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Drivers and Barriers of Used Cooking Oil Management in Catering Businesses: a DEMATEL Study in Yogyakarta, Indonesia

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Abstract

Used cooking oil (UCO) generated by food-service businesses presents environmental, food-safety, and resource-management challenges when it is repeatedly reused or improperly discarded. Effective management requires understanding not only individual factors but also the causal relationships among organizational, environmental, economic, and institutional determinants. This study examined the drivers and barriers influencing UCO management among catering businesses in Yogyakarta, Indonesia. Fifteen catering businesses participated from 25 businesses initially approached. Respondents were owners, managers, or employees directly familiar with operational activities and UCO handling. Eight driving factors and eight barrier factors were identified from the literature and field validation. Pairwise relationships among the factors were assessed using questionnaires and interviews and analyzed using the classical Decision-Making Trial and Evaluation Laboratory (DEMATEL) method. Direct and indirect influence matrices, prominence (D+R), relation (D−R), threshold values, and influence relation maps were used to identify dominant factors. Internal management policy and commitment emerged as the dominant driver in five of the 15 businesses (33.3%), followed by public-health considerations in four (26.7%). Availability of facilities and social awareness were each dominant in two businesses (13.3%), whereas profit and product innovation were each dominant in one (6.7%). The most frequent dominant barrier was insufficient commitment to reverse logistics, identified in six businesses (40.0%), followed by insufficient environmental awareness in five (33.3%). External government policy was dominant in two businesses, while insufficient knowledge and stakeholder socialization were each dominant in one. UCO management in catering businesses is shaped primarily by organizational commitment and reverse-logistics capability, although substantial heterogeneity exists between firms. Interventions should integrate internal environmental policy, staff capability development, reverse-logistics systems, supporting infrastructure, and more explicit external governance.

Keywords: *Catering Businesses, DEMATEL, Reverse Logistics, Sustainable Supply Chain Management, Used Cooking Oil, Waste Management.*

Introduction

Food-service and hospitality activities generate substantial quantities of waste through routine preparation, cooking, and service processes. Although food waste has attracted considerable sustainability attention, waste cooking oil represents a distinct management problem because its handling involves food safety, environmental protection, logistics, and opportunities for resource recovery. Hospitality businesses increasingly face pressure to integrate waste management into broader environmental and operational strategies rather than treating waste solely as an end-of-pipe problem [1]. For catering businesses, this issue is particularly relevant because cooking oil is routinely used in

food production and may generate a continuous stream of residual oil requiring appropriate collection, storage, transportation, reuse, or processing.

Repeated use of cooking oil can reduce its quality, while inadequate handling after use may create environmental and health concerns. Research on food vendors has shown that knowledge regarding appropriate cooking-oil use and quality remains uneven, creating the possibility of inappropriate repeated use [2], [3]. UCO should therefore be regarded not only as an operational residue but also as a material whose management affects food-service quality and environmental performance. When discarded improperly, UCO may enter drainage systems, soil, or aquatic environments. Experiences from waste-oil management systems show that organized collection is therefore an important component of local waste-management infrastructure [4].

At the same time, UCO has potential economic value when incorporated into resource-recovery systems. It can serve as a feedstock for biodiesel, offering an alternative pathway to disposal and potentially contributing to renewable-energy production [5]. UCO and related waste vegetable oils have also been investigated for other material applications, including incorporation into bituminous products [6]. At smaller scales, collected waste cooking oil can be processed into products such as soap or aromatherapy candles. These alternatives demonstrate that UCO can potentially be repositioned from an undesirable waste stream into a recoverable resource, provided that appropriate organizational and logistical systems exist.

However, technical possibilities alone do not guarantee sustainable UCO management. The behavior of food-service firms depends on multiple interacting organizational, economic, regulatory, social, and environmental conditions. Studies of sustainable supply-chain management identify internal managerial commitment, external pressure, environmental awareness, resources, organizational capabilities, and stakeholder involvement as important determinants of sustainability implementation [7], [8]. Restaurant-level sustainability also depends on the ability of organizations to convert environmental objectives into operational practices and competitive outcomes [9]. Consequently, improving UCO management requires identifying not only which factors are important but also which factors function as underlying causes capable of influencing other determinants.

