Supply Chain Management on the Production Process and Distribution Flows of the Superior Teak Seeds Production

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***Abstract* – Management of supply chain that interrelates and integrates both consumers and suppliers in a process to make a value of product or service for consumers is very importance and strategic as well. The research objective was to analyze and improve the sustainability performance of production process and distribution flow of the teak seeds production within its supply chain. This research used multiple dimensional analysis and value stream mapping to identify the sustainability performance and analytical network process to find the key factors that improve the SCM performance of superior teak seeds production. The research found that 1) the Parameter influencing SCM was supplier and therefore it requires system improvement. The problem was that the delivery of materials purchased in Surabaya took too long time before they were stored in the warehouse. Placing a purchase order long time beforehand may apparently solve the problem. But in fact, it created another problem because the materials were not to be stored in the warehouse for a long time due to their short expiry date and due to the limited infrastructures like warehouse and roads. SCM sustainability score on the production system of superior teak seeds production of BPPT located in Jatisari area was 56.62 with a quite high category. Based on the leverage analysis, the most dominating SCM components were waiting factor at the value of 2.71; overproduction at 2.30 and inventory at 2.25. 2) Based on the ANP analysis, the research found a position map of SCM components at the stress value of 3.411% meaning that it is an "Excellent" model suitability while the index of fit (R^2) is at 94.673% meaning it meets the appropriateness. Transportation process consists of transportation of auxiliary material of seeds production, travel of seeds from nurseries to adapting areas, and distribution of seeds. Slow supply of consumables required for seeds production process due to long distance between the production areas and supplier sites will cause delayed delivery of goods particularly of those that are not scheduled because of special cases.**

Keywords: *Supply Chain, ANP, Transportation, Distribution Flows, Superior Teak Seeds*

1 Introduction

Forest destruction, either in the form of deforestation and degradation continues. An indication is the quantity world's natural forests continue to decline during recent decades. Between 1990 and 2000, the sum of world's forests loss reached 13.1 million Hectares (Ha) per year. With the establishment of plantations of 4.8 million Ha, the rate of net forest loss in the period 1990-2000 was 8.9 million Ha per year [1].

Deforestation is the conversion of land cover from forest to non-forested land use including plantation, settlement, industrial area and others. Forest area changes are changes of forest vastness that take place as a result of the release of forest area to be used for non-forestry purposes, swap of forest areas, and forest function changes. The Directorate of Forest Resources Inventory and Monitoring states that 610 375.9 Ha of Indonesian forest have been deforested [2].

Forest rehabilitation are required to restore, maintain and improve the forests and land functions then its capacity, productivity, and roles in maintaining the life support system are well preserved [23]. Previous implemented forest rehabilitation includes reforestation, re-vegetation, plants maintenance, enrichment planting, and implementation of vegetative 5 and engineering land conservation techniques to critical and unproductive lands [3].

For comparison purpose, the research used the profit sharing system of community based partnership of Wanabakti Nusantara Housing Cooperative (WNHC), a fostered cooperative of Indonesian Ministry of Forestry. The cooperative program is to develop the archipelago superior teak plantation (ASTP). The common 40 years teak harvesting period is shortened to 5 and 20 years. A profit sharing system applied by the cooperative is a partnership among investors or partners, land owners, working farmers, village officials and the business unit of WNHC that playing roles of facilitator and insurance institution. Timber harvested will be shared proportionally and profitable to all. Profit proportion sharing is 40% for investors, 10% for land owners, 25% for working farmers, 10% for village government officials, and 15% for WNHC [4].

