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***Research paper***

# Cluster Analysis of Innovativeness in Manufacturing Companies and Its Influence to Business Success

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**Abstract**

The competition makes the companies under pressure to always survive in the conditions that dynamically changed. Innovation has been known as an important factor in improving the performance of the company in the face of dynamic market. The purpose of this paper are (1) to analyze innovativeness by using the 58 operations managers of manufacturing companies in Tasikmalaya City, West Java Indonesia as respondents, and (2) to know the types of innovativeness cluster determining business success. The results showed the four types of clusters of Innovativeness consisting (1) Leading Innovators cluster that have the outclass value than the others in every aspect of innovativeness, (2) Followers cluster is as the very low radical product innovations capability, (3) Inventors are very strong radical product innovations, while (4) Laggers are the lowest scores in all innovation types among the clusters. Based on ANOVA, it is concluded that every clusters of innovativeness has its own business success difference. The leading innovators type has the highest mean of business success measured by the comparison innovations type among clusters in the sales growth.

***Keywords***: *Types of Innovation, Innovativeness, Business Success, Manufacturing Companies.*

## 1. Introduction

ASEAN Economic Community (AEC) in 2015 aimed to improve the stability of the economy in the ASEAN region and formed the economic area among ASEAN countries is strong. AEC will be a good opportunity for the trade barriers which will tend to diminish, even they will be non-existent. These will impact on increasing exports, then, it will increase the Gross Domestic Product (GDP). On the investment side, the AEC can enhance the competitiveness of ASEAN to attract the influx of Foreign Direct Investment (FDI), which can stimulate economic growth through technology development, job creation, human resource development and easier access to the world market.

But until the end of 2016, Indonesia as part of the AEC has not been able to show its efforts to compete in the AEC. This can be seen from Indonesia's ranking in the list of Global Competitiveness Index (GCI) 2016. The rank is 41 of 138 countries. This is decreased when compared by 2015 ranked 37th (World Economic Forum, 2016). This position is still under some Southeast Asian countries, such as Singapore (ranked 2nd), Malaysia (25th) and Thailand (ranked 34th). Although the Indonesian government has made a number of reformations in the field of business economics, the results are still not satisfying. In addition, this economic performance is quite good proven by seven-level rise to the rank of 42 in the assessment of financial development. However, in fact, the health and basic education sector (down 20 spots to 100) are the causes of the decrease of this level.

Based on the report of Global Innovation Index (GII) 2016 as the result of collaboration between Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO), Indonesia was ranked 88 in the list of most innovative countries in the world this year. This is far behind the other five country members of the AEC, such as Philippines (ranked 74), Vietnam (ranked 59), Thailand (ranked 52), Malaysia (ranked 35), and Singapore (ranked 6). This preparation of global innovation index is based on a number of factors including infrastructure, business and market satisfaction, creative products, and research.

Gunday, et.al (1) states that innovation is broadly seen as an essential component of competitiveness embedded in the organizational structures, processes, products, and services within a firm. According to Drucker (2), innovativeness is one of the fundamental instruments of growth strategies to enter new markets, to increase the existing market share and to provide the company with a competitive edge. Thus, innovations constitute an indispensable component of the corporate strategies for several reasons such as to apply more productive manufacturing processes, to perform better in the market, to seek positive reputation in customers' perception and as a result to gain sustainable competitive advantage. These points are in line with Gopalaksihnan and Damanpour (3) that a company with a competitive advantage is the company

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which is capable of creating innovation and creativity through effective and planned innovation process.

Even though earlier researchers in innovation management literature have mostly focused on two types of innovations, namely product and process innovations, recently, other types of innovations began to receive more attention. In the OECD Oslo Manual (4), four different innovation types are introduced. These are product innovation, process innovation, marketing innovation and organizational innovation. Furthermore, the product innovation is considered in two components: incremental and radical product innovations.

Damanpour (5) defines innovativeness as the rate of adoption of innovations and indicates that it is operationalized in many studies as the number of innovations adopted within a given period. In an organization, innovation begins with an intelligent individual who has the instinct to discover new needs, which then creates or improvises them into methods, processes, and new resources to meet the needs of the novelty.

