Green Manufacturing Challenge in Small and Medium Industries (SMEs) Batik Laweyan Surakarta

Puspitasari Nia Budi*, *Yulianto* Muhammad Faisal Afa, *Rosyada* Zainal Fanani

Department of Industrial Engineering, Diponegoro University 1269 Semarang, Indonesia

Abstract. Small and medium industries (SMEs) are the main contributor of the economic growth in the countries, especially developing countries. On the other hand, SMEs also produce serious problems to the environment. Therefore, SMEs, especially the textile and apparel sector need to apply green manufacturing (GM). GM can reduce the amount of waste and pollution produced. It can lead to financial benefits and a positive public image of the SMEs if properly implemented. It is a challenge to apply GM in SMEs because their limitation of knowledge and resources. It needs a study the enabler and inhibiter factors to the application of GM. It need also an analysis how the factors related each other. The aim of this study is to determine the most significant enabler and inhibiter factors in applying GM to SMEs at Kampung Batik Laweyan Surakarta. This study uses Interpretive Structural Modeling (ISM) approach to compare the perceptions of respondents regarding the relationship of each factor. The results show that the main enabler factor is the implementation of environmental regulations and strict supervision, while the main inhibiter factor is the lack of subsidies provided for SMEs to implement GM.

Keywords: Green Manufacturing, ISM, SMEs, Batik, Enabler, Inhibiter

1 Introduction

The rapid development of the industrial world today has caused this sector as one of the important sectors related to improving the prosperity of the community through the field of work development. Globalization, especially in the industrial sector has created competition as well as opportunities for Small and Medium Enterprises (SMEs) to develop through cost efficiency and quality improvement1. SMEs have an important role in the economic growth of a country and can be said to be a supporter of economic growth in all countries2. Based on the Ministry of Cooperatives and SMEs, the contribution of the SME sector to Gross

* Corresponding author: niabudipuspitasari@lecturer.undip.ac.id

Domestic Product (GDP) reached 60.34% in 2018. Labor absorption in this sector also increased, from 96.99% to 97.22% in the same period.

One of the SMEs sectors that are the mainstay is textiles and apparel, because it provides a major contribution to the national economy. Growth in the textile and apparel industry in the first quarter of 2019 was recorded at the highest with reaching 18.98%. The batik industry is one of the industries in the textile and apparel sector that plays an important role in national economic growth. The batik industry sector is able to contribute significantly to the country's foreign exchange through exports. The Ministry of Industry noted the export value of batik and batik products in 2017 reached USD 58.46 million with its main markets being Japan, the United States, and Europe.

Over time, demand for batik products has increased due to population growth and development trends, where batik is now a lifestyle3. This resulted in diminishing available natural resources. In addition, the use of batik equipment and production systems that are less efficient, also plays a role in causing environmental degradation. Therefore, the batik industry can no longer just carry out business as usual processes and must adjust to the development of environmental conditions as consumers' preferences for environmentally friendly products increase.

One of the concepts of an environmentally friendly industry that can be applied to maintain or improve the quality of the environment is green manufacturing. Green Manufacturing (GM) is defined as an integrated system with the aim of minimizing environmental impact while trying to maximize the efficiency of resources used for product and process design issues with manufacturing planning and control problems to identify and manage environmental waste flows4. GM principles are basically processes / systems that have minimal impact on the environment or do not cause negative impacts on the environment5.

Increased awareness of environmental aspects throughout the world has driven the industry to apply the concept of GM to their business activities2 6. More attention to environmental factors is also needed by SMEs because the waste generated tends to be less so the impact is least heeded. However, if calculated from small industries with large and growing numbers, small industries have a large impact on the environment7. SMEs from developed and developing countries are responsible for 60 - 70% of the dangerous emissions produced by these countries8. Therefore, it is important for MSMEs to be able to implement GM.

