Analysing the barriers of reverse logistics implementation: A case study

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Abstract. An increase in both consumers’ environmental awareness and government regulation related to the environment encourages industries to be more responsible for their products after consumption. As a result, a relatively new concept in logistics called reverse logistics (RL) is introduced. While the forward (or traditional) logistics refers to the process of distributing products from companies (or producers) to consumers, RL refers to the process of moving products from consumers to producers. This practice has attracted not only scholars but also practitioners in the field of supply chain and sustainability. A company could gain benefits from the implementation of RL since it can lead to higher profit. However, some barriers regard its implementation despite the benefits that make the company reluctant to implement it. Therefore, this study aims to investigate the barriers to implementing RL in a bottled drinking water company. Moreover, this study also analyses the interaction among the barriers to looking for the possible “root barrier”. The interpretative structural modelling and MICMAC analysis were used to accomplish the objective of the study. It is expected that the study could help the management to better formulate policies about the implementation of RL.

1. Introduction
The concept of reverse logistics (RL) in recent decades has attracted huge attention in industries. Shorty, this concept refers to the process of moving products from the consumers to the producers, i.e., the company. To be more precise, it is related to the process from planning, executing, and monitoring the cost-efficient flow of materials; controlling the inventory; to monitoring the delivery of finished products from the point of consumption to the point of origin [1]. Comparing to the forward or traditional logistics, it is a “reversed” process, i.e., allowing products (and information) to be returned to the company.

There are several reasons why RL has received huge attention, from a pure environmental concern to competition and marketing motives. A company that manages RL practice well can gain several benefits, such as higher revenue, lower operational costs, and higher customer satisfaction [2]. Other advantages that can be mentioned are environmental protection and efficient resource usage [3][4]. In addition, an increase in consumer awareness and company social responsibilities towards the environment also drives the company to implement RL [5].

Nevertheless, regardless advantages, several challenging endeavours might hinder the implementation especially since RL could generate cost that might affect the financial performance of the company. In the beginning, it is obvious that RL implementation is costly; comparing to forward
logistics, it can cost to five times greater [6]. Also, the products that are moved back to the company might pile up in the company’s warehouse [7].

Most of the research regarding the analysis of RL implementation barriers were conducted in developed countries; only a few researches were conducted in developing countries (e.g. [8][9][10]). This phenomenon is not really surprising because RL has become a mandatory practice in the developed countries, but, in the developing countries, it is still in its infancy state [11][12]. This condition has motivated us to study this issue and its practice in Indonesia, as one of the developing countries.

The object of this research is a bottled drinking water company located in Semarang, Central Java Province, Indonesia. The rate of consumption of bottled drinking water in Central Java Province shows an increasing trend, from 9.2% in 2007 to 68.1% in 2017, meaning that this is a promising sector. In addition, according to ASPADIN, an association of Indonesian bottled drinking water companies, total national revenues generated from this sector is about USD 1.676 million in 2013 and it is projected to grow about 11.1% per year to 2017. However, the bad effect of this increased consumption is that the waste generated is also increasing. The disposable packaging, i.e. the plastic bottle, the straw and its packaging, as well as plastic labels covered the bottle, obviously have a harmful impact on the environment. The materials used to produce those things would take more than 20 years to decompose if those are thrown into the landfills.

Although disposable packaging can be recycled to reduce the environmental effects, the practice remains limited, especially from the manufacturer’s perspective. Therefore, a proper RL practice is required to improve the effectiveness of the process. As has been stated previously, the implementation of RL has some barriers. The barriers could influence both the RL operations and also influence one another. It is important to recognize the mutual relationship among the barriers. The investigation of the possible “root barrier” and the barriers that are influenced by others might help the management to better execute the RL practice. In addition, it could be good support for taking appropriate action to deal with the barriers to implementing RL.

The objectives of the study are then threefold. Firstly, this study aims to identify RL implementation barriers in a bottled drinking water company. It used a literature review and interviews. Secondly, this study aims to investigate the interaction of the barriers by using interpretative structural modelling (ISM). Lastly, this study aims to map the barriers into the driver-dependence diagram by employing MICMAC analysis.

2. Research design

To accomplish the objective of the study, the barriers of RL implementation have to be identified first. ISM then was employed to identify the contextual relationship among the barriers. It also can be used to identify the “root” barrier(s), i.e., the barrier(s) in which most influence(s) other barriers. Finally, Matrice d’impacts croisés multiplication appliquée à un classement (MICMAC) or in English: cross-impact matrix multiplication applied to the classification analysis was used to investigate the dependence and the driver powers of the barriers.

