Selection of Warehouse Location along the R3A Route of Lao People's Democratic Republic by Analytic Hierarchy Process

Tarathorn Kullpattaranirun* and Rachata singhagumpon**

Abstract

This study is intended (1) to study the factor structure of the selection of suitable warehouse site along the R3A, (2) to evaluate the weightings of the factors in the selection of suitable warehouse site by means of the Analytic Hierarchy Process, and (3) to determine a suitable warehouse site along the R3A between Bokeo Province and Luang Namtha Province, Lao People's Democratic Republic, by means of the Analytic Hierarchy Process. The researchers have chosen 18 factors from 7 researches on warehouse site selection and put the 18 factors through the process of calculating the index of item-objective congruence (IOC) by interviewing experts. As a result, only 16 factors remained to be analysed by the Analytic Hierarchy Process (AHP). Via the AHP, the weightings of each factor in the determination of the most suitable warehouse location has been assessed; the factor group of costs weighed the highest at 40.35%, followed by the marketing group at 21.68%, being the second, and the labour group at 14.76%, being the third. Furthermore, the factor groups of environment and infrastructure weighed at 12.68% and 10.53%, ranked the fourth and the fifth highest respectively. As for the experts' conclusion on selecting the location, the warehouse site

* Lecturer, Department of Management, Faculty of Business Administration, Mahanakorn University of Technology

** Student, Faculty of Business Administration, Mahanakorn University of Technology

suitability of Bokeo Province was topmost determined at 54.90%, while the Luang Namtha Province was assessed at 44.69%

Key Word: Analytic Hierarchy Process, Warehouse, Location

Introduction

The R3A route was built to serve as an economic link between of the countries in Mekong subregion, steering them towards economic, social and political integration, and it also connects Bangkok to Kunming, Yunnan Province; starting from Bangkok past Chiang Khong district of Chiang Rai, Thailand, crossed the Mekong River to Ban Huay Sai of Bokeo Province, Lao People's Democratic Republic, through the route of Bokeo Province-Luang Namtha-Ban Boten and the border to Jinghong of Sipsongpanna and ended in Kunming, Yunnan Province, People's Republic of China, a total distance of 1,987 kilometres. Due to the very long distance and left/right-hand traffic complication in effect, accidents tend to occur and often cause damages and delays to goods transportation, and particularly since the transportation route has established a bridge between many countries, finding a site for a warehouse that will be used as a depot, a loading dock, a rest area, and a truck repair and maintenance service garage is essential, according to Chen-Tung Chen (2001) who analyses the factors in warehouse site selection and remarks that warehouses can pull customers, organisations, and suppliers together to reduce the costs of transportation, performance evaluation, and logistic efficiency test. Also, a study on the competition in the supply chain by Rohit Bhatnagar, Amrik S. Sohal (2005) states that competitiveness is influenced by various factors, starting from selecting a location. So, in order to make Laos become more than a country that transportation vehicles just passing through and to deal with abovementioned situations, warehouses are a necessity on the R3A in Lao People's Democratic Republic territory (Bokeo Province and Luang Namtha Province).

Objectives

This research was conducted (1) to study the factor structure of the selection of suitable warehouse site along the R3A, (2) to evaluate the weightings of the factors in the selection of suitable warehouse site by means of the Analytic Hierarchy Process, and (3) to determine a suitable warehouse site along the R3A between Bokeo Province and Luang Namtha Province, Lao People's Democratic Republic, by means of the Analytic Hierarchy Process.

Methodology

Defining the Problem and Objective

The problem and objective is defined in order to achieve an intended result on suitable warehouse site selection, as the defined problem and objective would further led to a conclusion on suitable warehouse location, herein by taking the affecting factors into account.

Screening the Factors

By reviewing 7 relevant studies to identify the factors in location selection by means of Analytic Hierarchy Process, 18 factors were recognised to be put through an IOC process which three experts would be the decision makers.

Appointing the Experts

There were five experts in total in this research; two of which were scholars and the other three were warehouse specialists.

Designing Questionnaire to Calculate the Index of Item-Objective Congruence (IOC)

The researchers prepared questionnaire to re-examine the factors derived from the literature review to eliminate redundant factors via

assigning important weightings by three experts; two of which were scholars and the other one was a warehouse specialists.