A taxonomy based on formal cluster analysis is developed by Kilic et al. (6), by clustering firms according to their innovativeness pertaining to various innovation types (i.e., product, process, marketing and organizational). In their analysis, data are collected from 184 companies from various industries in Northern Marmara region in Turkey. They conclude that firms can be grouped into four homogenous categories, such as Leading innovators, Followers, Inventors, and Laggers.

This study performs cluster analysis of the manufacturing company in Tasikmalaya City, West Java Province, Indonesia, based on the taxonomy of innovativeness of the Kilic et al. (6). Then, this taxonomy will be used to determine the difference in business success as measured by business survival, sales growth, and employment growth.

## 2. Theoretical Review

### Innovation

Innovation was first described by Schumpeter (7) who defined it as the driving force in economic growth. There are five manifestations of innovation proposed in his definition:

1. The implementation of goods (products) that are new to consumers, or higher quality than their previous counterparts;
2. The implementation of production methods that are new to specific industries and economic activities in which they are used;
3. The opening of new markets;
4. The use of new sources of raw materials;
5. The implementation of new forms of competition that lead to structural changes in the industries of their implementation.

In line with Schumpeterian concept, innovation is defined as a source of competitive advantage and seen as a decisive factor for economic growth and the basic condition of company development in a competitive environment (8). In general, two major conceptual of innovations can be distinguished: innovation as a process encouraging change (the result of the emphasis on innovation); innovation as an event, object, or a discrete product characterized by novelty (3).

Innovation is widely regarded as one of the most important sources of sustainable competitive advantage in an increasingly changing environment, because it leads to product and process improvements, makes continuous advances that helps firms to survive, allows firms to grow more quickly, be more efficient, and ultimately be more profitable than non-innovators (9). According to Therrien et al. (10), innovation is a complex process related to changes in production functions and processes, whereby firms seek to acquire and build upon their distinctive technological competence, understood as the set of resources a firm possesses and the way in which these are transformed by innovative capabilities.

### Types of Innovation

Schumpeter (7) described different types of innovation: new products, new methods of production, new sources of supply, the exploitation of new markets, and new ways to organize business. It is also classified in two types as radical and incremental, according to its degree (11). Brouwer (12) also classified it under two main types, as product or process innovations. In relevant, Bessant and Tidd (13) distinguished four types of innovation are product innovation, process innovation, position innovation and paradigm innovation.

The current study is based on the classification of four types of innovation described in the Oslo Manual(4). The main types of innovations in accordance with OECD methodology can be summarized as follows adapted from Kotsemir et al. (14) (Table 1).

**Table 1:** Typology of innovation in the OECD methodology

| Type of Innovation | Field of Application | Distinctive Characteristic |
|---|---|---|
| 1. Product Innovation | Innovations related to goods and services. | Significant improvements in the technical specifications, components and materials in the embedded software in the degree of friendliness to the user or other functional characteristics. |
| 2. Process Innovation | Implementation of new or significantly improved methods of production or delivery of the product. | Significant changes in technology, production equipment and / or software. |
| 3. Marketing Innovation | Implementation of new methods of marketing, including significant changes in design or packaging of the product during its storage, market promotion and market-based prices. | Increasing in the degree of consumer satisfaction, creating new markets or new, more favorable market position for production companies to increase sales. |
| 4. Organizational Innovation | Implementation of new forms and methods of organization of business companies, the organization of jobs and external relations. | Implementation of business practices in the organization of workplaces or in the external relations previously used for organizational method that represents the result of the implementation of strategic decisions. |

## Taxonomy of Innovativeness

Midgley and Dowling (15) stated that innovativeness is conceptualized as the degree to which an individual adopts an innovation relatively earlier than others. It is as the notion of openness to new ideas as an aspect of a firm culture and propose an input based operationalization of innovativeness, i.e., innovativeness is measured based on its antecedents (16). In contrast, Damanpour and Evan (17) assert that an innovation is realized after implementation of a new idea. In line with this assertion, Damanpour (5) defines innovativeness as the rate of adoption of innovations and indicates that it is operationalized in many studies as the number of innovations adopted within a given period. This conceptualization of innovativeness has led to numerous studies that have an output based measure of innovativeness (18-20) i.e., innovativeness is measured based on realized innovations.