This distinction is particularly important for UCO supply chains. Restaurant awareness and willingness to submit waste cooking oil to formal recovery systems are affected by the institutional and operational environment surrounding the businesses [10]. The effectiveness of UCO management therefore depends on interactions between individual businesses, collectors, government agencies, processors, and other stakeholders. Policy interventions may fail when they address only visible outcomes while neglecting upstream causal factors such as managerial commitment, inadequate reverse logistics, weak environmental awareness, or insufficient infrastructure. Similar patterns have been observed in broader food-waste systems, where barriers and drivers are interdependent rather than isolated [11].

Methods capable of examining causal interrelationships are therefore useful for prioritizing UCO management interventions. The Decision-Making Trial and Evaluation Laboratory (DEMATEL) method converts expert assessments of pairwise influence into structured causal relationships. It

distinguishes factors according to their overall prominence and whether they predominantly influence or are influenced by other factors. DEMATEL has been applied in managerial and supply-chain decision contexts because it enables complex systems to be represented through causal diagrams rather than simple independent rankings [12], [13].

Evidence on such causal relationships remains limited for small and medium food-service businesses in Indonesian urban settings. Yogyakarta provides a relevant context because its catering sector includes businesses of different operational scales, while UCO handling involves simultaneous environmental, health, organizational, and institutional considerations. The present study therefore aimed to identify the dominant drivers and barriers influencing UCO management among catering businesses in Yogyakarta and to examine the causal relationships among these factors using classical DEMATEL. By distinguishing high-leverage causal factors from factors that are predominantly outcomes of the system, the study seeks to provide a more actionable basis for business-level management and public-policy intervention.

Methods

A. Study Design and Setting

This study employed a cross-sectional decision-analysis design using the classical DEMATEL method. The research was conducted among catering businesses located in Yogyakarta City, Indonesia, covering businesses in Danurejan, Gedongtengen, Gondokusuman, Jetis, Ngampilan, Tegalrejo, and Wirobrajan. Catering businesses of small, medium, and large operational scales were eligible for inclusion. Respondents were owners, managers, or personnel responsible for or knowledgeable about UCO handling and daily catering operations. Potential catering businesses were identified using Google Maps and snowball sampling. Twenty-five businesses were approached and 15 agreed to participate, resulting in a participation yield of 60%. Data collection took place through direct visits during 2022. The relatively limited number of participating businesses reflected field-access constraints during the COVID-19 pandemic. The unit of analysis was the catering business, with one knowledgeable respondent representing each business. The research combined field observations, literature review, questionnaires, and interviews. Literature-derived factors were discussed and confirmed against actual catering conditions before inclusion in the DEMATEL instrument. This approach was intended to ensure that the evaluated determinants were relevant to the operational context of UCO management in Yogyakarta.

B. Factors, Instrument, and Data Collection

Two sets of determinants were examined: eight driving factors and eight barriers. The drivers comprised environmental awareness, social awareness, increased company profit, internal policy/management commitment, external government policy, product innovation, public-health considerations, and availability of company facilities. The barriers comprised insufficient environmental awareness, inadequate external government policy, insufficient knowledge, cost, insufficient commitment to reverse logistics, insufficient management commitment, unavailable infrastructure, and insufficient stakeholder socialization. A DEMATEL questionnaire was developed to evaluate the

influence of each factor on every other factor within the same group. Respondents assessed pairwise relationships, producing separate evaluations for driving and barrier structures. Interviews were also conducted with the participating catering representatives to obtain contextual information regarding existing UCO practices. The pairwise assessments used an influence scale represented in the source data from 0 to 4, where higher scores indicated stronger perceived influence. The resulting judgments were compiled across the participating catering businesses and subsequently processed separately for each business, allowing the causal structure of UCO management to vary across organizational contexts.

C. DEMATEL Analysis

Data were processed using classical DEMATEL with Microsoft Excel. Analysis began by compiling questionnaire responses and constructing a direct-relation matrix for each catering business. The matrices were normalized and transformed into total-relation matrices incorporating both direct and indirect effects. For each factor, D represented the sum of its outgoing influences, while R represented the sum of incoming influences. Two indices were then derived. D+R, or prominence, represented the overall importance and connectedness of a factor within the system. D−R, or relation, indicated its causal role. Positive D−R values represented factors that were predominantly causal or influential, whereas negative values indicated factors that were predominantly affected by other factors. A threshold value was calculated from the average of all elements in the total-influence matrix. Relationships below this threshold were omitted from the Influence Relation Map (IRM), allowing attention to focus on substantively stronger relationships. The resulting IRMs and D+R/D−R coordinates were used to categorize factors and determine the most influential driver and barrier for each participating catering business.