Calculating the Index of Item-Objective Congruence (IOC)

IOC procedure was applied to provide the information about the agreement between the 18 derived factors and the objective, using the questionnaire to assess the IOC by three experts who had to assign each factor a value ranging from -1 to 1, with the index level of model congruent value no less than 0.05.

Building a Hierarchical Diagram or Decision Model

After determining the factors in the process of warehouse site selection via IOC procedure, the researchers have symbolised the 16 factors, as noted in Table 1, and built a decision model, as presented by figure 1.

Table 1 Factor Symbols

Symbol	Factor
C1	Investment Costs
C2	Transportation Costs
C3	Tax and Tax Rates
C4	Labour Costs
C5	Levels of Customer Service
C6	Market Proximity
C7	Competitions
C8	Environmental Laws
C9	Political Risks
C10	Public Policies
C11	Working Cultures
C12	Workmanship
C13	Workforce Adequacy
C14	Facilities
C15	Transportation and Communication Systems

Table 1 (Con.)

Symbol	Factor
C16	Quality and Reliability of Transportation System

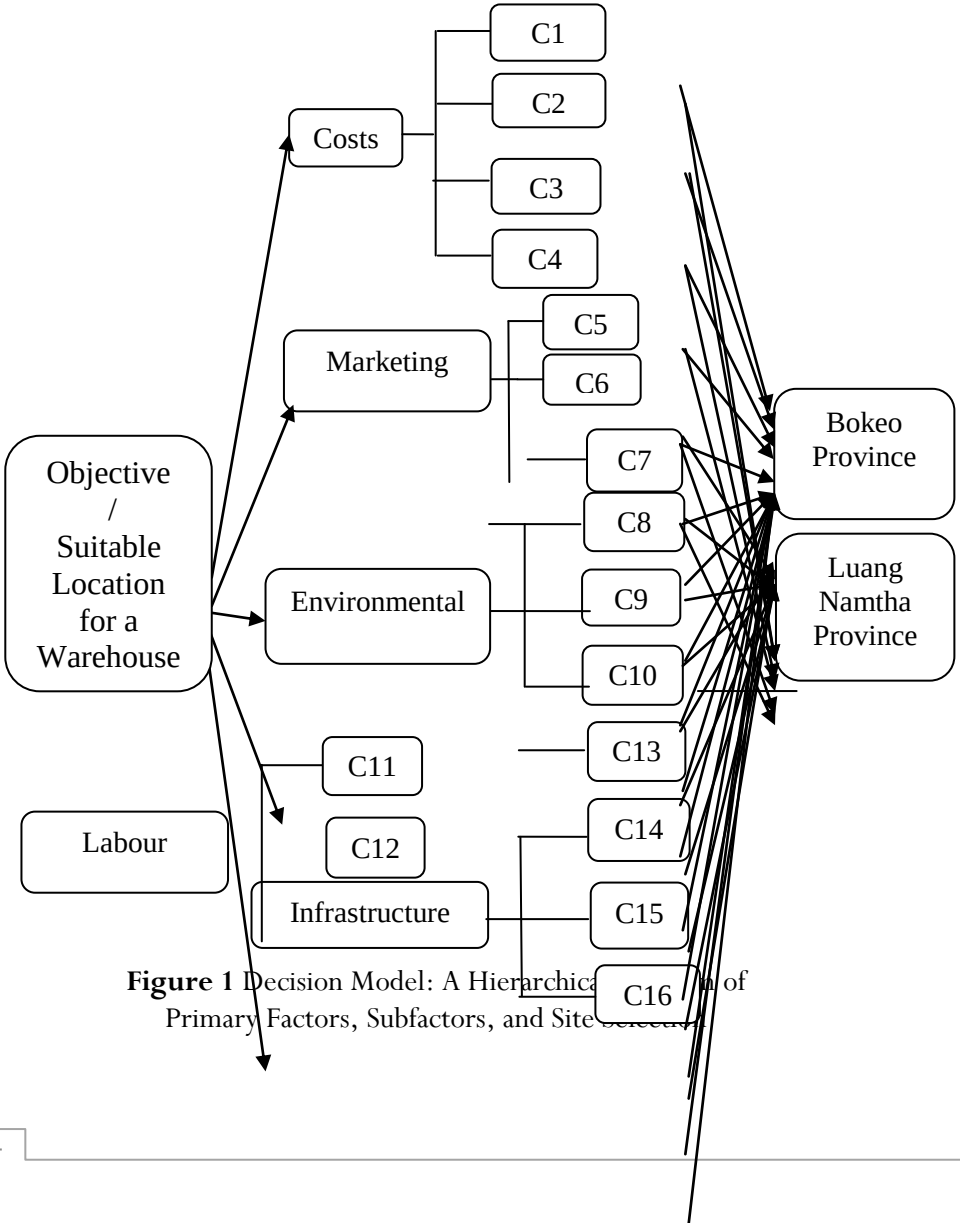

Figure 1 Decision Model: A Hierarchical Tree of Primary Factors, Subfactors, and Site Selection

Model Validation

After the decision model has been built in accordance to the Analytic Hierarchy Process, the model was then presented to the five experts for the purpose of validation.

Building an Analysis Model by Using Microsoft Excel and Design a Questionnaire in AHP Format

Designing a questionnaire in AHP format allows for pairwise comparison of the factors with respect to the objective of the problem statement, and such comparison would further reflect relative importance thereof, which was agreed by the experts to use numerical scale ranging from 1 to 9 to as weightings. The questionnaire comprised of three sections;

1. Definition of Factors
2. Questionnaire, for the purpose of studying and assessing the factors influencing the warehouse site selection process
3. Questionnaire, to compare the importance of the factors and the alternatives

Data Collection

Data collection was done by comparing decision criteria and alternatives, divided into stages as follows:

1) Introduction and Explanation

The researchers contacted each of the experts to present the decision model and explain the questionnaire that had been designed to determine the important weightings by pairwise comparison and also provide the respondents with a brief information on conducting comparisons by this particular means and basic information of each location in order to ensure that the respondents had adequate information to fill out the questionnaire. Then the researchers enquired about the importance of decision criteria and interests in each alternative to find a trend of thought on the pairwise comparisons among the respondents.