Innovation taxonomy by classifying companies according to their innovation is related to various types of innovation. Avermaeta et al. (21) focuses that the companies can be grouped into four categories: Non-Innovator, Traditional, Followers, and Leaders. Lehtoranta (22) says that the taxonomic analysis of innovation is based on the intensity of the proposed innovation which there is

three groups of companies: innovators intensive, persistent innovators, and innovators with the innovation.
This study bases taxonomy of innovation in a research of Kilic et al. (6) who used questionnaires distributed to the top managers of companies operating in six different manufacturing sectors (textiles, chemicals, metal products, machinery, household appliances and automotive industries) in the northern region of Marmara in Turkey. This concludes that there are four taxonomic innovations: Leading innovators, Followers, Inventors, and Laggers.

### Business Success

The growth of an enterprise has been operationalized by the measures of growth in sales and growth in profits, and especially public authorities are interested in the measure of growth in employment. Profitability has been measured by using profit margin, absolute profits and profits per employee while sales per employee have been used as a measure of productivity reflecting the internal efficiency of an enterprise (23). In this research, the business success is referred to business survival, employment growth, and sales growth.

## 3. Research Method

The purpose of the field study is to explore the links between innovation types and business success in the manufacturing industry. A survey questionnaire was based on Kilic et al. (6). The samples used for data collection are included the manufacturing companies in Tasikmalaya, West Java, Indonesia. A total of 58 manufacturing companies were selected from 9 manufacturing sectors (food and beverage, textile, garment, leather, wood, chemical, rubber and plastics, mining, and furniture). The questions are represented four types of innovation (product, process, marketing, and organizational) and three dimensions of business success (business survival, employment growth, and sales growth). These questionnaires are filled out by the operating managers / owners. The analytical tools used in this study are as follows:
1. Descriptive Analysis: The analysis used to generate an overview of the data has been collected based on the respondent's answer through the distribution of items.
2. Cluster Analysis: It is a technique to reduce the information. This information is on the number of objects reduced to a number of clusters where the number of clusters is smaller than the number of objects. The same objects are collected in a cluster that has a high degree of similarity in comparison with the objects of other clusters. Then, principally, this analysis is used to reduce the data that is explicitly as the process of summarizing a number of variables into fewer (into several clusters). This is because of the number of samples was under the number of 100 respondents (58 respondents), and this grouping is used to Hierarchical Clustering. This clustering method is agglomerative procedure. It gave the result that all industries in Tasikmalaya City would be one group. To this procedure, the method of Ward is to form a cluster based on the total squared deviation of each observation from the average cluster members. In this case, the value of the sum of the square is the objective function at the time of incorporation (Hair et al., 2006).
3. Analysis of Variance (ANOVA): After respondents are into their clusters, then test is done through ANOVA (Analysis of Variance) to know the difference, the next procedure of analysis is One Way ANOVA or it is called Factor Design which is one of the ANOVA statistic units. This is to test whether more than two independent populations has the average which is considered to be the same or difference. This tests the variability from each observed group and between Mean of group. By this variability, means of population can be concluded.

## 4. Findings and Discussion

### Descriptive Statistics Analysis

Based on descriptive statistical analysis as shown in Table 2, type of innovation most often carried out by companies in the manufacturing industries is Marketing Innovation with an emphasis on innovation promotion techniques. Second frequent type of innovation is the innovation process. This innovation is the innovation process often implemented in an industrial manufacturing companies prioritizing continuous improvement of production process. This is by identifying activities that do not have the added value as well as repair material suppliers that can produce higher quality results of output manufacturing.
The third is the type of incremental product innovation. This type of innovation is quite often done by manufacturing companies in Tasikmalaya City. The type of incremental product innovation focuses on experimental activities in the innovation component or material that can lower the cost of production, but can increase customer satisfaction. The fourth is Organizational Innovation. It demonstrates that organizational innovation is still quite rarely performed by companies manufacturing in the Tasikmalaya City. It shows that innovation organizational structure is very rarely done by most companies manufacturing industry in Tasikmalaya. They just do innovation at the level of coordination, human resource management, and innovation in enterprise information systems. The last innovation type which is still very rarely done by manufacturing companies in Tasikmalaya is Product Radical Innovation. This indicates that there are only few of manufacturing industries in Tasikmalaya city who rarely implement this type of innovation.