2.1. Barriers of reverse logistics implementation

To investigate the barriers of RL implementation at the object of the research, a literature review was performed through examining several related studies (i.e. [1][5][10][13]-[16]). The barriers found from the literature review were required to be refined due to several considerations (e.g., different locations and conditions). Some experts also had been interviewed for giving such insight into the barriers which hinder the implementation of RL at the object of the research. Finally, there are thirteen barriers which are described as follows.

The first barrier is the lack of information systems (IS) and technology (BR1). IS is considered as a vital factor for good RL implementation [17]. If a company desires to implement a good RL, it has to establish a proper IS, particularly for the process of tracing and tracking products’ status after delivering to the consumers. However, the situation at the bottled drinking water company as the object of the research is that the company manages an internal IS, meaning that the information regarding materials
and finished products only available from the suppliers to the company and from the company to the retailers. After the products left from the retailers, the information cannot be traced anymore. The second barrier is some problems related to product condition (BR2). Comparing to the forward logistics as the company could maintain the uniformity of the quality of the product, the condition of the returned products is heterogeneous. The products can be returned because they are indeed defective, guarantee returns, or because of violating the environmental issue [1]. The condition at the object of the research is that the company does not have a good gatekeeping to do a screening of the defective products and unwarranted products. The third barrier relates to firm policies (BR3), particularly in managing product returns. Most returned products are crushed or dumped in the garbage. The returned products are rarely remanufactured, recycled, or reused. Interestingly, a study by [18] identified that more than one-third of more than one hundred and fifty managers who responsible for RL practice believe that firm policies eventually negatively affect RL practice.

The fourth barrier is the resistance of the management to fully implement RL (BR4). An organizational change could generate resistance and scepticism in the company’s employees, causing it hard to achieve improvement. RL implementation somehow needs a radical change in the employee as well as employers’ mindset and practice especially when the previous system is not really supported. The fifth barrier is financial constraint (BR5). This financial issue is considered as one of the major barriers in implementing RL because it is important to support not only the workforce but also the infrastructure of the RL practice. Good training and IS indeed need the company’s financial support. If the company does not have a desire to establish a good RL practice, the company then will not assign the funds for investing in RL. The sixth barrier is lack of commitment by top management (BR6). The top management has to provide a clear vision to the RL implementation. They also have to deliver good strategic plans regarding the RL practice and also action plans to successfully execute the plans.

The seventh barrier is unawareness of the customers (BR7). Demands from consumers nowadays are the most critical type of external pressure. If the customers demand firms to implement RL, it will be a “burden” for such firms if they do not fulfil customers’ demands. The eighth barrier is lack of government support (BR8). The regulation from the government can either encourage or eventually discourage the process of innovation adoption since the government is the entity who sets the regulations for the industry [19]. If the government is reluctant or discourage to implement “the new concept” in the logistics practice, i.e., RL, it might be a major barrier. The ninth barrier is lack of training related to RL (BR9). Training of the company’s employees is one of the main requirements in order to achieve success in any company; hence, a lack of competent or qualified employees is a barrier in RL implementation. A good RL training has to be performed for all people in the company, not only for top-level management but also for the operator level as well.

The tenth barrier is the fear of failure when adopting RL (BR10). This might lead to monetary losses or losing a competitive advantage. The eleventh barrier is the lack of environmental management system (EMS) certification (BR11), for instance, ISO 14001. A study by [20] examined the multifaceted connection green supply chain management (GSCM) practices and ISO 14001 certification in Japanese companies. The result showed that ISO 14001 could promote GSCM activities. It implies that a lack of knowledge of EMS could represent as a barrier in RL implementation [21]. The twelfth barrier is the lack of corporate social responsibility (CSR) (BR12). CSR recommends that a company is keen to go beyond trivial compliance and consider public consequences of its actions [22]. It suggests the company to do voluntary but strategic practices, for instance, eliminating wastes and informing consumers about the negative environmental effect of the products. Therefore, if the firm is unaware of this responsibility, it will hinder the firm to implement RL practice.

