Proceeding International Joint Conference on Science and Technology (IJCST) 2017

ISBN : 978-602-99806-3-9

Decision support systems: transportation mode selection for agricultural product distribution

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ABSTRACT: Agriculture sector in Indonesia encounters several problems, two of them are distribution and long marketing chain. In Indonesia, system that can integrate the information of the parties in the distribution chain in agriculture is limited. This research contributes in the form of an E-Market which not only accommodate sellers and buyers, but also the distributor which provides transportation mode to deliver the agriculture product. Decision Support System feature allow the most suitable distributor, as well as its transportation mode, is selected by the users based on the common evaluation of transportation mode using Analytic Hierarchy Process (AHP) method. The advantages of this system are the seller can be independently determine its market and the buyers can search for potential producers and distributors as preferred.

Keywords: Four or five keywords (First characters of each word are in capital/uppercase letters), Italic

1. INTRODUCTION

Agriculture sector in Indonesia encounters several problems, two of them are distribution and long marketing chain [1]. Problems in distribution are caused by the natural geographical features, since Indonesia is an archipelagic country, and some agricultural sites are in secluded locations. This circumstance requires the availability of decent distribution chain consisting of various modes of transportation. Therefore, system that can integrate between sellers, buyers and distributors is necessary to shorten distribution chain. Given such a system, there will be a large selection of distributors with multi-modal options.

The agriculture products can be delivered by a variety of transportation modes. The fastest delivery time is by airplane, another alternative is by trucks, with a longer travel time, and other alternative is using water transportation modes [2]. In Sulawesi Island there is a solution to deliver agricultural products by a motorcycle. The last transportation mode is using a combination of transportation modes/intermodal, although there were challenges when it is applied [3]. The difficulty in determining transportation modes and delivery services provider bring opportunities for organizations and individuals to get involved in the supply chain.

In Indonesia, marketing and distribution of agricultural products activities are controlled by government organizations, in particular department of agriculture. The advantage is farmers as well as the organization have permanent customers and distributors. The disadvantage is farmers will have limited sales coverage, the organization must be fully responsible for marketing and distribution, and finally the distributor cannot contribute vigorously in supply chain. Several systems are developed

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to ease the seller (the farmers) for searching potential buyers, and vice versa, where the product distribution is controlled by the buyer. The advantages are the seller can be independently determine its market and prospective buyers of the product can also search for potential producers as preferred. The disadvantage is that the seller does not have a definite market and the prospective buyer usually has difficulty determining the right distributor (which is usually passive).

Research conducted by [4] aims to facilitate the distribution of information generated by farmers where the system can be accessed by anyone via the Internet. In that study, the system provides information of commodities prices, products, product sales offers and bids for products, but not address the problem of distribution. The concept used in the study is known as crowdsourcing. An emerging concept in the field of business in 2005 explains the concept of the process of achieving a goal of both goods and services through online media from the contributions of many parties. ITS (Intelligent Transportation Systems) Indonesia developments is emerging by [5], although unfortunately it is still not synchronized and coordinated. Information heterogeneity of ITS Indonesia becomes an obstacle to provide interoperability. They also suggest establishing Cloud ITS based on cloud computing, it is feasible to accommodate transportation information sharing platform.

This research contributes in the form of an E-Market which not only accommodate sellers and buyers but it can also accommodate the distributor and has a Decision Support System feature that can provide the most suitable distributors and transportation mode based on the characteristics of products traded. Characteristics of agricultural products that will be used as objects in this study is limited to horticultural crops. This type of plant is selected because it is decayed more quickly and it needs special handling due to fluctuating selling prices. The decrease in the quality of horticultural products is also related to the activities during the distribution process, especially related to the time factor, distance or temperature and transportation facilities in each distribution chain.

2. LITERATURE REVIEW

2.1. Decision Support Systems

Decision Support Systems are a computer-based system that supports choice by assisting the decision maker in the organization of information and modelling of outcomes [6], [7]. The concept of decision support systems comes from a balance between human judgement and information process by a computer. There are three fundamental components of decision support systems. First, there is database management system (DBMS) which serves as a data bank for the system. The second component is model-based management system (MBMS). The role of MBMS is analogous to that of a DBMS and, the third is the method of dialog generation and management system (DGMS).