In order to apply GM in the Kampung Batik Laweyan in Surakarta, a study is needed to understand the potential and conditions of a number of factors that can play a role as an enabler or barrier of SMEs factors in GM implementation. Based on previous research, SMEs need assistance such as models, tools, approaches and frameworks to improve their environmental performance9. A study in Hong Kong also showed that increasing awareness about the environmental impact of SMEs has resulted in an increase in the number of GM programs implemented in Hong Kong10. Several other studies that have been carried out previously such as those conducted by2 4 11 12 will be made into reference in determining the main driving and inhibiting factors in GM implementation in the SMEs of Kampung Batik Laweyan Surakarta using the Interpretive Structural Modeling (ISM) method. Therefore, the focus of this study is on the application of green manufacturing (GM), specifically the enabler and barrier factors in their application for SMEs in Kampung Batik Laweyan Surakarta from the combined assistance of existing literature and expert opinion in the relevant field.

2 Research Method

This research begins by conducting a literature study to obtain the enabler and barrier factors in the application of green manufacturing. What to do next is problem formulation and research objectives are carried out. The aim of this study is to find out the main enabler and barrier factors in the application of GM in SMEs in Kampung Batik Laweyan Surakarta and provide recommendations in order to application of GM can run effectively. Based on literature studies, the authors have identified 15 enablers and 17 inhibiters.

Experts from the batik industry, which included SMEs, government, practitioners and academics were consulted to assist the writer in identifying the contextual relationship between enablers and inhibiter. The group of experts comprised of nine decision makers; consist of the Functional Surakarta Environmental Office, Head of Surakarta SMEs Empowerment and Protection, Environmental Engineering Lecturer, Chairman of the Kampung Batik Laweyan Development Forum (FPKBL), as well as five representatives of SME practitioners from the Kampung Batik Laweyan. The respondents were chosen based on their work experience and field of work relevant to the research.

Afterwards enabler and barrier factors are obtained through the literature study, validation is carried out to determine whether these factors are in accordance with the conditions in Kampung Batik Laweyan Surakarta. Validation is used using a questionnaire given to the several respondents and will be processed using the Delphi method. If a factor has a percentage score above 70% of the total score that can be obtained, then the factor is said to be valid and can be used.

Subsequently going through the validation process, valid enablers and inhibiter will be processed using the Interpretive Structural Modeling (ISM) method. ISM is an interactive planning method that allows groups of people, working as a team, to develop structures that define the relationships between elements in a set 13. The method is said to be interpreted because the relationship between the elements in the problem being studied is obtained based on discussions with the experts (expert). The method is said to be structural because it describes a complex problem in a system through carefully designed patterns using graphics. The steps in the ISM method are 11:

- Identification of elements obtained based on the results of research either in the form of questionnaires or literature studies.
- Determination of contextual relationships between elements is determined in accordance with the objectives of the study
- Developing a structural self-interaction matrix (SSIM) which is the result expert perceptions of the contextual relations between elements or between sub elements.
- Establishing a reachability matrix (RM) that is used to convert code in SSIM into binary numbers and checking the matrix transitive.
- Constructing level partitioning for each element into a different level of the ISM structure that will be formed.
- Developing Canonical Matrix is done by rearranging the reachability matrix based on the levels generated from the partition level
- Generating the ISM Model describes all elements that are interconnected directly and hierarchical level.

After obtaining the main enablers and inhibiter from the ISM model, MICMAC Analysis is performed to determine the category of a factor. In this step the enablers and inhibiter factors will be grouped based on the driving power (DP) and the dependence power (D) they have into four clusters, namely (i) autonomous cluster, where the factors in this cluster have a low influence on the system; (ii) cluster dependence, where the factors located in this cluster are very dependent on the input or other factors applied to the system; (iii) linkage cluster, where the factors in this cluster play an important role in GM implementation because it has a high driving force so that it can be called strategic enablers

(Ghazilla et al., 2015); (iv) independent cluster, where the driving factor located in this cluster is a key factor because it has a very high driving force. The next thing to do is to analyze the results of data processing. Then conclusions are drawn and suggestions for further research are made.