**Table 2** Descriptive Analysis

| Variable Innovation | Means |
|---|---|
| 1. Radical Product Innovation | 2.48 |
| a. Developing new products with techniques and specifications that are totally different from the previous | 1.11 |
| b. Developing new products with components and materials that are totally different from the previous | 2.85 |
| 2. Incremental Product Innovation | 3.37 |
| a. Introducing innovations in components and materials of existing products to improve the quality of the product | 3.05 |
| b. Introducing innovation in superior products to improve ease of use of the product and improve customer satisfaction | 3.65 |
| c. Introducing innovation in product components and materials available to lower the cost of the product | 3.40 |
| 3. Innovation Process | 3.35 |
| a. Determining and eliminating the activities in the production process that does not add value | 3.50 |
| b. Increasing the speed of delivery of logistics processes | 3.40 |
| c. Lowering the variable cost component in the production process | 3.41 |
| d. Improving delivery speed | 3.44 |
| e. Improving the quality of output in the production process | 2,99 |
| 4. Marketing Innovation | 4.25 |
| a. Updating the distribution channel | 3.99 |
| b. Updating techniques of pricing | 4.15 |
| c. Updating promotion techniques | 4.61 |
| 5. Organizational Innovation | 3.05 |
| a. Updating the organizational structure | 1.95 |
| b. Updating coordination system | 3.15 |
| c. Updating HR System | 3.61 |
| d. Updating the management of information system | 3.48 |

### Cluster analysis of innovativeness

Cluster analysis is done based on the object, in order to classify the respondents. In this case, the respondents are the manufacturing companies in Tasikmalaya City. They are classified into several groups according to the total number of respondents. It is based on similar characteristics of the industries. Grouping is occurred one by one and started from the most similar characteristics. To this fact, the manufacturing companies which have similarities in innovation types will form one group, while the companies which have many differences will be formed into other

groups.Based on cluster analysis using the Hierarchical Clustering by procedures agglomerative (Ward's method), the companies are resulted into four clusters. Cluster 1 (Leading Innovators) consists of 11 companies. Cluster 2 (Followers) consists of 30 companies. Cluster 3 (Inventors) consists of 12 companies, whereas Cluster 4 (Laggers) consists of 5companies.

**Table 3** Cluster Membership*

| Cluster | Respondent | Total |
|---|---|---|
| **Leading innovators (Cluster 1)** | 31, 41, 25, 19, 9, 20, 26, 34, 4, 37, 7. | 11 |
| **Followers (Cluster 2)** | 18, 1, 35, 49, 53, 13, 52, 15, 40, 55, 57, 14, 46, 56, 8, 48, 51, 29, 45, 50, 54, 23, 27, 58, 33, 43, 21, 42, 3, 17. | 30 |
| **Inventors (Cluster 3)** | 16, 36, 6, 30, 24, 11, 2, 22, 28, 32, 38, 10. | 12 |
| **Laggers (Cluster 4)** | 44, 47, 5, 39, 12. | 5 |

*Dendrogram using Average Linkage (Between Groups)

**Table 4** Innovation cluster and their innovativeness

| Innovativeness | Radical product innovations | Incremental product innovations | Process innovation | Marketing innovations | Organizational innovations |
|---|---|---|---|---|---|
| **Leading innovators (Cluster 1)** | 2.78 | 3.40 | 4.29 | 3.40 | 3.67 |
| **Followers (Cluster 2)** | 1.33 | 3.26 | 2.34 | 2.97 | 3.10 |
| **Inventors (Cluster 3)** | 3.06 | 2.03 | 2.30 | 2.03 | 2.85 |
| **Laggers (Cluster 4)** | 1.03 | 1.15 | 1.21 | 1.65 | 1.60 |

Leading Innovators are the cluster of companies that have a high average score for all aspects of this type of innovation. Companies that are in this cluster are more often implementing all types of innovation. Most of the manufacturing industries in Tasikmalaya City are in followers cluster. The cluster of followers shows the low radical product innovation. Followers prefer the type of incremental product innovation. They also do a quite strong organizational innovation. Inventors have the better innovativeness than the Laggers, but they are still lower than the leading innovators. If the leading innovators do almost all types of innovation, the inventors are more often to implement the type of radical product innovation. This cluster is also very much appreciated by the cluster of followers because they will immediately do the process innovation to be able to improvise from potential new product innovations resulted from the cluster inventors. Laggers are the lowest cluster in the power of innovation. It has the smallest scores compared to three other types of innovation. Cluster of Laggers rarely implements the new product innovations because it only imitates products. The companies are already comfortable with the existing conditions and feel that innovation requires a large investment fund with the results that do not necessarily provide a great advantage for them.

