



Supplier Selection under Uncertainty: A Detailed Case Study

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Abstract

The part of purchasing in supply chain management has received huge attention as the years go by. Purchasing increases efficiency and competitiveness among other benefits but to realize these benefits it is imperative to select and maintain competent suppliers. However, many factors affect a firm's capability to select the right supplier. Uncertainty is a big issue that has received great attention. It affects all functions of a company accordingly affecting purchasing and supplier selection.

One of the realizations of this paper is that there is a relationship between the characteristics or problems faced by new firms and uncertainty. Uncertainties created by new firms include lack of trust and commitment, inadequate finance, poor quality, poor delivery, inadequate logistic technological capabilities. No new types or sources of uncertainty were discovered however, it was found that uncertainty was certainly higher when working with new firms.

The criteria delivery, quality, cost/price, financial position and communication and technology were recognized as the commonly used criteria a fact confirmed from empirical results as well as in previous literature. However other criteria such as reliability, credibility, good references and product development were also identified. These criteria had existed before but did not receive the same attention in previous researchers. This show that focus is shifting from entirely relying on quantitative factors to include qualitative criteria.

Keywords: Supply Chain Management, Supplier Selection, Uncertainty.

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1. Introduction

Global supply chains are subject to two sources of risk, routine operational problems and major disruptions. Although literature on mitigating operational risks is well developed, there is a shortage of models for addressing disruption risks. Disruptive events such as earthquakes, fires, hurricanes and labor strikes have caused major damage to various companies in different business segments. This paper aims at formulating a multi objective optimization model to mitigate disruption risks while simultaneously addressing operational risks as well. The model's solution is a mitigation plan, through backup suppliers, that would be used when the supply chain faces a disruption and a supplier-order assignment matrix that optimizes the multiple objectives of the model.

The study of uncertainty is centered on risks related to capacity, demand and variable cost uncertainty. Capacity risks are due to uncertain manufacturing or service output levels at suppliers. Raw material defects, machine performances, delivery delays from lower tier suppliers and transportation disruptions are among the factors which make capacity at suppliers random. Demand uncertainty represents unknown customer demand for products or services offered by the buyer. Consumer preferences, competition and economic uncertainty are among the factors that contribute to demand uncertainty. Uncertainty in variable costs is broken down into two as transportation cost uncertainty and uncertainty in other variable costs.

Transportation costs can account for up to two thirds of logistics costs in global supply chains and may present large variations since the scale of the supply chain increases exposure to transportation risks. Due to this volatility in transportation costs, models in this paper allow separate input of transportation and other variable costs, which may include operating, purchasing and holding costs. Models developed in this paper assume that the buyer has some information about the uncertain capacity and demand; either the entire distribution governing these uncertain inputs or at least the mean and the standard deviation of the capacity and demand random variables [1].

Supply Chain Management has attracted much attention since its first appearance in the 1990s. Many authors have attributed its growing popularity to driving forces such as global sourcing, an emphasis on time, quality based competition and many others. The concept has since been subjected to many definitions. One of the acceptable definitions has been given.

“The systematic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across business functions within the supply chain, for the purpose of improving the long-term performing of the individual companies and the supply chain as a whole. The traditional business functions mentioned in the definition may include marketing, sales, production, purchasing etc. These basic functions are coordinated to achieve customer satisfaction, value, profitability, and competitive advantage for individual companies and the entire supply chain” [8]. Supplier selection has received considerable attention for its significant effect toward successful Logistic and supply chain management. The ripple effect of this development could be passed on to others areas along the supply chain which would consequently affect competitive advantage of the entire supply chain. Additionally,” In today's competitive operating environment it is impossible to successfully produce low cost high quality product without a satisfactory vendor”. Thus one of the important purchasing decisions is the selection and maintenance of a competent group of suppliers [9]”.

