Assessing enablers to a circular economy in Indonesian furniture industry using Fuzzy-DEMATEL

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Abstract. The furniture industry is one of the leading sectors and has a positive trend in Indonesia's industrial sector. However, currently, there is a gap between supply and demand for timber and environmental impacts problem. The circular economy model entered as a restorative or regenerative concept to optimize resources and waste minimization. This research is conducted to assess the factors that drive the implementation of circular economy in the Indonesian furniture industry. The Fuzzy-Dematel was used to find the factors that were contributing to the implementation of the circular economy. As a result, the cause group consists of knowledge of circular economy, government support & legislation, consumer awareness, the business principle for the environment, and scarcity of resources. Furthermore, the effect group consists of resources efficiency, economic (financial), technology availability, environmental safety & management, customer-supplier collaboration, corporate image, consumer demand, increased value products, and cost reduction. In addition, some strategies for the government and industry were proposed for circular economy implementation in the Indonesian furniture industry.

1. Introduction
The global market's needs are increasingly integrated through the rapid globalization in recent years. Sustainability has been a vital issue due to the increase of natural resource demand in the future [1]. Indonesia is known as a country that has an abundance of natural resources. Its natural resources advantages have supported the manufacturing sector, especially in the furniture industry [2]. However, the availability of timber becomes a threat to the furniture industry in Indonesia. Illegal logging, deliberate forest fires, conversion to agricultural land have not been resolved. Its deforestation declines the supply of good quality timber. Meanwhile, the furniture industry plays an essential role in supporting the national and global market's needs of furniture products [3]. It causes an imbalance condition between supply and demand for wood as raw materials. From the environmental perspective, wood processing in the industry furniture produces much waste as its impact has to be considered.

The circular economy (CE) model offers a paradigm to preserve environmental functions, prevent pollution and environmental damage. The circular economy model considers many factors in reducing the need for resources, energy, emissions, and waste by using a closed-loop production-consumption cycle. Due to an increased awareness of sustainability, 6R approaches are used in the circular economy model, including reduce, reuse, recycle, recover, redesign and remanufacture [4]. The practice of implementing the CE can be carried out at three-layer levels includes the micro-level, meso-level, and macro-level [5].
Central Java is one of the provinces in Indonesia which has a significant role as the centre of the national wood furniture industry. So, the CE transition of the Central Java furniture industry is considered. Furniture production in Central Java has been known due to its quality, art, and competitive prices. However, the linear economy model with the take-make-dispose principle still dominates the business process. This principle explains that resources are taken and transformed into use-value products and then disposed of as waste. This model certainly does not emphasize sustainability as long as limited resources are continuously taken without considering the conservation. It will continue to cause environmental damage [6].

The driver factors in implementing CE have been investigated by some researchers [4,5]. However, to the best of our knowledge, no researchers are exploring the furniture industry sector. Besides, the furniture industries have a role in environmental damage. So, the investigation of driver factors in implementing CE is essential to achieve sustainability in the furniture sector. This study aims to assess the factors that drive the implementation of circular economy in the Indonesian furniture industry and recommend the strategy for implementing CE. In this paper, the fuzzy DEMATEL method is used to build structural relationships among the drivers of CE implementation. Systematically, it will identify the relationships of driver factors that affect the implementation of CE in the Central Java furniture industry. Fuzzy DEMATEL has advantages over DEMATEL to minimize the expert's judgment's bias, ambiguity, and uncertainty [7].

2. Methodology

2.1. Research design

2.1.1. Cut-Off Point. The variables obtained in problem-solving are not always limited. Variables that can be used as fixed variables in solving a problem can be determined by the degree of need by using the Cut Off Point (COP) method [8]. According to the respondents, the cut-off point method assesses the level of importance of variables based on the weight of the importance of these variables. This total weight is then calculated for the overall average of each variable so the specific value can be obtained. The assessment of the level of importance in the questionnaire was divided into five, namely very important given a weight of 5, essential being given a weight of 4, neutral being given a weight of 3, not important being given a weight of 2, and very unimportant given a weight of 1. All variables that are weighted based on the questionnaire are sorted from the highest value to the lowest value, then the COP value is determined with the following formula:

\[
\text{Natural Cut-Off Point} = \frac{\max(\bar{x}_k) + \min(\bar{x}_k)}{2}
\]

Where: \( k = \) number of variables; \( \bar{x}_k = \) mean of variable

2.1.2. Fuzzy DEMATEL. The DEMATEL technique relies on graph theory that can be used as a visualization method. DEMATEL is capable of revealing the relationship between factors that influence other factors and capable of uncovering the structure of complex causal relationships.

