

Ekaterina Vasina

**ANALYZING THE PROCESS OF SUPPLIER SELECTION.
THE APPLICATION OF AHP METHOD**

Thesis

CENTRIA UNIVERSITY OF APPLIED SCIENCES

Degree Programme in Industrial Management

May 2014

ABSTRACT

Unit Technology Unit, Ylivieska	Date April 2014	Author/s Ekaterina Vasina
Degree programme Industrial Management		
Name of thesis ANALYZING THE PROCESS OF SUPPLIER SELECTION. THE APPLICATION OF AHP METHOD		
Instructor Ossi Päiväläinen		Pages 63 + 14
Supervisor Ossi Päiväläinen		
<p>With the development of the economy and business industries within all sectors, the level of competition has greatly increased. Many organizations have been forced to find innovative ways of improving their performance to take a part of the market share. Nowadays success depends on more factors than just the activities that occur within organization. A strong reliable partnership has become the key for success.</p> <p>This work presents a study which objective was to investigate the role of the supplier selection and purchasing process itself. It clarifies measuring criteria used for the supplier selection and explores the meaning and difference of the terms purchasing, procurement and sourcing. The final thesis familiarizes with the existing methods and techniques that can be used for the actual supplier selection.</p> <p>A real case study was implemented to show the application of AHP. Based on the literature, the purchasing process was developed and applied. Real suppliers were contacted in order to collect sufficient information. Measuring criteria were structured and the AHP method was applied in order to obtain the final results</p>		
Key words AHP, CSR, supply chain, supply chain management, supplier selection		

PREFACE

Since the beginning of my education at Centria University of Applied Sciences, I have grown as a person and as a professional in the field of Engineering and Management. I am grateful to the University and all the professors, executives and working personnel for giving me such a great opportunity to study in Centria UAS.

I would like to express special thanks to my supervisor Ossi Päiväläinen for his help, instructions and evaluation of my work without which I would not be able to complete my studies. I also wish to express my gratitude to Lena Segler-Heikkilä for her great support in every aspect during all my studying years. Also many thanks to Ulla Orjala who helped me with the guidelines for the English academic writing. At the same time I would like to thank Markku Mäkitalo for the inspiration and interesting lectures.

ABBREVIATIONS

AA1000 – AccountAbility's AA1000 series

ABC – Activity Based Costing

AHP – Analytical Hierarchical Process

AI – Artificial Intelligence

Amnesty – Amnesty International's Human Rights Guidelines for Companies

ANP – Analytical Network Process

APEC – APEC Code of Business Conduct

B2B – Business-to-business

BBS – Balanced Business Scorecard

Bench Marks – Principles for Global Corporate Responsibility Bench Marks for Measuring Business

CA – Cluster Analysis

Caux – Caux Round Table Principles for Business

CI – Consistency Index

CR – Consistency Ratio

CSR – Corporate Social Responsibility

DEA – Data Envelopment Analysis

DJSI – Dow Jones Sustainability Index

Eco-Label – EU Eco-Label Criteria

EFQM – EFQM Business Excellence Model

ELECTRE – ELimination Et Choix Traduisant la Réalité

EMAS – Eco-Management and Audit Scheme

ETI – Ethical Trading Initiative Base Code

FSC – Forest Stewardship Council's Principles and Criteria for Forest Management

FTSE4Good – FTSE4Good Selection Criteria

GRI – Global Reporting Initiative Guidelines

ICC – International Chamber of Commerce

IFOAM – IFOAM Basic Standards

ISO – International Organization for Standardization

ISO 9000 – Quality management systems

ISO14000 – Environmental management

IT – Information Technology

MCDA – Multiple-criteria decision analysis

OECD – Organization for Economic Co-Operation and Development Guidelines for Multinational Enterprises

OEM – Original Equipment Manufacturer

PROMETHEE – Preference Ranking Organization Method for Enrichment Evaluation

R&D – Research and Development

RFI – Request for Information

RFP – Request for Proposal

RFQ – Request for Quotation

RI – Random Consistency Index

SA8000 – Social Accountability 8000

SCM – Supply Chain Management

Sullivan – Global Sullivan Principles

TCO – Total Cost of Ownership

TNS – The Natural Step

TOPSIS – Techniques for Order Preference by Similarity to an Ideal Solution

UN GC – UN Global Compact

WHO/UNICEF – WHO/UNICEF International Code on Marketing of Breast-milk Substitutes

LIST OF GRAPHS, TABLES AND EQUATIONS

Graphs

GRAPH 1. Supply Chain

GRAPH 2. Supply Chain network structure

GRAPH 3. Porter's Value Chain

GRAPH 4. Running Supply Chains is Like a Massively Multiplayer Online Game

GRAPH 5. Purchasing process model and some related concept

GRAPH 6. Proactive strategic vision of a company

GRAPH 7. General model of organizational decision process by Webster and Wind (1972)

