An Analysis and Design of Responsive Supply Chain for Pineapple Multi Products SME Based On Digital Business Ecosystem (DBE)

CONFERENCE PAPER · SEPTEMBER 2015

READS
20

2 AUTHORS, INCLUDING:

Taufik Djatna
Bogor Agricultural University
69 PUBLICATIONS **13** CITATIONS

SEE PROFILE

Proceeding of Industrial Engineering and Service Science, 2015

An Analysis and Design of Responsive Supply Chain for Pineapple Multi Products SME Based On Digital Business Ecosystem (DBE)

Taufik Djatna[a*], Rohmah Luthfiyanti[b]

[a]Post Graduate Program of Agro Industrial Technology, Bogor Agricultural University, Indonesia, taufikdjatna@ipb.ac.id
[b]Graduate Program of Agro Industrial Technology, Bogor Agricultural University, Indonesia, romce2000@yahoo.com

ABSTRACT

Nowadays, Small and Medium Enterprises (SME), need tight requirements to increase the diffuse and adopt of information and communication technology (ITC), so that the digital gap between large and small enterprises as well as regional difference can be avoided. Digital business ecosystem (DBE) is centralized collaboration environment of the species as stakeholder communities within the business ecosystem. This paper describes to model the responsive supply chain through the analysis and design to answer the stakeholder's needs of information and decisions, and involve in managing product and perishable material as well. Therefore, the objectives of this research are to identify the component and process in systems analysis, to develop the design responsive supply chain system of pineapple multi product for SME. The benefits that can be obtained by digitalized information are cost efficiency and effectiveness of service time for SMEs, employees and consumers when it responds quickly to changes the information system, supply of raw materials, production facilities and inventory system. The research approach includes decomposition of process analysis by business process model notation (BPMN). Then quantitative modeling design deployed decision tree classifier method. The model consisted of structures, information system, mode transportation, raw material and finish good inventory. The last step is optimization of responsive model by cross platform drivers function. Computational results and managerial insights are provided. To show that substantial reduction in response time can achieved with minimal increase in total cost in the design of responsive supply chain.

Keywords: *Analysis and Design, Communities Stakeholder, Digital Business Ecosystem (DBE), Pineapple Multi Product, Responsive Supply Chain.*

1. Introduction

Small medium enterpirses (SME) was produced pineapple multi product such as juice, jam, and dodol. It is very interesting to be discussed about how to design a supply-chain for pineapple multi product that is responsive to market demand. Design of supply chain for pineapple multi products which would be developed through the identification of responsive components in the supply chain and how to identify the processes with respectively stakeholders involved in SME business environment.

Design and analysis of supply chain are very useful for stakeholder to identify important components in the pineapple multi product business environment. System design will develope to answer the stakeholder's needs in getting information, decision making and the flow of materials and products perishable. [10] Digital business ecosystem is digital technology consist of digital ecosystem to facilitate business activity. Ecosystem digital was presented the activity of ecosystem business for the purpose of seeking and finding. The first DBE's layer will be explained the digital business which is a collection of stakeholders who are interacting and having the same purpose. On the second DBE's layer is an operational digital from digital business in the first layer. The advantages that can be gained by doing digital of information are the effective time and efficient cost in serving consumers demand.

Problems that occur in supply chain for pineapple multi products is how the flow of information between stakeholders involved can be delivered quickly so that stakeholders could make decision well. In addition, the flow of materials in supply chain for pineapple multi products also noteworthy due to the material being supplied is easily damaged so that the decrease of raw material quality can have an effect on the quality of the end product. Responsive supply chain is one of the solutions can be offered to SME in running the business. [5] one of the weakness

of SME in keeping the exsistence of business is still not adopting information technology in response to the needs of information for stakeholders involved in this supply chain.

Previously [11] made the supply-chain more responsive so that the products can be marketed more quickly with the cost more efficient. [6] designed responsive supply chain on uncertainty demand condition, where considered criteria is transportation time, residence time, flow of schedule in multiproduct factories and inventory management where a small change in a lead time is effected significantly to the value of NPV and the structure of supply chain. [12] Studied the MTO system and ATO to accomplish the responsive supply chain to the various products distribution, high consumer demand and short product cycles.