The last barrier is the lack of support from dealers, distributors, and retailers (BR13). In fact, there is no such policy that administers the products to be returned from consumers to the distributors (or dealers or retailers); or in other words, the consumers can return the products with any condition. This condition might harm the distributors because there is no pricing policy. If the distributors decline to do cooperation in RL, the company might meet problems in collecting the products that will be returned to the company.
2.2. Interpretative structural modelling

ISM is a well-established method to spot relations among variables. In the process of this method, a group of various directly- and indirectly-related variables will be structured into a comprehensive systematic model. The model can picture the structure of a posh problem by graphics also as words [23]. ISM has been broadly used in many areas, e.g., [5], [10], [13]–[16].

ISM begins with variables identification and then expands through group problem solving; ISM also can be utilized for individual problem-solving. A relevant secondary or subordinate relation is selected contextually. A structural self-interaction matrix (SSIM) is then generated after determining contextual relation on each element set. A reachability matrix (RM) is then generated by converting the SSIM. The next step is to check the transitivity and then to obtain a matrix model. After a matrix model is found, the partitioning of the elements and extraction of the structural model is then generated.

In this study, the identified thirteen barriers are examined by employing the ISM to identify the relationship among them. A thorough examination of the relationship can provide a clearer portrait of the situation than only considers one barrier alone. ISM can also be employed as a method to examine an individual interaction state of affairs since the idea of variable relationships as well as the overall structure are often extracted from the system [24].

2.3. MICMAC analysis

MICMAC analysis is usually used to study the dependence and driver powers among variables which have relations. The principle is according to the multiplication of matrices to classify the important variables that drive the system in various categories. The MICMAC analysis has been widely used as a supplement of the ISM method, see for example [4], [9], [12], [14], [15], and [15].

Depending on the dependence and driver powers, the variables are categorized into four groups or quadrants, i.e., autonomous, linkage, independent, and dependent quadrant. The autonomous quadrant belongs to the variables that have both weak driver power and dependence power. The linkage quadrant belongs to the variables which have both strong driver power and dependence power. The independent quadrant includes variables which have weak dependence power but strong driver power. Lastly, the dependent quadrant includes variables which have strong dependence power but weak driver power.

3. Results and Discussion

3.1. Interpretative Structural Modelling Hierarchy

After thirteen barriers were recognized, interviews with five employees of the object of the research were conducted. They are a manager of human resource and general affairs department, a manager of marketing department, three employees of marketing, logistics, and production departments. They were asked to answer several questions about the relationships among thirteen barriers which have been identified previously.

The contextual relationship among the barriers— which is then depicted in the SSIM—concerning which sets of barriers are inspected. The relationship between barrier m and barrier n is labelled by four symbols as follows:

- V: Barrier m will facilitate to reduce barrier n;
- A: Barrier m will be reduced by barrier n;
- X: Both barriers will facilitate to attain each other;
- O: Both barriers are unconnected.

If the symbol, let say, for barrier 6 (BR6) to barrier 10 (BR10) is V, meaning that when the commitment of the top management about RL practice is increasing, then the fear of failure to implement RL will decrease. Another example, when A is assigned for barrier 6 (BR6) to barrier 1 (BR1), meaning that elimination of the lack of commitment of the top management will help to reduce the lack of IS and technology. In the other words, when the top level of management has a clear vision regarding RL implementation, the company agrees to assign its funds to be invested in IS and
technology for enabling RL implementation. When the relationship between barrier 3 (BR3) to barrier 4 (BR4) is assigned with X, meaning that when firm policies barrier and resistance to change to RL are eliminated, it might facilitate to attain each other. If O is assigned to the relationship between barrier 6 (BR6) and barrier 7 (BR7), meaning that the respondents thought these barriers do not have any relationship.

The next step is establishing an initial RM. The previous symbols O, X, A, and V are converted into a binary matrix:

• If \((m,n)\) entry in SSIM is O, the entry \((m,n)\) in RM is 0 and \((n,m)\) is 0.
• If \((m,n)\) entry in SSIM is X, the entry \((m,n)\) in RM is 1 and \((n,m)\) is 1.
• If \((m,n)\) entry in SSIM is A, the entry \((m,n)\) in RM is 0 and \((n,m)\) is 1.
• If \((m,n)\) entry in SSIM is V, the entry \((m,n)\) in RM is 1 and \((n,m)\) is 0.

Five initial RMs are recapped to establish total RM. A threshold of 3 (three) is set, meaning that if an entry in total RM is equal to or more than 3, the entry is assigned to number 1 (one) in final RM; vice versa. Table 1 shows the final RM. Calculating the dependence power and driver power for each barrier is the next step to be performed. The dependence power is the number of barriers (including itself) that facilitates to attain it; whereas the driver power of a certain barrier is the number of barriers that it might facilitate to attain. These dependence and driver powers are used in designing the MICMAC diagram.

