IMPROVING SUPPLY CHAIN ACTIVITIES BY ADVANCING AND TEACHING AHP APPLICATIONS

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SESSION ABSTRACT

This session includes three research proposals on analytic hierarchy process (AHP). The first study attempts to demonstrate an application framework of both AHP and DEA (data envelopment analysis) for evaluating suppliers, 3PL firms, and supply chain activities. Two approaches will enable supply chain managers to combine subjective data with AHP and objective data with DEA for supply chain management. The second study investigates improving scales for consistent AHP results. This study explores different scales with examples for finding one that provides AHP users with consistent evaluation scores. The third study discusses pedagogy for teaching DEA to supply chain students. AHP is a highly useful approach for supply chain management as evidenced with numerous AHP applications in the supply chain management area. Accordingly, teaching AHP to the students in supply chain management programs can be an imperative issue. In fact, many supply chain programs at universities include a course for supply chain modeling, which can adopt AHP. This study demonstrates the use of Microsoft Excel for computing AHP weights for simple problems.

Keywords: analytic hierarchy process, data envelopment analysis, supplier evaluation, scale development, pedagogy.

COMBINING SUBJECTIVE AND OBJECTIVE CRITERIA FOR EVALUATING SUPPLIERS USING AHP AND DEA

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ABSTRACT

It is necessary to evaluate of supply chain partners such as suppliers and third-party logistics (3PL) providers for the selection and development of the partners. When we evaluate the partners for their performance, we have two choices for including data such as subjective and objective criteria. If we assess their performance using two types of criteria in different models, we may have contradictory results with opposite directions. In addition, it is difficult to compare the results because they are estimated separately. We attempt to combine subjective criteria using analytic hierarchy process (AHP) and objective criteria using data envelopment analysis (DEA). We include weights from judgment matrices and objective data in relevant DEA models for evaluating the supply chain partners. We propose and demonstrate a framework with an example. At the time of this study, we found one study that utilized this approach using simple data from a previous study with limited variables. Accordingly, the major contributions of this study will be enriching literature in this area and providing practical insights to supply chain managers.

Keywords: supplier evaluation, analytic hierarchy process, data envelopment analysis.

1. Introduction

There are two types of criteria available for evaluating supply chain partners such as subjective and objective criteria. We propose a framework that can include two types of criteria and demonstrate its usefulness with an example.

2. Literature Review

There are three approaches for evaluating suppliers in the literature, which combine AHP and DEA. First approach derives weights with AHP and uses the weights as variables in DEA models (Kuo and Lin, 2012; Falsini et al., 2012). Second method combines AHP weights and objective measures and analyzes them in DEA models (Ramanathan, 2007). Last approach is known as DEAHP (data envelopment analytic hierarchy process) proposed by Ramanathan (2006). DEAHP uses judgment matrices and derives weights using DEA. There are couple recent applications of DEAHP for supplier evaluations (Zhang, Lee, and Chang, 2012; Sevkli et al., 2007). The summary of these approaches is presented in the following paragraphs.

Kuo and Lin (2012) computed the weights of criteria or variables using ANP and normalized the weights for a DEA model. They ran a super efficiency DEA model using the normalized weights for evaluating 42 suppliers. Supplier evaluation was conducted in two stages by creating data or weights using a subjective model (ANP) and by evaluating the weights using an objective method (DEA). Falsini et al. (2012) proposed the model that combined AHP, DEA, and LP for evaluating 3PL companies. They computed weights with AHP and corrected the weights with high CR values using LP. The processed weights were fed to a DEA model for evaluating 3PL firms. Similar to Kuo and Lin (2012), a two-stage approach was used by using AHP and LP first and DEA next.

Ramanathan (2007) tried to combine objective and subjective criteria for evaluating suppliers by using three approaches such as DEA, AHP, and TOC (total ownership cost). Ramanathan obtained objective data with TOC and subjective data with AHP from a previous study (Bhutta and Huq, 2002). He chose total costs for the only input and three AHP weights for outputs for DEA. He demonstrated supplier evaluation using three DEA models: a CCR model, a super efficiency-model, and an assurance-region model. He concluded that the assurance-region model was preferred due to its non-overlapping efficiency scores with relative importance.