This study aims to identify and analyze the components of the process, then analysis and develop the design of supply chain pineapple multi products. The first stage is to identify the components of the supply chain responsiveness and modeling in business analytics models with BPMN 2.0. The next step is to design model supply chain pineapple multi product. Multi-party elections pineapple products chosen to be produced by using classification with decision tree data mining method. Responsive supply chain design [6] to model the expected lead time optimization.

The result of this research is to make the model of business design of responsive supply chain for pineapple multi products in the form of business model, then ecosystem business which interacting and having the same purpose are made in the ecosystem digital business concept where the first layer is the ecosystem business and the second one is its digital operation that integrated in the first layer of ecosystem business.

The rest of this paper is organized as follows: Section 2 discussion of related works and section 3 we present our approach and methodology. Next, in the Section 4, we provide a result and discussion. Finally, we provide a conclusion and future work in section 5.

2. Related Work

Responsive supply chain [3] is the ability to respond quickly to customer requests in large amounts, can minimize waiting time, handling a variety of diverse product demand, creating innovative products and service levels are very high. [11] characterizes the supply chain are high flexibility, low cost, in response to the number of different requests quickly, handles a wide variety of products, respond with speed, the service can be improved, the uncertainty of supply can be addressed. [6] optimizing the design and planning the responsive supply chain for uncertain demands consider the economic criteria. The resulting model has been applied to two case of medium and large scale of polystyrene supply chain. The problems of responsive supply chain are modeled with MINLP method by optimized double goals that are maximizing the NPV and minimizing lead time. To get the optimal value of NPV is completed with constraint method and optimization procedures Pareto curve. The Algorithm is used to solve the differences in decision making at each level.

[12] The result of computing for responsive supply chain problems is MTO model where this model can reduce response time and minimize the improvement of total cost. MTO and ATO systems are business strategy that has succeed to solve the responsive supply chain problems to the distribution of various products, a high consumer's demand and a short product cycle. [8] a responsive replenishment system considering the speed of response to fluctuate consumer demand and timeliness of providing goods with minimum cost. Embraces system method with fuzzy logical principle is used to accomplish the uncertain of consumer demand and to increase the respond for goods replenishment. [14] The simulation is used to develop the newer management technic and technology information so that it is potential to create responsive supply chain for the company to maintain its position in a competitive market. [9] The digital business ecosystem (DBE) is one way to centralize the data and information of every community stakeholder in the supply chain responsive multi pineapple products so that decisions can be taken more quickly. DBE based system also allows changes caused by the uncertainty of booking requests can be responded quickly and cost cheaper.

3. Methodology

3.1. Identification System

The design and analysis system which follow life cycle of SDLC (system development life cycle) system are idea, requirement human/user, requirement system, design, evaluation, and deployment maintenance [13]. The first step which is done to design a system is to define first the limitation of problems, goals, desirable and undesirable inputs, involved stakeholders, desirable and undesirable outputs, resources, rule, role, and the weakness of system. The further steps are analyze the needs and used case related to human requirement by taking the attribute and entities system. Use case is used for the first time to make UML.

3.2. Process Hierarchy Diagram (PHD)

Steps for analysis iniated with a PHD as a guidance to work breakdown structure (WBS). A PHD is the flow process diagram that depict to the highest tasking level consists of a series of process and decomposition of task interconnection link. For each level of decomposition at each process can be described at many functions of kinds of business.

3.3. Business Process Diagram (BPD)

BPD describes a system at highest level. Diagram business process facilitates the graphical display from the control or the data flow between processes at each level of built system. BPD has fewer notations and it is usually used by the user to analyze the flow system process that will be developed.

3.4. Business Process Model and Notation (BPMN)

Business process in supply chain responsive for pineapple multi product system is modeled in BPMN 2.0. It is started from the making of simple flow chart, identification stakeholder, granting information related roles, process, data and information to description; therefore it can be analyzed and simulated. System analysis is conducted for parse a system be resolved into components so it the interactions between components and its environment can be seen.