GRAPH 8. Purchasing activities by Dobler et al. (1996)

GRAPH 9. Initial Supplier Evaluation and Selection Audit development by Monczka et al. (2011)

GRAPH 10. Buying process by Van Weele (2009)

GRAPH 11. Strategic supplier selection by Cousins (2008)

GRAPH 12. Purchasing process. Source: author

GRAPH 13. Information sources for supplier identification

GRAPH 14. Benefits of applying green strategies

GRAPH 15. Supplier selection hierarchy process

GRAPH 16. Supplier selection hierarchy process for single alternative

GRAPH 17. Supplier selection hierarchy process for single alternative with numerical weight

Tables

TABLE 1. Approaches to Purchasing Process

TABLE 2. The supplier selection framework by De Boer (1998)

TABLE 3. Incoterms 2000

TABLE 4. Primary and secondary stakeholders

TABLE 5. Models and techniques in supplier evaluation

TABLE 6. Ranking Scale

TABLE 7. Assigning weights and priorities to criteria using pair-wise comparison

TABLE 8. Normalization of reciprocal matrix values into a common scale

TABLE 9: Criteria and sub-criteria importance

TABLE 10. Value for Random Consistency Index proposed by Saaty (1980)

TABLE 11. Eighteen vector calculation

TABLE 12. Scoring alternatives based on collected information

TABLE 13. Pair-wise comparison for sub-criteria Reference

Equations

- (1) – Efficiency
- (2) – Positive Reciprocal Matrix A
- (3) – Range of X
- (4) – Consistency Ratio (CR)
- (5) – Consistency Index (CI)
- (6) – Computed Average
- (7) – CI Calculation
- (8) – CR Calculation
- (9) – Total Weight

TABLE OF CONTENTS

PREFACE

ABBREVIATIONS

LIST OF GRAPHS, TABLES AND EQUATIONS

1. INTRODUCTION	1
2. WHAT IS A SUPPLY CHAIN	4
2.1. The Evolution of Supply Chain Management and Purchasing Function	4
2.2. Supply Chain Ideology	5
2.3. Key Players in Supply Chain	8
3. THE ROLE OF SOURCING, PROCUREMENT AND PURCHASING	10
4. SUPPLIER SELECTION	13
4.1. The Main Stages in the Process of Supplier Selection	17
4.1.1. Defining Business Need	19
4.1.2. Determining Specifications	19
4.1.3. Agreeing on the Measuring Criteria	20
4.1.4. Identifying Buying Alternatives	21
4.1.5. Supplier Selection	22
4.1.6. Purchasing	23
4.1.7. Performance Evaluation	23
4.2. Selection Criteria	24
4.2.1. Literature Review	24
4.2.2. Selection Criteria	26
5. THE FUTURE OF STRATEGIC DECISIONS: ETHICS, ENVIRONMENT AND SUSTAINABILITY	32
5.1. Corporate Social Responsibility	33
5.2. Documentation to assure CSR	35
6. MODELS AND TECHNIQUES IN SUPPLIER EVALUATION	36
6.1. Cluster Analysis	37
6.2. Categorical Method	38

6.3. Data Envelopment Analysis	38
6.4. Analytical Hierarchical Process	38
6.5. Analytical Network Process	39
6.6. TOPSIS	40
6.7. Outranking models	40
6.8. Total Cost of Ownership	41
6.9. Activity Based Costing	41
6.10. Artificial Intelligence	41
6.11. Mathematical Programming	42
6.12. Fuzzy set theory	42
7. CASE STUDY	44
7.1. Description and Data Collection	44
7.2. Application of AHP	46
7.2.1. Structure Hierarchy	47
7.2.2. Assigning weights and priorities	49
7.2.3. Checking Consistency	52
7.2.4. Scoring Alternatives	54
7.2.5. Obtaining Overall Ratings	55
8. CONCLUSION	58
REFERENCES	59
APPENDICES	

1. INTRODUCTION

Strong reliable relationships in B2B environment significantly influence both organizations and their overall performance. Due to the fast development of economy and industries worldwide, there was a high attention to studies about internal and external processes in different types of businesses in recent years. Thus, nowadays we have got much more possibilities and ways of managing and controlling the supply chain and related activities.

Before starting my education in Degree Program in Industrial Management at Centria University of Applied Sciences, I believed that the most effective way of obtaining money is to sell the product. In the same time to be able to sell the product we need to obtain it from specific place. Then there is the question of selection among hundreds of potential offers where the wrong choice can be crucial. How to find a product that fits specifications? Where to find a reliable supplier that will be able to maintain fully the deal based on agreement? Is it realistic to obtain the ideal product for the resources that possible to invest? All these are about planning the purchase from the very beginning till the end, managing every single step in the process and monitoring the whole chain of activities in order to limit the risks and improve the performance. Solving the problem of supplier selection and evaluation requires profound knowledge to be able to analyze the pros and cons of every decision that can be made and to understand clearly the effect of those decisions on the supply chain and specific tiers belonging to it.