The problems for furniture industry particularly in Central Java are unbalance situation of high demand and low availability of raw material, unfair competitiveness, raw material scarcity, varied rate price of raw material provided by wood suppliers, unevenly distribution of value-added, and very low access of market information

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and requirement for legal certification of raw material [5]. These situations have triggered some teakwood illegal supplies either from Java Island or other islands in Indonesia. This problem arises because of raw material scarcity by the monopoly system applied by Indonesia State-Owned Enterprise "*Perhutani"* in teak timber market. It resulted in a twice more expensive price of raw material. The owners of furniture home industry were forced to buy illegal teak timber from farmers that had no legal certificate issued by Perhutani. Even worst, they sometime bought teak timber stolen from Perhutani plantations. The illegal teak timber could be purchased at a half the normal Perhutani price rate. A popular word "half-stolen timber" was used by the furniture industry owners in Jepara to call such stolen teak timber [6].

Teak plantation however has a prospect when considering the demands for wood that never decline while the hard wood forests are quickly disappearing. This has triggered the people to search for hard timber with shorter harvest period. Many teak plantations have been developing teak seeds that require much shorter growing length and that can be harvested at 5 years old compared to the 40-year harvest of conventional teak [7].

To meet the high demand of teak timber, it is important to provide high quality teak seeds that can be harvested in only in few years and that require low production and distribution costs. BPPT Teak, a type of superior teak seeds that can be harvested after 8 years old has been developed recently by BPPT, an Agency for the Assessment and Application of Technology.

BPPT teak seeds have been developed in Bondowoso and Situbondo, the areas located in East Java Province. Supriyatna [8] states that to increase the marketing competitiveness both nationally and internationally, to provide abundant products with high quality and more efficient production cost and to apply the approach strategy of supply chain management. This approach is applied not only by improving the productivity and product quality but also the packaging method, product branding, efficiency, transportation, organizational strengthening and continuous and systematic innovations also information and decision management [9].

The objective of this study is to find out the performance improvement of SCM in the BPPT superior teak seeds process that takes place in Bondowoso.

2 Literature Review

2.1. Business Process Reengineering

Business process reengineering is a step to improve existing business processes with the aim of getting a new business process that is better or more in line with corporate or organizational goals. Thomton argues that reengineering can help companies to simplify processes, improve productivity, improve quality, save costs, improve efficiency and deliver entirely new jobs and grow as companies grow [10].

The success of the business process reengineering model is supported by four principles, namely: process mapping, fail-saving, teamwork, and communication. Each team member must be educated to understand these four principles and be empowered to use what they have learned to solve business or manufacturing problems [11], [12].

2.2. Value Stream Mapping Concept

Value stream is defined as a special activity within the supply chain required for designing, ordering and establishing a product or value. Value Stream Mapping maps not only the flow of material but also the information flow that signifies and controls material flow [13]. The material flow path of a product is traced back from the final operation and its journey to the raw material storage location. This flow illustrates the representation of process facilities by helping to identify the value-added stages of a value stream, and eliminating non-value added or waste steps [14].

2.3. Seven Waste Concept

Waste can be interpreted as activities that do not provide value-added for the company. There are seven types of waste identified they are Over Production, Defect (Reject), Unnecessary Inventory, Inappropriate Processing, Excessive Transportation, Waiting / Idle and Unnecessary Motion [15]. Considering the seven wastes in supply chain management and business process can increase the production process efficiency [24].

2.4. Multidimensional Scaling Analysis

Multidimensional scaling (MDS) analysis was able to visualize every dimension and aggregate, so it could improve the understanding of the ongoing sustainability status of each dimension.

3 Methodology

The approach used in this study is descriptive method that made use of the business cases of teakwood afforestation in the teak forest located in Situbondo and Bondowoso managed by PT Harfam Jaya Makmur, Indonesia.

The framework for this research is presented in Figure 1. Observation was carried out by visiting and collecting information of the business process of teakwood afforestation in Situbondo and Bondowoso. The data obtained from the observation were then analyzed qualitatively and quantitatively. The analysis was used to reassess and portrait the business process of BPPT superior teak seeds.

This study employs to types of data namely primary and secondary data in relation with teakwood afforestation in Situbondo and Bondowoso districts, East Java, Indonesia. The primary data obtained by interview and questionnaire completion by the experts, practitioners and stockholders. Questionnaires were used to collect their opinion regarding teakwood afforestation business process that had been identified based on the analysis upon the collected data and information. The interview was intended to collect information and inputs based on the stakeholder's practical experience and knowledge on afforestation business of tree or teakwood planting.

