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Analysis of Driving Factors for Used Cooking Oil Management in Catering at Yogyakarta City

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Abstract

Based on a preliminary study, it was found that several catering businesses have not managed waste cooking oil properly. Waste cooking oil that is not managed correctly can cause environmental pollution, and if it is still used, it will cause health problems. This study explored the driving factors that motivate catering entrepreneurs to manage used cooking oil using the DEMATEL (Decision Making Trial Evaluation and Laboratory) approach. Fifteen catering businesses in the eastern part of Yogyakarta are the objects of this research. The results showed that public health was the dominant driving factor influencing other driving factors, most often found in the catering businesses studied, although some catering showed different results. Another result of this study is that the availability of facilities is the factor that has the greatest relationship with other factors. Furthermore, the management's commitment and increasing company profit are also factors that can influence other driving factors. Environmental awareness, social awareness, government regulation, and product innovation are independent factors. One of the benefits of the results is that the government can use it in regulating the used cooking oil management by taking into account these driving factors.

Keywords
Driving factors, Used cooking oil, Catering, DEMATEL

1. Introduction
Yogyakarta is one of the big cities in Indonesia, with a population of 441,295 people (Central Bureau of Statistics Yogyakarta City, 2019). Therefore, the city of Yogyakarta is the right place for business actors as a profitable opportunity. One of the business opportunities is in the food and beverage sector. The economic growth of the food and beverage business industry is a sector with a reasonably significant contribution in the city of Yogyakarta, namely 5.81% of gross regional domestic product (Central Bureau of Statistics Yogyakarta City, 2016). Catering is an option for food and beverage businesses

The process of preparing food in catering indeed cannot be separated from the use of cooking oil. The more processed food, the more used cooking oil is produced. Cooking oil that is used repeatedly can harm health and the environment if not managed properly. According to Ardhany & Lamsiyah (2018), used cooking oil can indirectly cause death if consumed continuously because used cooking oil is a trigger for various diseases such as coronary heart disease, stroke, hypertension, and cancer. If used cooking oil is thrown away at the water disposal, it will clog the pipe and damage it (Linarti et al., 2019).

The catering business actor's role in managing the used cooking oil produced is crucial. However, from the initial study results for this research, catering entrepreneurs have not adequately managed used cooking oil. As mentioned in Nugroho's research (2020), the main obstacle for business actors in Yogyakarta is their lack of knowledge in managing used cooking oil.

Cooking oil management that is carried out correctly will reduce the waste of used cooking oil produced and provide financial benefits. Some of the practices of using used cooking oil include being used as raw material for making biodiesel (Darmawan & Susila, 2013) and as an ingredient for making bath soap (Kusumaningtyas et al., 2018).

To motivate food business actors to be willing to manage their cooking oil waste, it is necessary to explore what factors can drive these activities. Determination of the driving factors begins with a literature study on related research, then checks with actual conditions in the catering business.

1.1 Objectives
The objectives of this research are:
1. To determine the behavior of catering business actors in managing used cooking oil.
2. To find the most dominant driving factors in the management of used cooking oil in the catering business.
3. To find out the relationship between the driving factors in the management of used cooking oil in the catering business.

2. Literature Review
This section will discuss the factors that can encourage food business actors to manage used cooking oil. Based on the literature review, there are eight driving factors for the management of used cooking oil, which are considered in this study.

Environmental awareness is the first factor that can encourage the management of used cooking oil. According to Özçelik & Avci Öztürk (2014), the industry is not only profit-oriented but must minimize its adverse effects on the environment and be responsible for health and safety. It is also stated by Saeed & Kersten (2019) that the industry is considered responsible for activities that can affect the environment. Further, César et al. (2017) said that collecting used cooking oil could help the industry campaign for the importance of preventing environmental problems.

