al. 2013)
Business Models	Sales focus	D1	(Bocken et al. 2016)
	Uncertain re-production volume of residual products	D2	(Linder and Wiliander 2015)
Technical	Technology	E1	(Kok et al. 2013)
	Demonstration project	E2	(Kok et al. 2013)
	Quality of input material	E3	(Pheifer 2017)
	Product design	E4	(Pheifer 2017)

Based on the survey and literature study, we indicate that there are 5 most pressing CE barriers. The first one is Socio-Culture. We found that many company have lack of awareness and willingness to get involved in circular economy (Pheifer 2017), it can be caused by internal and external factors such as the urgency of CE application, recycle material demands, second-hand product demands, and the company's business orientation which is not in accordance with CE principles. The second barrier is Company Regulations. We studied that there are only a few basic policies or guidelines that support the implementation of the circular economy (Mont et al. 2017). The third barrier is Business Model. This aspect become a barrier because the business model run by the company is not in line with the concept of circular economy. Furniture industry has not implemented one or a combination of the four existing CE business models (Tonelli and Cristoni 2018).The fourth barriers is Financial. Of course the Financial aspect can be a barrier because this aspect is a bit “sensitive” since this aspect talks directly about the company's income and expenses which are different from one another. The company cannot be declared economically feasible / capable to implement CE yet because of the high investment risk if those industry want to transition from a linear business model to a circular business model. And the fifth barrier is Technical. There are some technical factors that the company does not have as conditions for implementing the circular business model such as the production technology (Kok et al. 2013), lack of CE demonstration project (Kok et al. 2013), poor quality of input materials (Pheifer 2017), and inappropriate CE product design (Pheifer 2017).

3. Methods

Data obtained from previous research and also from interviews with furniture industry stakeholders related to the production process of the furniture industry, inputs used by the furniture industry, the outputs produced, the application of circular economy, and the barriers faced during the implementation process. The data collection stage was taken from 5 July 2019 to 17 September 2019 by distributing questionnaires to 75 respondents of furniture companies in Central Java, Indonesia. The questionnaire consisted of 5 barriers and 17 sub-barrier listed above. The results of the questionnaire will be processed by Analytical Hierarchy Proves (AHP) (Saaty 1970) and assisted with Expert Choice software. The software will automatically rank the barriers with the highest weight to the lowest, and will also automatically calculate the Consistency Ratio (CR) of each barrier. If the value of $CR \leq 0.1$ then the comparison matrix can be stated consistent (Saaty 1970). The anticipation strategy is made for the barrier with the highest weight. Figure 1 contain the hierarchy of barriers.

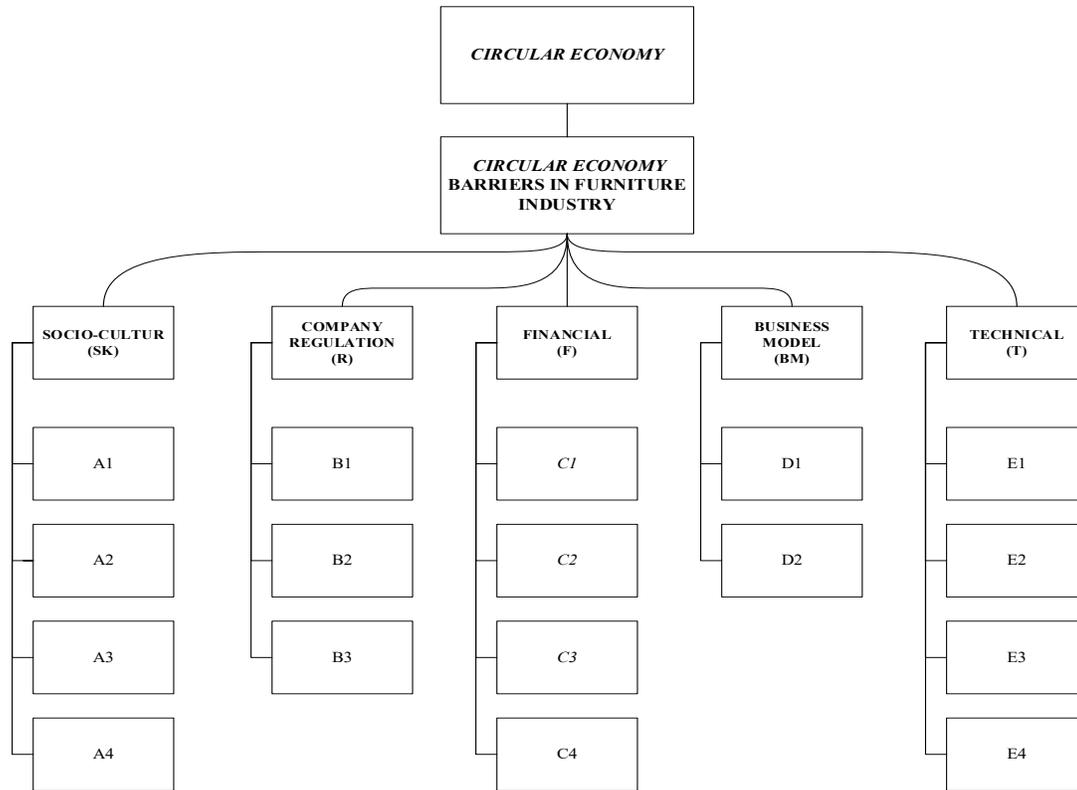


Figure 1. Hierarchy process of the circular economy barriers

4. Result and Discussion

Data processed with the help of the Expert Choice software. The first step is to give weight to each variable based on the calculation of the AHP method. The parameters used to check whether the pairwise comparisons in the assessment questionnaire conducted by management have been done consistently or not, it is necessary to calculate the Consistency ratio (CR). The formulation used is as follows:

$$CR = \frac{CI}{RI} \tag{1}$$

CI = consistency ratio

RI = ratio index

The following table 2 is the result of weighting the barriers using Expert Choice software:

Table 2. Weighting the barriers

Barriers	Weight	Rank	CR
Socio-Culture	0,167	3	0,044
Company Regulations	0,164	4	
Business Model	0,109	5	
Financial	0,355	1	
Technical	0,208	2	

The consistency ratio are ≤ 0.1 which means the comparison matrix can be stated consistent. Table 3 is the result of weighting sub-barriers using the Expert Choice software.

Table 3. Weighting the sub-barriers

Variables	Sub-Variable	Weight	CR
Financial	High investment value	0,328	0,011
	Repair & Recovery cost	0,297	
	Labor cost	0,197	
	Financial focus	0,178	
Technical	Technology	0,321	0,022
	Demonstration project	0,265	
	Quality of input material	0,250	
	Product design	0,156	
Socio-Culture	Second-hand products demand	0,347	0,07
	Recycle material demand	0,345	
	Urgency of application	0,183	
	Business Orientation	0,125	
Company Regulation	Guidelines for post-use products	0,426	0,034
	Value chain constrains	0,330	
	Internal integration	0,244	
Business Models	Sales Focus	0,695	0,0000001
	Uncertain re-production volume of residual products	0,305	

All of sub-barrier's consistency ratio are ≤ 0.1 which means the comparison matrix can be stated consistent. The majority of respondents agreed with Financial variable as the most important barrier because this barrier affect the readiness and desire of the company in an internal culture to switch from linear economy to circular economy. This aspect is also affects the company's technical readiness for the transition. Furniture industry prioritizes the Financial aspect because in the CE concepts, the company's financial readiness needs to be prepared at the earliest considering that revenue points can only be reached after months or years. Financial barrier are a little difficult to overcome if the furniture company wants to implement a circular economy because of the high investment risk. To create a financial system that supports a CE transition, changes are needed both from company and from external investors. The company must present their business model clearly and explain how the stages carried out will provide benefit in the future (Kraneeen, 2016).

We try to validate the results to one of the respondents namely CV Mugiharjo. This company believes that financial barriers are the barriers that most influence the implementation of CE. Following is the company's perception of CE barriers. Table 4 is the company's perception of CE barriers.

Table 4. CV Mugiharjo's perception of CE barriers.

Barriers	Weight	Rank
Socio-Culture	0,127	3
Company Regulations	0,028	5
Business Model	0,061	4
Financial	0,531	1
Technical	0,264	2

Based on interviews with furniture respondents, they agreed that Product Life Extension is a suitable business model to overcome financial barrier and suitable to applied in the furniture industry. This business model is concerned with the extension of the use period of goods through the introduction of service loops to extend product life, including reuse of the product itself, maintenance, repair, and technical upgrading, and a combination of these (Bocken et al. 2016). CV Mugiharjo in Boyolali, Central Java - as one of the respondents - applies the concept of Design for Disassembly and Reassembly. The purpose of this design is to ensure that products and parts can be easily dismantled and re-assembled by simplifying the product structure, minimizing the number of connectors for furniture product

components and using simple but strong connector tools (nuts, bolts, etc. of wood or metal which are small sized), or using materials that are more suitable for the disassembly and reassembly processes - such as ferromagnetic. CV Mugiharjo can save on export costs because this design can overcome the problem of product packaging. The cost of exports has decreased because the more minimal the product were packaged, the more the container will fit. This product packaging also cuts the size of the storage room so that CV Mugiharjo can save on warehouse costs.

All of CV Mugiharjo's products are designed in such a way, with a minimalist size, joints that are easily removable, and with MDF material (medium density fiber-board) which is a recycled material from mahogany wood. The use of MDF material is proof that the company adopting a business model that prioritizes extended product life. The company can also create an innovative product with recycled material (such as MDF), so that it can reduce the use of virgin materials.

5. Conclusion

There are 5 barriers and 17 sub-barriers in circular economy in the furniture industry. Based on the results of AHP, the Financial variable has the highest weight, which is 0.355. Then the Technical variable occupies the second position with an importance weight of 0.208 followed by the Socio- Cultural variable in the third position with a weight of 0.167, Business Model occupies the fourth position with the weight of 0.160, and Company Regulation occupies the fifth position with an weight of 0.109. The anticipation strategies are given for Financial barrier as the highest weight barrier. Financial barrier are a little difficult to overcome if the furniture company wants to implement a circular economy because of the high investment risk. To create a financial system that supports a CE transition, changes are needed both from company and from external investors. The company must present their business model clearly and explain how the stages carried out will provide benefit in the future. Based on interviews with furniture respondents, they agreed that Product Life Extension is a suitable business model to overcome financial barrier and suitable to applied in the furniture industry. Based on an interview with one of the respondents, the purpose of this design is to ensure that products and parts can be easily dismantled and re-assembled. It also make it easier for companies to package the product and trim storage space, because they only need a little space to display product samples in the catalog.

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