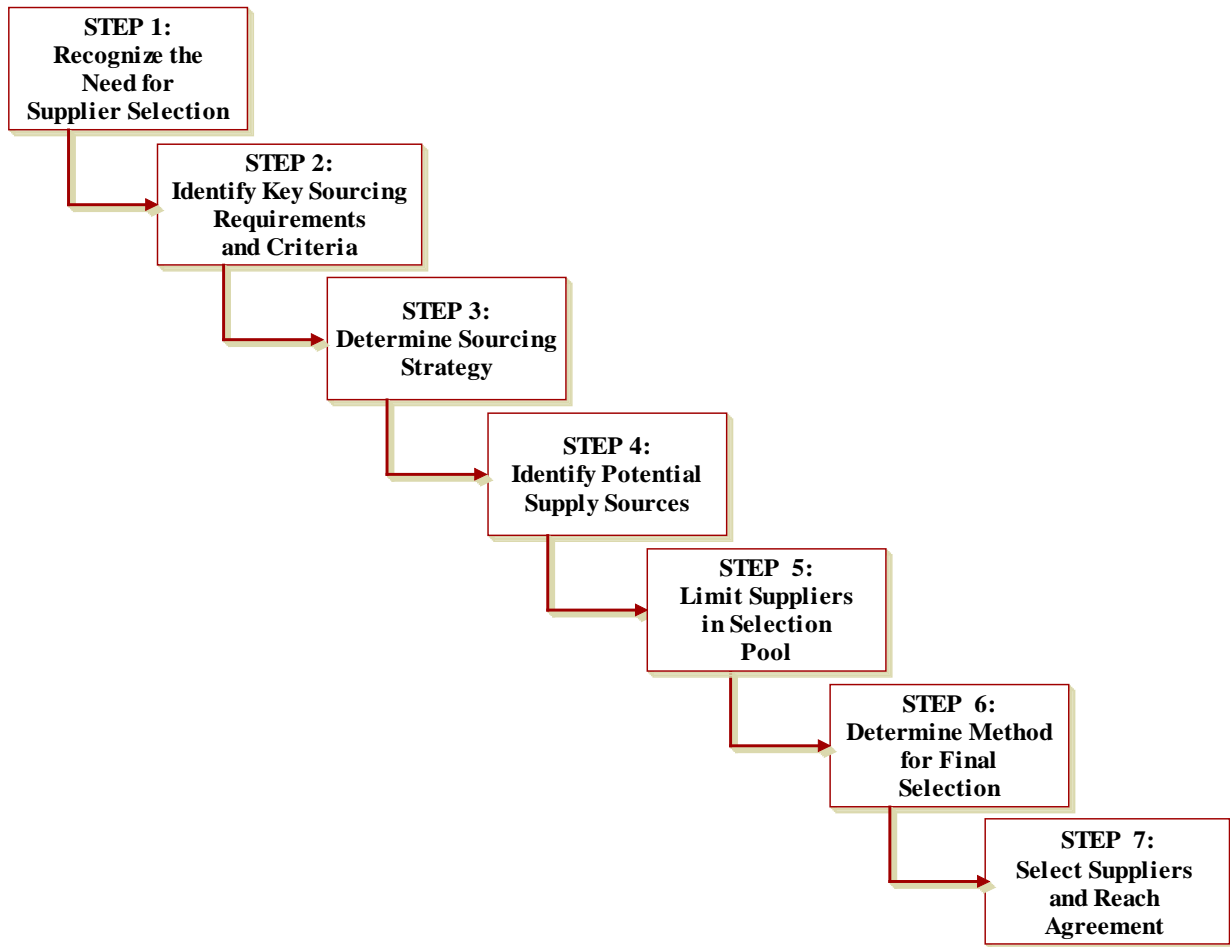


Figure .1 Supplier Evaluations and Selection Process

The subject of uncertainty is widely researched. Supplier selection is a key operational task for developing sustainable supply chain partnerships. Environmental, social, and economic dimensions must all be considered in order to select a well rounded sustainable supplier, one that can enhance supply chain performance. Part of the supplier selection process involves supplier evaluation together with selection, which is an important issue to supply chain and production and operation management literature [2].

Currently, due to outsourcing initiatives, organizations have become more dependent on suppliers making it more critical to choose and evaluate their supplier performance. Supplier evaluation and selection requires the consideration of multiple objectives and criteria [3]. A supplier selection model with demand uncertainty and unreliable suppliers. They model the demand as a continuous random variable and assign a reliability index varying in the interval (0, 1) to each supplier. They further introduce a diversification benefit function that encourages buyers to procure from different suppliers [4].

Decision-makers that face uncertainty may, hence, respond by reducing their effort if the required information processing demand is perceived to be beyond their cognitive capacity [10].

Both operational risks and disruption risks in an inventory problem. They consider two suppliers (a reliable and an unreliable) and derive expressions of optimal order quantities under different conditions [5]. Dada et al. analyze a supplier selection problem with both reliable and unreliable suppliers. Unreliable suppliers are prone to deliver less than the amount determined in the supply contract. They examine a case where item costs are considered to choose qualifying suppliers and reliability is considered to determine the winners [6]. The uncertainty affects the supply chains through firm's individual actions termed internal uncertainty, the external environment and relations between firms and their customer called network uncertainty [7].

2. Identification of Problem and Purpose:

Numerous studies about supplier selection under uncertainty have centered on the type of supplier selection methods applicable under uncertain conditions. However research about the types or choice of criteria to use under conditions of uncertainty has been neglected. Furthermore studies about supplier selection methods and criteria have not been made with particular reference to new firms. Thus this study redresses the above shortcomings.

Supplier selection is a sensitive process even when it involves existing firms that have proven their worth over time and whom buyers know much about. Furthermore, Ford also confirms this by stating that, there is the tendency for buyers to favour those suppliers with whom they already have relations or who have firmly established a strong brand in the market [36]. The business world has witness an increasing interest in entrepreneurship which has given rise to the prevalence of new companies which play a crucial role in the economy [37]. These newly created companies share the characteristics as expressed by Ford. They have neither created a brand nor have they had previous dealings with potential customers. The absence of a past performance record which would act as a vital proof of their ability to perform is an indication of the difficulties that customers would face when deciding on engaging a new firm as a supplier.

This induces the authors of this study to question if the supplier selection process is even more complex when firms carry out a supplier selection involving newly created firms that have not yet known the market nor created a name or reputation. The authors of this research are interested in investigating uncertainties that affect the supplier selection process and thus enhancing the understanding of the uncertainties that plague buying firms, originating from the newness of the supplier.

As stated by of Ellram different situations require the use of different models and criteria for supplier selection. Given that firm's environments affect the decisions, the authors see the need to evaluate the fitness of existing supplier selection criteria when applied to newly created supplier firms [26].