2.2. Analytics Hierarchy Process Method

AHP (Analytic Hierarchy Process) was proposed by (8) to model multi-criteria problems in a hierarchical system. Hierarchy in AHP method consists of an overall objective, a set of preferences or alternatives for attaining the objective, and a set of factors or criteria that relate the alternatives to the objective. The criteria is able to be decomposed into sub criteria, sub-sub criteria, and so on, in as many levels as the problem requires.

AHP method generates a weight, denoted by w, for each evaluation criterion according to the decision maker's pairwise comparisons of the criteria. Each weight represents the quantified strength of the compared element against another, on the standard "1 – to – 9" measurement scale. The higher the weight, the more important the corresponding criterion. Then, a score to each preference is assigned, according to the decision maker's pairwise comparisons of the preferences based on the criterion. The higher value shows the performance of the preference, with respect to the considered criterion, is better. The criteria weights and the preference values are combined, thus the global value for each preference are determined. The global value for a given preference is a weighted sum of the values obtained with respect to all the criteria.

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The important element of the AHP method is measuring the consistency ratio (CR) of matrices of relative weights on each level of hierarchy. Since the numeric values are derived from the subjective preferences of individuals, there is possibility of inconsistencies in determining the weights. Based on [8], a consistency ratio (CR) of 10% or less is acceptable to continue the analysis. Otherwise, it is necessary to revise the judgments to discover the cause of the inconsistency and correct it.

3. RESULTS

There are 8 criteria used in determining the distribution of agricultural product delivery. Among them are transportation costs, delivery time, fleet modernity, transportation reliability, transportation quality, safety, and fleet utilization (Baran and Jacek, 2013). And also based on the results in the field, the horticultural type of agent prefer the three criteria that they consider important is the delivery time, shipping costs, and the capacity of modes of transportation.

3.1 Delivery Time

Delivery time is dominant in the distribution of products such as horticultural crops. The nature of horticultural crops that are more susceptible to decay should be immediately reached to the destination to get further treatment.

Table 1 Delivery Time

Delivery Time Interval (Hours)	Saaty Scale
$X \leq 3$	9
$3 < X \leq 5$	7
$5 < X \leq 7$	5
$7 < X \leq 9$	3
$X > 9$	1

3.2 Mode Capacity Transportation

Capacity accommodated in the mode of transportation is chosen to be the next criteria, because if it has a very fast delivery time but inadequate capacity will also be a waste. The greater the capacity of transportation modes, the greater the likelihood of transporting large quantities of horticultural products.

Table 2 Mode Capacity

Mode Capacity Interval (Kg)	Saaty Scale
$Y \leq 100$	1
$100 < Y \leq 300$	3
$300 < Y \leq 500$	5
$500 < Y \leq 700$	7
$Y > 700$	9

3.3 Shipping Costs

Shipping costs also have a vital role in the products distribution like horticultural crops. Two important things that cannot be separated is the delivery time and shipping costs. Cost and delivery time has an upside-down ratio, the lower of the cost and the delivery time, the higher the buyer's satisfaction level. Vice versa if the higher the value of cost and delivery time, the lower the level of customer satisfaction.

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Table 3 Shipping Costs

Shipping Costs (Rp) Interval	Saaty Scale
$Z \leq 500.000$	9
$500.000 < Z \leq 1.000.000$	7
$1.000.000 < Z \leq 1.500.000$	5
$1.500.000 < Z \leq 2.000.000$	3
$Z > 2.000.00$	1

4. CONCLUSION

Decision support system using AHP Method has been successfully established. This system has a distributor selection feature using AHP method. This system is used to facilitate and support the agent (buyer) in making the decision to select the appropriate distributor so that buyers feel helped by this system.

5. ACKNOWLEDGEMENTS

The research has been supported by Research and Community Services of UPN "Veteran" Jawa Timur through fundamental research scheme funding. This support is gratefully acknowledged. The authors would like to express their appreciation for the valuable and insightful comments made by an anonymous reviewer.

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