To find the influence of production component to supply chain management, a structured equation model was used. Analysis of SCM of BPPT superior teak seeds production used Multidimensional Scale. The strategy to improve SCM performance is formulated by analyzing the SCM process flow to identify what nodes or points that can hinder or drive the flow [18].

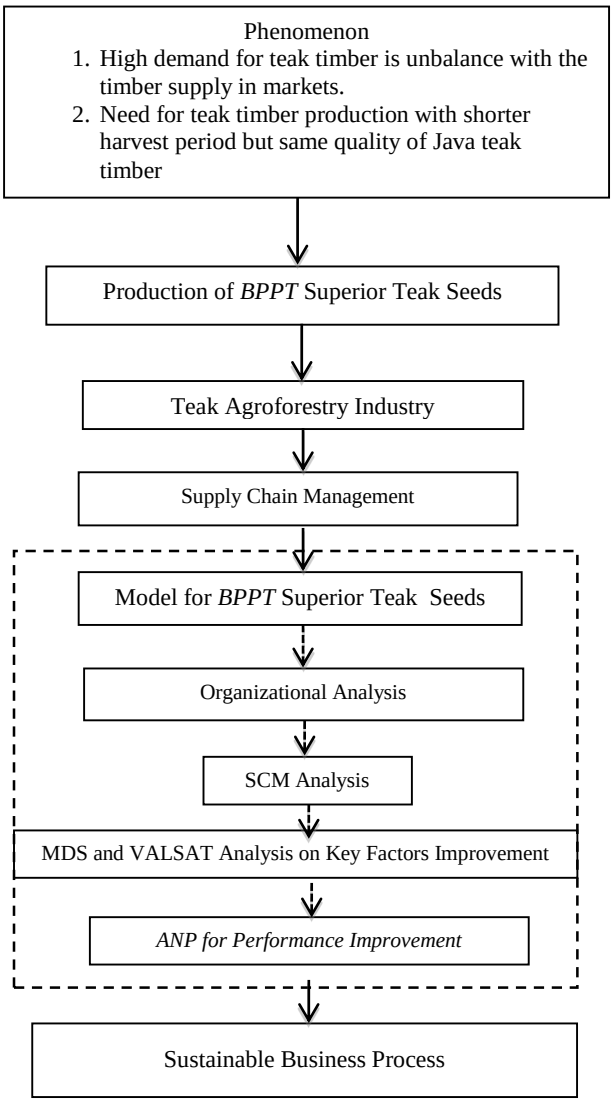


Figure 1. Theoretical Framework

3.1. Value Stream Mapping

Performance indicators of value stream mapping are quality, cost and lead time, as follows [16]:

1. FTT (First time through)
   Percentage of units processed perfectly and in accordance with quality standards at the first process (without scrap, rerun, retest, repair or returned).
2. BTS (Build to schedule)
   Scheduling to see the execution of the right product creation plan at the correct time and sequence.
3. DTD (Dock to dock time)
   Time between unloading raw material and completion of finished product to be ready to ship.
4. OEE (Overall equipment effectiveness)
   Measures the availability, efficiency and quality of an equipment and also limits capacity utilization of an operation.
5. Value rate (ratio)
   Percentage of all activities that are value added.

6. Other indicators:
   - A / T: Available time = Total work time - rest time
   - T / T: Takt Time = Available Time / Production Volume
   - C / T: Cycle Time = (Available Time - Average Downtime - Defect Time) / Production Volume
   - W / T: Working Time = Working time of each operator
   - VA: time value added
   - NVA: non-value-added time (including waste)

3.2. Value Stream Analysis Tools (VALSAT)

VALSAT is a dynamic method for creating an effective value stream. There are several advantages of the VALSAT approach:

1. Enter at least two levels of value stream in the analysis process.
2. A strong approach by providing a combined subjective and objective measurement.
3. Can be applied in various positions in value stream.
4. Useful as a special planning scenario where if there is a complex network of value stream relationships that are difficult to separate.
5. Provide an opportunity to analyze how major breakthroughs can be achieved that will make it difficult for competitors to imitate.