Although the importance of uncertainty and supplier selection studies are widely recognized, the concept of uncertainty, with respect to supplier selection of newly created firms has not been vastly exploited. Thus the aim of this thesis is to provide an understanding of the supplier selection process and criteria under circumstances of uncertainty.

3. Literature review:

Supplier selection is the art of identifying from a number of competitive suppliers, a potential one to satisfy a company's need and aspirations. It has attracted the attention of many academicians and purchasing practitioners since 1960. Wadhwa and Ravindran modeled the supplier selection problem as a multi-objective programming problem, in which there are three objective functions, such as minimization of price, lead time, and rejects. Three solution approaches, including weighted objective method, goal programming method, and compromise programming, were used to compare the solutions [12].

Suppliers have assumed an important role in the success of individual firms and in formidable supply chains as well. Many authors have attributed the causes of this change to high premium to the individual firms as well as the supply chains place on issues such cost, quality, delivery reliability and other similar factors to enhance profitability and competitive advantage. This has resulted in the attention supplier selection is receiving as a crucial component in any purchasing process [23]. Hong presented a mixed-integer linear programming model for the supplier selection problem. The model was to determine the optimal number of suppliers and the optimal order quantity so that the revenue could be maximized. The change in suppliers' supply capabilities and customer needs over a period of time were considered [11]. Akarte developed a web-based AHP system to evaluate the casting suppliers with respect to 18 criteria. In the system, suppliers had to register, and then input their casting specifications. To evaluate the suppliers, buyers had to determine the relative importance weightings for the criteria based on the casting specifications, and then assigned the performance rating for each criterion using a pair wise comparison [13].

Hou and Su developed an AHP-based decision support system for the supplier selection problem in a mass customization environment. Factors from external and internal influences were considered to meet the needs of markets within the global changing environment[14]. Ha and Krishnan applied an integrated approach in an auto parts manufacturing company for supplier selection. Twelve evaluating criteria were proposed for the selection problem. In the approach, AHP was used first to evaluate the performance of suppliers with respect to five qualitative factors. Then, the remaining seven quantitative criteria along with the scores for each supplier calculated by AHP were passed to DEA and artificial neural network to measure the performance efficiency of each supplier. Both results were compiled into one efficiency index using a Simple averaging method [15].

With the categorical method the experience and ability of the individual buyer is taken into consideration. Opinions of people in responsible for purchasing, quality, production and sales are expressed about the supplier's performance based on standard criteria which are important to them. The departments assign either rating for each of the selected attributes for every contending supplier. The buyers determine the suppliers overall score after discussion the rating with members of the departments. It is assessed as very simple and has the main advantage of helping to structure the evaluation process in a clear and systematic way. The main drawback is selected attributes are weighted equally and it provides fairly subjective decision [24].

Perçin applied an integrated AHP–GP approach for supplier selection. AHP was used first to measure the relative importance weightings of potential suppliers with respect to 20 evaluating factors. The weightings were then used as the coefficients of five objective functions in the GP model. The model was to determine the optimal order

quantity from the most appropriate supplier while considering the capacities of potential suppliers [16]. Bottani and Rizzi developed an integrated approach for supplier selection. The approach integrated cluster analysis and AHP to group and rank alternatives, and to progressively reduce the amount of alternatives and select the most suitable cluster. Fuzzy logic was also brought in to cope with the intrinsic qualitative nature of the selection process [17].

Supplier selection process has to do with the systematic evaluating and selecting of a potential supplier. Organizations use different approaches to arrive at satisfied conclusions since there is no hard and fast way of selecting of a supplier that has been agreed upon. The most important aim of the evaluating process is to rigorously follow the selection procedure that would ensure that risk is minimal and value is maximized by the purchaser.

Jain et al. suggested a fuzzy based approach for supplier selection. The authors addressed that it might be difficult for an expert to define a complete rule set for evaluating the supplier performance. GA was therefore integrated to generate a number of rules inside the rule set according to the nature and type of the priorities associated with the products and their supplier's attributes [18].

The main problem of purchasing manager when developing supplier survey is mainly about which performance criteria to include. The basic criteria that are generally used and therefore considered to be critical are price / cost, quality, and delivery [25].

Liao and Rittscher formulated a multi-objective programming model for supplier selection under stochastic demand conditions. Four objective functions were incorporated into the model. Instead of solving the model to optimality, GA was deployed to select the optimal supplier in an efficient manner [19].

Ding et al. presented a GA based optimization methodology for supplier selection. The proposed method provided possible configurations of the selected suppliers, including transportation modes. Each configuration was then evaluated with respect to the key performance indicators [20]. Supplier selection based on number of qualitative criteria is influenced by personal judgements. These criteria are less accurate because of the complications involve in their measuring as compared to the quantitative criteria. Bayazit proposed an ANP model to tackle the supplier selection problem. There were ten evaluating criteria in the model, which were classified into supplier's performance and capability clusters. To formulate interrelationships among all criteria, each of them was considered as a controlling factor for a pair wise comparison matrix [21].

Seydel used DEA to tackle the supplier selection problem. Unlike the above approaches, there was no input considered in the model. A seven point scale was deployed to assign ratings to the qualitative criteria. The author addressed that the proposed DEA required less involvement of decision makers than SMART [22].

Ellram in a study of supplier selection among firms engaged in buyer supplier relationships identified additional factors considered as 'soft' factors and grouped them under financial issues, organizational culture and strategy, technology and miscellaneous factors. Ellram did not rule out the importance of the quantitative criteria but looked out for supplementary criteria that are related to maintaining long term relationship [26].