Social awareness is the second factor driving the management of used cooking oil. The social awareness factor in question is the increasing awareness of business actors or owners regarding business opportunities that may arise with the management of used cooking oil, which can open up job opportunities. Cantele & Cassia (2020) state that social responsibility in the management process is an opportunity to improve company performance. Alonso-Almeida et al. (2018) said that social practice is positively related to success factors in the market, such as company image, customer satisfaction, and employee satisfaction. Therefore, international/regional regulatory pressures force industries to ensure they meet specific social requirements (Saeed & Kersten, 2019).

The third factor that drives the management of used cooking oil is an external policy in the form of government regulations. It is a factor related to the availability of policies, regulations, and laws related to waste cooking oil management. Saeed & Kersten (2019) stated that regulatory pressure is significant to encourage the industry to take initiatives for sustainable waste management practices. Caniato et al. (2012) mentioned that legislation helps to raise awareness and influence the industry to adopt sustainability practices. Furthermore, according to (Liu et al., 2018), local government policies affect industry participation in collecting waste cooking oil for recycling.

The fourth factor as a driving force for the management of used cooking oil is an internal policy in the form of management commitment. It is related to the company's policy to implement sustainable supply chain management practices, especially in the management of used cooking oil. (Saeed & Kersten, 2019) stated that applying sustainable practices in the industry improves social and environmental performance and can help achieve competitive advantage both within and outside the industry. (Tay et al., 2015) said that commitment from top management influences the industry to push towards sustainable practices. Liu et al. (2018) stated that the industry must employ exceptional staff who handle used cooking oil to support the practice of managing used cooking oil.

Furthermore, product innovation is the fifth factor driving the management of used cooking oil. The factor in question is the opportunity to use used cooking oil in a product worth selling. (Saeed & Kersten, 2019) said that product and process innovation is evidence of the industry's willingness to change and improve sustainability practices. Waste cooking oil can be used in manufacturing products in the biodiesel production industry, as done by César et al. (2017) and (Khan et al., 2019).

The sixth factor that drives the management of used cooking oil is to increase the company's profit. This factor is a profit opportunity obtained from using used cooking oil as a material for another product. Some of the authors, including (Liu et al., 2018), César et al. (2017), and Khan et al. (2019), stated that the use of used cooking oil by converting waste cooking oil into biofuel has the potential to increase profits.

The seventh factor is public health reasons. This reason is related to the consideration of consumer health if the food processing served uses used cooking oil that is used repeatedly. Several authors have stated that public health reasons are one of the drivers in used cooking oil management activities, including Noriko et al., (2012), Liu et al., (2018), and Ardhany & Lamsiyah (2018). Noriko et al. (2012), mention that oil damage caused by repeated use of cooking oil will affect the quality and nutritional value of fried foods. Meanwhile, according to Liu et al. (2018), reprocessing used cooking oil and selling it for reuse will cause damage to human health and food safety problems. Furthermore, Ardhany & Lamsiyah (2018) stated that using cooking oil that is used repeatedly would increase free fatty acids and damage vitamins and essential fatty acids so that it has the potential to produce toxins in the body.

The impact on public health can occur because of the lack of awareness of food business actors on the impacts caused by the repeated use of cooking oil. As Inayati & Dhanti (2021) stated, most used cooking oil users know the impact but choose to use it more than twice.

Meanwhile, the eighth factor considered as a driving force for the management of used cooking oil is the availability of facilities at the company. These factors are the availability of infrastructure, tools, facilities, and space owned by catering companies to manage used cooking oil. Saeed & Kersten (2019) say that renewable technologies and equipment are important factors for implementing sustainability practices and improving operational performance. In addition, according to (Liu et al., 2018), the government could enforce a policy of providing facilities to support the used cooking oil collection system.

3. Method

Decision Making Trial and Evaluation Laboratory (DEMATEL) is a method for designing and analyzing complex problems by creating a structured model of causal relationships between factors and systems (Wu & Lee, 2007). In this study, the DEMATEL method was used to determine the relationship between the driving factors in the management of used cooking oil. Eight driving factors for the management of used cooking oil have been mentioned in the literature review section.