3.5. Classification of Pineapple Multi Product

Classification of pineapple multi product used method decision tree (DT) classification techniques of data mining. The first step to build classifier is built describing a predetermined set of data classes or concept. This is the learning step (or training phase), where a classification algorithm builds the classifier by analyzing or "learning form" a training set made up database tuples and their associated class labels. DT formulations have to be followed to perform the splitting or separation which will form the root node, internal nodes and leaf nodes [7]. The formulations are to be followed is the determination of entropy and information gain, and the following is formulation [1]

$$Info(D) = -\sum_{i=1}^{m} p_i \log_2 p_i \qquad (1)$$

$$Info_A(D) = \sum_{j=1}^{v} \frac{|D_j|}{|D|} \times Info(D_j) \qquad (2)$$

$$Gain(A) = Info(D) - Info_A(D) \qquad (3)$$

D is the entropy of training set, where p_i is nonzero probability that an arbitrary tuple in ***D*** belongs to class C_i. In this paper it's just have three classes, that are combination multi products "Juice - Jar", "Jar - Dodol" and "Jar - Dodol" and ***m*** is the number of partitions in the training set, in this paper the value of ***m*** is 48.

3.6. Optimization of Supply Chain Responsive Model

Responsive supply chain quantitative model used in this paper is used to minimize expected lead time [6]. This optimize model will be accomplished by linear programming model with expected lead time as seen below:

$$Minimasi\ Z = PY^{l}_{k,j,ls,ld} + \sum_{x=1}^{n} PY^{P}_{k_x,i_x,j,ld}\theta_{k_x,i_x} + \sum_{x=1}^{n-1} PY^{N}_{k_x,k_{x+1},j,ld}\lambda^{N}_{k_x,k_{x+1}} + PY^{O}_{k_n,j,m,ld}\lambda^{O}_{k_n,m} + Y^{S}_{m,ld}\lambda^{S}_{m,ld}, \qquad (4)$$

$$\forall (ls, k_1, k_2, \ldots k_n, m, ld) \in Path_{ls,k,m,ld}$$

Subject to:

$$PY + PY2 = \Pr ob_{j,ld} \ \forall j, ld \qquad (5)$$

$$PY \le Y \ \ \forall j, ld \qquad (6)$$

$$PY2 \le 1 - Y \quad \forall j, ld \tag{7}$$

$$TP \ge 0 \tag{8}$$

$$Y^{l}_{k,ls}, Y^{P}_{k,i}, Y^{O}_{k,m}, Y^{S}_{m,ld} \in \{0,1\} \tag{9}$$

Where:

Z	=	Expected lead time of the whole supply chain network
PY	=	Stock-out probability for product j customer *ld* at time period *t*
$Y^{I}_{k,ls}$	=	1 if a transportation link from supplier *ls* to plant site *k* is set up
$Y^{P}_{kx,ix}$	=	1 if plant *i* in site *k* is installed
$\theta_{kx,ix}$	=	Time delay by production of plant *i* in site *k*
$Y^{N}_{kx,kx+1}$	=	1 if an inter-site transportation link from site *k'* to site *k* is set up
$\lambda^{N}_{kx,kx+1}$	=	Transportation time from plant site *k* to *k'*
$Y^{O}_{kn,m}$	=	1 if transportation link from site *k* to distribution center *m* is set up
$\lambda^{O}_{kn,m}$	=	Transportation time from plant site *k* to distribution center *m*
$Y^{S}_{m,Id}$	=	1 if a transportation link from distribution center *m* to customer *ld* is set up
$\lambda^{S}_{m,Id}$	=	Transportation time from distribution center *m* to customer *ld*
$Path_{ls,k,m,Id}$	=	Set of possible paths of chemical flow from supplier to some site and distribution center, finally ends at customer. Elements are in the form of $(ls, k_1, k_2 \ldots k_n, m, Id)$
$PY2$	=	Slack variable

4. Result and Discussion

4.1. Identification System

Identification of the supply chain system responsive pineapple multi product was begins by making diagrams of input, process and output. Then determined the needs analysis and entities at build the system, such as stakeholders, input, output, rule, purpose and role. **Figure 1** shows the construction of the system entities design of supply chain responsive pineapple multi products [13]