4. Methodology:

This chapter discusses the main research approach used in the study. It also specifies the sources of data and analysis of data collected. It again deals with our method of data collection in terms of selection of respondents and interview procedure. We conclude by considering limitations and constraints encountered in the course of this research work.

4.1. Research Approach:

The research method used in this study is the qualitative approach. Qualitative research involves investigating opinions, behaviors and experiences from the informant points of view. Qualitative approach is 'an array of interpretative techniques which seek to describe, decode, translate and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world.

Qualitative research uses a naturalistic approach that seeks to understand phenomena in context specific settings, such as "real world setting where the researcher does not attempt to manipulate the phenomenon of interest"[27]. Qualitative analysis results in a different type of knowledge than does quantitative inquiry because one party argues from the underlying philosophical nature of each paradigm, enjoying detailed interviewing and the other focuses on the apparent compatibility of the research methods, "enjoying the rewards of both numbers and words" [33]. This means such methods like interviews and observations are dominant in the naturalist (interpretive) paradigm and supplementary in the positive paradigm, where the use of survey serves in opposite order.

Patton supports the notion of researcher's involvement and immersion into the research by discussing that the real world are subject to change and therefore, a qualitative researcher should be present during the changes to record an event after and before the change occurs. However, both qualitative and quantitative researchers need to test and demonstrate that their studies are credible. While the credibility in quantitative research depends on instrument construction, in qualitative research, "the researcher is the instrument" .Thus, it seems when quantitative researchers speak of research validity and reliability, they are usually referring to a research that is credible while the credibility of a qualitative research depends on the ability and effort of the researcher. Although reliability and validity are treated separately in quantitative studies, these terms are not viewed separately in qualitative research. Instead, terminology that encompasses both, such as credibility, transferability, and trustworthiness is used [27].

Our research adopts a qualitative approach because there is the need to have personal interactions with respondents through an interview procedure to identify whether uncertainty is high or low with respect to new supplier firms as compared to established firms, identify the suitable criteria and the ways through which uncertainty can be reduced so that we can draw conclusion through the interpretation of gathered data from our interview.

The quantitative approach on the other hand, studies phenomena using numerical means. There is an emphasis on counting, describing and using standard statistic. In this type of approach researchers are more interested in outcomes. It also requires detachment of the observer, especially in the experimental method where the personal

involvement can affect the outcome of the research.

4.2. Sources of Data:

Research studies are often conducted empirically, implying the gathering of and the use of the data. The reason for gathering data is to obtain information of importance for the research problem under scrutiny. The quality of the information depends considerably on the measurement procedure used in the gathering of the data [31]. Two main types of data exist for gathering information on which to do inferences and make conclusions. They are the primary and secondary data.

Primary data refers to information that must be collected by the researcher for a particular Purpose from primary sources through questionnaires, interviews or observations. Primary data for this study has been collected through telephone conversations, emails correspondences and interviews.

Secondary data is raw data that is already available and need only be extracted from sources like government publications, earlier research, personal records or the mass media [28].

4.3. Data gathering techniques:

4.3.1 Case study approach

Case studies enables the researcher to gain a rich understanding of the context of the research and the processes being carried in a bid to provide answers to questions of what, how and why .

4.3.2 Interviews

An interview is a purposeful discussion between two or more people aimed at gathering information that is reliable and relevant for answering research questions and objectives [29].

There are different types of interviews which vary according to their degree of formality and structure. Interviews are classified as structured, semi structured and unstructured interviews. Interviews could also be standardized or non-standardized as well as respondent or informant interviews .Structured interviews use predetermined and standardized questionnaires which are similar for each respondent. Such interviews are used in descriptive studies to identify general pat-terns and also for explanatory research. Semi structured and unstructured interviews use non-standardized and additional questions and probes may be used to improve quality of answers received. For semi structured interviews, the themes and questions may be different for each interviewee. This type is mostly used for explanatory studies to understand relationships between variables and to some extent for exploratory studies.

Unstructured interviews are informal, are also referred to as in depth or non directive interviews. They are used for in depth exploration of subjects of interest and thus this is highly appropriate for exploratory research to find out what actually happens in a given situation and to seek new insight. They have no predetermined list of questions as such the interviewee can talk freely based on his or her perceptions of the topic hence it is also called a respondent

interview [29].

Given the above explanations the authors of this study use both semi- structured and unstructured interviews. They are appropriate for explanatory and exploratory research and encourage interviewee's use of their perception as well as in-depth information about phenomenon.

