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Green Supply Chain Productivity Modeling for Oyster Mushrooms Agroindustry Improvement

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ABSTRACT: Oyster mushrooms agroindustry in Indonesia have been potential in an effort to support local economic development. The objectives in this paper are to analysis the requirement of system design green productivity oyster mushrooms supply chain, to select the important attributes and to determine development strategies for increased green productivity. In order to analyze the requirement system, use case diagram and Business Process Model and Notation (BPMN) were used in this paper. Relief method was used to select the important parameter attributes which sufficiently describe environment variables affecting the upstream and downstream supply chain of oyster mushroom. Then, to establish the rule in the formation of strategy formulation, Association Rules Mining was applied. The results are analysis in this paper system with BPMN business flow diagram can describe the system more easily. Relief method shows that the most important economic variable is sawdust. Association Rules Mining shows that economic variables with high corn and high ring was produced low sawdust with 100% confidence level and support value of 0.167 This research is expected to facilitate prediction of strategy to increase productivity oyster mushroom agroindustry based on existing environment condition.

KEYWORDS*:* Association Rules Mining, Green Productivity, Oyster Mushrooms, Relief, Supply Chain

INTRODUCTION

The development of the oyster mushroom industry is currently growing rapidly along with the changing paradigm of people in consuming fruits and vegetables. Consumer demand in vegetable consumption can only be met by oyster mushroom farmers by 2015 amounting to 3% of total demand for vegetables in Indonesia (Direktorat Jenderal Bina Produksi Hortikultura 2015). In this case the company is required to continue to improve performance in order to compete with various other agroindustries. Along with the increase of production, have many environmental problems. The problem is caused by the production process often result in the disposal of materials and Emision that will burden the environment, whereas good production processes not only attention to the safety and side effects of waste waste process, but also reduce waste generated. This problem is also often ignored by the oyster mushroom agroindustry, whereas now the environmental issues become quite warmly discussed. Therefore, it is very important for oyster mushroom agroindustry attention to environmental aspects in each production process implemented in order to create suitability with the surrounding environment, and also organic agriculture should sustain and enhance the health of soil, plant, animal, human and planet as one and be indivisible. It should be based on living ecological systems and cycles, work with them, emulate them and help sustain them (Adiprasetyo *et al. 2015*).

To improve productivity while reducing environmental impacts, the Green Productivity method can be an approach to help companies deal with existing problems. Thus, the application of this method is expected to increase productivity by minimizing waste and reduce the impact on the environment. Green productivity (GP) is a strategy to increase company productivity and environmental performance simultaneously in overall socioeconomic development (Asian Productivity Organization 2001). Green productivity is an application of the right techniques, technology and management system to produce environmentally friendly products or services. GP reconciles two needs that are always in conflict, namely the business needs to generate profit and the needs of everyone to protect the environment. GP is not just an environmental strategy, but a total business strategy.

In fact, that when GP is implemented, companies will experience productivity improvements through reduced spending on environmental protection, such as resource depletion, waste minimization, pollution reduction and better production. From here, the company can achieve higher productivity and protect the environment that will lead to sustainable development. This includes the use of products and services that can meet basic human needs and improve quality of life. The entire life cycle of this product should be based on the minimization of the use of natural resources and toxic substances that can lead to emissions.

The definition of Productivity itself is the ratio (ratio) between output per input (Wignjosoebroto & Sritomo 2015). ith the knowing of productivity, it will also be known how efficiently the input sources have been successfully saved. Over the last few decades, productivity is a fairly popular term, and according to the fact that productivity has become a national economic priority. In a micro level, increased productivity means enhancing the company's competition and better quality of life. Then an indicator can be defined as a parameter or a measurable amount based on the amount examined or calculated. An environmental indicator is one thing that is expected to reflect on the impacts of an activity on the environment and efforts to reduce it. For the selection of solutions from existing alternatives, the relief method is used.

Relief algorithms are an effective, simple, and widely used approach to measuring feature weights. The weights for the measurement vector feature are defined in terms of feature relevance. In probabilistic interpretation the relief is made to state that the weight indicates in a propositional feature with the difference between two conditional probabilities. Both of these probabilities are the value of different features conditioned on the nearest nearest kesalahn and the closest takings. Thus, the relief typically performs better than any other filter-based approach due to feedback from the nearest alternative classifier.