Furthermore, the terms used for naming the driving factors are Environmental awareness (D1), Social awareness (D2), External policy/ Government regulation (D3), Internal policy/ Management commitment (D4), Product innovation (D5), Increasing company profit (D6), Public health (D7), and Availability of facilities (D8).

Based on Safdari Ranjbar et al. (2014) and (Si et al., 2018), the steps of the DEMATEL method are as follows:
1. Determining intensity of the relationship between factors, an assessment of the relationship between factors is carried out to determine the impact and effectiveness of the relationship using a Likert scale of 0 to 4. Where 0 means that the first factor has no effect on the second factor and four means that the first factor is very influential on the second factor.
2. Create a Z matrix, where Zij influences factor i on factor j. At the same time, the main diagonal line of the matrix is set to 0.

$$Z = \begin{bmatrix} 0 & Z_{12} & \dots & Z_{1n} \\ Z_{21} & 0 & \dots & Z_{2n} \\ \vdots & \vdots & 0 & \vdots \\ Z_{n1} & Z_{n2} & \dots & 0 \end{bmatrix} \qquad (1)$$

$$Z_{ij} = \frac{1}{l}\sum_{k=1}^{i} Z_{ij}^k \qquad (2)$$

k = respondent index, with k = 1,2,3, …, l
i, j = factor index, with i, j = 1,2,3, …, n

3. Make normalizing the Z matrix to build the X matrix. The normalization of the Z direct relationship matrix to the X matrix is carried out by equations (3) and (4). The main diagonal matrix remains 0, and the maximum number of each row and column is 1.

$$X = \frac{Z}{S} \qquad (3)$$

$$S = \max\left(\max_{1\le i\le n}\sum_{j=1}^{n} z_{ij}, \max_{1\le j\le n}\sum_{i=1}^{n} z_{ij}\right) \qquad (4)$$

4. Create a Total Impact Matrix (T) with equation (5).

$$T = X(I - X)^{-1} \qquad (5)$$

With I is an identity matrix.

5. Produce the Impact Relation Map (IRM) by calculating the total value in each row (R) and column (C), with equations (6) and (7), and create an IRM that connects all factors.

$$R = \sum_{j=1}^{n} T_{ij} \qquad (6)$$

$$C = \sum_{i=1}^{n} T_{ij} \qquad (7)$$

6. Build a causal effect diagram by making values (R+C) as the horizontal axis and values (R-C) as the vertical axis. Next, place each factor's coordinates (R+C) and (R-C) into the causal effect diagram.

4. Data Collection

Before data collection, it is necessary to validate the driving factors for the management of used cooking oil obtained from the literature review. This validation is intended to determine whether these factors are under the actual conditions in the catering business. Validation was carried out by MR, NY, DC, and TP catering owners. Based on the results of the field validation, it was decided that all the factors considered in this study could be used.

Furthermore, the distribution of questionnaires to catering managers in the Eastern City of Yogyakarta is from August to October 2021. Respondents were people who understood the management of used cooking oil at the catering concerned. Fifteen respondents are owners of 15 caterers who can be explored the management of used cooking oil. The 15 caterers are MR, NY, BD, AC, CC, TP, DC, WB, RC, SC, TC, VC, MC, BW, and BN catering. The location of each catering is shown in Figure 1, which is marked with a brown dot. The demographic data of respondents are presented in Figure 2.
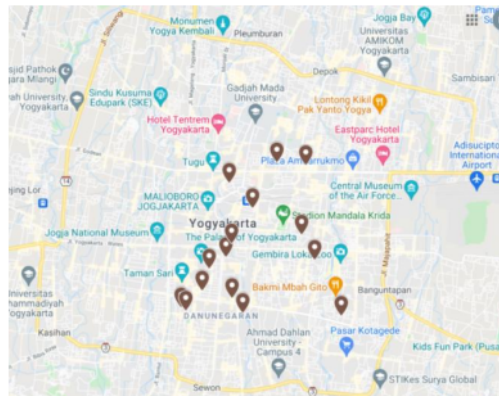