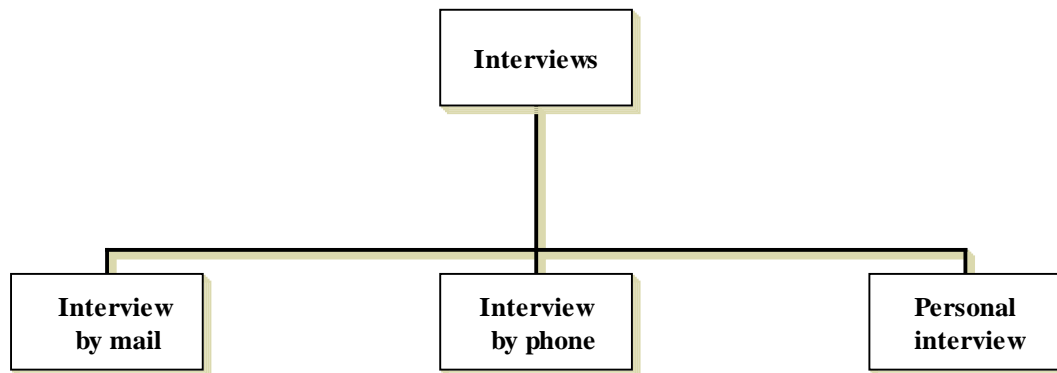


Figure: 2 a typology of interviews [30]

For the purpose of our research the interviews were performed by telephone or by personal contact based on proximity. The interviews begin with general information about the company and extend to the interviewees individual or perceptions regarding the topics under review .Semi structured questions were used to allow for greater flexibility. After each interview session, the information was then reviewed and further questions are derived to close the gaps. Questions were aimed at finding out details about issues considered of selection criteria to be of prime importance as well as to shift focus to neglected aspects.

4.4. Presentation and Analysis of Empirical Findings

Analysis of qualitative data involves four main processes which include data categorization, unitization of data, relationship recognition and development of analysis and lastly, development and testing of hypothesis [29].Data categorization refers to the classification of data obtained from empirical sources or from the theoretical framework into meaningful categories in order to create a well structured framework .The choice of categories are derived from research questions and objectives. Unitizing of data refers to attaching relevant parts of data also called units, to the categories that have been developed. Recognizing relationships and developing categories enables the researcher to develop categories and assign different units of data under each category thus enabling the researcher to identity patterns and relationships between categories. Finally in the development and testing process, patterns or relations can be transformed into hypothesis and tested to conclude about the existence of relationships. In this study the authors create organize data collected from empirical sourced into categories. These categories are derived from theoretical and empirical data, and guided by the research questions and purpose. The organized information

obtained is then compared with the theoretical literature to find points of divergence or convergence.

4.5. Method Criticism

4.5.1 Validity:

The concept of validity is described by a wide range of terms in qualitative studies. This concept is not a single, fixed or universal concept, but “rather a contingent construct, inescapably grounded in the processes and intentions of particular research methodologies and projects” [33]. Although some qualitative researchers have argued that the term validity is not applicable to qualitative research, but at the same time, they have realized the need for some kind of qualifying check or measure for their research.

The issue of validity in qualitative research has not been disregarded by Stenbacka as she has for the issue of reliability in qualitative research. Instead, she argues that the concept of validity should be redefined for qualitative researches. He describes the notion of reliability as one of the quality concepts in qualitative research which "to be solved in order to claim a study as part of proper research [34]".

Validity is affected by the researcher's perception of validity in the study and his/her choice of paradigm assumption [34]. Validity can be explained as the extent to which the research findings accurately represent what is happening in the situation under study. The validity of any research can be hindered by faulty research procedures, poor samples or misleading measurement [31].

4.5.2 Reliability:

When we examine a construct in a study, we choose one of a number of possible ways to measure that construct see the section on Constructs in quantitative research, if you are unsure what constructs are, or the difference between constructs and variables.

Reliability is concerned with the consistency and accuracy of the results obtained and it is achieved if research results can be repeated [31]. According to the authors, reliability is achieved by measuring a construct using a particular instrument, comparable results can be obtained irrespective of when the measurement is done, which version is used or who is doing the measurement. In quantitative research, the measurement procedure consists of variables; whether a single variable or a number of variables that may make up a construct. When we think about there liability of these variables, we want to know how stable or constant they are. This assumption, that the variable you are measuring is stable or constant, is central to the concept of reliability. In principal, a measurement procedure that is stable or constant should produce nearly same results if the same individuals and conditions are used. Furthermore, the research is reliable as the interviews are conducted in the same way for all respondents.

4.5.3 Generalizability:

Generalization refers to the ability to apply the results of a particular research to cases or situations other than those examined in that study. It is also described as the extent to which conclusions about a whole population based on

information obtained from a single sample [31].

A final issue in qualitative analysis is that of generalizability. Generalizability refers to the extent to which findings from a study apply to a wider population or to different contexts.

The cases in this study differed in activity, size, scope and age as well as their positions in their various supply chains. Though the sample size may not be large enough to represent the entire population of companies involved in the industry or supply chain position, we believe that the results of the study will be beneficial to those categories of firm represented. Generalizability in qualitative research refers to the extent to which theory developed within one study may be exported to provide explanatory theory for the experiences of other individuals who are in comparable situations. Other authors also argue for the richness of detail within a single case by looking for multiple implications of the ideas under study. On the other direction, multiple case studies are considered more appropriate for studies not involving rare, critical or revelatory cases. In this approach one should be clear that every case has to serve a particular purpose in the study and it also important to justify the selection of each case [30].

4.5.4 Limitation of study:

The problems encountered during this study include the following:

Firstly the authors of this research encountered a lot of resistance and unwillingness from firms who were contacted for this study. Phone calls and even visits to their premises proved futile. This limited the choice and number of companies involved in the study. Language and communication barriers. The authors did not understand Swedish while some of the firm representatives understood and spoke little or no English. The information from some of the websites was entirely in Swedish and the help of some Library staff was enlisted to translate the required information. This might have affected the level of detail and choice of responses obtained hence the validity and reliability.