Analysis of Variance (ANOVA)

ANOVA tests the variability from each observed group and between Mean of group. By these two populations, the Mean of population can be concluded. The aim of this analysis in this research is to know whether there is the difference of business success between clusters of manufactures in Tasikmalaya City. The types of innovation group formed based on cluster analysis of manufactures are leading innovators, followers, inventors, and Laggers. In addition, the business success is measured by using the survival business level, employment growth, and sales growth.

Test of Homogeneity of Variance

The basic assumption from ANOVA is that all formed groups must have the same variance. To test this assumption, it can be noticed from the homogeneity test of variance by using Levene Statistics. The hypotheses used in homogeneity test variance are:

H0 : the four variance are the same

H1 : the four variance are different

The foundations of these are:

If probability > 0.05, H0 is accepted

If probability < 0.05, H0 is rejected

Variance Homogeneity Test is done to test the business success where there are three dimensions to measure. They are business survival, employment growth, and sales growth. To these three dimensions, variance homogeneity test is used to measure this success. The following table shows this description.

**Table 5** Variance Homogeneity Test of Business Success

| Business Success | Levene Statistic | Significance | Decision |
|---|---|---|---|
| Business Survival | 6.820 | 0.000 | Rejected |
| Sales growth | 0.247 | 0.863 | Accepted |
| Employment growth | 5.881 | 0.002 | Rejected |

From the One-Way ANOVA analyses, the business survival and employment growth for homogeneity test variance has the probability level < 0.05. It means that both of success measurement have no the same variance. Therefore, this does not fulfill the basic assumption of the test by using ANOVA where all groups must have the same variance. By this reason, survival business and employment growth cannot be used to test the difference of each group. However, the homogeneity test of sales growth from One-Way ANNOVA has the probability score > 0.05. This means that the success measurement by using the sales growth of all groups has the same variance which can be used to test the difference of each group. To know the means difference of each group, Post Hoc Test is used.

ANOVA Test

The hypotheses used in ANOVA test are:

H0 : the four innovation groups have the same average sales growth

H1 : the four innovation groups have the different average sales growth.

The foundations of the decision are:

- If F sum > F table 0.05, H0 rejected
- If F sum < F table 0.05, H0 accepted

From the result of ANOVA to the sales growth, F sum is 9.401 by the significance 0.000 and F table is 3.55. Therefore, H0 is rejected and H1 is accepted. This result indicates that the average of sales growth from the four types of innovativeness is significantly different.

Post Hoc Test

From ANOVA (F test), generally, it has been known that the four types of innovativeness have the difference in the business success (sales growth). To know this difference, it needs Post Hoc Test by using one of Tukey functions. The used hypotheses are:

H0 : Both groups have the same sales growth average.

H1 : Both groups have the different sales growth average.

The determination of this test is:

- If probability > 0.05, H0 is accepted
- If probability < 0.05, H0 is rejected

Based on Post Hoc Test output, it can be seen the difference between two clusters, as follows:

a. The means difference between leading innovators and followers

The probability score of the difference between leading innovators and followers is 0.000. Therefore, the probability is 0.000 > 0.05, than H0: is rejected. This means that the average of sales growth

between leading innovators and followers are significantly different.

b. The means difference between Leading innovator and inventors

The probability score of the difference between leading innovators and inventors is 0.122. The probability is 0.122 < 0.05, therefore, H0: is accepted. This means that the sales growth average between leading innovator and inventors are significantly the same.

c. The means difference between leading innovators and Laggers

The probability score of the difference between leading innovators and Laggers is 0.001. The probability is 0.001 > 0.05, therefore, H0: is rejected. This means that the sales growth average between leading innovator and laggers are significantly different.