The intention to choose this topic was, first of all, my personal interest about the processes within a supply chain starting from obtaining raw materials to manufacturing and further material movements to the final consumer. I decided to narrow the topic to the actual process of supplier selection in a company within Supply Chain. In the case study I will evaluate products from textile and apparel industry sector based on the modern standards and trends. Textile and Apparel manufacturing industry today is highly technology developed. This opens to consumers a wide range of possibilities for investing, investigating import/export opportunities and search for costs minimization.

The thesis presents a study whose objective was to investigate the role of the supplier selection process in the supply chain, the purchasing itself in regard to supplier selection and to become more familiar with the existing methods and techniques of actual supplier evaluation.

In term of scope, the study is divided into several parts. The first part consists of the introduction to the supply chain. It starts with reviewing the history and development of the theory of Supply Chain over time. The concept of modern management is described as well as the various factors having the greatest impact on a company. The second part shows the complexity of terminology existed within the concept of Supply Chain and its understanding that can greatly vary from country to country and from business to business as well. The major outline of the chapter is to explore the meaning of terms such as sourcing, procurement and purchasing and their interconnection within an organization. The next part tells about the process of supplier selection. I have reviewed some of the works which focus was the supplier selection problem offered by authors starting from the emergence of the supply chain to modern science. I also decided to spend time on evaluating various factors that mostly affect the final selection and I offered possible evaluation criteria that can be used for small and medium enterprises operating in sales sector of textile and apparel industry. One of the important issues in supplier selection concerns technological development of industries and how consumer's priorities are changing over the years. There is no single opinion that initiates the development. Likely, this is a natural process of human being in order to improve surrounding, learn new and achieve better and better results. Thus R&D is an important activity in an organization as new materials require new machinery and equipment, new technological processes force to train employees and standardized continuous improvement is highly appreciated as it benefits the status of a company.

The last two parts of the thesis introduce modern models and techniques that are widely used for supplier evaluation and the actual application of one of the methods on a real life case. Personally I did not have a chance to test computerized software developed especially for the problem of supplier selection, but I focused more on working principles for a specific method. In addition to this often those methods are used as a supportive function of monitoring the overall supplier performance. Based on the literature reviewed I have selected a few types of methodologies that are sub-divided into techniques for pre-selection and actual final decision.

The short description of those is given. Finally, I applied in practice one technique that I consider effective and visually clear to be presented as an example.

This final thesis combines both research theoretical framework and practical application study. The research methodology for theoretical part relies mainly on books, articles, reports and business journals. Literature published in foreign languages was used to familiarize with the terminology and concept diversity in the language of the author (especially in Russian language). Business forums were also visited to compare different opinions and recent problems in the area of management, supply chain and purchasing.

2. WHAT IS SUPPLY CHAIN

Supply Chain Management (SCM) entered business environment as a term relatively recently but became one of the most reviewed topics by managers for investigating the ways of its improvement. Today competitiveness depends on far more factors than just the activities that occur within an organization. It depends on the overall performance of the full value chain that cover every step a business goes through (Investopedia US, 2014).

2.1. The Evolution of Supply Chain Management and Purchasing Function

The concept of SCM is one of the fastest growing areas of scientific and practical activities in the past decades. Initially, the emergence of the concept was cited by K. Oliver and M. Weber «Supply Chain Management: Logistics Catches up with Strategy», released in London in 1982 (Smirnova, 2009). However, the history of purchasing and supply chain development belongs to the time when a salesperson was the most valued employee in a company (Shah, 2009). The salesperson was the representative face and voice of the organization.

With globalization of the world at the end of the twentieth century time has changed and the world economy gained new characteristics. It offered new possibilities and covered the most important processes of socio-economic development of the world, helping to accelerate the economic growth and modernization. At the same time, globalization created new contradictions and problems. In the 1980s in many industries got into situation in which the cost of production has decreased as much as practically possible (Smirnova, 2009). To maintain competitiveness there was a need for a new concept of business management. Thus many companies had to search for possible ways to source materials and products as well as develop flexible network coordinated flows between organizations to discover their own “playing field” to run a successful business (Lünendonk, 2011). Therefore, for many foreign companies, it became clear that effective SCM is the next a step that is necessary for them to improve their competitiveness, to decrease such expenses as transportation cost, warehousing

costs, and other expenses that are involved in business (Smirnova, 2009). There were many drivers for supplier selection development and purchasing evolution. Chopra (2007) in his book defined 6 main drivers that mostly influence supply chain overall performance: facilities, inventory, transportation, information, sourcing, and pricing that are more connected directly to the company. Moreover, Cousins (2008) assumed that the main reasons driving the evolution of purchasing is the pressure from the competitive environment that can be analyzed by PEST.