However, DEMATEL has several limitations. The DEMATEL is not able to handle the bias and uncertainty of human judgments in the data. In many real-life situations, the judgment of the decision-maker is usually accompanied by ambiguity. The fuzzy concept is suggested to be integrated with the DEMATEL technique to handle its limitations. Recent literature shows that the fuzzy DEMATEL technique is used in various studies to analyze various decision-making problems [9].

Fuzzy set theory can be used to represent fuzzy, probabilistic, and imprecise information. The effectiveness of using fuzzy set theory is shown and suggested in the decision-making process when information is inadequate or incomplete [10]. Fuzzy numbers represent appropriate linguistic variables as the most common fuzzy numbers. Triangular Fuzzy Numbers (TFNs) are applicable to capture uncertain information. It is often used in research because of the ease of calculation. Each TFN was expressed as a triplet (e, f, g) to describe a fuzzy event. The parameters e, f, and g determine the smallest
possible, the most promising, and the most significant values, respectively [7]. The approach of the presented methods comprises eight steps:

Step 1: Form expert panel to assess the criteria
The first step is to form a panel consists of experts which have related knowledge.

Step 2: Constructing the direct initial matrix (A)
The identified drivers are assessed by experts using a scale from 0 to 4 (0 = no influence; 1 = very low influence; 2 = low influence; 3 = high influence; 4 = very influence). Triangular Fuzzy Numbers (TFNs) were used to capture fuzziness in the judgments. Table 3. shows the fuzzy linguistic scale used in this research. Suppose \( \alpha = \frac{1}{K} \sum_{k=1}^{K} x_{ij}^k \) (2.2)
The defuzzification process is required to change the fuzzy numbers into crisp numbers. Using the weighted average method, Eq 2.3 is used to defuzzify the fuzzy direct relation matrix.

\[ I_1 = \frac{1}{K} (e+4f+g) \] (2.3)

Step 3: Determining the normalized initial matrix (D)
This matrix can be formed by the following equation.

\[ D = m \times A \] (2.4)

Step 4: Obtaining the total relation matrix (T)
The total relation matrix (T) can be obtained by Eq 2.6.

\[ T = D(I-D)^{-1} \] (2.6)

Step 5: Determining the sum of rows (R) and columns (S)
The total sum of rows (R) shows the overall effects produced by driver \((i)\) on driver \((j)\). The total sum of columns (C) shows the overall effects received by driver \((i)\) on driver \((j)\). The sum of rows and columns is calculated by the following equation.

\[ R = \left[ \sum_{j=1}^{n} t_{ij} \right]_{n \times 1} \] (2.7)

\[ C = \left[ \sum_{i=1}^{n} t_{ij} \right]_{1 \times n} \] (2.8)

Step 6: Calculating the threshold value (\(\alpha\))
The threshold value is obtained by calculating the average of each element in the total relation matrix (T) in order to eliminate the drivers that are not significant [11]. The threshold value (\(\alpha\)) is obtained using the following equation.

\[ \alpha = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} T_{ij}}{n^2} \] (2.9)

Where \(n\) represents the total number of elements in matrix T

Step 7: Conducting the cause-effect diagram
The cause-effect diagram is figured by mapping the data set of \((R+C)\) and \((R-C)\). \((R+C)\) Alternatively, prominence is the horizontal axis which represents total effects in terms of influenced and influential power. \((R-C)\) Alternatively, a relation is a vertical axis that represents the cause-effect relationship between the drivers. The drivers will be grouped into the cause group if \((R-C)\) has a positive value. If \((R-C)\) has a negative value, the drivers will be grouped into the effect group [12].

Step 8: Drawing the causal relation map
The causal relation map is drawn to get the interrelationship among the drivers. If the value of drivers in T matrix is lower than \(\alpha\), the drivers are eliminated from the causal relation map [11].
2.2. Methodology

This research is conducted using the quadruple helix model as the respondents of this study, consisting of 10 experts representing academia, government, industry, and community [13]. The selected objects are located in Semarang, Central Java.

