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Assessment of Managerial Innovation in Company X Using Fuzzy AHP

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Abstract

Company X is an Indonesian dairy company with a significantly large market share. The successes of its product innovation are highly linked with its managerial function, which indicates the existence of innovation in its company management. The company should understand the level of its managerial innovation and utilize its potential to produce product innovations continuously. This research aims to determine the company's level of managerial innovation to support product innovation accomplishments. The study utilizes two methods in determining managerial innovation levels. The first method is by measuring employee perception of managerial functions of the company through a survey. The second method is through direct observation of executive activities related to managerial functions using a prearranged observation protocol. The final managerial innovation score will be calculated using the Fuzzy AHP method. The study found that the company's managerial innovation level reached 57%, which is a relatively high level. The study also found that leading function is very innovative, while organization function should be improved to support better product innovations.

Keywords: *managerial innovation, management functions, fuzzy AHP*

INTRODUCTION

The X company is a food & beverage company that has become Indonesia's first UHT milk industry. The product has been developed since 1975 and has evolved consistently according to Indonesian's needs. Besides UHT milk, the X company is also developing other UHT beverages. The company has produced more than 60 UHT products, which gained market both in Indonesia and foreign countries (Ultrajaya, 2014 - 2018). The company's Management also consistently applied modern technology to support the packaging process, logistics, and IT (Ultrajaya, 2014 - 2018). With many years of experience in the UHT industry, producing a new downstream product with higher values was also supported by new technology in packaging and business process efficiency. As a result, the X company dominated the 49,5% market in the UHT milk segment. It can be concluded that this is an innovative company because it has developed many new products that were absorbed by the market (Silitonga & Sitepu, 2018)

Along with the increasing level of community welfare, demand for consumer goods also increased. This has led to the emergence of other manufacturers engaged in the beverage industry and becoming competitors for the company (Ultrajaya, 2014 - 2018). This impacts the decline in the company's market share since 2014.

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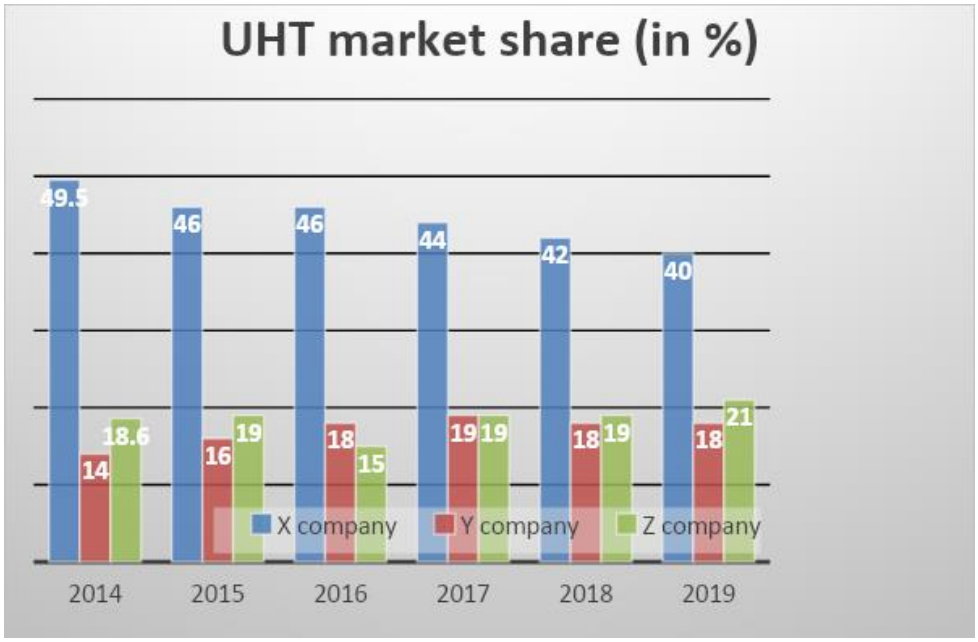

Figure 1. UHT milk's market share (in %) (Ultrajaya, 2014 - 2018)

Compared to the level of consumption of liquid milk, Indonesia has increased the level of consumption of liquid milk. If this decline in market share continues, the company's revenue will be affected because, based on the company's public exposure, 71% of the company's income comes from UHT milk (Ultrajaya, 2017 - 2019).