According to the literature reviewed there are several stages in the development of the concept of supply chain theory and practice. The table (see APPENDIX 1) identifies those stages and period of time and gives a description of the supply chain and the role of purchasing during different stages.

2.2. Supply Chain Ideology

SCM over the last few decades is one of the fastest growing concepts at the interface of marketing, logistics, operations management and strategic management. Modern science offers a variety of definitions describing the meaning of Supply Chain and SCM. To date, there is no consensus about the single concept of supply chain as it is constantly refined and changed depending on the country, school and specific vision of researchers. During the development of the SCM many authors offered definitions in order to describe the concept of Supply chain. Thus the APICS Dictionary (1995) defines Supply Chain as:

“1) The processes from the initial raw materials to the ultimate consumption of the finished product linking across supplier-user companies. 2) The functions within and outside a company that enable the value chain to make products and provide services to the customer.”

And Christopher (1998) defines as:

“The management of upstream and downstream relationships with supplier and customers to deliver superior customer value at less cost to the supply chain as a whole.”

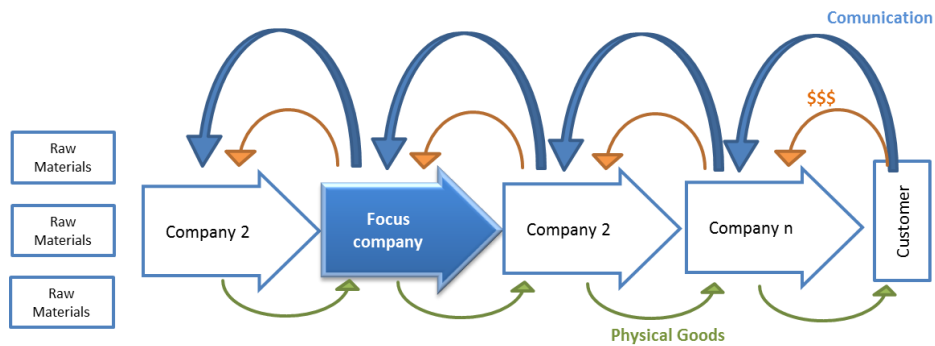
Handfield and Nichols (1999) define Supply Chain and supply chain and management as:

“The supply chain encompasses all organizations and activities associated with the flow and transformation of goods from the raw material stage, through to the end user, as well as the associated information flows. Material and information flows both up and down supply chain. “SCM is the integration and management of supply chain organizations and activities through cooperative organizational relationship, effective business processes, and high level of information sharing to create high-performing value systems that provide member organizations a sustainable competitive advantage”.

As one can see, there are many examples of different interpretations of the term "Supply Chain". There are several reasons why it is difficult to cover the entire spectrum of these interpretations, consisting of a variety of diverse and changeable terminology. Some of the reasons could be that the Supply Chain is a relatively new science. The large number of different terms is borrowed from close-related sciences because the Supply Chain has the interdisciplinary nature that combines many disciplines including both economic and technical-engineering subjects. There are different leading schools and trends as well. It is also possible to assume that certain terms are absent in the various languages or their understanding can be inaccurate. (Smirnova, 2009)

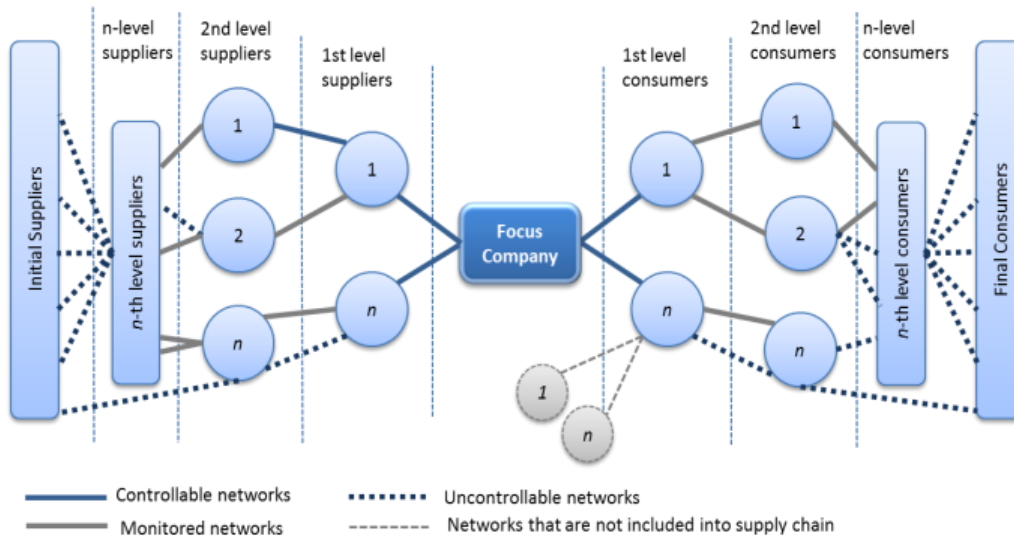
A supply chain can significantly be different from one organization to another. The difference between the old model of supply chain and today's model is that companies have moved away from slow-moving vertical integration where the flows of products, materials and money moved only in one direction (Hugos, 2011). Nowadays the market requires fast response and much flexibility in movements across the network and between all the participants. However,