Figure 1. Catering locations as research respondents

A questionnaire based on the DEMATEL method contains a list of questions related to the relationship between the driving factors for the management of used cooking oil. Furthermore, interviews were also conducted with respondents regarding motivation, barriers, knowledge, and application of used cooking oil management in each catering.
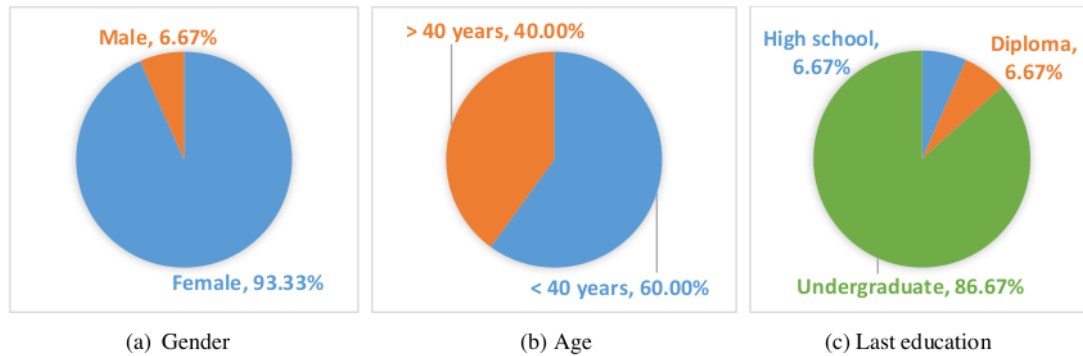
(a) Gender	(b) Age	(c) Last education

Figure 2. Demographic data of respondents

5. Results and Discussion

5.1. Results

The results of interviews about the knowledge, processes, and barriers to managing used cooking oil that has existed for each catering are shown in Table 1. In general, they are pretty knowledgeable about the management of used cooking oil. Most of them deposit their used cooking oil to third parties or collectors, except AC, RC, VC, and BN catering. No catering processed the used cooking oil independently.

Table 1. Interview results for each catering

No	Catering name	Used cooking oil management knowledge	Process of managing used cooking oil	Barriers to the management of used cooking oil
1.	MR	Enough knowledge	Handed over to collectors	Lack of knowledge
2.	NY	Enough knowledge	Handed over to collectors	Lack of time and competent employees
3.	BD	Have no knowledge	Throw away	Don't understand how to manage
4.	AC	Little knowledge	Do not have a cooking oil waste management mechanism	Don't understand how to manage
5.	CC	Enough knowledge	Handed over to collectors	Lack of knowledge
6.	TP	Enough knowledge	Handed over to collectors	Don't understand how to manage
7.	DC	Enough knowledge	Handed over to collectors	Lack of attention from local government, no time, and limited facilities
8.	WB	Enough knowledge	Handed over to collectors	If it is managed independently, it will cost money
9.	RC	Enough knowledge	Do not have a cooking oil waste management mechanism	Lack of encouragement or support from local government
10.	SC	Enough knowledge	Handed over to collectors	Lack of competent employees
11.	TC	Enough knowledge	Handed over to collectors	Lack of serious attention from local government
12.	VC	Little knowledge	Do not have a cooking oil waste management mechanism	There is not enough space, do not understand how to manage, and no time
13.	MC	Enough knowledge	Handed over to collectors	Don't understand how to manage
14.	BW	Enough knowledge	Handed over to collectors	Do not understand how to manage and lack of human resources
15.	BN	Little knowledge	Do not have a cooking oil waste management mechanism.	Lack of knowledge, employees who help the process, supporting facilities

Furthermore, data processing is carried out using the DEMATEL method. Data processing is carried out globally for all catering by treating each catering as one respondent. Thus the value in the Z matrix is the average value of the respondents' answers. After that, the calculations are carried out according to equations (3) to (5). Table 2 shows the total impact matrix (T). The blocked values in Table 2 are greater than the threshold value, where the threshold value is the average value of the values in Table 2. The unblocked values indicate that the two factors are not related. The results of the blocked cells are used as the basis for making IRM, shown in Figure 3.