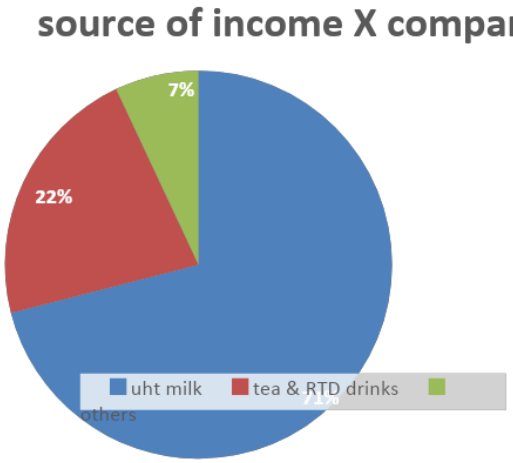

Figure 2. Source of income (Ultrajaya, 2017 - 2019)

The decline condition indicated that the company products reached maturity (Vernon, 1966). If the company does not innovate, the product will reach the decline stage, where the market is no longer interested in the product dying (Vernon, 1966). On the other hand, innovation to the product or process will attract consumer interest (Hartono, 2018), making the company superior to other companies (Joe Tidd, 2009). Therefore, it is crucial to conduct research related to managerial innovation in the X company. By knowing the level of managerial innovation, the X company will be able to utilize its potential optimally so that its product does not reach the decline stage and remain

a market leader for UHT milk in Indonesia. The measurement of managerial innovation level has been presented by (Ayhan & Oztemel, 2014) in manufacturing companies. The study measured managerial innovation based on the evolution of managerial functions: planning, organizing, leading, controlling, and coordinating. Found in these five functions, the level of the managerial functions is determined using the results of the questionnaire and observations applied to the company. The result showed that the innovation score for the manufacturing company was below 50%, but it was not explained how to measure the weight of managerial functions. (Silitonga & Setiawati, 2018) has demonstrated the measurement of managerial function weights using AHP pairwise comparison. This method is easy to use in multiple criteria decisions. However, the AHP also produced wrong choices, and the results are uncertain due to observations that produce subjective data (Emrouznejad & Ho, 2018). Therefore, in this research, the Fuzzy AHP method was selected. This method is better because it reduces the uncertainty that arose in decision making with the ordinary AHP (Emrouznejad & Ho, 2018) and covered weaknesses in ordinary AHP regarding subjective criteria (Irawan, 2018).

The purpose of the study is to measure the managerial innovation level of the company based on the evolution of managerial functions, and the measurement of managerial function weights is proceed using Fuzzy AHP.

LITERATURE REVIEW

Managerial innovation is the company's ability to change and handle changes that occur in its managerial structure so that it can be in line with a company's development in the most appropriate way. To deal with these changes, managerial innovation needs to be measured by analyzing the level following the stages of managerial evolution. Managerial evolution occurs in five managerial functions: planning, organizing, leading, controlling, and coordinating (Sutisna, 2019). The measurement is done by giving weight to the five existing managerial functions. As explained by (Silitonga & Sitepu 2018), the greatest importance is given to the most modern managerial functions. The measurement's final value will demonstrate the potential size of the company's managerial innovation—the higher the value, the greater the company's potential for innovation.

Figure 3. Managerial Function Evolution

Figure 3 shows the evolution of managerial functions. Again, the value of managerial innovation will be higher if the organization's position increases to the right—the further the right position, the greater the company's potential to innovate.

An organization's measurement of managerial innovation level can be measured with the method developed by Ayhan and Oztemel (Ayhan & Oztemel, 2014), where companies with great potential in innovation are companies with managerial innovation scores above 50%. This innovation score

is based on the level of evolution of managerial function that has been given a weighting for each of these functions. The weight for each function will be shown in Table 1. Thus, the managerial function is seen from its evolution in the company, and the value of innovation is obtained by making direct observations.