4 Results and Discussion

4.1. Supply Chain Management (SCM)

Supply chain management (SCM) is defined in many ways but the goals are generally aligned to ensuring effective and efficient supply chains to achieve competitive advantages [17]. Furthermore, SCM is an integrative approach that aims to satisfy the expectations of consumers, through continual improvement of processes and relationships that support the efficient development and flow of products and services from producers to consumers [18], [25]. The production process of BPPT superior teak seeds is different from other production of superior teak seeds. The production of teak seeds is as follows:

1. Mother Plant Production
   Mother Plants are plants duplicated from the parent plants that are certified by BPPT, an Agency for the Assessment and Application of Technology. They have high quality, selected productivity (optimum diameter, free of branch optimum height, high aesthetics), maximum vegetative and generative growth rate, and they are free from pests and diseases so they can breed high quality explants to be used for ex vitro culture.
2. Cutting

Cutting is harvesting the quality explants shoots (two segments of young tissue explants, shoot top begins to open, fresh and free from pest and disease) Cutting is carried out on the mother plants and the shoots are used as the material for ex vitro culture.

3. Explants Planting
   Planting is a process of explants planting into the growing media using BPPT formula in order to form good rooting to make sure a new quality teak plant.
4. Incubation is a phase to be carried out after planting a plant into incubator. The incubation period is between 3 and 4 weeks under controlled temperature, humidity, sunlight intensity and environment.
5. Acclimation
   Acclimation is a process where an explant that has reached a perfect plant is taken out of the incubator and given 30% sunlight under double shade net. In this process, two segments have grown and had roots. At this phase, liquid fertilizer can be applied based on the BPPT formula.
6. Nursery
   Nursery is the next phase after acclimation the seeds is able to adapt to the environment with 70% sunlight intensity under single shade net and controlled humidity. At this phase, environmental conservation is applied by using bio fertilizer produced by BPPT.
7. Adaptation
   Adaptation is the subsequent phase after nursery where the seeds are able to adapt to outside environment. BPPT formula is applied at this phase to maximize its growth.
8. Distribution
   Transportation is a process of removing the seeds from the adaptation phase to planting site or to other adaptation phase.