This study used two types of questionnaires in data collection. The first questionnaire contains the validation of the driving factors. In the first step, a draft list of drivers in implementing CE is conducted through the literature review. Then, the listed draft is validated to determine the relevant factors that influence the implementation of CE in the Central Java furniture industry. The validation process is carried out using the cut-off point method. In assessing each factor, respondents use a 5-point Likert scale (1 = very unimportant, 2 = not important, 3 = neutral, 4 = important, 5 = very important). The next step is to calculate the natural cut-off point value. Factors that have a value below the natural cut-off point will be eliminated. The validation process results in a total of 14 drivers that are important and relevant to the condition. These identified 14 drivers then are used in the next following step. The final list is provided in Table 1.

| Drivers | Code | Definition | References |
|---------|------|------------|------------|
| Government Support & Legislation | GSL | Policies set by the government to implement cleaner production, waste management as well as providing incentives. | [4] |
| Economic Resources Efficiency | EF | The CE model can increase revenue in the long term. | [4] |
| Business principle for The Environment Increase of Corporate Image | RE | The CE model can increase the efficiency of energy and material use in the manufacture of products. | [4] & [14] |
| Increase of Value Products Cost Reduction Knowledge about CE | BP | Management commitment and long-term plan to prioritize sustainable principles. | [14] |
| Customer-Supplier Collaboration Consumer Demand Technology Availability | CI | The adoption of CE model has a potential to strengthen the brand and image in the market. | [15] & [16] |
| | VP | The CE model is able to encourage the development of products that have durability and a longer life cycle. | [4] |
| | CR | Reduced manufacturing costs due to the use of recycled materials. | [6] |
| | KCE | Knowledge has a potential to drive CE adoption. | [15] & [17] |
| | CSC | Collaboration and cooperation among supply chain partners are crucial in realizing CE. | [14] & [15] |
| | CD | The increasing of consumer needs and desires for circular products. | [15] & [17] |
| | TA | The availability of technology that can support to carry out CE initiatives. | [14] & [18] |
| | ESM | The CE model reduces the environmental impact to protect the environment. | [19] |
| | CA | Consumer are getting knowledge about environmental impacts | [4] |
| | SOR | The availability of natural resources is limited so that its use needs to be maintained. | [6] |

The second questionnaire is proposed to assess the relationship between the driving factors which will be processed using the Fuzzy DEMATEL method. Respondents were asked to give a pair-wise
assessment using a linguistic scale that has a correspondence value with TFN (Triangular Fuzzy Numbers). Table 2. shows the fuzzy linguistic scale used in this research.

### Table 2. Fuzzy linguistic scale.

| Preference in terms of score | Description of linguistic variable | Equivalent TFNs  |
|-----------------------------|------------------------------------|------------------|
| 0                           | No Influence (No)                  | (0.0,0,0.25)     |
| 1                           | Very low influence (VL)            | (0.0,0.25,0.5)   |
| 2                           | Low influence (L)                  | (0.25,0.5,0.75)  |
| 3                           | High influence (H)                 | (0.5,0.75,1.0)   |
| 4                           | Very high influence (VH)           | (0.75,1.0,1.0)   |

3. Result and discussion

3.1. Result

This section represents fuzzy DEMATEL results. The relationship among drivers is discovered using the Fuzzy DEMATEL method which a total of ten fuzzy matrices were developed from the linguistic assessment process. Each of the ten matrices was transformed into a crisp number by the defuzzification process. Then, the average direct initial relation matrix was obtained. The average direct initial relation matrix (A) is shown in Table 3. The normalized initial matrix (D) was developed using the formula (3), and the results were used to obtain the total relation matrix (T). Respectively, the normalized matrix (D) and the total relation matrix (T) are presented in Table 4 and Table 5. In order to develop the causal diagram, the datasets of (R+C) and (R-C) were developed by the sum of rows (R) and the sum of columns (C). The following results of the prominence and relation are shown in Table 6.