often the supply chain includes many more tiers in collaborative network. It can be a very complex, global, multi-layered network, with many different types of business partners.



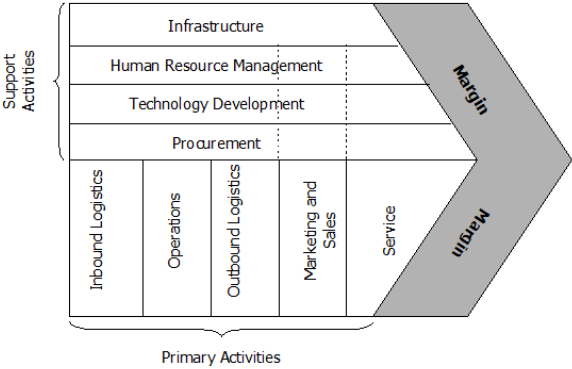
GRAPH 1. Supply Chain (adapted from Lawrence, 2000)

Understanding the supply chain ideology requires understanding of how and where some of sufficient internal functions of a firm can add value. The Graph1 shows that supply chain includes more than just the physical movement of materials and goods, but also information flow and money flow between many participants.



GRAPH 2. Supply Chain network structure (adapted from Lambert and Cooper, 2000)

In the Graph 2 above one can see that there are different flows, functions and activities in a supply chain. Some of functions that are grouped together are called value chain. One of the most known studies related to creating the value chain in the organization belongs to Porter (1985). According to his study the value chain includes primary and support activities shown at Graph 3. By monitoring and improving all the activities inside the supply chain it is possible to achieve a better overall performance of the company and add an intangible competitive advantage.

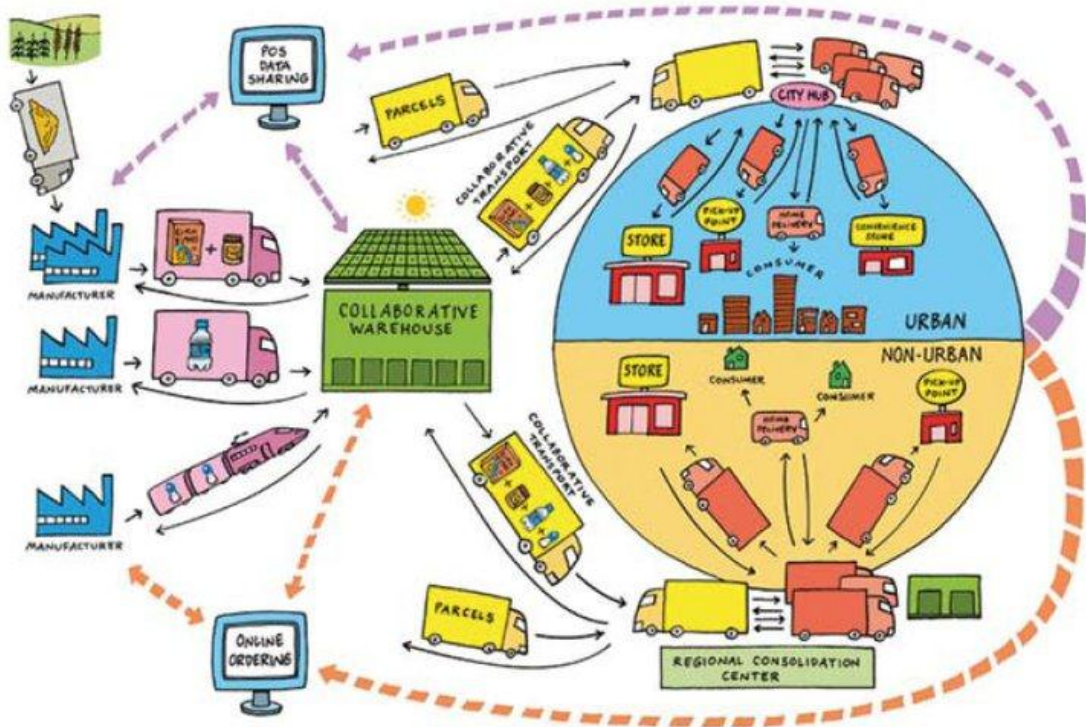


GRAPH 3. Porter’s Value Chain (redrawn from Van Weele, 2009)