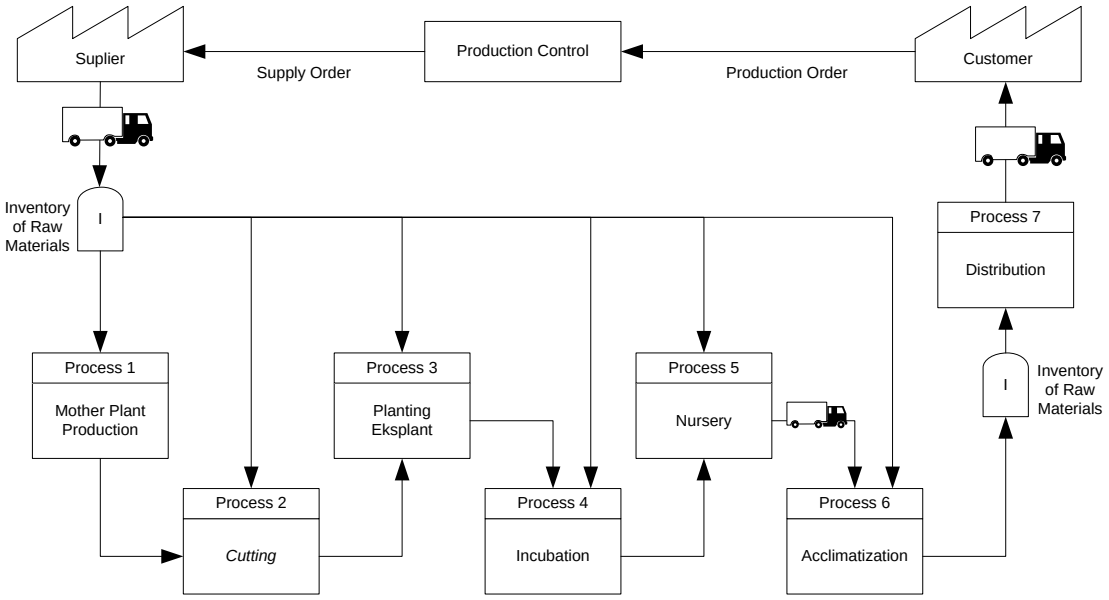


Figure 2. Supply Chain Management of Teak Seeds Production

Based on the teak seeds production process, an analysis can be applied to the SCM process at every productions area. Seeds production areas are Emplacement, Jatisari, Nogosari, Cangkring, Pandak and Trotosari. In emplacement area, the process starts from mother plant duplication to distribution. Not all seeds resulted from emplacement and after incubation phase can be placed in the same area for acclimation. Therefore, some of them are distributed to other areas. SCM is the full cycle of production that begins with management activities at every link of production chain and ends with quality products for users [24]. The SCM approach to horticulture products is based on (a) A process of producing products (horticulture), (b) Transforming the raw material (harvest and post-harvest management) (c) Product delivery to the consumers through distribution system.

To ensure the successful of Supply Chain Management (SCM) application it is necessary to be aware of the following supporting factors like policies, human resources, infrastructures, facilities, technology, organization, capital/ funding, information system, socio cultural aspects and other environments [19].

The SCM approach to horticulture products is based on (a) A process of producing products (horticulture), (b) Transforming the raw material (harvest and post-harvest management) (c) Product delivery to the consumers through distribution system. The implementation of SCM will improve the efficiency of distribution, thereby improving product quality which in turn provides consumer satisfaction, reduces costs, and improves all outcomes of the entire supply chain [20].

4.2. Analysis on the Production Component that Influences Supply Chain Management (SCM)

The SCM concept includes 6 principles as developed by AFFA (Australian Department of Forestry and Fisheries) among others a focus on the consumers and customers, chain always creates and shares mutual values among actors, products that really meet the customer specifications, effective logistic and distribution, an information and communication strategy involving all actors, effective relation that tightens and shares of belonging. To find out the correlations of productions factors and SCM in the teak seeds production process, a production model analysis was applied by employing Analytical Network Process.

4.3. Supply Chain Management (SCM) Analysis

Supply chain performance at each location was analyzed using multiple dimensional scaling technique with Rapinfra software. The result shows that the SCM score of BPPT superior teak seeds production in Jatisari area is 56.62 falling at a quite high category. Based on the leverage analysis, the dominating SCM components are transportation at 2.71; policy at 2.30 and infrastructure at 2.25 as presented in Figure 3.

No.	Nursery	SCM Score	Category
1	Emplasement	55.16	quite high
2	Jatisari	56.62	quite high
3	Nogosari	60.13	quite high
4	Cangkring	59.83	quite high
5	Pandak	47.19	quite high
6	Trotosari	56.37	quite high

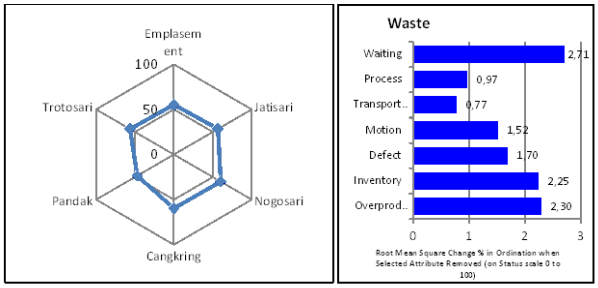


Figure 3. MDS Analysis for SCM of BPPT Superior Teak Seeds Production

4.4. Analysis of SCM Performance Improvement Factors

SCM performance improvement was carried out by analyzing the network that supports SCM using Analytical Network Process (ANP). The SCM supporting Network is presented in Figure 4.