Table 1. Weight for each managerial functions

Manufacturing Management Types	Planning	Organizing	Leading	Controlling	Coordinating
Pre Scientific Management (20)	Rules (1)	Product (1)	Dictation (1)	If required (1)	Direct (1)
Departmental Management (21)	Procedures (2)	Departmental (2)	Hierarchical (2)	Scheduled (2)	Hierarchical (2)
Process Management (22)	Planned Processes (4)	Processes (4)	Supportive (4)	Flexible (4)	MIS (4)
Management by Objective (23)	Programs (8)	Customer (8)	Participatory (8)	Continous (8)	Internet (8)
Virtual Management (24)	Rolling plans (16)	Territory (16)	Esteemed (16)	Aggregated (16)	AI (16)

Analytic Hierarchy Process (AHP) is a broadly applied multi-criteria decision-making method to determine the weights of criteria and priorities of alternatives in a structured manner based on pairwise comparison. As subjective judgments during comparison might be imprecise, fuzzy sets have been combined with AHP. This is referred to as fuzzy AHP or FAHP (Liu, Eckert, and Earl, 2020). Fuzzy AHP is a method with a fuzzy concept approach. FAHP covers the deficiencies arising from the usual AHP method that is many subjective traits problem that occurs in assessment criteria (Chan, Kai, Wang, & Xiaojun, 2013). Uncertainty is presented in order of scale. To determine FAHP degree of membership, function rules are used in a Triangular Fuzzy Number (TFN), which is arranged based on the linguistic set.

METHODOLOGY

The study uses questionnaires and observations to assess the managerial innovation level. The questionnaire will find the weight of each management function, while the observation will decide the level of each management function. To obtain the capability of innovation in each managerial function, the results of each observation must be included in the following equation:

$$C_i = \frac{\sum_{j=1}^{5}(b_j . n_{ij})}{n_i . 16} \quad (1)$$

Where:
i : type of managerial function
j : evolution category

C_i : managerial function innovation capability at - i
b_j : evolution weight of managerial function at - j
N_{ij} : the sum of managerial function categories at column i row j.
n_i : the sum of managerial category functions at-i

The equation can determine the percentage of managerial innovation level:

$$\delta MI = \frac{\sum_{i=1}^{5}(W_i . C_i)}{\sum_{i=1}^{5} W_i} \quad (2)$$

Where:
δMI : level of managerial innovation
C_i : managerial function innovation capabilities at - i
W_i : managerial functions weight at-i
for i = 1: Planning 4: Controlling
2: Organizing 5: Coordinating
3: Leading

The questionnaire analysis to determine the weight of each management function is done by Fuzzy AHP. The scale of the triangular fuzzy number is shown in the table below:

Table 2. Triangular Fuzzy Number Scale (Chan, Kai, Wang, & Xiaojun, 2013), (Irawan, 2018)

The intensity of interest AHP	Linguistic Set	Triangular Fuzzy Number (TFN)	Reciprocal (reverse)
1	just equal	(1, 1, 1)	(1, 1, 1)
2	intermediate	(1/2, 1, 3/2)	(2/3, 1, 2)
3	One element moderately important than others	(1, 3/2, 2)	(1/2, 2/3, 1)
4	one element more important enough than others (intermediate)	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
5	One element strongly important than others	(2, 5/2, 3)	(1/3, 2/5, 1/2)
6	intermediate	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)
7	One element very strong than others	(3, 7/2, 4)	(1/4, 2/7, 1/3)
8	intermediate	(7/2, 4, 9/2)	(2/9, 1/4, 2/7)
9	One element extremely strong than others	(4, 9/2, 9/2)	(2/9, 2/9, 1/4)

Steps to solve the problem with the F – AHP method:

1. Arrange the hierarchy structure of the problem and determine the pairwise matrix comparison between criteria with a triangular fuzzy number (Table 3).
2. Determine the priority fuzzy synthesis value (Si) using the following equation:

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \times \left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \quad (3)$$

where:

S_i = fuzzy synthesis value

$\sum_{j=1}^{m} M_{gi}^{j}$ = Sum of the values of each TFN number in the cell column in the matrix