Productivity is enhanced by the selection of appropriate strategies to run optimally within the company. In the preparation of strategy will be used method of Associate Rule Mining ARM method. Association rule mining is one method of data mining that can identify relationships between items (Han *et al.* 2012). In this method it takes an algorithm to find candidates for association rules. One common algorithm used is an a priori algorithm. The merit of association rules with this a priori is simpler and can handle large data. While other algorithms have a weakness in the use of memory when the amount of large data, of course, affect the number of items processed. The importance of the rules of association can be identified by two parameters, minimum support (percentage of item combinations in the database) and minimum confidence (both strong relations between items in associative rules), both determined by the user (Will 2009). The use of a priori is aimed to find association rule in simulation of increasing productivity of oyster mushroom agroindustry with green productivity approach.

In this study, will conduct research by creating a system that applies the method of association rule mining as a strategy simulation tool. Variables contained in the data is the result of the selection with the method of relief which is then prepared with the approach of green productivity. The approach taken is to look for similarities between items on each transaction. Then formed associative rules based on these similarities. Associative rules serve as a reference in weather precision in this study.

MATERIAL AND METHOD

A. Thinking Framework

System analysis to know the description of the repair process productivity supply chain. This system analysis is simulated by modeling design and system consisting of requirement analysis, use case diagram, and BPMN. Design and system design using sybase PowerDesigner® v16.0 tools to perform system analysis. The steps in making the system can be seen in figure 1.

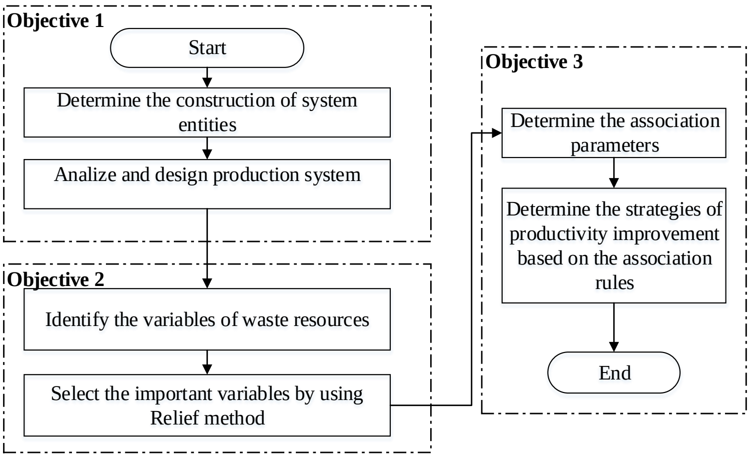


Figure 1. Stages of system formation

B. Needs Analysis

Needs analysis by determining inputs (Acceptable and Unacceptable), stakeholders, and controls needed to achieve system goals. Steps in needs analysis include identifying and making system requirements, prioritizing system requirements, updating project plans and communicating system requirements.

C. Use Case Diagram

Use case diagram is a graphical representation in which a set of use cases is covered by system boundaries, communication (participation) relationship between actors based on system to be improved.

D. Process Hierarchy Diagram (PHD)

PHD is a graph that analyzes business functions as a process hierarchy to help decipher subprocesses in the system.

E. Business Process Model Notation (BPMN)

BPMN is a graphical notation that can represent a stream of business processes. BPMN is used as a modeling process in a system. In BPMN requires having successive business process activities.

F. Input Details

In this paper that will be done to improve the system that is by conducting analysis and design system improvement of environmental productivity supply chain oyster mushroom agroindustry. In analyzing and designing this system, seven variable sources of waste generation (waste) are used in the production activities in an activity of added value that is Emision consumption, water consumption, waste material, waste, transportation, emission and biodiversity (Kira *et al.* 1992).