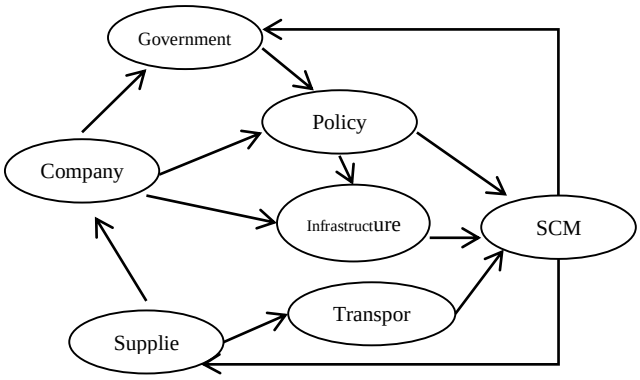


Figure 4. Network Process of BPPT Superior Teak Seeds Production

The analysis used SCM and resulted in a networking diagram as presented in Figure 4. The strategies to improve SCM performance were found by identifying the nodes that stimulated positively and negatively to the network. The strategies will take form after identification of nodes stimulating positive (driving) influence or negative (hindering) influence to the system performance. The conclusion drawn from the identification will be taken into account in developing policies to improve SCM performance. In general, the planned strategy is divided into two systems namely system A and system B. System A represents the efforts to external improvement while system B are those for internal improvement.

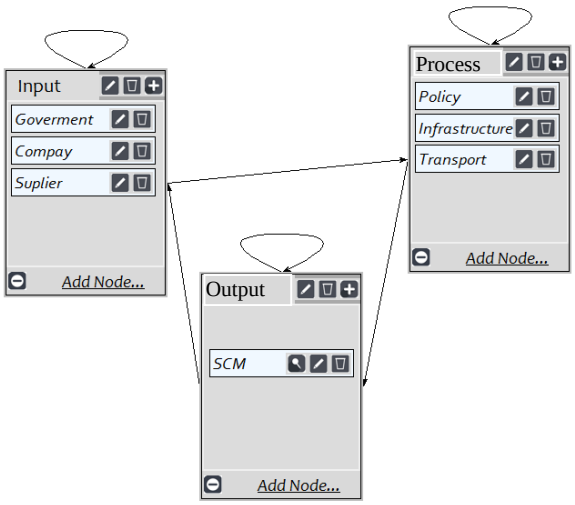
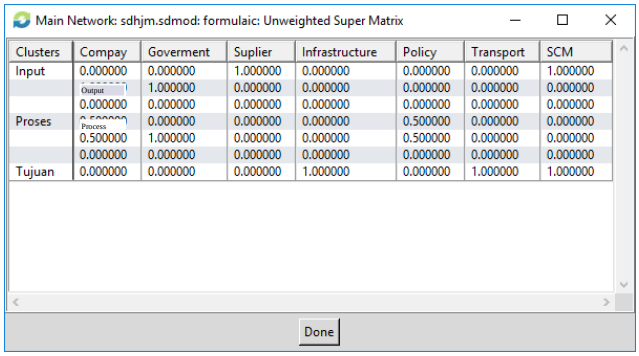


Figure 5. SCM Network Model

Interaction matrix analysis of the underweight model on Figure 5 is presented in Figure 6. Results of ANP analysis will help to find the factors that can improve SCM performance by comparing the changes of internal factors (System A) and improvement of external factors (System B).



Clusters	Compay	Goverment	Suplier	Infrastructure	Policy	Transport	SCM
Input	0.000000	0.000000	1.000000	0.000000	0.000000	0.000000	1.000000
	Output	1.000000	0.000000	0.000000	0.000000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Proses		0.000000	0.000000	0.000000	0.500000	0.000000	0.000000
	0.500000	1.000000	0.000000	0.000000	0.500000	0.000000	0.000000
	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Tujuan	0.000000	0.000000	0.000000	1.000000	0.000000	1.000000	1.000000

Figure 6. Underweight Matrix

System A represents an internal process of teak seeds development in Bondowoso that consisting of the interactions between the infrastructures belong to the seeds company like roads, bridges and storages, the company internal policies regarding the requirements of seeds process, transportation of the company like motor vehicles and facilities to distribute any material for seeds production and the seeds.