### Table 3. The average direct initial relation matrix.

|               | GSL  | EF   | RE   | BP   | CI   | VP   | CR   | KCE  | CSC  | CD   | TA   | ESM  | CA   | SOR  |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| **GSL**       | 0.042| 0.750| 0.850| 0.500| 0.683| 0.600| 0.958| 0.750| 0.725| 0.642| 0.750| 0.958| 0.550| 0.750|
| **EF**        | 0.708| 0.042| 0.458| 0.625| 0.763| 0.475| 0.475| 0.792| 0.500| 0.571| 0.938| 0.450| 0.650| 0.550|
| **RE**        | 0.675| 0.833| 0.042| 0.600| 0.750| 0.525| 0.958| 0.400| 0.625| 0.525| 0.500| 0.600| 0.550| 0.500|
| **BP**        | 0.750| 0.600| 0.692| 0.042| 0.813| 0.771| 0.546| 0.479| 0.750| 0.600| 0.675| 0.833| 0.500| 0.750|
| **CI**        | 0.375| 0.917| 0.700| 0.450| 0.042| 0.763| 0.750| 0.425| 0.675| 0.896| 0.500| 0.500| 0.625| 0.042|
| **VP**        | 0.500| 0.763| 0.600| 0.725| 0.938| 0.042| 0.450| 0.550| 0.800| 0.854| 0.500| 0.596| 0.525| 0.579|
| **CR**        | 0.579| 0.938| 0.738| 0.450| 0.750| 0.425| 0.042| 0.646| 0.600| 0.808| 0.725| 0.358| 0.625| 0.650|
| **KCE**       | 0.833| 0.625| 0.713| 0.792| 0.717| 0.738| 0.592| 0.042| 0.650| 0.350| 0.813| 0.875| 0.567| 0.875|
| **CSC**       | 0.529| 0.575| 0.475| 0.500| 0.792| 0.750| 0.825| 0.650| 0.042| 0.404| 0.700| 0.750| 0.500| 0.833|
| **CD**        | 0.625| 0.938| 0.458| 0.688| 0.600| 0.725| 0.250| 0.675| 0.625| 0.042| 0.533| 0.525| 0.896| 0.650|
| **TA**        | 0.450| 0.500| 0.750| 0.750| 0.167| 0.896| 0.713| 0.525| 0.575| 0.692| 0.042| 0.500| 0.413| 0.550|
| **ESM**       | 0.600| 0.300| 0.788| 0.725| 0.788| 0.688| 0.554| 0.750| 0.650| 0.600| 0.596| 0.042| 0.500| 0.617|
| **CA**        | 0.650| 0.550| 0.700| 0.692| 0.042| 0.338| 0.642| 0.750| 0.650| 0.958| 0.475| 0.896| 0.042| 0.600|
| **SOR**       | 0.854| 0.379| 0.913| 0.875| 0.042| 0.867| 0.642| 0.250| 0.825| 0.571| 0.242| 0.833| 0.600| 0.042|

### Table 4. The normalized matrix.

|               | GSL  | EF   | RE   | BP   | CI   | VP   | CR   | KCE  | CSC  | CD   | TA   | ESM  | CA   | SOR  |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| **GSL**       | 0.004| 0.079| 0.089| 0.053| 0.072| 0.063| 0.101| 0.079| 0.076| 0.067| 0.079| 0.101| 0.058| 0.079|
| **EF**        | 0.074| 0.004| 0.048| 0.066| 0.080| 0.050| 0.050| 0.083| 0.053| 0.060| 0.099| 0.047| 0.068| 0.058|
| **RE**        | 0.071| 0.088| 0.004| 0.063| 0.079| 0.055| 0.101| 0.042| 0.066| 0.055| 0.053| 0.063| 0.058| 0.053|
| **BP**        | 0.079| 0.063| 0.073| 0.004| 0.085| 0.081| 0.057| 0.050| 0.079| 0.063| 0.071| 0.088| 0.053| 0.079|
### Table 5. The total relation matrix.