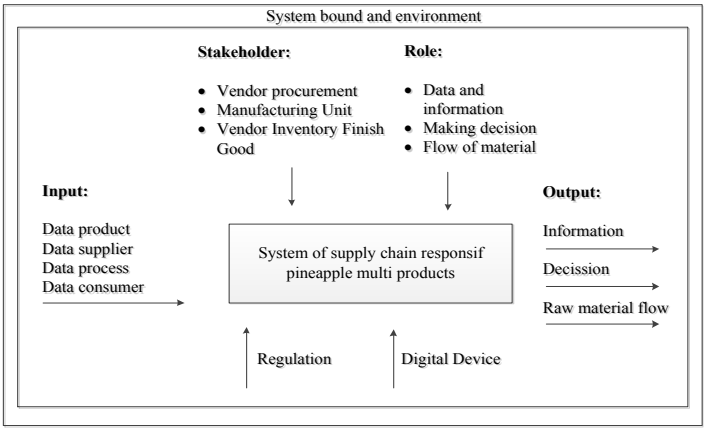

Figure 1. System entity construction based on [14]

4.2. Business Process Analysis

The analysis supply chain responsive of pineapple multi products system which will be developed is done by using BPMN 2.0. BPMN 2.0 is a model that can help identify, define and describe the problem in a business process. Business process is one or more linked procedures or activities which aim to achieve overall business goals, usually in the context of an organizational structure that defines the functional roles and relationships [5]. Results of analysis of business processes described in **Figure 2** have been validated.

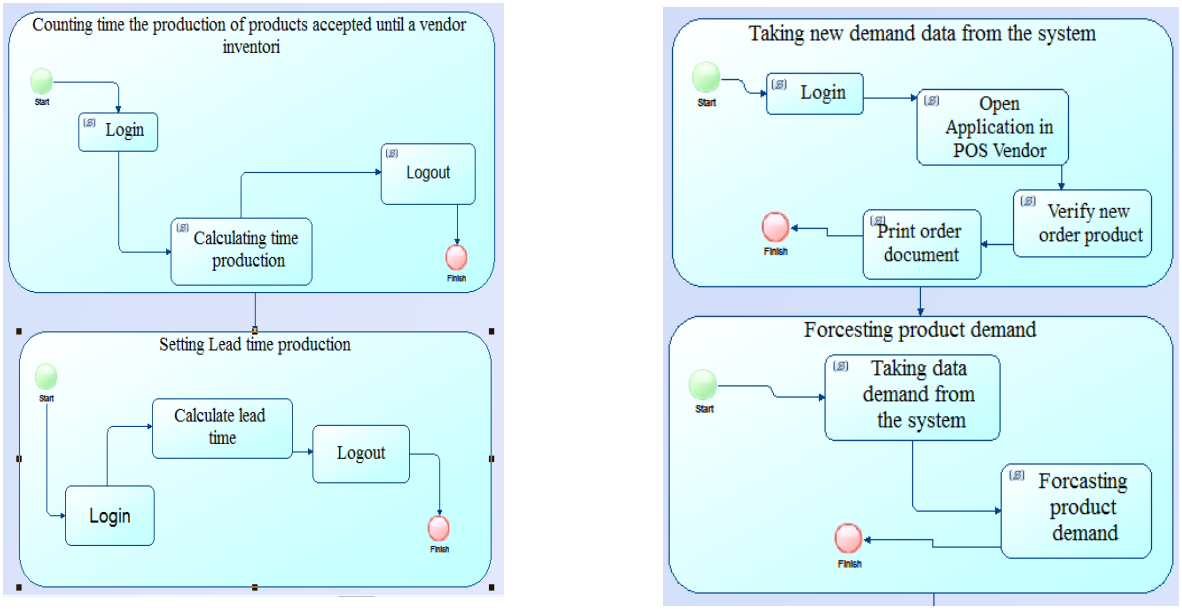

Figure 2. Fragment business analysis diagram in supply chain responsive of pineapple multi product

4.3. Classification of Pineapple Multi Product

The resulting decision tree structure can be seen in **Figure 3.** Classification of pineapple multi products using decision tree data mining and produce a decision in the form of rule. Results of processing by using a computational program WEKA 2.6 obtained seven rule. The combination of products that will be produced can be seen in **Table 1** pineapple pattern of multi product. Rule produced by a combination of selection of a combination of products that will be produce on specified conditions where the combination of these products are divided into three classes, namely products juices-jam, juices-dodol, and jam - dodol .