System B is an external network influencing SCM in providing the necessities for seeds process, supporting the people and material movement in seeds process represented in some policies, facilities and infrastructures provided by and owned the government or suppliers. Another system is system C that is a combination of System A and B. Results of ANP analysis is presented in the Figure 7.

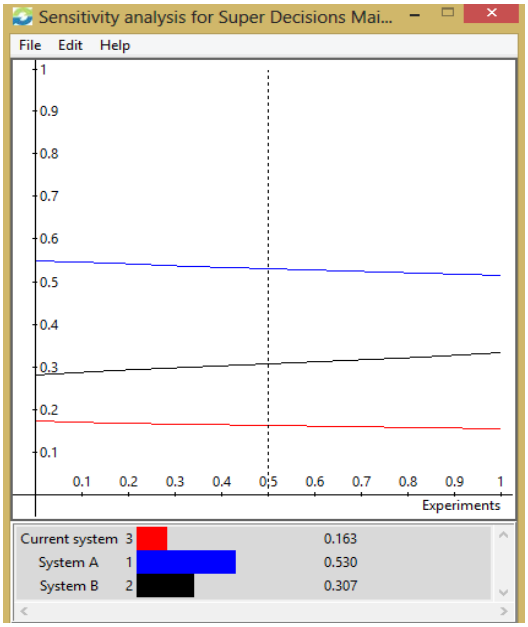


Figure 7. Sensitivity Testing Results

The analysis indicates that the improvement of internal system between the company and suppliers has an influence to SCM performance up to 0.530 or 53%, while any change to government policies or external factors will have an influence up to 0.307 or 30.7%. Without any treatment, the influence will only get point at 0.163 or 16.3%. The analysis using SCM model compliant with Analytical Network Process resulted in the following matrix:

```
For matrix
Stress =    .03411       RSQ = .94673

Configuration derived in 2 dimensions

                    Stimulus
Coordinates
                         Dimension

Stimulus    Stimulus      1         2
 Number       Name

     1       G .4211    1.1267
     2       C           -.2452   -1.3416
     3       S .9776     .2001
     4       I           -.5356    -.4087
     5       P           1.7910    -.5681
     6       T          -2.0654    -.1744
```

Based on the ANP analysis, the position map for SCM component has a stress score of 3.411% meaning it has an "Excellent" model suitability while the index of fit (R^2) scores for 94.673% meaning that it has met the eligibility. The stimulus coordinates are then stated in the Figure 8:

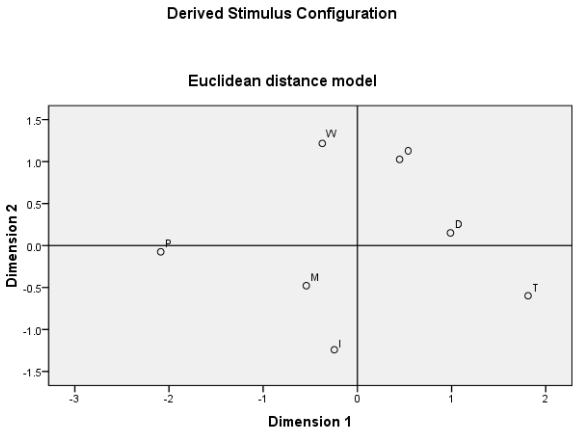


Figure 8. Object Position

From the configuration map, it is clear that the component obtaining the highest score is infrastructure showing an Euclidean distance of (-0.5356; -0.4087). The second highest component is supplier showing Euclidean distance of (0.9776; 0.2001).