3 Result

Before conducting data processing using the ISM method to obtain the main enablers and inhibiter factors, a validation of the factors obtained from the literature study with the Delphi method was carried out. This is to find out whether these factors are in line with the conditions in Kampung Batik Laweyan Surakarta. Validation is used using a questionnaire given to the several respondents. In the Delphi method if a statement item has a percentage value ≥ 70% of the maximum score, then it can be said as consensus or agreement and can be said to be valid 1415. Table 1 shows the enabler factors and table 2 shows the GM barrier factors.

Table 1. GM Enablers

No	GM Enablers	Source
1	Implementation of environmental regulations and more stringent supervision	11
2	Top management commitment to implement GM	2, 11
3	Awareness of the impact of GM implementation throughout the organization	2
4	Stakeholder involvement and their environmental concern	11
5	GM training and environmental awareness education are part of the organization's training	2, 11
6	Availability of information about GM	2
7	New market opportunities for green products	2
8	Consumer demand for green products/processes	2, 11
9	Public pressure on the industry to change the behavior of environmentally friendly industries	2
10	Cost efficiency through reducing waste and emissions in order to increase profits	2
11	Improved positive public image about SMEs	2, 11
12	The use of technology/production equipment that is more environmentally friendly	11
13	Increased competitiveness by increasing the quality of the products produced	2, 11
14	The concept of incentives for SMEs that applied GM	Expert recommendation
15	An acknowledgment/label for products processed through GM	Expert recommendation

What to do next is data processing to determine the main enablers and inhibiter. Determination of the main enablers and inhibiter in the application of GM application is identified using the Interpretive Structural Modeling (ISM). The ISM method begins by determining the relationship between factors/elements with the preparation of SSIM which is the perception of experts. After that, the preparation of the reachability matrix (RM) which is a conversion from SSIM into binary numbers. Then a canonical matrix is formed, which is the RM that has been rearranged based on partitioning levels. The closing step is the making of the ISM model and MICMAC Analysis. Data collection was carried out

using a questionnaire given to nine respondents as stated in the research method. Based on the results of the questionnaire that was obtained from the respondents, the SSIM will be made for the driving factors then as in table 3.

Table 2. GM Inhibiter

No	GM Inhibiter	Source
1	Weak organizational structure to support GM implementation	16
2	Limited resources that affect the ability of organizations to implement GM	17
3	High hesitation from SMEs to change conventional production practices into GM	11
4	Lack of knowledge of SMEs about GM	18
5	Lack of awareness of SMEs about the impact of GM on business	19
6	Lack of market demand for green products	11
7	Weak public pressure on green products/processes	11
8	Absence of financial and policy incentives for SMEs that implement GM	11
9	High initial capital costs for GM implementation	11
10	GM certification/validation costs are high, making it difficult for SMEs	11
11	Low supplier commitment to GM implementation	11
12	The market response that prefers products at low prices	Expert recommendation
13	Lack of providing subsidies for SMEs to implement GM	Expert recommendation

RM is done to get the driving power (DP) and the dependence power (D). The initial RM matrix needs to be modified to show direct and indirect reachability. From the modified RM matrix, obtained the value of DP and D. The RM table for enablers that have been rearranged based on the result of level partitioning is shown in Table 3, while the inhibiter is shown in Table 4.

The ISM model is created using vertices and lines connecting each node. The direction of the arrow of the model shows the relationship between factors. The ISM model is used to show the factors and their relationships in the form of lines and vertices. The ISM model is made based on the results of partitioning level. The top level factor is placed at the top of the ISM model, the second level factor is placed in the second position of the ISM model, and so on until the lowest level factor is at the lowest position on the ISM model. The ISM model for the enabler factors can be seen in Figure 1, while for the barrier factors can be seen in Figure 2.

Based on the model that results from ISM processing for enabler factors, it can be seen that the driving factors at the first level are the implementation factors of environmental regulations as well as more stringent supervision (1). This factor is a very significant enabler for the application of GMs in Kampung Batik Laweyan Surakarta because it lies at the base of the ISM hierarchy. This factor will affect all other driving factors. Regulations on the environment can regulate the types of dyes that may be used in production activities, such as procedures for disposal of production waste and water quality standards as an indication of river conditions. Currently, there are no regulations regarding the batik industry that specifically regulates the provisions of raw materials, energy use, packaging,

etc. There are only regulations that are optional, that is only applied and applies to companies/industries that want to obtain green certification from the government.