Table 1. Final reachability matrix.

| Barrier | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | Driver Power |
|---------|---|---|---|---|---|---|---|---|---|----|----|----|----|-------------|
| BR1     | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0  | 0  | 0  | 2  |             |
| BR2     | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0  | 0  | 0  | 2  |             |
| BR3     | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0  | 1  | 1  | 10 |             |
| BR4     | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0  | 0  | 1  | 5  |             |
| BR5     | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0  | 0  | 1  | 7  |             |
| BR6     | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0  | 0  | 0  | 5  |             |
| BR7     | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0  | 0  | 0  | 4  |             |
| BR8     | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1  | 0  | 0  | 10 |             |
| BR9     | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1  | 0  | 1  | 8  |             |
| BR10    | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1  | 0  | 0  | 5  |             |
| BR11    | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0  | 1  | 1  | 6  |             |
| BR12    | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1  | 0  | 1  | 9  |             |
| BR13    | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0  | 0  | 1  | 6  |             |

RM is subdivided into several levels. The reachability set of the particular barrier contains the barrier itself and others that might facilitate to attain. The predecessor set contains the barrier itself and others that might facilitate to attain them. Then, the intersection set can be established, it is the intersection between barriers in the reachability set and in the predecessor set. The “top level” barrier is investigated from the intersection set that consists of all barriers from reachability set. After identifying “top level” barrier, the barrier is casted off from other remaining barriers. The iteration is continued till all levels are discovered. The iteration process is depicted in Table 2.
Table 2. Final level partition.

| Barrier   | Reachability Sets | Predecessor Sets          | Intersection Sets | Level Partitions |
|-----------|-------------------|---------------------------|-------------------|------------------|
| BR2       | 2, 10             | 2, 3, 6, 7, 8, 9, 10, 11, 12, 13 | 2, 10             | I                |
| BR1       | 1                 | 1, 3, 5, 7, 8, 9, 11, 12, 13 | 1                 | II               |
| BR7       | 3, 7              | 3, 6, 7, 8, 9, 12         | 3, 7              | III              |
| BR13      | 4, 13             | 4, 5, 9, 13               | 4, 13             | IV               |
| BR6       | 6                 | 5, 6, 8, 9, 11, 12        | 6                 | V                |
| BR4       | 5, 9              | 5, 8, 9, 12               | 5, 9              | VI               |
| BR10      | 5                 | 5, 8, 9, 12               | 5                 | VI               |
| BR9       | 9                 | 8, 9, 12                  | 9                 | VI               |
| BR5       | 5                 | 5                          | 5                 | VI               |
| BR12      | 12                | 11, 12                    | 12                | VII              |
| BR11      | 11                | 8, 11                     | 11                | VIII             |
| BR3       | 8                 | 8                          | 8                 | VIII             |
| BR8       | 8                 | 8                          | 8                 | VIII             |

Figure 1. ISM-based model for the barriers of reverse logistics implementation: The final digraph.

According to the iteration, the structural model can be established. If the relation exists between barrier $m$ and $n$, an arrow from $m$ to $n$ is assigned. The resulting model is called a digraph which is shown in Figure 1. Note that the BR3 (firm policies), BR8 (lack of government support), and BR11 (lack of EMS certification) are the most critical barriers because they are located at the bottom of the digraph. They are called the “root barriers”. They lead to lack of CSR of the firm (BR12), and so on.
As a consequence of this result, the company must be able to eliminate these root barriers for successfully implementing the RL. To eliminate BR3, the firm has to provide a policy especially related to product stewardship. The company must ensure the process of handling safely, as well as the use of its products during their life cycle. Legislation and regulation are the mechanisms that are required for the proper governance of business organisations containing their environment as well. In particular, the environmental laws and regulations are also crucial because they are intended to initiate sustainable development and clean production in a society. The government of Indonesia could adapt the regulations applied in the developed countries: they implement the extended producer responsibility (EPR). In this regulation, the manufacturers are required to take financial and physical responsibility through a return program to reduce the volume of waste in landfills [24]. The implementation of EPR is not yet legally enforced, so that most product stewardship programs are limited to the voluntary participation of the manufacturers [25]. The EPR’s objectives are to decrease waste disposal, raise recycling rates, resource conservation, and promote environmental design products [26]. In sum, support and guidance from authorities, i.e., the government, in the area of green SCM, especially in RL, are necessary for prevention of pollution and reduction of environmental load to achieve sustainable society.