|     | GSL   | EF    | RE    | BP    | CI    | VP    | CR    | KCE   | CSC   | CD    | TA    | ESM   | CA    | SOR   |
|-----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| GSL | 0.485 | 0.586 | 0.602 | 0.544 | 0.540 | 0.564 | 0.587 | 0.529 | 0.581 | 0.562 | 0.546 | 0.601 | 0.501 | 0.545 |
| EF  | 0.479 | 0.440 | 0.488 | 0.482 | 0.474 | 0.479 | 0.468 | 0.464 | 0.484 | 0.482 | 0.494 | 0.479 | 0.444 | 0.456 |
| RE  | 0.479 | 0.523 | 0.449 | 0.482 | 0.480 | 0.484 | 0.517 | 0.432 | 0.499 | 0.482 | 0.457 | 0.495 | 0.439 | 0.454 |
| BP  | 0.520 | 0.536 | 0.516 | 0.566 | 0.519 | 0.546 | 0.514 | 0.471 | 0.548 | 0.524 | 0.505 | 0.555 | 0.465 | 0.511 |
| CI  | 0.428 | 0.509 | 0.487 | 0.446 | 0.391 | 0.483 | 0.473 | 0.415 | 0.480 | 0.494 | 0.436 | 0.461 | 0.427 | 0.390 |
| VP  | 0.478 | 0.532 | 0.520 | 0.510 | 0.513 | 0.455 | 0.484 | 0.460 | 0.532 | 0.528 | 0.471 | 0.512 | 0.451 | 0.476 |
| CR  | 0.481 | 0.544 | 0.528 | 0.480 | 0.487 | 0.488 | 0.439 | 0.465 | 0.508 | 0.518 | 0.488 | 0.484 | 0.456 | 0.478 |
| KCE | 0.548 | 0.557 | 0.575 | 0.557 | 0.528 | 0.563 | 0.539 | 0.444 | 0.560 | 0.520 | 0.537 | 0.580 | 0.488 | 0.542 |
| CSC | 0.476 | 0.508 | 0.506 | 0.486 | 0.493 | 0.519 | 0.516 | 0.464 | 0.454 | 0.482 | 0.484 | 0.521 | 0.443 | 0.496 |
| CD  | 0.484 | 0.538 | 0.499 | 0.501 | 0.471 | 0.513 | 0.458 | 0.465 | 0.508 | 0.441 | 0.467 | 0.470 | 0.478 | 0.447 |
| TA  | 0.433 | 0.463 | 0.491 | 0.472 | 0.401 | 0.494 | 0.467 | 0.418 | 0.468 | 0.469 | 0.384 | 0.460 | 0.402 | 0.437 |
| ESM | 0.479 | 0.479 | 0.530 | 0.502 | 0.490 | 0.509 | 0.487 | 0.469 | 0.510 | 0.495 | 0.470 | 0.449 | 0.440 | 0.472 |
| CA  | 0.478 | 0.492 | 0.513 | 0.492 | 0.411 | 0.467 | 0.485 | 0.464 | 0.500 | 0.518 | 0.453 | 0.525 | 0.387 | 0.467 |
| SOR | 0.494 | 0.475 | 0.531 | 0.506 | 0.413 | 0.514 | 0.485 | 0.415 | 0.516 | 0.481 | 0.428 | 0.518 | 0.440 | 0.409 |

### Table 6. Total relation and prominence.

| No | Factor | RI | CI | R+C | R-C | Description |
|----|--------|----|----|-----|-----|-------------|
| 1  | GSL    | 7.773 | 6.742 | 14.515 | 1.031 | Cause       |
| 2  | EF     | 6.612 | 7.180 | 13.792 | -0.568 | Effect      |
| 3  | RE     | 6.670 | 7.268 | 13.938 | -0.598 | Effect      |
| 4  | BP     | 7.227 | 6.923 | 14.150 | 0.304 | Cause       |
| 5  | CI     | 6.321 | 6.608 | 12.929 | -0.287 | Effect      |
| 6  | VP     | 6.922 | 7.078 | 14.000 | -0.156 | Effect      |
| 7  | CR     | 6.844 | 6.919 | 13.764 | -0.075 | Effect      |
| 8  | KCE    | 7.538 | 6.377 | 13.915 | 1.162 | Cause       |
| 9  | CSC    | 6.848 | 7.148 | 13.995 | -0.300 | Effect      |
| 10 | CD     | 6.799 | 6.995 | 13.794 | -0.196 | Effect      |
| 11 | TA     | 6.259 | 6.621 | 12.881 | -0.362 | Effect      |
| 12 | ESM    | 6.781 | 7.139 | 13.919 | -0.358 | Effect      |
| 13 | CA     | 6.652 | 6.261 | 12.913 | 0.391 | Cause       |
The table below shows the data plot of the R+C and R-C values that have been determined in Table 5.

| No | Factor | RI  | CI  | R+C  | R-C  | Description |
|----|--------|-----|-----|------|------|-------------|
| 14 | SOR    | 6.625 | 6.610 | 13.235 | 0.015 | Cause       |

Figure 1. referred to as a causal diagram which shows the data plot of the R+C and R-C values that have been determined in Table 5.