The lack of regulations that compulsorily regulate green industries resulted in the effects of these regulations being felt less for SMEs.

Table 3. RM Final Enablers

Enablers	11	13	5	12	4	15	2	10	8	3	14	7	6	9	1	Driving Power
11	1	0	1	1	0	0	1	0	0	1	1	0	1	0	0	7
13	1	1	0	0	1	0	0	0	1	1	0	0	0	0	1	6
5	1	1	1	0	1	0	1	1	0	0	1	0	0	1	0	8
12	1	1	0	1	1	1	0	0	1	0	1	1	1	1	0	10
4	0	1	1	1	1	1	1	1	1	1	0	1	1	0	0	11
15	1	1	0	1	1	1	1	0	1	0	0	1	0	0	0	8
2	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	12
10	1	1	1	1	0	0	1	1	1	1	1	0	0	0	1	10
8	0	1	1	1	0	1	1	1	1	1	1	1	0	1	0	11
3	1	1	1	1	1	1	1	1	1	1	1	0	1	0	1	13
14	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	12
7	1	1	1	1	1	0	1	1	0	1	1	1	1	0	0	11
6	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	12
9	1	1	1	1	0	1	1	0	1	1	0	1	1	1	1	12
1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	14
Dependence Power	13	14	12	12	9	10	13	10	11	12	10	9	10	7	5	157

From Figure 1 it can be seen that the enabler factor which is at the ninth level as well as the peak of the ISM model is an increase in a positive public image of SMEs to increase people's trust and interest in the products produced (11).

Table 4. RM Final Inhibiter

Inhibiter	3	1	12	4	11	2	9	5	6	7	8	10	13	*Driving Power*
3	1	1	1	1	1	0	1	1	1	0	1	0	0	9
1	1	1	0	1	1	0	0	0	0	0	0	1	0	5
12	1	1	1	1	0	0	1	1	1	1	1	0	0	9
4	1	1	1	1	1	1	1	1	1	1	0	0	1	11
11	1	0	1	1	1	0	0	1	0	1	0	0	0	6
2	1	1	0	1	1	1	0	0	0	1	0	1	1	8
9	1	1	1	1	0	1	1	1	1	0	1	1	0	10
5	1	1	1	1	1	1	1	1	0	1	1	0	0	10
6	1	1	1	0	0	1	1	1	1	1	0	1	0	9
7	1	1	1	1	0	1	1	1	1	1	0	0	0	9
8	1	0	1	1	1	0	1	1	0	0	1	1	1	9
10	1	1	0	1	0	1	1	1	1	1	0	1	0	9

Inhibiter	**3**	**1**	**12**	**4**	**11**	**2**	**9**	**5**	**6**	**7**	**8**	**10**	**13**	***Driving Power***
13	1	0	1	1	0	1	0	1	1	1	1	1	1	10
Dependence Power	13	10	10	12	7	8	9	11	8	9	6	7	4	114

This enabler factor is influenced by all the existing driving factors. Public image/image is a very important thing in the sustainability of a business. This is because consumers who have a positive image of a business, will be more likely to make purchases of business products 20. The emergence of public awareness about the importance of environmentally friendly products will certainly lead to a positive image of SMEs that have implemented GM in the production process.