The definition of the system in this paper is a unity of elements that are integrated through input in the form of supply chain productivity elements with green productivity approach based on environmental indicators elements in the form of seven sources of waste generators operated by using Relief and Association Rules Mining method to produce output in the formulation of strategies to increase productivity chains Supply of oyster mushrooms that are synergistically conducted by stakeholders involved in the researcher, farmer, oyster mushroom agroindustry and government. To produce the system required analysis entisas forming system. The entity-forming system diagram can be seen as figure 2:

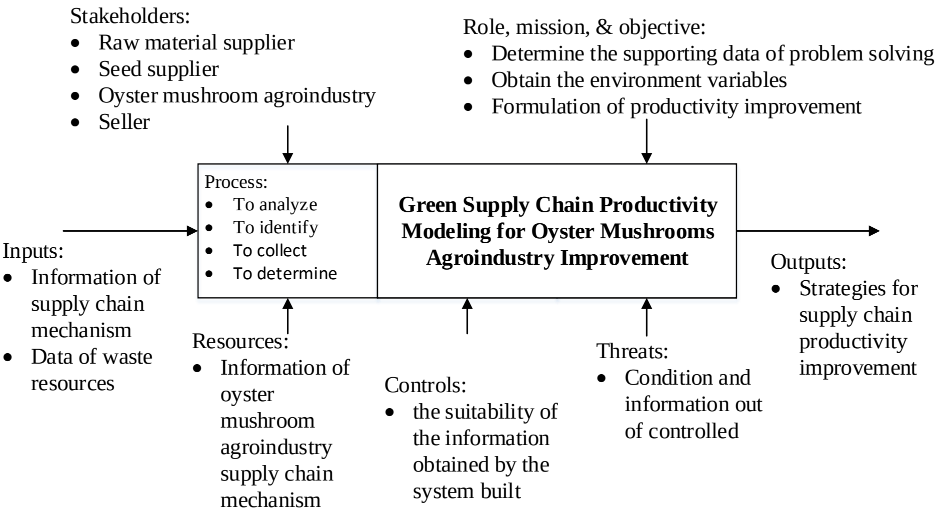


Figure 2. Need Analysis System & Design

G. Formulation Process

Relief

Identification of the most influential environmental variables on increasing productivity of the supply chain of oyster mushroom agro industry starting from the formulation of the concept of the problem and the identification of seven sources of waste generation from upstream and downstream sectors.

In this paper the data used are dummy data from seven variable sources of waste generating materials, waste, transportation, biodiversity, water, emission and Emision. An analysis of seven sources of waste generation is conducted to identify the flow of green materials. Through this identification, it is found that the source data material that influences as a source of waste generators, which then used as a basis in the formulation of strategies to increase supply chain environmental productivity.

Preprocessing data by using relief consists of the stages of data normalization, the calculation of the weight value of each variable and ranking. Normalization of data is the process of normalizing the data so that the distance between attributes is not much different. Normalization of data is done by using the following formula:

$$x_i' = \frac{Xi - \min i\,(Xi)}{max_i\,(Xi) - min_i\,(Xi)}$$

Relief is one of the feature selection methods. The relief algorithm works by random sampling by finding the location of the nearest feature of the same class (hit) and opposite (miss). The relief algorithm is generally as follows (Niu & Chen 2013):

Relief (δ, m, τ)

Separate δ^- *(negative instance) dan* δ^+ *(positive instance)*

W = (0, 0,... 0)

For i = 1 to m

Pict at random an instance X∈

Pict at random one of positive instances

Closest to X, $Z^- \in \delta^+$

Pict at random one of positive instances

Closest to X, $Z^+ \in \delta^-$

If (X is intance positif)

Then Near-hit = Z^+*, Near-miss =* Z^-

Else Near-hit = Z^-*, Near-miss =* Z^+
Update-weight (W,X,Near-hit, Near-miss)
Relevance= (1/m)W
For i=1 to p
If (relevance $\in \tau$*)*
Then f_i *is a relevant feature*
Else f_i *is a irrelevant feature*
Update-weight (W, X, Near-hit, Near-miss)
For i = 1 to p
Wi= Wi – diffi (Xi, near-hit$_i$*)+ diffi (Xi, near-miss*$_i$*)*

Association Rule Mining

Data mining is a generic term which cover research results, techniques and tools used to extract useful information from large database (Agrawal & Srikand 1994). Association rules is one the mot populer data mining techniques widedly used for discovering interestring association and corelations as between data elements in a diverse range of application (Kusrini & Emha 2009). Associated analysis is also known as one of the data mining techniques that became the basis of one of the other data mining techniques. In particular, one of the stages of association analysis that attracted the attention of many researchers to produce an efficient algorithm, namely the analysis of frequent pattern mining (Han *et al.* 2006).