2) Gathering Data by Interviews

The researchers gathered judgement data regarding the pairwise comparison starting from the interviews of each expert. The data gathering started from comparison of smaller elements, weightings of the main factors, to higher tiers accordingly. In other words, the researchers intended to conduct a pairwise comparison of Bokeo Province and Luang Namtha Province, which were on the third tier, to the higher factors on the second tier, and compare the second-tier major criteria, to the goal on the first tier accordingly after all the major criteria pairs have been compared.

3) Consistency Check

The researchers put the data gathered from the interviews in Microsoft Excel's software suite to calculate the consistency of each expert.

4) Adjusting the Judgement

If the judgement of any expert did not meet the criteria, the researcher would then contact that expert to revise his/her judgement individually using Microsoft Excel software suite directly in order to reassess the weightings and calculate the consistency immediately whenever a change in the old data occurred until the consistency level fell within an acceptable range, or not exceed the value of 0.1. Any alteration would be under an agreement of the respondent

Data Analysis

In this step, the data were analysed via Microsoft Excel in accordance to the Analytic Hierarchy Process to weigh the factors in order of importance and measuring the weightings in the selection of suitable warehouse site by refining complications to just the comparison between main factors and subfactors and selection of the location, and then synthesise all the data. The synthesis result would then be the alternatives' relative ability to achieve the decision goal.

Result

The result finds that the scores of alternatives from the experts to determine the best thereof appeared to be in favour of Bokeo Province over Luang Namtha Province at 54.90% and 44.69% respectively.

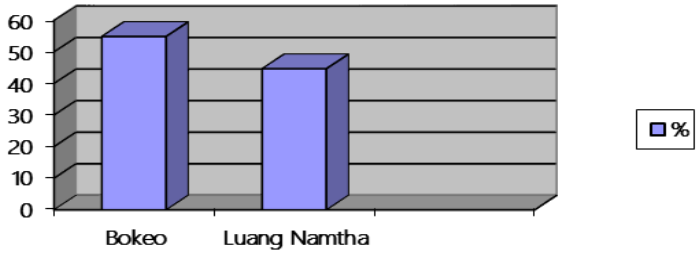

Figure 2 Scores of Alternatives for Warehouse Location

Figure 3, representing the average of weightings of the main factors calculated by Microsoft Excel, illustrates that the group of factors of costs has the highest weight (40.35%), followed by marketing (21.68%), labour (14.76%), environment (12.68%) and infrastructure (10.53%).