We also found that some of the firms who were willing to grant us audience would not fit as case studies. Some of the firms had existed before and had only changed names while some of them had existed for long and had only created new branches and thus the authors did not consider them as newly created firms. One of the firms was still in the process of being started hence not yet operational. This further limited the choice and number of companies chosen for the study. One of the interviews had to be carried out over the phone and hence lacked the detail and flexibility associated with face to face interviews.

5. Theofil Carlsson AB

5.1 About the Company:

Theofil Carlsson AB belongs to the Vattern Industrier AB. The company has two parts of operational sectors mainly stores and warehouses. The main warehouse of the company is in Jonkoping from where it distributes to all other sub-stores and sub-warehouses in other areas in Sweden. It has 55 employees in the all the four well established stores and warehouses in Sweden. The company had 130 million SEK, as a turnover in 2006 and has

projected a turnover of 137 million SEK, in 2007.

Theofil Carlsson popularly known as 'Theofils' is admittedly one of Sweden's established local tools retail companies, established in 1922 which sells kitchen fittings, fitting for sliding doors, electric tools for carpenters, adhesives for woodworking industries and other small items i.e. screws and knots. Theofils has been in existence serving their customers for about 85 years. Until 1967, Theofils concentrated on selling to furniture manufacturing companies locally. It started selling and concentrated on small and medium sized customers in 1994. For all these years, Theofils was selling from its main warehouse in Jonkoping. In 1997 it established a store and warehouse in Stockholm, the capital of Sweden. Another store was opened in Malmo in 2005. Its final development project was establishing a store in Gothenburg in the 2007 [35].

5.2 Services offered by Theofils

Theofils offers a large range of assorted items to their customers mainly for manufacturing of kitchen, Bathroom, office decorations, furnishing, and other necessities. They sell electric tools for carpenters. They are committed to providing high standard logistic services mainly daily deliveries and well equipped warehouses to serve their customers needs and at the expected times. The company has highly skilled staffs that seek to provide solutions to their numerous customers and suppliers.

5.3 Theofils Customers:

Theofils deals with significantly quite a large number of customers. The number of customers will fall within the environment of 6000. The customers are mainly within the range of small and medium size companies. 95% of these customers are local firms and the remaining 5% are firms in Norway and Finland. Theofils works closely with the potential customers to foster cooperation and long term relation. The cooperation is maintained through constant meetings, exhibitions, new product development, and training. Theofils provides highly efficient order management, standard warehousing and highly precise delivery security for the customers. Theofils started making efficient use of ecommerce since 2004. This provides the large range of customers with all kinds of service which creates enabling environment for transactions.

5.4 Supplier Selection Process of Theofils :

One of the most significant aims of Theofils is to serve their numerous customers with the best products in the markets at every time. Theofils do not produce any single item they serve their customers by themselves. Thus selecting a supplier that would prove worthy of the desire of Theofils as well as their numerous customers is very crucial to their success and paramount in their business plan. Theofils therefore leaves no stone unturned in conducting the evaluation of suppliers to approve the selecting of a supplier

The identification of the basic criteria is always the first step and then assigned weighted points. Suppliers are evaluated directly through visit to their firms. However far off companies with minimal or small volumes of transactions are negotiated with by phone and internet. The results of the evaluation are scrutinized by various responsible persons namely the Managing Director, Sale and Purchasing Manager etc. Final selection of the

potential supplier is made.

5.5 Criteria for the evaluation of established firms:

Theofilis regularly works with few very important criteria in their evaluation process of old and established firms. Empathically, Theofilis has the usual trend of selecting well established producers in order to ensure that they maintain the quality of their products and remain competitive in the market. The most important criteria in their selection process are delivery time. Significantly, this criterion has to do with an effective logistic system of the companies under evaluation. The companies must have regular and precise delivery times. Financial position of the suppliers is other criterion mentioned by the authorities of Theofilis. Price, reliability and quality were also mentioned. ISO Certificate to ensure that the companies are well certified by an International Organization of the quality of product and services is also considered. The companies have to prove of some kind of credibility over time.

6. Uncertainty:

Uncertainty is a term used in subtly different ways in a number of fields, including philosophy, physics, statistics, economics, finance, psychology, sociology, engineering, and information science. It applies to predictions of future events, to physical measurement that are already made, or to the unknown.

Although the terms are used in various ways among the general public, many specialists in decision theory, statistics and other quantitative fields have defined uncertainty, risk, and their measurement as:

1. **Uncertainty:** The lack of certainty. A state of having limited knowledge where it is impossible to exactly describe the existing state, a future outcome, or more than one possible outcome.
2. **Measurement of Uncertainty:** A set of possible states or outcomes where probabilities are assigned to each possible state or outcome – this also includes the application of a probability density function to continuous variable
3. **Risk:** A state of uncertainty where some possible outcomes have an undesired effect or significant loss.
4. **Measurement of Risk:** A set of measured uncertainties where some possible outcomes are losses, and the magnitudes of those losses – this also includes loss functions over continuous variables.

According to the manager of Theofilis in every purchase transaction there exist several elements of uncertainty. These uncertainties have to be analyzed and their sources and impact evaluated and solutions found to minimize them.