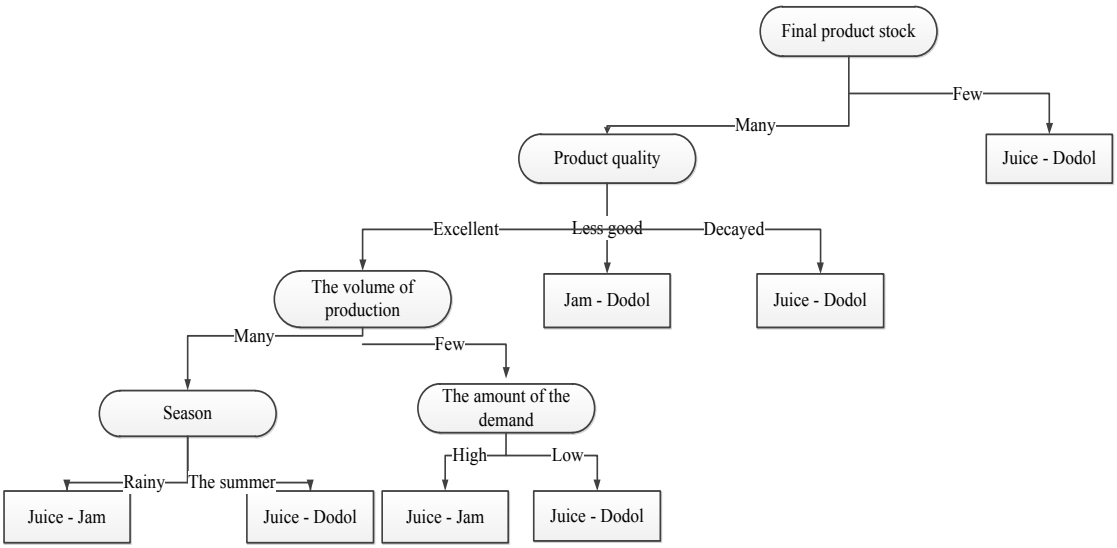

Figure 3. Decision tree structure results

Table 1. Patterns of pineapple multi product with class "juice - jam", "juice - dodol" and "jam - dodol"

No	Rule
1	IF final product stocks = many AND product quality= excellent AND the volume of production = many AND season = rainy, THEN a manufactured product = juice – jam
2	IF final product stocks = many AND product quality= excellent AND the volume of production = few AND the amount of the demand = high, THEN a manufactured product = juice – jam

3	IF final product stocks = many AND product quality= excellent AND the volume of production = many AND season = the summer, THEN a manufactured product = juice – dodol
4	IF final product stocks = many AND product quality= excellent AND the volume of production = few AND the amount of the demand = low, THEN a manufactured product = juice – dodol
5	IF final product stocks = many AND product quality= decayed, THEN a manufactured product= juice – dodol
6	IF final product stocks = few THEN a manufactured product = juice – dodol
7	IF final product stocks = many AND product quality= less good, THEN a manufactured product = jam – dodol

4.4. Optimization of Responsive Supply Chain Model

Based the Equation 4 responsive supply chain is undertaken by using linear programming model and solved using Lips 1.1 package. Kruskal's spanning tree algorithm [2] was deployed to compute minimum distances of material distribution from each element in supply chain path up to final customers. Each optimized path was then deploys for variables values of Equation 4. Which ensure minimizes transportation time and the lowest cost. **Figure 4.** Provided how relationship among element interacted to support responsive supply chain with multi product.