$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$ = Invers value from sum of all TFN

i = row

j = column

Value of $\sum_{j=1}^{m} M_{gi}^{j}$ obtained from fuzzy m addition on a matrix with the following equation:

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j \, , \sum_{j=1}^{m} m_j \, , \sum_{j=1}^{m} u_j\right) \quad (4)$$

where:

$\sum_{j=1}^{m} l_j$ = number of cells in the 1st matrix column (lower value)

$\sum_{j=1}^{m} m_j$ = number of cells in the 2nd matrix column (median value)

$\sum_{j=1}^{m} u_j$ = number of cells in the 3rd matrix column (upper value)

To obtain value of $\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$, all number of TFN from M_{gi}^{j}

(j = 1, 2, ..., m) must be add first like following equation:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right] = \left[\sum_{i=1}^{n}\sum_{j=1}^{m} l_{ij} \, , \sum_{i=1}^{n}\sum_{j=1}^{m} m_{ij} \, , \sum_{i=1}^{n}\sum_{j=1}^{m} u_{ij}\right] \quad (5)$$

Invers from equation (5) is:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i, \sum_{i=1}^{n} m_i \, , \sum_{i=1}^{n} l_i}\right) \quad (6)$$

a. Comparison of possible degrees between fuzzy numbers

A comparison is made to find the value of membership degree for each weight in each managerial function. For example, there are two triangular fuzzy numbers $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$. Comparison of possibility degree $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ can be defined as vector value, so the value can be obtained by comparing $V\ (M_2 \geq M_1)$ with equation below:

$$V(M_2 \geq M_1) = \begin{cases} 1 & , \quad if\ m2 \geq m1 \\ 0 & , \quad if\ l1 \geq u2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & , \quad other\ than\ above \end{cases} \qquad (7)$$

b. If the result of the function value is greater than k fuzzy, M_i $(i = 1, 2, \dots, k)$ which can be defined as:

$$V\ (M \geq M_1, M_2, \dots, M_k) = V\ [(M \geq M_1)\ and\ (M \geq M_2)\ and \dots (M \geq M_i) = min\ V\ (M \geq M_i) \qquad (8)$$

where:

V = vector value

M = fuzzy synthesis value matrix

l = lower

m = median

u = upper

So that the ordinate value (d') is obtained as follows:

$$d'\ (A_i) = min\ V\ (S_i \geq S_k) \qquad (9)$$

where: S_i = fuzzy synthesis value one

S_k = fuzzy synthesis other value

for $k = 1, 2, \dots, n;\ k \neq i$, the priority weight vector value (W'):

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))T \qquad (10)$$

The results of the ordinate value (d') are shown in the figure below.

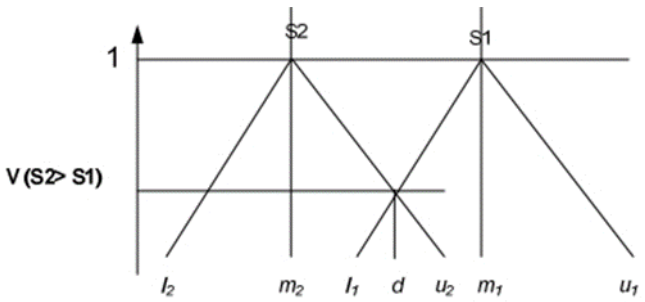

Figure 1. Intersection graph between $\boldsymbol{S_1}$ and $\boldsymbol{S_2}$

Normalization of vector weights or managerial function priority values that the formula has obtained:

$$W = (d\ (A_1), d\ (A_2), \dots, d\ (A_n))T \qquad (11)$$

Where W is unfuzzy numbers.

Data was collected from 19th February 2020 until 1st March 2020. Data were collected using a questionnaire distributed to employees in several departments and by doing observation of the leaders in the company using an observation protocol (Yin, 2017). The questionnaire consists of questions that will determine critical success factors. The sampling technique used in this questionnaire is purposive sampling, and the question will use 4 – point Likert scales. The scale will reduce the bias from the respondent's psychology (Johnson, 2016). Meanwhile, the observation protocol was arranged before the research started. The protocol explained about measurement dimension, scoring index and theoretical background explanation.