Results

A. Participant Characteristics

Fifteen catering businesses participated. Respondents ranged from 26 to 56 years of age, with a mean age of 33 years. Eight respondents were women and seven were men. Twelve held bachelor's degrees, two had vocational high-school education, and one had senior high-school education. Nine respondents were business owners, three worked in food-and-beverage functions, and three occupied other operational positions related to equipment, warehousing, cooking, or management. The characteristics of the respondents are presented in Table 1.

Table 1. Characteristics of participating catering representatives

Characteristic	n	%
Participating catering businesses	15	100
Female respondents	8	53.3
Male respondents	7	46.7
Bachelor's degree	12	80.0
Vocational high school	2	13.3
Senior high school	1	6.7
Owner	9	60.0
Food and beverage function	3	20.0
Other operational roles	3	20.0

Mean respondent age = 33 years; range = 26–56 years.

B. Dominant Drivers and Barriers by Catering Business

DEMATEL demonstrated considerable heterogeneity among catering businesses. No single driver or barrier occupied the dominant position across all organizations. Nevertheless, clear recurring patterns were evident. The dominant drivers and barriers in the catering business are presented in Table 2.

Table 2. Dominant driver and barrier identified for each catering business

Catering code	Dominant driver	Dominant barrier
PC	Internal policy/management commitment	External government policy
CIS	Social awareness	Insufficient environmental awareness
CC	Increased company profit	Insufficient environmental awareness
CBR	Public-health considerations	Insufficient environmental awareness
NC	Social awareness	Insufficient environmental awareness
SK	Availability of company facilities	Insufficient commitment to reverse logistics
MCJ	Public-health considerations	Insufficient knowledge
AC	Public-health considerations	Insufficient environmental awareness
PIC	Internal policy/management commitment	External government policy
CJ	Product innovation	Insufficient commitment to reverse logistics
MC	Internal policy/management commitment	Insufficient commitment to reverse logistics
HC	Internal policy/management commitment	Insufficient commitment to reverse logistics
ACJ	Internal policy/management commitment	Insufficient commitment to reverse logistics
DMC	Availability of company facilities	Insufficient stakeholder socialization
CDN	Public-health considerations	Insufficient commitment to reverse logistics

The original analysis identified internal policy and management commitment as dominant for PC, PIC, MC, HC, and ACJ, while public-health considerations were dominant for CBR, MCJ, AC, and CDN. The dominant-barrier analysis showed that insufficient commitment to reverse logistics occurred most frequently, particularly among SK, CJ, MC, HC, ACJ, and CDN.

C. Aggregate Pattern of Dominant Factors

In order to provide a comprehensive understanding of the dynamics within catering businesses, this study identifies both the dominant drivers and barriers that influence operational sustainability. By examining these factors, the analysis highlights the critical elements that shape decision-making processes and strategic development in the catering sector. Table 3 summarizes the frequency distribution of dominant drivers and barriers identified across 15 catering businesses.

Table 3. Frequency of dominant drivers and barriers across 15 catering businesses

Dominant factor	Businesses, n	%
Drivers		
Internal policy/management commitment	5	33.3
Public-health considerations	4	26.7
Availability of company facilities	2	13.3
Social awareness	2	13.3
Increased company profit	1	6.7
Product innovation	1	6.7
Environmental awareness	0	0.0
External government policy	0	0.0
Barriers		
Insufficient commitment to reverse logistics	6	40.0
Insufficient environmental awareness	5	33.3
Inadequate external government policy	2	13.3

Dominant factor	Businesses, n	%
Insufficient knowledge	1	6.7
Insufficient stakeholder socialization	1	6.7
Cost	0	0.0
Insufficient management commitment	0	0.0
Unavailable infrastructure	0	0.0

Overall, organizational commitment was the most recurrent positive leverage point, whereas failure to operationalize reverse logistics was the most recurrent barrier. The findings also indicate that financial cost was not the primary barrier in any participating business, suggesting that organizational and institutional constraints were more salient than direct expenditure alone.