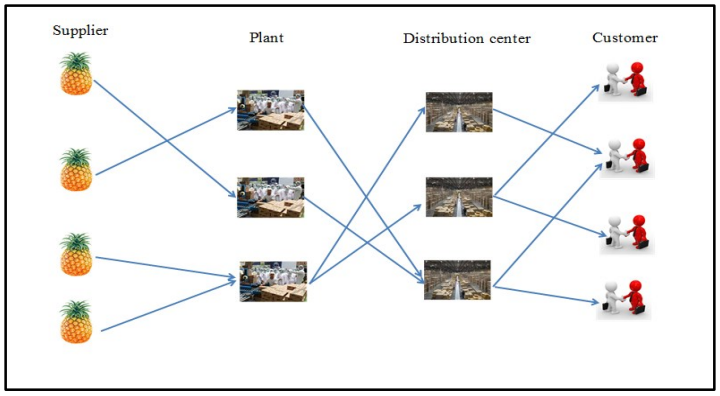

Figure 4. Optimize network of supply chain responsif pinneaple multi products

5. Conclusion and Future Work

We have described and evaluated a design of supply chain responsive for pineapple multi products and the design was verified. The results showed that there were three stakeholder taking role in supply chain responsive system. The classification of pineapple multi products obtained seven rule combination of product from five attributes. Optimize of supply chain responsive has been acquired supply chain in procedure that was the shortest by the expected lead time and reduce total cost. This design can be applied by supporting a designed information system. This is the subject of our future work. Another possible future extension is to integrate design of responsive supply chain pineapple multi product with the infrastructure of digital business ecosystem and information system. With this next challenge, each of the stakeholders may involve and scatter in several locations can be access digital system easily, so that cost to reduce. Further potential extension that might be done in the future is to investigate an adaptive procurement mitigation in this responsive supply chain.

6. Acknowledgements

We would like to thank Aditia Ginantaka for his comments and suggestions regarding the design system. We also would like to thank Hety Handayani, IB Dharma Yoga and Hadi for fruitful discussions as well as their support and encouragement. This research was conducted for Agro industrial Department, Bogor Agricultural University contact address PO. BOX 220 Bogor.

7. References

[1] M. Bramer, "Principles of Data Mining, 1st Edition," London: *Springer*, 2007.
[2] T.H. Cormen, C.E. Leiserson, R.L. Rivest and C. Stein, "Introduction to Algorithms," 3rd Edition, MIT Press, Cambridge, Massachusetts, 2009.
[3] S. Chopra and P. Mendel, "Supply Chain Management Strategy, Planning, and Operation," 3th Edition, Pearson Prentice Hall, Upper Saddle River, New Jersey, 2007.
[4] E. Conchione, "Evalutionary and Pervasive Services," *Journal DIGIBIZ*, ST21, 2009, p149-155.
[5] D. Draheim, "Business Process Technology: A Unified View on Business Process," New York: *Springer* Heidelberg, 2010.

[6] F. You and I. G. Grossmann, "Design of Responsive Supply Chains Under Demand Uncertainty," *Journal Elsevier, Computers and Chemical Engineering*," Vol. 32, Issue 12, Des 2008, p3090-3111.22p.
[7] J. Han, M. Kamber and J. Pei, "Data Mining Concepts and Techniques, 3rd Edition," USA: Morgan Kaufmann, 2012.
[8] R.W.K. Leung, H.C.W. Lau, and C.K. Kwong, "On a Responsive Replenishment System: A Fuzzy Logic Approach**,"** *Article Expert System*, February 2003, Vol.20. No. 1.
[9] M.A.T. Khalil, P.D.D. Dominic, M.F. Hassan and A. Mushtaq, "An in Depth Analysis of Ecosystems and Blueprint of Digital Business Ecosystem (DBE) Framework for Malaysian SMEs," *Computer Science Journal*, Volume 1, Issue 1, April 2011, p65-78.
[10] F. Nachira, P. Dini and A. Nicolai, "A Network of Digital Business Ecosystem for Europe: Roots, Processes, and Perspectives. under: F. Nachira, A. Nicolai, P.Dini, M.L. Louarn and L.R. Leon, editor. *Digital Business Ecosystems*," Luxembourg: European Commission, 2007, p1-20.
[11] M.K. Tiwari, B. Mahanty, S.P. Sarmah and M. Jenamani, "Modeling of Responsive Supply Chain. IIT Kharagpur Research Monograph Series," CRC Press, New York. 2013.
[12] N. Vidyarthi, S. Elhedhli and E. Jewkes, "Response Time Reduction in Making-to-Order and Assembly-to-Order Supply Chain Design," *IIES Transactions*, 2009, 41, p448-466.
[13] C.S. Wasson, "System Analysis, Design, and Development Concept, Principles and Practices," New Jersey (CA): John Wiley & Sons, 2006.
[14] Q. Wang, and N. Ingham, "A Discrete Event Modeling Approach for Supply Chain Simulation," *Int j simul model 7*, 2008, p124-134.