In general, the association rule has the form: LHS => RHS where LHS and RHS are set items; If any items in the LHS are contained in the transaction then the items in the RHS are also contained in the transaction. Association rules are usually expressed in forms (Tan *et al.* 2006):

{A, B} => {C} (support = 10%, confidence = 50%)

This method uses data from the three ranking variables in the relief method. The stages to form rules by using association rules are:

1. Calculate the bond value

Obtained conjunctive and disjuctive value to then get bond value

$$Bond\ (AB) = \frac{P\ (A \land B)}{\Sigma AVB}\ x\ 100\%$$

$\Sigma A\Lambda B$ = *Conjunctive*

ΣAVB = *Disjunctive*

2. Calculate the support value

$$Support\ (AB) = \frac{P\ (A \land B)}{\Sigma n}\ x\ 100\%$$

3. Calculate the confidence value

$$Confidence\ (A \rightarrow B) = \frac{P\ (A \land B)}{Conjunctive\ (A)}\ x\ 100\%$$

4. Calculate the lift value

$$Lift\ (A,B) = \frac{Support\ (A,B)}{Support(A) \times Support(B)}$$

5. Calculate the conviction value

Conviction (A→B)

$$= \frac{1-\text{supp(B)}}{1-\text{conf(A→B)}}$$

$$= \frac{\text{P(A)P(\sim B)}}{\text{P(A}\cap\sim\text{B)}}$$

=((Support(A)×Support(~B))/Support(A→~B))×100%

6. Calcculate the leverage value

Leverage (A→B)

$= \text{P}(\text{A} \cap \text{B}) - (\text{P}(\text{A})\text{P}(\text{B}))$

= (*Support* (A→B) (*Support*(A) × *Support*(B))) ×100%

7. Determines Top-10 association rules

$= Value\ supp\ x\ Value\ conf$

8. Formulate association rules into mathematical models

$R_n = \{A_1^n\} \rightarrow \{Y^n\}$

In this paper the algorithm used to form association rules is by using a priori algorithm. Priori algorithm is an algorithm used for mining frequent itemset using boolean association rules (Niu & Chen 2013). Here is the a priori algorithm (Agrawal & Srikand 1994):

$k = 1$
$F_k = \{i \mid i \in I \land \sigma\ (\{i\})N \times minsup\}.$
$\{Find\ all\ frequent\ 1 - itemsets\}$
$repeat$
$k = k + 1$
$C_k = apriori - gen\ (F_{K-1}).$
$\{Generate\ candidate\ itemsets\}$
$for\ each\ transaction\ t\ \in T\ do$
$C_t = subset(C_k, t).$
$\{Identify\ all\ candidates\ that\ belong\ to\ t\}$
$for\ each\ candidate\ itemset\ c\ \epsilon\ C_t$
$do\ \sigma\ (c) = \sigma\ (c) + 1. \{Increment\ support\ count\}$
$end\ for$
$end\ for$
$F_k = \{c \mid c \in C_k\ \land\ \sigma\ (c) \geq N \times minsup\}.$
$Extract\ the\ frequent\ k - itemsets\}$
$until\ F_k = \emptyset$
$Result = \cup\ F_k$

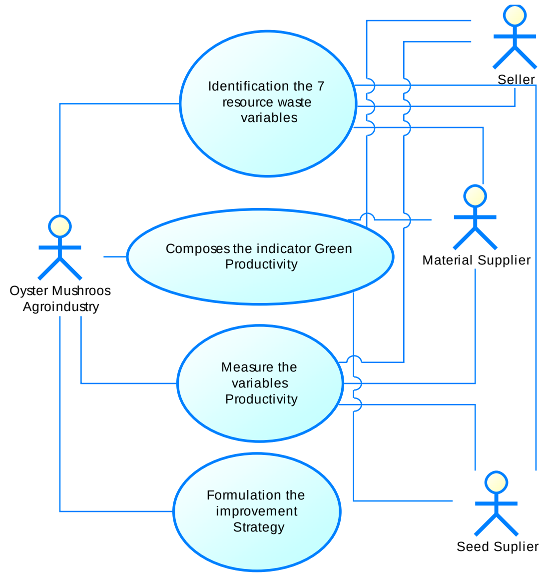
H. Verification and Validation

Verification is done by checking whether the system design improves the supply chain productivity of oyster mushrooms. Analysis of systems that are created by being implemented correctly or not. Verification is obtained in the software used. Validation can be done using a method approach will be used to demonstrate and ensure the system that meets the operational needs.