2.3. Key Players in Supply Chain

Generally, the supply chain includes the company itself, multiple levels of suppliers and customers, and various intermediaries and contractors. The center of the extended supply chain is the focus company, and the focus of this company is the customer (who can be customer’s customer or ultimate customer). On the other hand, there are suppliers of different levels. In addition, there is a whole category of service providers who are professionals in supplying a wide range of activities in logistics, finance, marketing, and information technology. Those can be distributors or wholesalers, transport provider or specialists in customer marketing. As we can see in the picture below (see Graph 4), presented by Michael

Hugos (Center for Systems Innovation), the supply chain can consist of hundreds of participants that will play their own significant role for the end- customer



GRAPH 4: Running Supply Chains is Like a Massively Multiplayer Online Game. Author: Michael Hugos. <http://www.gdconf.com/conference/git.html>

3. THE ROLE OF SOURCING, PROCUREMENT AND PURCHASING

All the three terms described in the Chapter 3 refer to the process of obtaining goods or services from a supplier (or several suppliers). In most cases, these decisions in the supply chain increase its overall performance, create the value chain, but the main reason for focusing on sourcing, procurement and purchasing is to reduce expenses and minimize risks.

Risks can be of different importance level, but as we know, even "the small spark of fire can cause the explosion". Thereby, the importance of strategic sourcing, efficient procurement and purchasing function is obvious.

If the definition of purchasing is clear and easy to find and the term procurement is also well-described in the literature, the last term can be rather difficult to determine. While investigating the meaning of sourcing and procurement, I met different opinions and discussions of what are those terms are. In the discussion in LinkedIn.com, Lew.G who runs IT Sourcing Group offered a formula: Sourcing = Procurement + Purchasing; while Solomon K., Director of Sales at MnSteels, LLC stated that: Procurement = Sourcing + Purchasing (LinkedIn, 2014). Many times the sourcing and procurement are used interchangeably, but the fact is that they represent two different concepts.

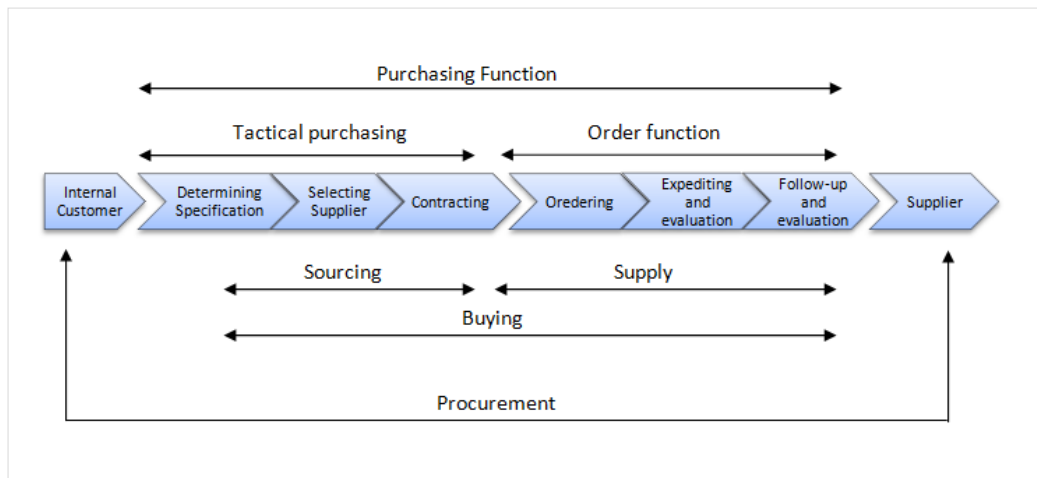
Sourcing refers to the value added strategic management tool to ensure access to adequate resources. One of the most known functions is mapping the supplier selection and designing conditions of their collaboration. Procurement is something related to management activities required to establish and maintain relationship between business and its vendors/suppliers through a process and procedure for acquiring and releasing goods and services. Purchasing is more about a function of material management: the actual acquiring of specific approved goods.

Van Weele (2009) in his book Purchasing and Supply Chain Management agreed that:

"In practice, as well as in the literature, many terms and concepts nowadays are used in the area of purchasing. However, no agreement exists about the definition of these

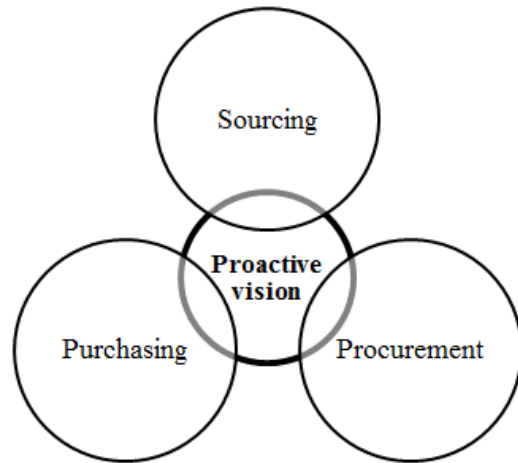
terms. Terms like procurement, purchasing, sourcing, and supply management are used interchangeably.”