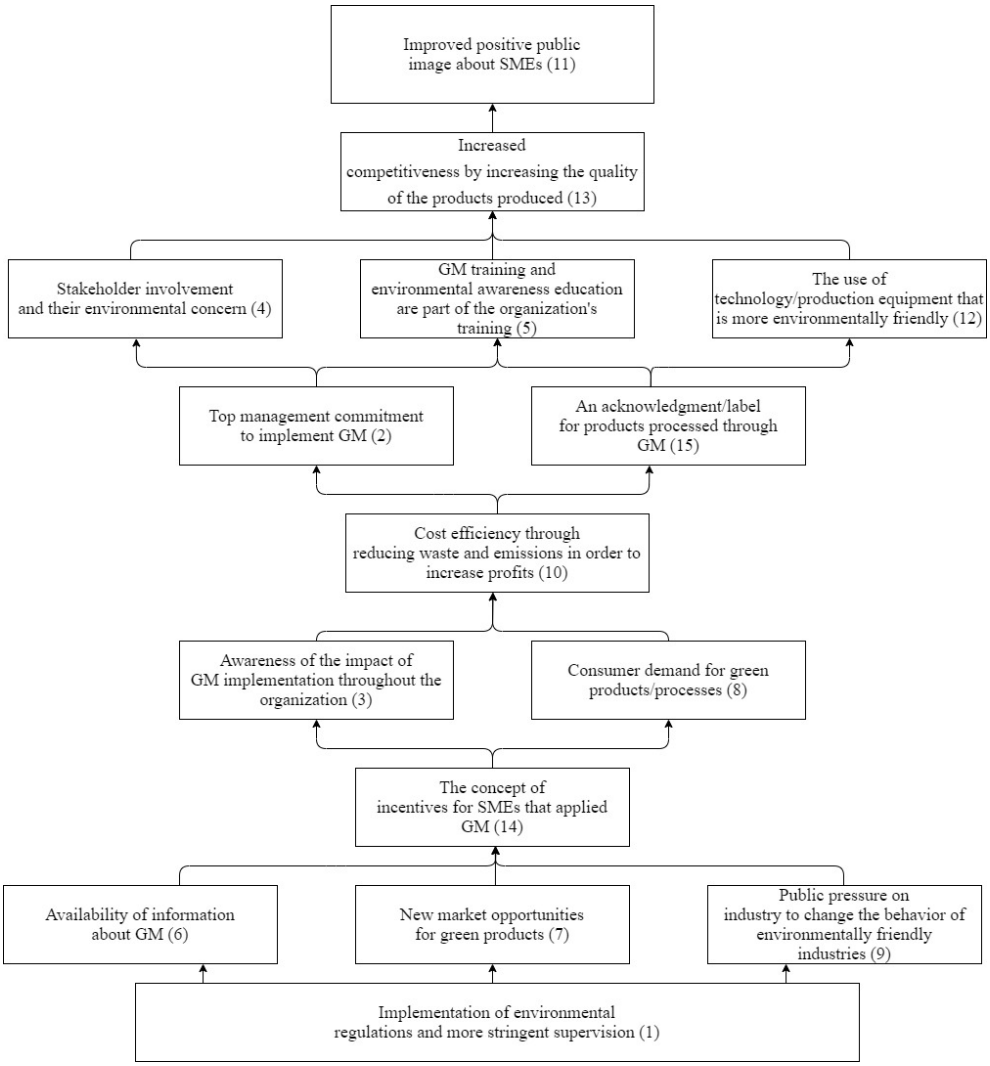

Fig. 1. ISM Model Enablers

Based on the model generated from ISM processing in Figure 2, it can be seen that the barrier factor at the first level is the lack of subsidies for SMEs to implement GM (13). This

factor becomes a very significant obstacle for GM implementation in Kampung Batik Laweyan Surakarta because it lies at the basis of the ISM hierarchy. Financial problems are the most influential in implementing GM, where these obstacles affect other obstacles.

From Figure 3 it can be seen that the barrier factor that is at the eighth level as well as the peak of the ISM model is the high doubt from SMEs to change conventional production practices to GM (3). This factor is influenced by all the barrier factors. Although GM provides many positive impacts, both for SMEs and the environment. However, the fact is there are many obstacles and challenges that must be overcome to be able to implement GM. On the one hand, SMEs entrepreneurs must keep prices of products produced competitive in the market, on the other hand businesses cannot turn a blind eye to trends, namely the issue of environmental stewardship, although it is still limited to some circles.