Causal diagrams are formed by mapping vectors (R+C) and (R-C). The prominence vector (R+C) represents the degree of importance of the driving factors in implementing a circular economy, while the vector relation (R-C) plots the driving factors into cause and effect groups. Furthermore, the causal relation map is formed, which provides an overview of the relationship between one factor and another. The causal relation map is drawn in Figure 2.

Figure 1. Causal diagram of CE implementation.

Figure 2. Causal relation map of CE implementation.

The causal diagram is depicted in Figure 1 further divided into four quadrants to simplify understanding the driving factors of CE implementation [20]. The quadrant is depicted in Figure 3.
Figure 3. Four quadrant causal diagram.

Figure 3 shows that there are three drivers in Quadrant I (Core Factors), two drivers in Quadrant II (Driving Factors), two drivers in Quadrant III (Independent Factors), and seven drivers in the Quadrant IV (Impact Factors). The five most critical drivers must be considered to build design strategies for CE implementation. The drivers in Quadrant I show a high prominence (R+C) value with a high relation (R-C) value. It indicates a significant influence in the entire system and has the highest contribution to CE implementation. The drivers in Quadrant II show a low prominence (R+C) value but a high relation (R-C) value of drivers. The drivers in this Quadrant must be considered after Quadrant I. Quadrant III is represented by drivers with a low prominence (R+C) value and a low relation (R-C) value. It represents a small effect of the drivers in the entire system. Lastly, the drivers grouped into Quadrant IV present a high prominence (R+C) value and a low relation (R-C) value. It represents impacted drivers and cannot be directly improved.

3.2. Discussion

3.2.1. Analysis of cause group factors. The cause group factor is very vital as its direct impacts on the other factors [21]. "Knowledge about circular economy" (KCE) ranked first as the factor that has an influence on other factors with (R-C) and (R+C) scores of 1.162 and 13.915. This factor is essential in implementing the CE model in the furniture industry because having this knowledge will raise the company's awareness of adopting the model [17]. Next, the "Government support & legislation" (GSL) with (R-C) and (R+C) scores of 1.013 and 14.515. Government regulations that are set to support the practice of a CE have an impact on companies and have an impact on the public regarding the importance of implementing a CE [5]. The next factor that is included in the cause group is "Consumer awareness" (CA) with (R-C) and (R+C) scores of 0.391 and 12.913. The high level of consumers who are concerned for the environment and environmentally friendly products can pressure and encourage companies to fulfil consumer desires. Then the "Business principle for the environment" (BP) with (R-C) and (R+C) scores of 0.304 and 14.150. The commitment and long-term plan of the company's top-level management towards the environment will encourage companies to implement CE [17]. Lastly, in the cause group, the "Scarcity of resources" (SOR) has (R-C) and (R+C) scores of 0.015 and 13.235. CE model is known as a solution to the increased demand for natural resources that continue in the future. Industries that are dependent on natural resources will be more motivated to adopt a CE [19].

3.2.2. Analysis of effect group factors. Effect Group is also referred to as the influenced factor or factors that are influenced. The "resource efficiency" (RE) factor is the factor that receives the most significant influence from other factors with (R-C) and (R+C) scores of -0.598 and 13.938. The furniture industry sees that the implementation of the CE can answer the resource efficiency issues regarding the needs of wood as a raw material [4]. Next is "Economic" (EF) with (R-C) and R+C scores of -0.568 and 13.792. The furniture industry has an excellent opportunity to implement the CE model because, in the future, there will be a shifting demand for furniture products into environmentally friendly products. The shifting will increase the company's revenue and reduce the potential risk of costs incurred due to the
produced waste. The next factor, "Technology availability" (TA) with (R-C) and (R+C) scores of -0.362 and 12.881. Technology will assist and support the company's operation through the transition of CE model implementation [14].