d. The means difference between followers and inventors

The probability score of the difference between followers and inventors is 0.000. The probability is 0.000 < 0.05, therefore, H0: is rejected. This means that the sales growth average between followers and inventors types are significantly different.

e. The means difference between followers and Laggers

The probability score of the difference between followers and Laggers types is 0.092. The probability is 0.092 > 0.05, therefore, H0: is accepted. This means that the sales growth average between followers and Laggers are significantly the same.

f. The means difference between Inventors and Laggers

The probability score of the difference between inventors and Laggers is 0.000. The probability is 0.000 < 0.05, therefore, H0: is rejected. This means that the sales growth average between inventors and Laggers are significantly different.

Based on Post Hoc Test description, the recapitulation of it is as follows in table 5:

**Table 5:** The Post Hoc Test Result Recapitulation of Sales Growth

| Difference between Groups | Significance | Decision |
|---|---|---|
| Leading innovators - Followers | 0.000 | Difference |
| Leading innovators - Inventors | 0.122 | No Difference |
| Leading innovators - Laggers | 0.001 | Difference |
| Followers - Inventors | 0.000 | Difference |
| Followers - Laggers | 0.092 | No Difference |
| Inventors - Laggers | 0.000 | Difference |

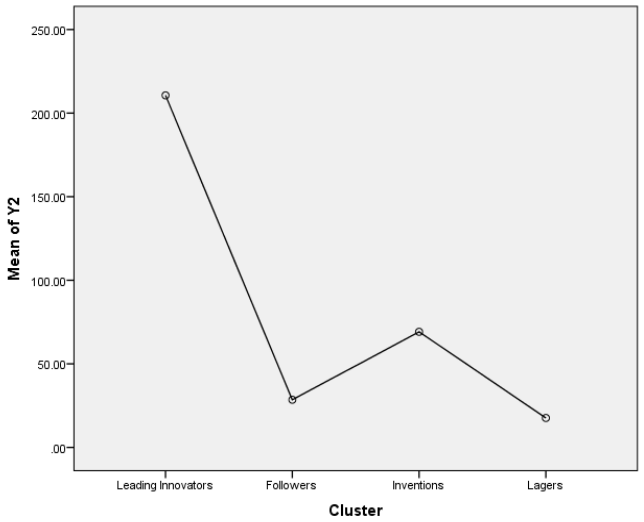



**Fig.1:** Means plots diagram of sales growth

The means plot diagram of sales growth show that the manufacture in Tasikmalaya City which has leading innovators cluster, has the highest means that the other three clusters. It is followed by inventors, followers, and Laggers which has the lowest means. These indicate that the leading innovators have the highest business success to the sales growth compared to the other types. These findings are relevant to Kelic et al. (6).

## 5. Conclusion

Based on the results of the cluster analysis of the manufacturing industry in Tasikmalaya City, there are four clusters of innovativeness: leading innovators, followers, inventors, and laggers. The Leading Innovators cluster, is as the outclass of others of innovativeness trying to nurture all innovation types. They especially give higher importance to radical product and process innovations. The Followers clusters prefer to develop incremental product innovations rather than radical product innovations. They are also relatively strong at organizational innovations. The Inventors perform better than the Laggers and worse the Leading Innovators in terms of all innovations types. On the other hand, the Inventors have very strong radical product innovations. The Laggers constitute the least innovative cluster. They have lowest scores in all innovation types among the clusters. They can be said that they do not even appreciate innovativeness as a component of company strategy.

Based One-Way ANOVA analysis, the business survival and employment growth for homogeneity test variance that both of success measurement have no the same variance. By this reason, survival business and employment growth cannot be used to test the difference of each group. However, the homogeneity test of sales growth from One-Way ANNOVA has the same variance which can be used to test the difference of each group.

Based on Post Hoc Test output, it can be seen the difference between two clusters. The means sales growth between leading innovators and followers are significantly different. The means sales growth between leading innovator and inventors are significantly the same. The means sales growth between leading innovators and Laggers are significantly different. The means sales growth between followers and inventors are significantly different. The means sales growth average between followers and Laggers are significantly the same. The means sales growth average between inventors and Laggers are significantly different. Based on the means plot of sales growth show that the leading innovators has the highest business success (sales growth) compared to the other clusters.

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