The analysis indicates correlations between the factors that can be explained as follows:

1. Infrastructures at the remote areas where seeds production takes place are to be provided by the government in order to improve SCM performance.
2. Seeds production process is often behind schedule due to delayed shipment of production necessities by the suppliers.
3. Distribution of supplies especially sprout growing hormones by the supplier is insufficient and poorly spread to all areas.

4.5. Managerial Implications Strategic

To ensure the success of Supply Chain Management (SCM) application it is necessary to be aware of the following supporting factors like policies, human resources, infrastructures, facilities, technology, organization, capital/ funding, information system, socio cultural aspects and other environments [21].

Transportation of seeds product has started from the nursery to the collecting area at the production center. Transportation depends much on the availability of local facilities or producer facilities. Some techniques to transport the seeds from the nurseries can be applied using human body, a pushcart, a bicycle, a motor cycle, or a small truck. Agro-industry potential has an impact to the making of policies regarding marketing, economic, distribution, and investment. It is useful for processing industry and other industries. It also effect employment opportunities in villages, other urban areas, and even countrywide.

The research results show there are four primary factors to improve the process of teak seeds production on the following sequence of priority:

1. Supplier, that has direct and indirect influence at 60.8% level of influence.
2. Transportation that has direct and indirect influence at 49.5% level of influence.
3. Infrastructure that has indirect influence at 3.8% level of influence.
4. Policy that has indirect influence at 2.5% level of influence.

Transportation process involves transportation of auxiliary material of seeds production, travel of seeds from nurseries to adapting areas, and distribution of seeds. Slow supply of consumables required for seeds production process due to long distance between the production areas and supplier sites will cause delayed delivery of goods particularly of those that are not scheduled because of special cases. While transportation of seeds from nurseries to the adapting areas that located very far from nurseries will also cause unnecessary stress to the seeds. Stressed seeds may reduce their survival. This generally happened when they were transported by sea to the customer's planting site. The seeds quality was already much reduced when received by the buyers. Pishvaz *et al.* states that supply chain configurations with the right service level will provide benefits in terms of delivery speed, quantity accuracy, quality and cost minimization [22].

Government policies have very strong influence to SCM. This is true in case of road class selection for transportation of materials needed for BPPT superior teak seeds production as it influences the seeds production pattern. Delicacy and complexity of seeds production process require an improved treatment starting from sprout cutting to adaptation process. Plant maintenance in nurseries plays a very important role in supporting the success of the seeds planting. However, in maintaining the seeds there are also some challenges like pests and plant diseases that can drop the quantity of seeds stock. These are defects. A defect may take place in plant cutting quality, planting process, growing media, plant pests and diseases and incorrect plant maintenance.

5 Conclusions and Suggestions

5.1. Conclusions

This research concluded that Policies, infrastructure, and transportation factors have significant influence to the Supply Chain Management of BPPT superior teak seeds production process in Bondowoso and Probolinggo, in East Java.

The Parameter influencing SCM is supplier and therefore it requires system improvement. The problem is that the delivery of materials purchased in Surabaya takes too long time before they are stored in the warehouse. Placing a purchase order long time beforehand may apparently solve the problem. But in fact, it creates another problem because the materials are not to be stored in the warehouse for a long time due to their short expiry date and due to the limited infrastructures like warehouse and roads.

SCM sustainability score on the production system of superior teak seeds production of BPPT located in Jatisari area was 56.62 with a quite high category. Based on the leverage analysis, the most dominating SCM components are waiting factor at the value of 2.71; overproduction at 2.30 and inventory at 2.25,

An SCM improvement strategy has to be implemented by intensifying the synergy of government policies because this will make very positive influence to meet the SCM requirements on the BPPT superior teak seeds production especially in transportation of materials and people.

5.2. Suggestions

This research suggests that seeds producing companies has to build a good coordination with the local government regarding transportation access as this is very important for seed production process especially the acclimation that requires access to areas with difficult terrain.

The local government is advised to support the seed producing companies by providing adequate transportation infrastructure and facilities and bridges since BPPT superior teak seeds can be adopted as one of the featured products of the Bondowoso Regency.

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