Next, compose a causal effect diagram based on the values of R and C obtained by equations (6) and (7). The values of R, C, (R+C), and (R-C) are presented in Table 3. To get a causal effect diagram, place the coordinates of values (R+C) and (R-C) of each factor into the Cartesian diagram. The diagram is made with the X-axis (R+C) and the Y-axis (R-C). The causal effect diagram is shown in Figure 4. In summary, the position of each factor in the quadrant is shown in Table 4.

Table 2. Total impact matrix (T)

Factor	D1	D2	D3	D4	D5	D6	D7	D8
D1	0.299	0.387	0.343	0.389	0.368	0.369	0.418	0.356
D2	0.394	0.278	0.331	0.375	0.352	0.341	0.406	0.337
D3	0.363	0.357	0.280	0.391	0.346	0.400	0.374	0.397
D4	0.453	0.433	0.419	0.331	0.396	0.428	0.435	0.427
D5	0.398	0.378	0.344	0.368	0.263	0.346	0.396	0.347
D6	0.405	0.397	0.430	0.425	0.403	0.313	0.434	0.427
D7	0.487	0.471	0.426	0.439	0.411	0.427	0.351	0.415
D8	0.414	0.409	0.444	0.440	0.405	0.433	0.424	0.314
threshold value	0.387							
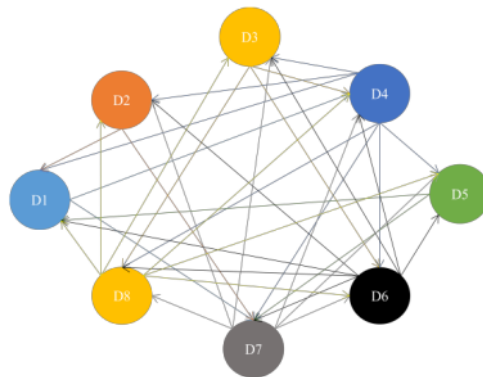
Figure 3. Impact Relation Map (IRM)

Table 3. The value of R, C, (R+C), and (R-C)

Factor	R	C	R+C	R-C
D1	2.930	3.213	6.143	-0.284
D2	2.814	3.111	5.925	-0.296
D3	2.908	3.018	5.926	-0.110
D4	3.322	3.158	6.479	0.164
D5	2.840	2.944	5.783	-0.104
D6	3.234	3.057	6.290	0.177
D7	3.427	3.238	6.665	0.189
D8	3.284	3.020	6.304	0.263
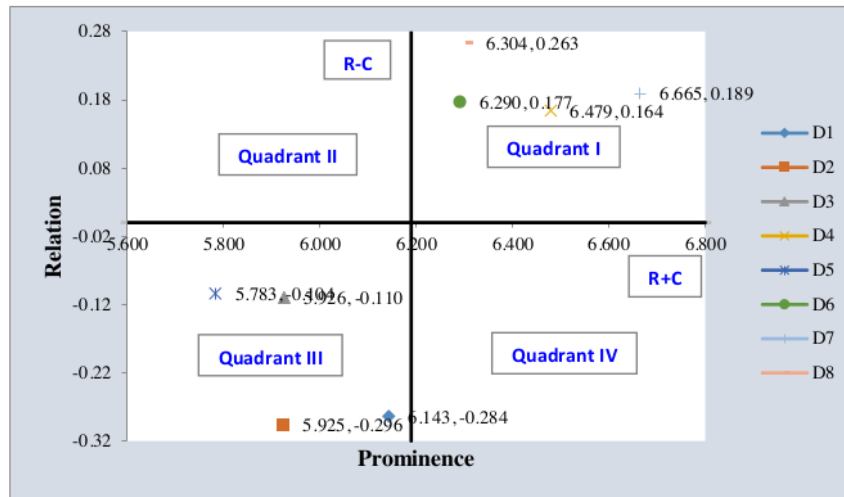
Figure 4. Causal effect diagram

Table 4. The position of factors in each quadrant

Quadrant	Factor
I	D4, D6, D7, D8
II	-
III	D1, D2, D3, D5
IV	-

Meanwhile, suppose analysis using DEMATEL is carried out on each catering treated as each unit of analysis, then the position of each factor in each catering is shown in Table 5.