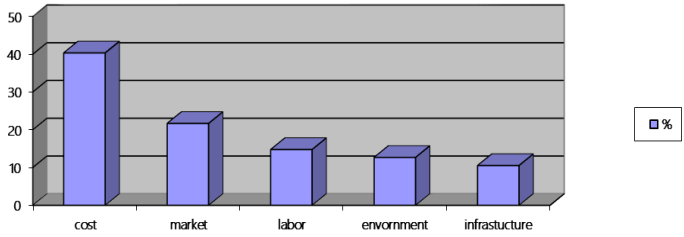

Figure 3 Average Weightings of Main Factors

Figure 4, representing the weightings of the second-tier subfactors of the factor of costs, consists of C1=Investment Costs

(52.98%), C2=Transportation Costs (22.90%), C3=Tax and Tax Rates (12.59%) and C4=Labour Costs (11.53%)

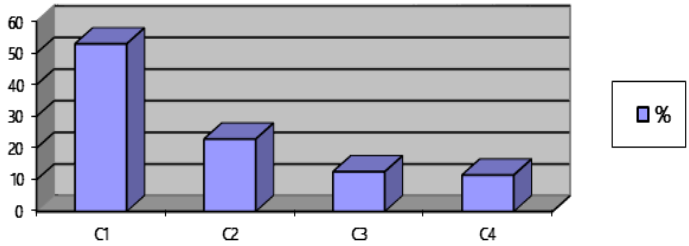

Figure 4 Weightings of Cost Subfactors

Figure 5, representing the weightings of the second-tier subfactors of the marketing factor group, consists of C5=Levels of Customer Service (47.94%), C6=Market Proximity (32.88%), and C7=Competitions (19.18%)

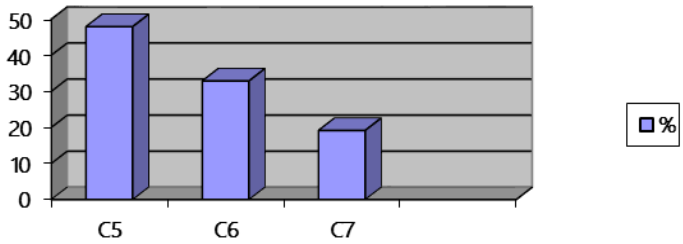

Figure 5 Weightings of Marketing Subfactors

Figure 6, representing the weightings of the second-tier subfactors of the environmental factor group, consists of C8=Environmental Law (22.17%), C9=Political Risks (34.93%), and C10=Public Policies (42.90%).

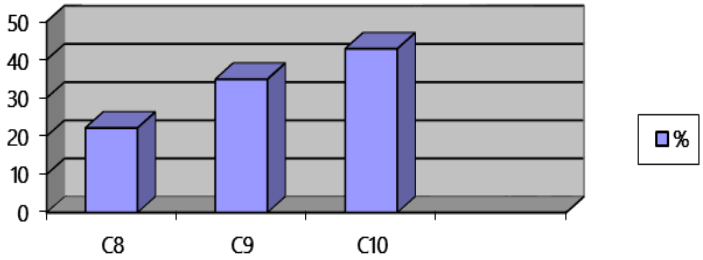

Figure 6 Weightings of Environmental Subfactors

Figure 7, representing the weightings of the second-tier subfactors of the labour factor group, consists of C11=Working Cultures (12.35%), C12=Workmanship (57.25%), and C13=Workforce Adequacy (30.70%).