He proposed the use of data envelopment analysis for computing weights for the judgment matrices of AHP. He included a unity as a dummy input variable and evaluation scores in the judgment matrices as output variables in DEA models. He found that this approach could be better than AHP for avoiding the rank reversal problem, which might happen when an irrelevant alternative was introduced or deleted. He named this approach DEAHP by combining the acronyms of the two methods. There are two recent applications of DEAHP for supplier evaluations (Zhang, Lee, and Chang, 2012; Sevkli et al., 2007).

3. Hypotheses/Objectives

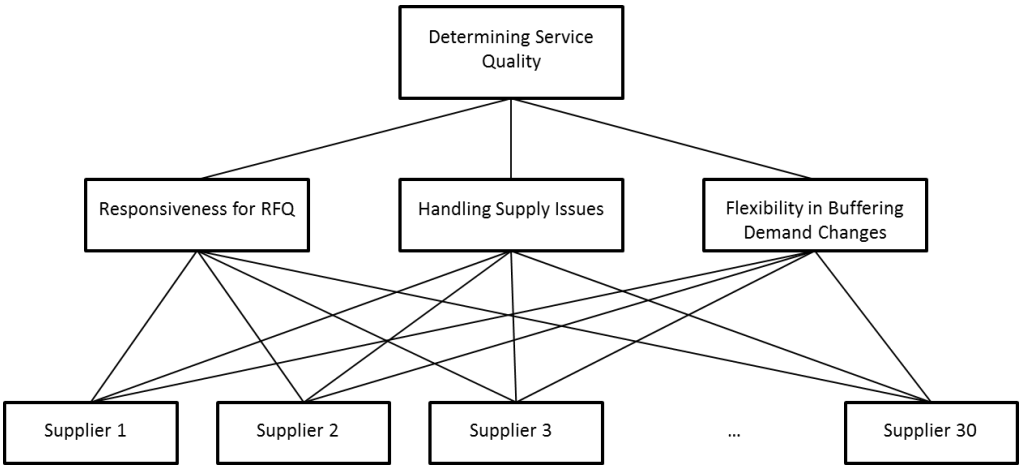
The major objective of this study is proposing a framework that includes subjective and objective variables in DEA models for evaluating suppliers. The subjective variables will be created using AHP.

4. Research Design/Methodology

When we evaluate suppliers, it is unrealistic to include all objective measures. In fact, there are many good reasons to include subjective measures for evaluating suppliers within supplier-buyer relationship. Buyers as customers to suppliers may want to include subjective evaluation criteria. We employ AHP for deriving a subjective variable on buyer satisfaction or service quality. 30 suppliers will be evaluated for service quality using an AHP model. Service quality along with objective variables will be analyzed in DEA models for assessing supplier performance.

5. Data/Model Analysis

The following diagram shows an AHP model for the subjective variable.



The supply office of a second-tier supplier to a major aircraft manufacturer provides data for its 30 suppliers, which are third-tier supplier to the aircraft manufacturer.

6. Limitations

Our study is limited by the availability of data, which is collected by the focal company. Ideally, we need to design a study first and collect data later. However, we have data first and developed our research framework later.

7. Conclusions

We propose a framework for supplier evaluation using subjective and objective measures. We demonstrate the usefulness of the framework using an example for a company in the aerospace industry. The contributions of this study include demonstrating the applicability of the framework and providing practical insights to supply chain managers.

8. Key References

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A NEW APPROACH TO THE USE OF A MEASUREMENT SCALE FOR ANALYTIC HIERARCHY PROCESS

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ABSTRACT

This study identifies issues on analytic hierarchy process (AHP), which is popular for selecting a reasonable alternative in the studies of social sciences, by way of empirical analysis and suggests a new measurement scale that resolves these issues. The nine-point bipolar scale (a total of 17 point scale) that is used when converting a subjective preference into numerical values in AHP offers a flexible way to a respondent for choosing an answer. However, this study points out that consistency in the responses may be undermined due to the excessive number of points in the scale. A preceding study with an example identified the 17-point scale (the nine-point bipolar scale) as one of the causes that undermine the consistency by increasing the consistency ratio (CR) value and suggested that a nine-point scale (a bipolar scale of five points) might be used in order to resolve this issue. However, since this study used only one example, it was difficult to generalize its result. Accordingly, this study conducts a survey on the same subjects twice: first, using a 17-point scale and, next, using a nine-point scale in the options given for responses. The distribution and range of responses along with CR values are compared to identify a scale that provides consistency in the responses and convenience to respondents. If the response results of the nine-point scale survey and the 17-point scale survey are similar, and the CR value by the nine-point scale survey is lower, then, there is no need to use the 17-point scale that makes it difficult to select a response.