RESULTS AND DISCUSSION

A. System Analysis

System analysis consists of needs analysis, use case diagram, PHD and BPMN. The needs analysis of this system consists of inputs, stakeholders, resources, threats, roles, required processes and expected outputs within the system. The use case describes the relationship between stakeholders consisting of researchers, oyster mushroom agroindustry, suppliers and government related to their respective functionalities following use case diagrams in the system of increasing supply chain productivity of onion agroindustry.



Figuere 3. Use case diagram

In systems analysis, modeling function BPMN flow of business activities so that the work flow system easier to understand. BPMN represents analysis and design of productivity improvement system of supply chain of oyster mushroom agro industry. Workflow process based on destination. The first stage is to analyze the problems in the supply chain of oyster mushroom agroindustry. The second stage is to analyze the environmental variables of both econonomic and environment sectors through weighting the value of each variable. The third step is to formulate a strategy to increase productivity of agro-industry supply chain by establishing association rules based on influential variables. BPMN can be seen in Figure 4, 5 and 6 as follows:

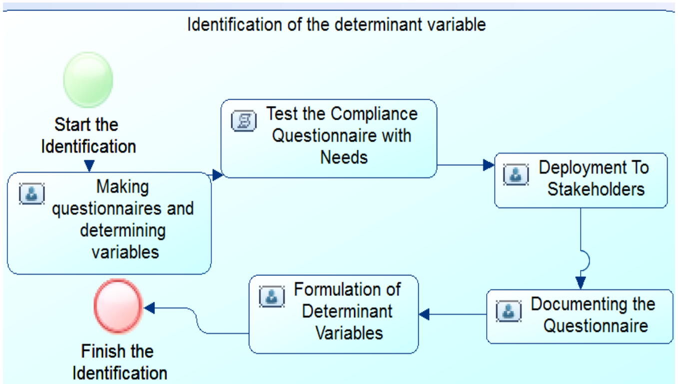


Figure 4. BPMN Determine the Indicator GP

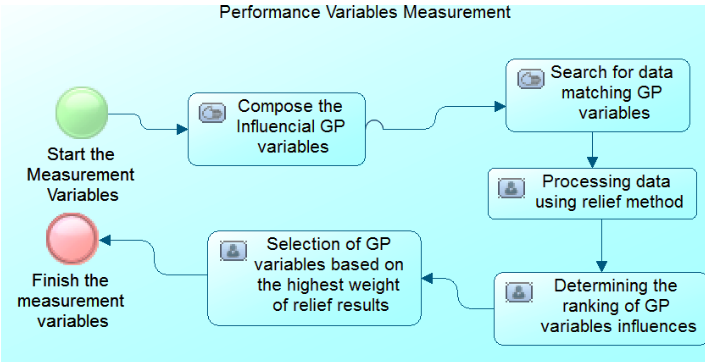


Fig 5. BPMN Measure of Performance Variable

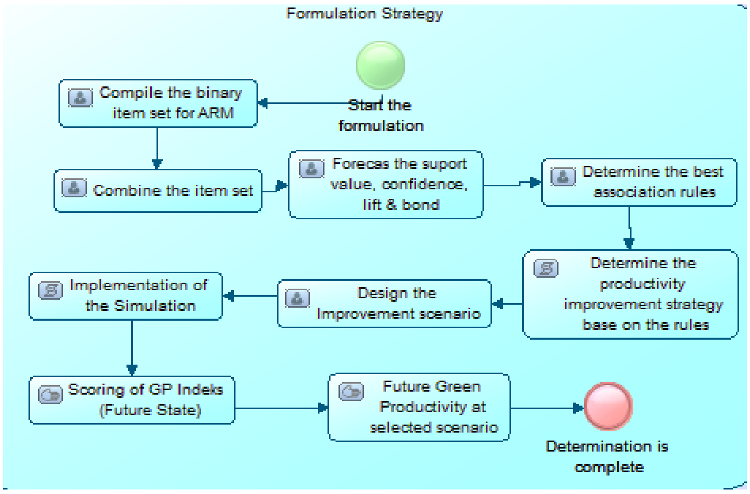


Figure 6. Determine Strategy of Association Rule

B. System Design

Relief

Based on the result of weighting relief by using weka on upstream and downstream sector environment variables shown in table 1.