Table 5. The position of the driving factors in each quadrant for each catering

Quadrant	MR	NY	BD	AC	CC	TP	DC	WB	RC	SC	TC	VC	MC	BW	BN
I	[3] D7 D8	D6 D7	D1 D7 D8	D4 D5 D6 D7 D8	D5 D6 D7	D6 D7 D8	D7	D1 D7	D4 D7	D4 D5	D1 D5 D7	D3 D6	D4 D7	D4 D6	D3
II			[3] D2 D5		D2 D4	D5	D2 D4 D6	[3 2]	D6 D8	D6 D7	D8	D2	D1 D8	D3 D8	D4 D5 D8
III	[3] D1 D2 D3 D4 D5 D6	D1 D2 D3 D4 D5 D8	D3 D4	D1 D2 D3	D1 D3		D1 D3 D5 D8	D3 D6 D8		D3	D2 D3 D6	D1 D4 D7 D8	D2 D5		D6 D7
IV			D6		D8	D1 D2 D3 D4		D4 D5	D1 D2 D3 D5	D1 D3 D8	D4	D5	D3 D6	D1 D2 D5 D7	D1 D2

5.2. Discussion

The results of interviews with catering managers presented in Table 1 show that, in general, the catering managers have sufficient knowledge about the management of used cooking oil, except for BD catering which states that they do not know about managing used cooking oil. Most catering managers have collaborated with third parties in collecting used cooking oil, except for BD catering, which directly disposes of used cooking oil. Likewise, there are four caterers namely: AC, RC, VC, and BN who state that they did not have a cooking oil waste management mechanism. Some catering faced various obstacles that hampered the management of used cooking oil in their business. Catering managers who claim to have sufficient knowledge in managing used cooking oil still experience obstacles in the form of lack of knowledge, time, competent employees, and do not understand how to manage. They felt there were obstacles from outside the company in the form of a lack of serious attention from the local government. Meanwhile, the caterers who stated they had little knowledge about the management of used cooking oil faced the problem of not having facilities and enough space to accommodate used cooking oil. They also felt that they did not understand how to manage.

The study results showing the influence of the driving factors for the management of used cooking oil can be seen in Table 2. From the table, it can be explained that the factors in row (i) are influencing factors and the factors in column (j) are factors that are influenced. Furthermore, it could be explained that the factor with more blocked values means that this factor affects other factors more than other factors influence it. It is because the value that is blocked is a value that is greater than the threshold value, which is the average value of the influencing and influenced factors. In this study, these factors are D4, D6, D7, and D8, namely Internal policy/Management commitment (D4), Increasing company profit (D6), Public health (D7), and Availability of facilities (D8). The sum of the values in the row is called the dispatcher.

On the other hand, the factors D1, D2, D3, and D5, namely Environmental awareness (D1), Social awareness (D2), External policy/Government regulation (D3), and Product innovation (D5), are factors that are more influenced by other factors than influencing other factors. Furthermore, the sum of the values in the column is referred to as the receiver. The relationship between these factors is dispatched in the IRM in Figure 3, where the starting point of the arrow means that the factor affects other factors. In comparison, the arrow's destination point means that other factors influence the factor.

The following result is a causal loop diagram based on the values of R+C and R-C, which is divided into four quadrants. The R+C value of one factor is the sum of the value of that factor in influencing other factors and is influenced by other factors. Thus, the value of R-C is a reduction in the value of these factors in influencing other factors minus the value of these factors being influenced by other factors. The results show that the driving factors for managing used cooking oil in the catering business fall into quadrants I and III, see Figure 4. Factors that fall into the quadrant I mean that they have a high R+C value and a positive R-C. It can be interpreted that these factors have high prominence and high relations. In contrast, the factors that fall into quadrant III have a low R+C value and a negative R-C. It can be interpreted that these factors are factors with low prominence and low relations.