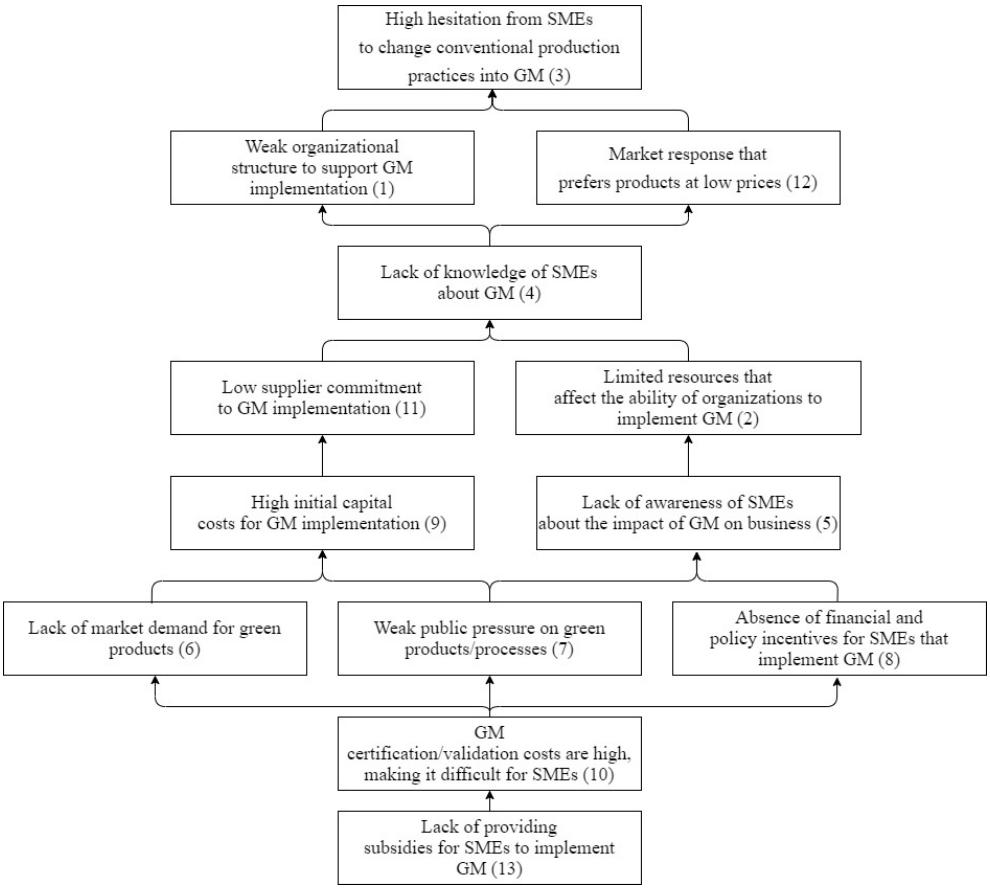

Fig. 2. ISM Model Inhibiter

MICMAC Analysis in this study is used to analyze the driving power (DP) and dependence power (D) of the research variables (driving and inhibiter factors). At this stage a classification of key variables that are important in developing a system in the ISM model from the combination of DP and D. The diagram showing the values of DP and D can provide important insights about the relative importance and interdependence between the enabler and barrier factors. These variables will be divided into four clusters, namely autonomous cluster, dependent cluster, linkage cluster and independent cluster. The

MICMAC analysis diagram for the driving factor is shown in Figure 3, while for the barrier factor is shown in Figure 4.