Van Weele (2009) also schematically illustrated the main activities within the purchasing model. In the Graph 5 one can see that many functions are in close interaction and can exist simultaneously within an organization.



GRAPH 5. Purchasing model and some related concept (redrawn from Van Weele, 2009)

Surely Procurement, Purchasing and Sourcing are useful strategies to pay attention to. Terms describe a set of activities (Graph 6) to broaden the proactive vision in a company by anticipating and predicting the future situation. These strategies are developed to plan and maximize the level of control rather than to react on something already happened.



GRAPH 6. Proactive strategic vision of a company (source: author)

4. SUPPLIER SELECTION

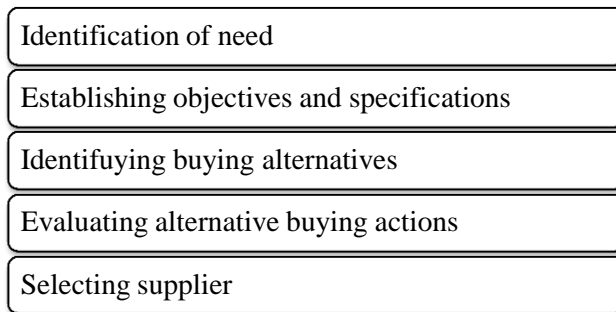
From the previous chapters one can see that many researches have been analyzing the purchasing concepts and modern terminology. Moreover, it is obvious that there are differences between all companies. No one can follow same strategy, has same financial status and reputation among its customers even by producing product of same specifications and quality. That is why many companies are ready to pay much more money, put more effort and time to improve the purchasing process, valuate in advance suppliers and all possible risks. In addition, in different companies the actual supplier selection can run in a different way. While for some product it can be a simple record of actions where every step of the formal process may not be required, for another product it can change into a highly complex framework where every step is regulated by professionals (Purchasing Insight, 2014). The actual process of supplier selection belongs to procurement strategic decision but in simpler way it can be also performed by purchasing department as automated steps.

In order to write this chapter I reviewed many authors who focused in some way on purchasing and supply chain activities. The following Table 1 shows a chronological list of the approaches of different authors used as a basis for developing the purchasing process and some of the important steps related to the concept of developing procurement strategy.

TABLE 1. Approaches to Purchasing Process (source: author)

AUTHOR	NAME OF APPROACH
Webster and Wind (1972)	General Model of Organizational Decision Process
Dobler et al. (1996)	The List of Purchasing Activities
De Boer(1998)	The Supplier Selection Framework
Cousins (2008)	Main Stages of Supplier Selection
Van Weele (2009)	Purchasing Process Model
Monczka et al. (2011)	Supplier evaluation and selection process, Initial supplier evaluation and audit development

Webster and Wind (1972) tried to define the basic model of organizational decision process that includes stages (shown at Graph 7) without attempting to specify every single step in the whole process. The specific steps can vary across the process of decision making as there are many factors influencing the buying behavior such as individual, social, environment and organizational climate. (Webster and Wind, 1972).



GRAPH 7. General model of organizational decision process by Webster and Wind (1972)

Later Dobler et al. (1996) argued that purchasing is common to all types of businesses and presented a list of purchasing activities (see Graph 8).



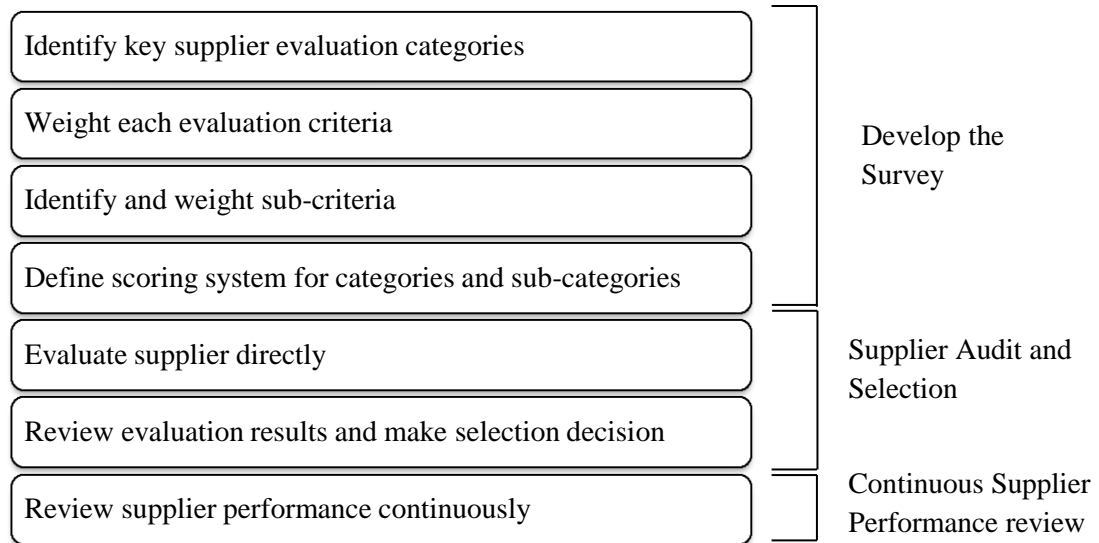
GRAPH 8. Purchasing activities by Dobler et al. (1996)