Discussion

The principal finding is that the management of used cooking oil among catering businesses is strongly shaped by organizational commitment, but the relative importance of specific determinants varies substantially between firms. Internal policy and management commitment was the dominant driver in one-third of participating businesses. This finding is consistent with sustainable supply-chain research showing that environmental practices require managerial commitment, internal policies, and organizational capabilities before they can become routine operational activities [7]. Similar arguments have been advanced for sustainable practices in restaurants, where organizational commitment can transform environmental initiatives into operational and competitive outcomes [9]. Reviews of sustainable supply-chain implementation also identify internal support as a central driver of implementation [8], while insufficient organizational commitment is frequently described as an important barrier to sustainable supply-chain management [14].

Public-health considerations constituted the second most frequent dominant driver. This result is important because UCO management in catering businesses occurs at the intersection of environmental management and food safety. Awareness of the consequences of repeatedly using or improperly handling cooking oil can motivate businesses to establish clearer disposal and recovery practices. Previous research among restaurants has demonstrated that awareness affects willingness to participate in organized UCO recovery systems [10]. Studies of food vendors similarly emphasize knowledge of cooking-oil quality and appropriate use [2,3]. Environmental and social awareness may consequently operate as complementary mechanisms: health concerns provide an immediate customer-oriented motivation, while environmental concern extends responsibility beyond food production itself. Such behavioral drivers are consistent with broader research on food-waste reduction [11] and waste-related environmental behavior [15].

The most important barrier across the businesses was insufficient commitment to reverse logistics. Six of the 15 businesses identified this as their leading barrier, indicating that willingness to handle waste is insufficient without an operational mechanism for moving UCO from the point of generation to collectors, processors, or other recovery channels. UCO supply-chain studies have similarly emphasized the importance of stakeholder coordination and collection arrangements [16]. In catering networks, incentives and structured collection relationships may affect willingness to supply waste oil to recovery companies [17]. Government intervention can also influence whether UCO is

successfully incorporated into energy and resource-recovery systems [18]. Policy design that aligns stakeholders and supply-chain incentives can improve both efficiency and sustainability [19], while evidence from organized collection systems demonstrates the importance of institutional continuity and accessible collection arrangements [4].

Availability of facilities and product innovation were dominant drivers in a smaller number of businesses, but they remain strategically relevant. Facilities determine whether UCO can be separated, stored, and transferred safely, while innovation can create an economic rationale for collection. UCO has established potential as a feedstock for biodiesel production [5], although biodiesel supply chains themselves encounter structural barriers requiring coordinated solutions [20]. At community level, UCO can be transformed into value-added products such as aromatherapy candles [21], and local Indonesian initiatives have demonstrated community-based waste-oil management possibilities [22]. Other applications, including incorporation of waste vegetable oil into construction materials, further illustrate its resource potential [6].

The findings therefore imply that interventions should not focus on a single universal obstacle. Catering businesses require an integrated strategy combining managerial policy, environmental and food-safety education, storage facilities, reverse-logistics partnerships, and government coordination. This aligns with the broader view that sustainability performance in hospitality emerges through interacting organizational and external drivers rather than isolated actions [9], [23]. Practical programs should first target high-leverage causal factors identified through DEMATEL and then adapt implementation to individual business conditions. Nevertheless, the study included only 15 catering businesses selected through snowball sampling in one Indonesian city. The findings should therefore be interpreted as a structured assessment of causal perceptions rather than population-level estimates. Future studies should involve larger samples, additional food-service sectors, and empirical measurement of UCO quantities, collection performance, and environmental outcomes.

Conclusion

Used cooking oil management among catering businesses in Yogyakarta is governed by an interdependent set of organizational, environmental, social, economic, and institutional factors. DEMATEL analysis showed that the dominant determinants differed between businesses, indicating that UCO-management interventions should be context-sensitive rather than standardized across firms. Internal policy and management commitment was the most frequently identified driver, followed by public-health considerations. In contrast, insufficient commitment to reverse logistics was the most common dominant barrier, followed by insufficient environmental awareness. These findings indicate that the principal challenge is not simply the cost of UCO management, but the ability of catering businesses to establish organizational commitment and connect internal waste-handling practices with external collection and recovery systems. Catering businesses should institutionalize UCO-management procedures, assign operational responsibility, educate employees, provide appropriate storage facilities, and develop partnerships with collectors or processors. Government and other stakeholders should complement these measures through clearer regulation, infrastructure, education, and coordinated

reverse-logistics networks. Strengthening these components could facilitate the transition of UCO from an unmanaged waste stream into a recoverable resource with environmental, health, and economic value.

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