The ISO 14001 standard is the key international standards for an organization which has an objective to apply an EMS as well as to get an environmental certification process. Since the launch of ISO 14001, the certification has acknowledged huge growth and widely implemented in numerous companies across the globe [28]. In sum, it is expected that the company needs to have EMS certification since this certification can be such a catalyst in implementing RL. Minimizing or fully eliminating those barriers are supposed to eliminating other barriers (which have positions “above” the rot barriers) as well.

3.2. MICMAC diagram

MICMAC diagram is employed to study the connection (or the relationship) between dependence and driver powers. The horizontal axis of the diagram shows the dependence power while the vertical axis shows the driver power. The barriers are categorized into four quadrants, i.e., autonomous (I), dependent (II), linkage (III), and independent (IV). For instance, BR4 has dependence power of 9 and driver power of 5, so that this barrier has the vertical axis of 5 and the horizontal axis of 9. The MICMAC diagram is shown in Figure 2.

Barriers belong to autonomous quadrant (I) have both weak driving and dependence powers. These are not really related to the system under consideration. Also, these might not have huge relations with others so that the barriers can be eliminated. According to Figure 2, there are five barriers belong to this cluster (BR5, BR6, BR7, BR11, and BR13), meaning that these barriers are not connected to the system. Barriers belong to dependent quadrant (II) have weak driver power but strong dependence power. They are BR1, BR2, BR4, and BR10. Barriers located in linkage quadrant (III) have both strong dependence power and driver power. Any action against the barriers might affect others and become feedback on the barriers themselves. There is only one barrier in this quadrant, i.e., BR3. Barriers located in independent quadrant (IV) have weak dependence power but strong driver power. They are BR8, BR9, and BR12. The improvements can be focused on these barriers.

As a consequence of this result, strategic issues such as government support, CSR of the firm, and training related to RL implementation must be considered in order to fruitfully applying the RL practice, since those barriers have high value of driving power. In other words, it is the priority of the company to manage those barriers because they can affect other barriers. The company is also recommended not to put a huge endeavour to remove the low driving power barriers; in this case, the company must provide adequate financial funding to support RL practice; the company must integrate RL into its policy; and the company must focus on building planning and strategies to increase employees’ awareness about RL by let say organizing an event explaining that RL is important and explaining that implementing the program might benefit to the company.
4. Conclusion

RL implementation barriers in a bottled drinking water company have been investigated by employing a literature review and interviews. Thirteen barriers influence RL implementation, i.e., lack of IS and technology (BR1), problems related to product condition (BR2), firm policies (BR3), resistance of the management to fully implement RL (BR), financial constraint (BR5), lack of commitment by top management (BR6), unawareness of the customers (BR7), lack of government support (BR8), lack of training related to RL (BR9), fear of failure (BR10), lack of EMS certification (BR11), lack of CSR of the firm (BR12), and lack of the support from dealers, distributors, and retailers (BR13). The barrier is expected to influence others; hence, the relationships among the barriers are needed to be understood to investigate root barrier(s) as well as the most influenced barrier(s). Interviews with five employees of the object of the research were conducted to investigate the relations among barriers.

Root barriers and their relationships are shown in the digraph (see Figure 1). It describes that root barriers RL implementation in the object of the research are firm policy, lack of government support, and lack of EMS certification. It means that the firm has to have a willingness to implement RL (fully) so that the policies related to RL implementation will be established. The government also has to fully support the implementation of RL in the industry by providing clear regulations and laws. Finally, the firm needs to have EMS certification, such as ISO 14001, since this certification can be such a catalyst in implementing RL. Minimizing or fully eliminating those barriers is supposed to eliminating other barriers (which have positions “above” the rot barriers) as well.

MICMAC diagram is used to analyse the connection between dependence and driver powers of the barriers. MICMAC diagram is partitioned into four quadrants. The autonomous quadrant is placed by five barriers, i.e., BR5, BR6, BR7, BR11, and BR13. The dependent quadrant consists of four barriers, i.e., BR1, BR2, BR4, and BR10. Only BR3 is located in the linkage quadrant. The independent quadrant consists of three barriers, i.e., BR8, BR9, and BR12. The company is recommended to minimize (or reduce) barriers located in independent quadrant because the barriers have strong driver powers which might affect others.

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