The "Environmental safety & management" (ESM) with (R-C) and (R+C) scores of -0.358 and 13.919. Risk control and environmental management aspect need to be considered as environmental impacts affect sustainability [2]. The next factor, "Customer-supplier collaboration" (CSC), with R-C and R+C scores of -0.300 and 13.995. The furniture industry has a close relationship with its partners in meeting the needs of wood, processing, and utilizing waste. The quality of the products produced by the furniture industry is also influenced by the quality of materials or wood materials sent by suppliers. The collaboration in the supply chain can create opportunities in implementing CE.

The "Increase of corporate image" (CI) with (R-C) and (R+C) scores of -0.287 and 12.929. Companies concerned about environmental impacts will have the opportunity to access and compete on the broader market. It is also affected the increased sales of products. As a result, the company will be more competitive [22]. The next factor, "Consumer demand" (CD) with (R-C) and (R+C) scores of -0.196 and 13.794. Consumers' demand will push the company to fulfil the increased demand towards a circular product [17]. The increase of consumer awareness on environmental impacts can affect consumer demand for circular products.

Next, the "Increase of value products" (VP) with (R-C) and (R+C) scores of -0.156 and 14.000. The development of design and production products that are more environmentally friendly can increase consumer satisfaction compared to linear products. It will be implemented by considering the minimization of pollution in the manufacturing process, resource efficiency, and waste management. Lastly, in the effect group, "Cost reduction" (CR) with (R-C) and (R+C) scores of -0.287 and 12.929. The potential for cost savings due to the implementation of the CE model is seen as a driving factor. In this case, a linear model with a take-make-dispose operating principle is considered a constraint due to the cost of materials or products disposed of in landfills [23]. In addition, the higher prices of raw materials can increase production costs, so CE adoption is an opportunity to answer these challenges.

3.2.3. Recommendations. This research helps the government and companies identify the essential drivers related to implementing the CE model. The results also reveal specific suggestions based on the findings. The recommendations are described as follows:

- Government should formulate a new policy, fiscal, and framework of CE. Stricter government regulations will encourage the implementation of the CE model. Landfill policies should be deployed by taking a highly-cost on disposal of production waste. There is a need for greater collaboration at a horizontal level. It should be followed by establishing a collection and retrieval centre for used products and waste to enhance natural resource use efficiency [23]. Many companies have difficulty improving their waste management because of the lack of finances. In order to accelerate the implementation of CE, providing incentives and easy access to credit through restructuring of machinery and equipment will help the company adopt the CE model. The government must establish comprehensive training for the company related to CE implementation.

- Companies must integrate CE issues with their business model. The integration will unlock the opportunities to develop a strategic collaboration with partners along the supply chain due to the increase of transfer knowledge among the companies or related partners such as social institutions. It allows the company to innovate and develop new products using used products or remaining material by integrating CE thinking along with the processes. The company needs to cooperate with its partners to improve economic and environmental performance [14]. The transition of CE requires changes in the behaviour of the consumers. A collaborative model also needs to be developed among the consumers by actively engaging them to provide product feedback. The company should take the initiative to provide information related to environmental impacts from each product. It might educate the consumer while increasing their awareness toward circular products. In order to influence consumer awareness, the different costs of the warranty for circular products should be considered as a strategy to change the customer perspective [24].
4. Conclusion
This study aims to assess the factors that drive the implementation of circular economy in the Indonesian furniture industry by uncovering the interrelationship among the drivers in CE implementation. The results reveal 14 identified drivers that affect the CE implementation in the Central Java furniture industry. The driving factors that have been validated then obtained the factors that are incorporated in the cause and effect group. The cause group consists of five driving factors, i.e. knowledge of circular economy, government support & legislation, consumer awareness, the business principle for the environment, and scarcity of resources. This group is required to be prioritized in order to build design strategies for CE implementation. Meanwhile, the effect group consists of nine driving factors, i.e. resources efficiency, economic (financial), technology availability, environmental safety & management, customer-supplier collaboration, increased corporate image, consumer demand, an increase of value products, and cost reduction.

The research findings were discussed with the experts to have solid strategies. It may help the government and companies accelerate and better understand the problem faced regarding the implementation of CE. This study also has some limitations. Its results may be more relevant in developing countries with similar CE implementation issues in the furniture sector. Further research can be carried out by developing scenarios that will be applied to implement CE into a dynamic system model. The behaviour of the system can be known through modelling and simulation, and the best scenario can be built.

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