FINDINGS AND DISCUSSION

The weights of each management functions, after processing the quesionaire with Fuzzy AHP, are presented below:

Table 3. Final weights of the main criteria

Criteria	Weight	Percentage (%)
Planning	0,2	20%
Organizing	0,2	20%
Leading	0,2	20%
Controlling	0,2	20%
Coordinating	0,2	20%
Total	1	100%

Based on observation, the level of innovation capability obtained for the 5 elements of the organizing function as follows:

a. Product-based, process-based, customer-based, and territory-based not shown during observations.

b. department Based (12,5%), shows through organization structure arranged based on the functional department.

According to observation results, there is one scoring category of assessment for organizing function, so the total weight is 1 x 16 = 16.

Table 4. Calculation of capabilities and weight of organizing function

Organizing		PB	DB	PC	CB	TB
Total categories	1	0	1	0	0	0
Weight total	16	1	2	4	8	16
capabilities		0,00%	12,5%	0,00%	0,00%	0,00%
Innovation of organizing		12,5%				

Based on observation, the level of innovation capability obtained for the 5 elements of the leading function as follows:

a. Dictative, Hierarchical, dan Supportive, not shown during observation.

b. Participatory (16,67%), shows through weekly work targets discussion, once every two weeks.

c. Esteemed (66,67%), shows through outbound activities, once every month. Leaders also invited employees to play badminton. Training usually used video to explain the topic.

According to observation results, there are six scoring categories of assessment for leading function, so the total weight is 6 x 16 = 96

Table 5. Calculation of capabilities and weight of Leading function

Leading		D	H	S	P	E
Total categories	6	0	0	0	2	4
Weight total	96	1	2	4	8	16
capabilities		0,00%	0,00%	0,00%	16,67%	66,67%
Innovation of leading		83,33%				

Based on observation, the level of innovation capability obtained for the 5 elements of controlling function as follows:

a. If Required, Scheduled, dan Flexible, not shown during observations

b. Continous & Self Control (20%), shows through standard operational training that has been done to operators about tool maintenance.

c. Aggregated (60%), shown through routine planning every year, yearly employee gathering, and integrated system with ERP.

According to observation results, there are five scoring categories of assessment for controlling function, so the total weight is 5 x 16 = 80

Table 6. Calculation of capabilities and weight of controlling

Controlling		IR	SC	FL	CN	AG
Total categories	5	0	0	0	2	3
Weight total	80	1	2	4	8	16
Capabilities		0,00%	0,00%	0,00%	20%	60%
Innovation of controlling		80%				

Based on observation, the level of innovation capability obtained for the 5 elements of coordinating function as follows:

a. Direct dan Hierarchical not shown during observations

b. Management Information System (12,5%), shown through an integrated company business process through ERP Oracle, every staff and employees connected into Oracle, also fingerprint system for attendance.

c. Internet (33,33%), shown through activities supported by the internet, like Oracle.

According to observation results, there are six scoring categories of assessment for coordinating function, so the total weight is 6 x 16 = 96.

Table 7. Calculation of capabilities and weight of Coordinating function

Coordinating	D	H	M	I	AI

Total categories	6	0	0	3	4	1
Weight total	96	1	2	4	8	16
Capabilities		0,00%	0,00%	12,50%	83,33%	16,67%
Innovation of coordinating		62,5%				

Finally, after knowing the capabilities of managerial innovation and result from the questionnaire, the level of innovation can be calculated by multiplying capabilities with the weight of each innovation function.

Table 8. Calculation of Innovation Level

Management Function	Capabilities of Innovation Function	Weight of Innovation Function
Planning	64,58%	20%
Organizing	12,5%	20%
Leading	83,33%	20%
Controlling	80%	20%
Coordinating	62,5%	20%
Managerial Innovation Level	57%	

Based on the capabilities and function weights obtained, the result of the managerial innovation level of the company is 57%. It means that in general the company will be able to keep abreast of the existing managerial innovations and can innovate more to become superior compared to other similar companies.

The importance of weight score for all managerial functions is 20%. This means that all functions are equally important so that there are no greater functions than other functions. Based on the above tables, 4 out of 5 managerial functions have innovative potential because the score is above 50%. The biggest score is 83,33% came from a leading function, which means this function is the most crucial thing in the company. The lowest score is the organizing function because it is below 50%.