Keywords: analytic hierarchy process, measurement scale, scale development.

1. Introduction

This study identifies an issue with the nine point bipolar scale for AHP and proposes a new scale that can overcome the issue. The popular nine-point bipolar scale may be unnecessarily complex and make respondents confused. As a result, consistency ratios become high for computed weights. We analyze this issue using empirical data and propose a new scale that is respondent friendly and improves consistency in responses.

2. Literature Review

Song and Lee (2013) attempted to explore the issue on the nine-point bipolar scale. However, they used only one example for analysis. This study will expand and generalize their study by including additional survey data.

9. Hypotheses/Objectives

This study points out an issue on the nine-point bipolar scale used by AHP studies and proposes a new scale that will provide improved consistency ratios.

10. Research Design/Methodology

This study conducts a series of surveys using the nine-point bipolar scale and new scale. Survey results will be compared for two scales. A parsimonious scale with an improved consistency ratio will be proposed.

11. Data/Model Analysis

Data will be collected using surveys with different measurement scales in Korea.

12. Limitations

This study will be conducted in Korean. Future studies may be necessary in different regions with different languages.

13. Conclusions

This study attempts to prove the problem of the nine-point bipolar scale and propose a new scale that can avoid the problem. The major contribution of this study includes developing a parsimonious scale for AHP studies.

14. Key References

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TEACHING ANALYTIC HIERARCHY PROCESS TO SUPPLY CHAIN STUDENTS

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ABSTRACT

Analytic hierarchy process (AHP) is a highly useful approach for evaluating suppliers for supplier selection and development, products and services for purchasing decisions, supply chain strategies and alternatives, and so on in supply chain management as evidenced by numerous AHP applications in this area. Accordingly, teaching AHP to the students in supply chain management programs can be an imperative issue. In fact, many supply chain programs at universities include a course for supply chain modeling, which can adopt AHP. This study demonstrates pedagogy using Microsoft Excel for computing AHP weights, which can be used for selecting suppliers and/or third-party logistics (3PL) providers and addressing other supply chain management related topics.

Keywords: analytic hierarchy process, pedagogy, Excel.

1. Introduction

AHP is relatively easy to understand compared to other quantitative methods that can be found in management science and operations research textbooks. Yet, AHP is powerful enough to be used for addressing various topics in supply chain management. This study demonstrates pedagogy for teaching AHP to the supply chain management students in business programs.

2. Literature Review

There are numerous AHP applications in supply chain management. Some recent examples include, but not limited to, supplier selection (Chan, 2013; Chen and Wu, 2013), manufacturing technology evaluation (Farooq and O'Brien, 2012), green supply chain management (Mathiyazhagan et al., 2014), and sustainability performance measurement (Yakovleva, 2012). Regardless plentiful AHP studies in supply chain management, we fail to find pedagogy papers on AHP in refereed journals at the time of this study.

15. Hypotheses/Objectives

The objective of this study is demonstrating pedagogy for teaching AHP to supply chain students.

16. Research Design/Methodology

This study demonstrates matrix computation for computing weights using simple examples. For small to medium problems, Microsoft Excel macro will be used for hands-on experience.

17. Data/Model Analysis

We use an example for selecting a family car for teaching AHP with Excel macro.

18. Limitations

This study demonstrates pedagogy for teaching AHP. Accordingly, serious researchers must use a professionally developed computer program and refer to textbooks and research papers published in refereed journals.

19. Conclusions

This study attempts to demonstrate pedagogy for teaching AHP to supply chain management students in business programs. The contribution of this study is providing insights to instructors for developing and teaching a course with AHP in supply chain management.

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