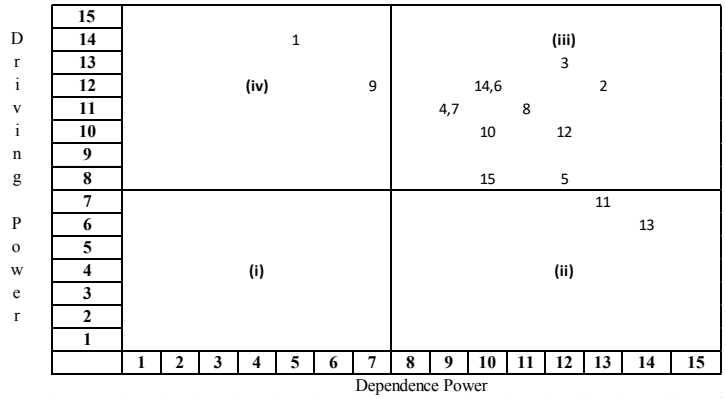

Fig. 3. Cluster of GM Enablers

Based on the MICMAC analysis diagram in Figure 3, it can be seen that the fourth cluster is an independent cluster, which has a high DP value but has a low D value. This means that the driving factor that lies in this cluster is a key factor because it has a very high driving force in the application of GM. Similar to linkage clusters, independent clusters also require special attention because each action related to this factor can have an influence on other driving factors. However, actions on the driving factors in this cluster will not have an effect on the factors themselves. Therefore, all the driving factors here are independent variables. Factors included in this cluster are factors driving the implementation of environmental regulations and tighter supervision (1) and public pressure on the industry to change the behaviour of environmentally friendly industries (9).

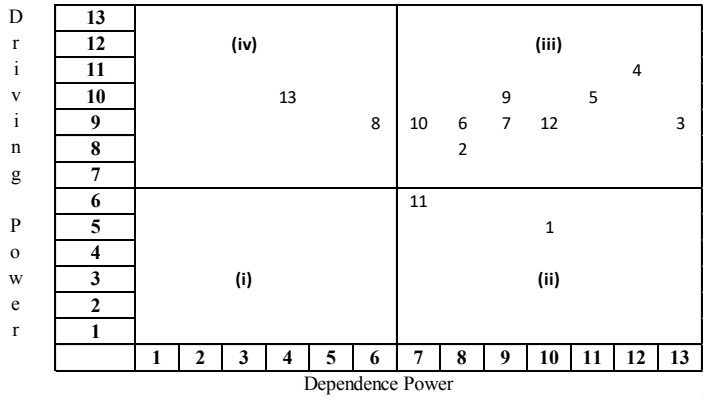

Fig. 4. Cluster of GM Inhibiter

Based on the MICMAC analysis diagram in Figure 4, it can be seen that the fourth cluster is an independent cluster, which has a high DP value but has a low D value. This means that the inhibiting factor located in this cluster is a key factor because it has a very high inhibitory strength in the application of GM. Similar to linkage clusters, independent clusters also require special attention because each action related to this factor can have an effect on other inhibiting factors. However, the action of the inhibiting factor in this cluster will not have an effect of the factor itself. Therefore, all the inhibiting factors here are

independent variables. Factors included in this cluster are the absence of financial and policy incentives for MSMEs that implement GM (8) and the lack of subsidies for MSMEs to implement GMs (13).

4 Conclusion

Based on the results of data processing and analysis that has been done, it can be seen that 15 enabler factors and 13 barrier factors to implement GM at SMEs in Kampung Batik Laweyan Surakarta with different relationships between factors. All the enabler and barrier factors are each constructed into an ISM model based on theirs driving power and dependence power. For the enabler factors, the key factors or strategic enablers are the implementation of environmental regulations and tighter supervision and public pressure on the industry to change the behavior of environmentally friendly industries. That is because these two factors have the high driving power, which affects other driving factors, but not vice versa.

For barrier factors, the key factor or strategic inhibiter are the lack of subsidies for SMEs to implement GM and the absence of financial and policy incentives for SMEs that implement GM. That is because these two factors have the high driving power, which affects other driving factors, but not vice versa.

For recommendations that can be given related to the key driving factors, namely the Government can work with environmental NGOs to provide education to SMEs to pay more attention to the environment. Besides increasing the campaign to buy environmentally friendly products to the surrounding community also needs to be done to increase awareness and interest of the community towards environmentally friendly products. Empowerment of the river care environment, community also plays an important role as a government partner to maintain the function and quality of the river.

In the main and key barrier factors, recommendations that can be given are building a culture of preserving the environment and continuously being maintained so that in the future it can increase commitment and environmental awareness of each business actor. Then to manage the wastewater treatment plant (WWTP) as well as subsidies provided by the Government and other institutions can be done by forming a Technical Implementation Unit so that it can be organized. In addition, the ease of applying for KUR loans as well as lending interest rates for MSMEs that have/will apply GM can be done to help overcome the limitations of SMEs resources.

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