Table 1. Result of relief environment variabel

Atribute	Hit	Rank
Transportation	0.2092	1
Emision	0.0991	2
Material	0.0783	3
Energy	-0.0181	4
Waste	-0.0192	5
Water	-0.0388	6

There are three variables that occupy the highest weight of transport, emissions and emissions. This variable is a source of waste that affects the productivity level of the oyster mushroom environment. The three variables with the highest weights are then used as variables in the formulation of rules of strategy formulation to improve the productivity of the supply chain environment of oyster mushroom agroindustry. These three variables will be processed by using association rule, resulting in table 2.

Table 2. Determine the association rules Top 10

IF	Then	Support	Conf	Lift	Convic
Material=Medium, Transportation= Medium	Emision= High	0.167	1.000	1.714	Infinity
Transportation=Medium, Emision=Medium	Material=Low	0.167	1.000	3.000	Infinity
Transportation=Medium, Material=Low	Emision=Medium	0.167	1.000	2.400	Infinity
Material=Medium,	Emision=High	0.417	0.833	1.429	2.500
Material=Low	Emision=Medium	0.250	0.750	1.800	2.333
Emision=High, Transportation High	Material=Medium	0.250	0.750	1.500	2.000
Transportation=High, Material=Medium	Emision=Medium	0.250	0.750	1.286	1.667
Emision=High, Transportation High	Material=Medium	0.417	0.714	1.429	1.750
Transportation=High	Emision=High	0.333	0.667	1.143	1.250
Transportation=High	Material=Medium	0.333	0.667	1.333	1.500

In association rules, rules are interpreted only by rules that have a lift value> 1. Also in determining the Top-10 rules the association of values used as a material consideration is the value of conviction. The value of conviction is a value that measures the level of implications of a rule. The result of the formulation of the rules is used to formulate a strategy to increase environmental productivity. In table 4 one of the association rules is {Material = Medium, Transportation = Mediun} →{Emision = High} with lift value 1,714, Support 0.167, conviction Infinity and 100% confidence (100% probability affects supply chain productivity improvement if material consumption Medium, medium-generated transport then use of Emision High consumption) causes low supply chain productivity and elevator> 1 indicates that the rule can be used. Table 4 shows the relationship between antencendent and consequent.

The final result of the standard operating procedure is the best decision which is taken from various opportunities with the help of "rule-based if and then" (Budi 2017). These rules can be formulated as a strategy to increase supply chain productivity. Based on the established rules, the strategies that can be applied are (1) minimize the use of materials, (2) minimize the use of transportation (3) to minimize the emissions produced. The rules can be seen in table 3 as follows.

CONCLUSIONS AND RECOMMENDATIONS

The conclusions in this paper are:

1. The analysis of the system of increasing supply chain productivity of oyster mushroom agroindustry is represented by using BPMN facilitate the writer in formulating strategy formulation.
2. Based on the results of the identification of environmental variables obtained by each three variables with the highest value weight. The influential environmental variables are Transport, Emission and Material.
3. On the establishment of association rules obtained maisng each sector Top-10 rules. Based on the rule then formed a strategy formulation on each variable that influences.

Suggestions in this study are:

Should in analyzing and designing to obtain valid system results used data in accordance with reality so that can represent the system in real.

Table 3. Rule Association

	Antecendent				Consequent		
IF	**Material**	**Transpo**	**Emision**	THEN	**Material**	**Transpo**	**Emision**
	Medium	Medium					High
		Medium	Medium				Medium
	Low	Medium					Medium
	Medium						High
	Low						Medium
		High	High		Medium		
	Medium	High					Medium
			High		Medium		
		High	High		Medium		
		High	High				High
		High			Medium		

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