Leading is the most innovative out of all the other functions. The leading style in the company leans toward participatory and esteemed elements. Participatory element can be observed through the company's routine weekly meeting on their work targets and biweekly meetings attended by the managers. Esteemed element can be observed through monthly outbound activities. Company leadership also often invite employees to sport sessions. Other esteemed elemnt can be seen through trainings and meetings with employees via video calls.

The organizing function has the lowest score, it means that this function is not supporting the innovation. Currently, the company structure is still at the department-based level because it is divided into several department functions. However, it must cover global wide monitoring, because of its export. The company should move to the next level of the evolution, into teritory based and or customer based organizational structure.

CONCLUSION AND FURTHER RESEARCH

The score of managerial innovation for company X is 57%. The company has innovated in planning, leadership, control, and coordination because these four managerial functions have scores above 50% and can be innovative. Meanwhile organizing function has the lowest score. Organizing function can be improved by converting the organization structure from function-based organization to teritory-based and or customer-based organization. Further research should explore the correlation between managerial innovations dan product innovations.

REFERENCES

Ayhan, M., & Oztemel. (2014). A Methodology to Measure the Degree of Managerial Innovation. Journal of Industrial Engineering and Mangement.
Azwar, S. (1986). Seri Pengukuran Psikologi: Reliabilitas dan Validitas Intepretasi dan Komputasi. Yogyakarta: Liberty.
Chan, Kai, H., Wang, & Xiaojun. (2013). Fuzzy Hierarchical Model for Risk Assessment. London: Springer.
Drucker, P. F. (2015). Innovation and Entrepreneurship. London: Taylor & Francis Ltd.
Emrouznejad, A., & Ho, W. (2018). Fuzzy Analytic Hierarchy Process. Newyork: Chapman and Hall/CRC.
Hartono, Y. E. (2018). Analisis Inovasi Produk X di PT. Nutrifood Indonesia. Jurnal Mahasiswa Manajemen Bisnis Agora, 6 (1).
Hidayati, K. (2012). Validasi Instrumen Non Tes dalam Penelitian Pendidikan Matematika. Prosiding Jurusan Matematika FMIPA UNY, 503 - 511.
Irawan, V. S. (2018). Analisis Penentuan Kriteria untuk Mengevaluasi Kinerja Supplier dengan Menggunakan Metode Fuzzy AHP. Bandung: Institut Teknologi Harapan Bangsa.
Joe Tidd, J. R. (2009). Managing Innovation: Integrating Technological, Market and Organizational Change. Chichester: John Wiley & Sons.
Johnson, R. L. (2016). Survey Scales: A Guide to Development, Analysis, and Reporting. New York: The Guilford Press.
Saaty, T. L. (2008). Decision Making with The Analytic Hierarchy Process. Int. J. Services Sciences, 1 (1), 83-98.
Liu, Y., Eckert, C. M. & Earl, C. (2020). A Review of Fuzzy AHP Methods for Decision-Making with Subjective Judgements. Expert Systems with Aplications, 161.
Silitonga, R. Y. H., & Setiawati, M. (2018). Assessment of Managerial Innovation in Manufacturing Company. IPTEK Journal of Proceedings Series.
Silitonga, R. Y. H., & Sitepu, T. E. (2018). Manajemen Inovasi Teknologi. Yogyakarta: Andi.
Sutisna, A. J. (2019). Dua Faktor Penentu Keberhasilan Sebuah Proses Inovasi. Jurnal Inovasi dan Bisnis, 7(1), 1-7. doi: https://doi.org/10.35314/inovbiz.v7i1.911
Trott, P. (2017). Innovation Management and New Product Development. Kingdom: Pearson.
Ultrajaya. (2014 - 2018). Annual Report.
Ultrajaya. (2017 - 2019). Public Expose.
Vernon, R. (1966). The Product Life Cycle. Quarterly Journal of Economics, 121-140.
Yin, K. R. (2017). Case Study Research and Applications: Design and Methods, Thousand Oaks. USA: Sage Publications.