The first aspect of uncertainty that is witnessed in the supplier selection process is felt at the initial stage. This is the stage that involves the identification of potential suppliers for a needed product. Uncertainty arises from the fact that at this initial stage there is no clear knowledge about firms. During this stage Theofilis purchase team must refer to information from the internet, from exhibitions, recommendations from other suppliers. To enhance information collected, visits to the supplier is also necessary. Uncertainty is further a problem because some of their suppliers are located in other countries such as Switzerland, Austria and as far as China.

However even with the company information obtained certain above, aspects of uncertainty still exist because the availability of information alone does not remove uncertainties from the business environment. Sources of uncertainty are classified into two categories. These are internal uncertainties that are specific to the supplying firm and those that come from the environment in which the firm exist.

Internal sources of uncertainty refer to those uncertainties that are caused by the actions of potential or existing suppliers. Theofilis is devoted to quality and prompt delivery of ordered goods to their customers. Thus the greatest source or types of uncertainty result for the fact that suppliers may not be able to deliver on time or may not produce the right quality. Issues about pricing are less uncertain because prices are usually negotiated at the beginning of the contract. Failure to deliver the right quality or failure to deliver on time has drastic consequences for Theofilis ability to satisfy their customers as well as it damages their finances.

Usually to enhance quality issues Theofilis order test products or models. There is no guarantee that these tests will meet the specifications of Theofilis and even when they do there is no guarantee that subsequent editions of the product will meet the expected quality.

Another source of uncertainty is the aspect of trust. This is because at the initial stage of the buyer supplier relationship Theofilis is not certain if the partner will work to the interest of the relationship. Sometimes a supplier may be enthusiastic and collaborative during the negotiations and trial period but performance may deteriorate after the contract has been established. Trust issues get better as the relationship continues.

Uncertainty could also result form the fact that suppliers do not have adequate capacity to produce the required amount with consistency hence variability in supply. This is important in inventory control as a certain level of inventory must be available in order to minimize risks of stock out as well as reduce inventory costs.

Lack of correct and up to date information. This could result from incompatibility in information systems or the lack of seriousness on the part of the suppliers to relay the right information and at the right time. Site visits and face to face meetings and negotiations are more frequent for suppliers within Sweden. For large suppliers outside Sweden supplying the main products, visits are less frequent but must be at least once a year. Smaller suppliers of peripheral products may not be visited.

Other sources of internal uncertainty include the lack of adequate financial resources, technology, commitment, and logistic capabilities. Other sources of uncertainty come from the environment in which the firm operates. Such uncertainty could come from the fact that better and updated versions of a product could be introduced in the market, Increases in the general price level of raw material thereby increasing costs, cultural barriers, Language differences and communication inefficiencies [35].

7. Conclusions:

The authors of the research highlight on the important findings from the study.

The research showed that the commonly used existing criteria such as delivery, quality, Cost/price, financial

position and communication /technology are still relevant in the selection of newly created suppliers despite the fact that they face higher level of uncertainties. The interview with the companies exposed the confirmation of the relevance of the criteria. This has been as a result of the current stress on the strategic dispensation where firms use these criteria as weapons to step up competitive edge in the market. Other criteria which were identified in the course of this research were reliability, credibility, good references and product development. These criteria are not entirely new to the previous researches and in the practical field, but were not given much attention because the authors paid more emphasis on the quantitative factors.

One other purpose of this paper searched to find out if firms pose a higher degree of uncertainty. In other words this study sought to find out if uncertainty varied with firms' age such that engaging a newly created company as supplier result in greater uncertainty than engaging an old well-known and more experienced company. Based on the empirical findings, no new type or sources of uncertainty was discovered. However it was identified from the views of the respondents of the purchasing companies that uncertainty was certainly higher when working with new firms. This is as a result of the negative characteristics of firms such those mentioned below,

- Lack of trust and commitment

- Lack of finance

- Bad Quality

- Slow delivery

- Logistic capabilities

- Technological capabilities

The basic factors that were identified as problems in the research also appeared to contribute to the uncertainty or risk that is associated with supplier as revealed by different authors in the theoretical framework. Naturally, when problems are identified there is also the need to made significant suggestions and some practical measures to help reduce uncertainty in the supplier selection process.

It is important that uncertainty or risk cannot be entirely eliminated in all situations. However as much the company representatives are concerned and from their point of view, these measures can significantly reduce the uncertainties that customers face when working with newly created suppliers.

References:

- [1] R. Ufuk Bilsel, A. Ravindran, "A multi objective chance constrained programming model for supplier selection under uncertainty". *Transportation Research Part B* 45 1284–1300, (2011).
- [2] Motwani, J., Youssef, M., 1999. Supplier selection in developing countries: a model development. *Emerald* 10 (13), 154,162.
- [3] Bhutta, K.S., Huq, F., 2002. Supplier selection problem: a comparison of total cost of ownership and analytic hierarchy process approaches. *Supply Chain Management: An International Journal* 7 (3), 126-135.
- [4] Burke, G.J., Carillo, J.E., Vakharia, A.J., 2007. Single versus multiple supplier sourcing strategies. *European Journal of Operational Research* 182 (1), 95–112
- [5] Chopra, S., Reinhardt, G., Mohan, U., 2007. The importance of decoupling recurrent and disruption risks in a supply chain. *Naval Research Logistics* 54 (5), 544–555.
- [6] Dada, M., Petruzzi, N.C., Schwarz, L.B., 2007. A news vendors procurement problem when suppliers are unreliable. *Manufacturing & Service Operations Management* 9 (1), 9–32.
- [7] Brindley, C. (2004). *Supply Chain Risk*. Ashgate Publishing limited. Gower House, Hampshire GU113HR, England.
- [8] Mentzer, J.T, De Wit., Keebler, J.S, Min, S., Smith, C.D. & Zacharia, Z.G.(2001). *Supply Chain Management*. Sage Publication Ltd. USA.
- [9] Weber, C.A., Current, J.R. and Benton, W.C.,(1991). Supplier selection criteria and methods. *European Journal of Operational Research*. Vol.50. 2-18.
- [10] Koufteros, X.A., Vonderembse, M.A., Doll, W.J., 2002. Integrated product development practices and competitive capabilities: the effects of uncertainty, equivocality, and platform strategy. *Journal of Operations Management* 20 (4), 331–355.
- [11] Hong, G.H., Park, S.C., Jang, D.S., Rho, H.M., 2005. An effective supplier selection method for constructing a competitive supply-relationship. *Expert Systems with Applications* 28 (4), 629–639.
- [12] Wadhwa, V., Ravindran, A.R., 2007. Vendor selection in outsourcing. *Computers and Operations Research* 34 (12), 3725–3737.
- [13] Akarte, M.M., Surendra, N.V., Ravi, B., Rangaraj, N., 2001. Web based casting supplier evaluation using analytical hierarchy process. *Journal of the Operational Research Society* 52 (5), 511–522.
- [14] Hou, J., Su, D., 2007. EJB–MVC oriented supplier selection system for mass customization. *Journal of*

Manufacturing Technology Management 18 (1), 54– 71.

[15] Ha, S.H., Krishnan, R., 2008. A hybrid approach to supplier selection for the maintenance of a competitive supply chain. *Expert Systems with Applications* 34 (2), 1303–1311.

[16] Perçin, S., 2006. An application of the integrated AHP–PGP model in supplier selection. *Measuring Business Excellence* 10 (4), 34–49.

[17] Bottani, E., Rizzi, A., 2008. An adapted multi-criteria approach to suppliers and products selection – An application oriented to lead-time reduction. *International Journal Production Economics* 111 (2), 763–781.

[18] Jain, V., Tiwari, M.K., Chan, F.T.S., 2004. Evaluation of the supplier performance using an evolutionary fuzzy-based approach. *Journal of Manufacturing Technology Management* 15 (8), 735–744.

[19] Liao, Z., Rittscher, J., 2007. A multi-objective supplier selection model under stochastic demand conditions. *International Journal of Production Economics* 105 (1), 150–159.

[20] Ding, H., Benyoucef, L., Xie, X., 2005. A simulation optimization methodology for supplier selection problem. *International Journal Computer Integrated Manufacturing* 18 (2–3), 210–224.

[21] Bayazit, O., 2006. Use of analytic network process in vendor selection decisions. *Benchmarking: An International Journal* 13 (5), 566–579.

[22] Seydel, J., 2006. Data envelopment analysis for decision support. *Industrial Management and Data Systems* 106 (1), 81–95

[23] Van Weele, A. J. (2000). *Purchasing and Supply Chain Management: Analysis, Planning and Practice*, (2nd Ed.). Business Press: Thomas learning UK.

[24] Timmerman (1986). An approach to supplier performance evaluation. *Journal of purchasing and material management*, Vol. 22 No. 4, pp: 2-4.

[25] Bello, J. S. (2003). A Case Study Approach to the Supplier Selection Process, [<http://grad.uprm.edu/tesis/suarezbello.pdf>] (Retrieved, December, 2007).

[26] Ellram, L. (1990). The Supplier Selection Decision in Strategic Partnerships. *Journal of Purchasing and Materials Management*, pp 8-14.

[27] Patton, M. Q. (2002). *Qualitative evaluation and research methods* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.

[28] Welman, J.C., Kruger, S.J., & Mitchell, B.C. (2005). *Research Methodology*. (3rd ed). Cape Town:Oxford University Press. Southern Africa

- [29] Saunders, M., Lewis, P., & Thornhill, A. (2003). *Research Methods for Business Students* (3rd ed.). Edinburgh Gate: Pearson Education Limited
- [30] Ghauri, P, Grønhaug, K & Kristianlund, L, (1995). *Research Methods in Business Studies. A Practical Guide*. Hertfordshire HP2 7EZ. UK
- [31] Collis, J., & Hussey, R. (2003). *Business Research. A practical guide for undergraduate and postgraduate students*. 2nd ed. Pelgrave Macmillan Ltd. New York, USA.
- [32] Glesne, C., & Peshkin, P. (1992). *Becoming qualitative researchers: An introduction*. New York, NY: Longman.
- [33] Winter, G. (2000). A comparative discussion of the notion of validity in qualitative and quantitative research. *The Qualitative Report*, 4(3&4). Retrieved February 25, 1998,
- [34] Stenbacka, C. (2001). Qualitative research requires quality concepts of its own. *Management Decision*, 39(7), 551-555
- [35] Mohammed Donkor Nartey , Anyinke Nkongtendem Nobegang “Supplier selection under Uncertainty.” January 2008
- [36] Ford, David (1990). *Understanding Business Marketing; Interaction, Relationships and Networks*. Academic Press. San Diego, CA. USA
- [37] Katz. A. J & Green .P. R (2007). *Entrepreneurial Small Business*. McGraw-Hill / Irwin Companies Inc. New York