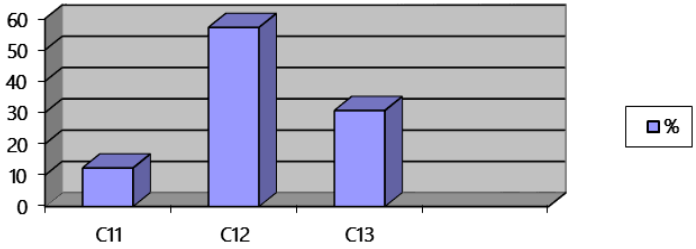

Figure 7 Weightings of Labour Subfactors

Figure 8, representing the weightings of the second-tier subfactors of the infrastructure factor group, consists of C14=Facilities (44.22%), C15=Transportation and Communication Systems (21.69%), and C16=Quality and Reliability of Transportation System (34.48%).

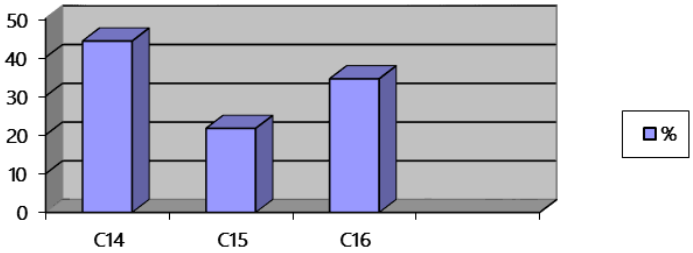

Figure 8 Weightings of Infrastructure Subfactors

Discussion

As a result to examining for a suitable warehouse location along the R3A in Lao People's Democratic Republic by means of Analytic Hierarchy Process, it was discovered that Bokeo Province was the most suitable and also found that the outcomes from such means were very reliable since pairwise comparisons were employed in the decision making, hierarchical diagram was built imitating human thinking process which was utilisable and comprehensible with ease, and the results would be in numerical format which meant that they could be arranged in order of importance and compared with that of other organisations, eliminating discrimination and biases in decision making. Given the fact that there are many Thai and Chinese warehouse firms, meeting in a private manner, the researcher realised that, according to Thai entrepreneurs, establishing a warehouse in Bokeo Province would make goods distribution, classification, and importing parts for assembly to deliver to customers more convenient than constructing one in Thailand, because the destinations of goods transportation could go beyond Lao People's Democratic Republic to the People's Republic of China and Socialist Republic of Vietnam as well. As for the Chinese entrepreneurs, it is observed that establishing a warehouse or storehouse in Bokeo Province within Chinese marketplace zone would allow one to be used as a storefront selling products from China to tourists in Bokeo, Lao People's Democratic

Republic, since most of which would typically go to a Chinese marketplace before visiting any other place. In regard to the weighting factors in decision making, the result of this study was agreed by both Thai and Chinese entrepreneurs that costs, marketing, labour, environment, and infrastructure were the biggest part in such decision making. Still, conducting a warehouse business in Lao People's Democratic Republic would be constrained by strict laws and regulation, as well as the left/right-hand traffic complication. Thus, in the perspective of Thai investors who intend to invest in a warehouse business of Bokeo Province, adapting business practices towards the culture and tradition thereof is also considered a necessity, among other things.

Recommendation

Most of the time, conducting a warehouse business would involve factors in location selection that are not so different, e.g., to use as a place to stock goods before selling on markets or store materials prior to production process, reducing transportation costs and input costs by procuring in a large quantity and receive a discount accordingly. Apart from that, it also yields faster and more convenient services to the customers. The process of determining the location of warehouse itself would typically involve a very high amount of investment, so it is crucial to brainstorm the experts to determine the decision criteria and a variety of alternatives and assessing them for the best. Applying the Analytic Hierarchy Process to aid in decision making is also another method that can be used to help with complex decisions. Moreover, bringing other techniques together with Analytic Hierarchy Process would yield more accurate decision making. Regarding Fuzzy Analytic Hierarchy Process, Mojtaba Tabari, Amin Kaboli, M.B. Aryanezhad, Kamran Shahanaghi, Ali Siadat (2008) have suggested a multiple-criteria decision making (MCDC) to determine the best location by considering both tangible factors and abstract factors affecting the decision making on warehouse location selection by a

presentation of procedures and methodology for calculation in warehouse site selection, demonstrating that the Analytic Hierarchy Process is widely acknowledge and has been used for decision making of various circumstances in efficient manner with a small chance of error, so it is considered another decision support system that is strongly recommended.

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