Factors that enter quadrant I are internal policy/ management commitment (D4), increasing company profit (D6), public health (D7), and availability of facilities (D8). Furthermore, it can be interpreted that the factors that enter quadrant I are the dominant core factors influencing other factors, so these factors must be guaranteed to always exist in the catering business. For this reason, the catering manager or owner must commit to managing used cooking oil; these activities can increase profits, consider public health, and provide facilities for managing used cooking oil. Of the four factors in quadrant I, the most prominent factor is public health (D7); simultaneously, the factor that has the greatest relationship with other factors is the availability of facilities factor (D8). Thus, these two factors must be a priority to get the attention of the management). or catering owner.

The factors that enter quadrant III are Environmental awareness (D1), Social awareness (D2), External policy/Government regulation (D3), and Product innovation (D5). Factors that enter quadrant III mean that they are independent factors. These factors do not impact other factors, and their effect on other factors is smaller than other factors that influence them. For this reason, the causal relationship with other attributes can be ignored. Of the four factors in quadrant III, Product innovation (D5) is the least prominent factor. At the same time, the factor with the smallest relationship with other factors is the Social awareness factor (D2). Thus, these two factors must still be present in the management of used cooking oil but do not affect other factors.

Furthermore, when viewed from the results of each catering based on Table 5, it can be seen that each catering has a different position of the driving factor. All catering has a driving factor in quadrant I, while several caterings do not have factors in quadrant II, III, or IV. For this reason, each catering must pay attention to the factors that are in quadrant I, which most of the caterers have, which are Increasing company profit (D6), Public health (D7), and Availability of facilities (D8).

The factors in quadrant II mean that they have a low level of prominence with a high level of relationship. This factor has a value (R+C) smaller than the average threshold value and (R-C) positive. It means that these factors have a greater influence on other factors than are influenced by other factors. However, this influence does not impact other factors because the value (R+C) is less than the threshold value. The factors in quadrant IV mean that they have a high level of prominence with a low level of relationship. This factor has a value (R+C) greater than the threshold value, and (R-C) is negative. It means that other factors than influencing other factors more dominantly influence these factors, but these factors have an impact on other factors.

From the analysis of the DEMATEL method with the application of analysis to all catering and each catering, it can be seen that the Public health factor (D7) is the most dominant driving factor that appears in quadrant I. For that reason, this factor can be said to be a driving factor in the management of used cooking oil in the catering business, which will affect other factors in encouraging used cooking oil management activities. Therefore, the manager or owner of catering must always consider public health when using cooking oil for serving food. These considerations can refer to the dangers that can be caused by the repeated use of used cooking oil, as mentioned in Noriko et al. (2012), Liu et al. (2018), and Ardhany & Lamsiyah (2018).

The results of this study do not cover all catering in the city of Yogyakarta or other areas in the Special Region of Yogyakarta Province. In addition, this research also does not cover all types of food service businesses that have the potential to produce used cooking oil. For this reason, research can be developed for areas and business units that this study has not reached.

6. Conclusions

The behavior of the catering manager or owner is that the used cooking oil produced has not been managed independently but acts as a supplier and cooperates with third parties, namely used cooking oil collectors. Most catering managers or owners have sufficient knowledge about the management of used cooking oil even though they feel some internal and external obstacles in managing used cooking oil. The results showed that the public health factor was the most prominent in the management of used cooking oil in the research area. Meanwhile, the factor that has the greatest relationship with other factors is the availability of facilities. In addition, two other factors, internal policy/ management commitment and increasing company profit affect other driving factors. Meanwhile, environmental awareness, social awareness, external policy/ government regulation, and product innovation are independent factors.

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