De Boer (1998) offered the supplier selection framework (see Table 2) that accommodates the diversity of situations in the purchasing practices on one axis and the actual steps of purchasing on another. He divided the purchasing process into a matrix that consists of problem definition, formulation of criteria, qualification and choice on a vertical plane and, on horizontal plane, new task, modified rebuy (leverage items), straight rebuy (routine items) and straight rebuy (strategic/bottleneck).

TABLE 2. The supplier selection framework by De Boer (1998)

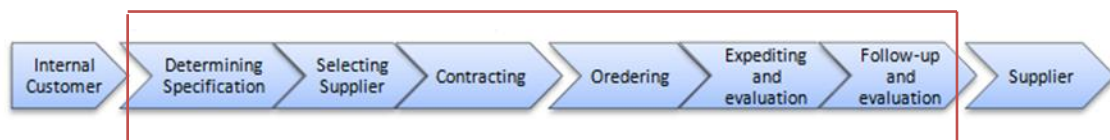
	New task	Modified rebuy (leverage items)	Straight rebuy (routine items)	Straight rebuy (strategic/bottleneck)
Problem definition	Use a supplier or not?	Use more, fewer or other suppliers?	Replacing the current supplier?	How to deal with the supplier?
Formulation of criteria	Varying importance One-off decision	Moderate/high importance Repeating decision	Low/moderate importance Repeating decision	High importance Repeating evaluation
	No historical data on suppliers available	Historical data on suppliers available	Historical data on suppliers available	Historical data on suppliers available, yet very few actual selections
Qualification	No previously used criteria available Varying importance	Previously used criteria available	Previously used criteria available	Previously used criteria available
	Small initial set of suppliers Sorting rather than ranking	Large set of initial suppliers Sorting as well as ranking	Large set of initial suppliers Sorting rather than ranking	Very small set of suppliers Sorting rather than ranking
	No historical records available	Historical data available	Historical data available	Historical data available
Choice	Small initial set of suppliers	Small to moderate set of initial suppliers	Small to moderate set of initial suppliers	Very small set of suppliers (often only one)
	Ranking rather than sorting	Ranking rather than sorting	Ranking rather than sorting	Historical data available
	Many criteria Much interaction	Also: how to allocate volume? Fewer criteria	Fewer criteria Less interaction	Evaluation rather selection Sole sourcing
	No historical records available Varying importance Model used once	Less interaction Historical data available Model used again	Historical data available Model used again Single sourcing rather than multiple sourcing	

Monczka et al. (2011) stated that the purchasing process requires continuous improvement of such activities as identifying requirements, evaluating the needs, identifying suppliers, ensuring that payment occurs in time, measuring supplier performance, and driving continuous improvement (Monczka et al., 2011). One of the main focuses of the study was to understand the corporate purchasing duties, how to meet the required objectives and policies of company, how to evaluate performance and in which way it is possible to redesign activities to improve the overall performance (see Graph 9).



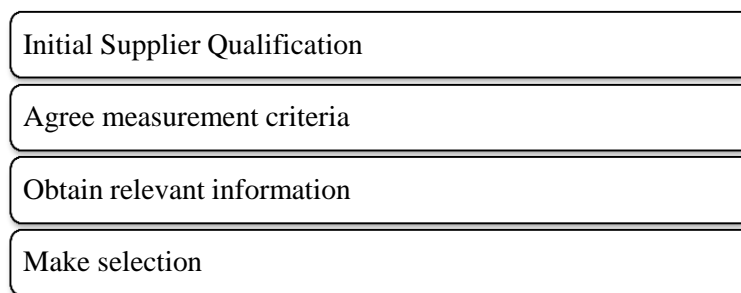
GRAPH 9. Initial Supplier Evaluation and Selection Audit development by Monczka et al. (2011)

Van Weele (2009) cited that purchasing function refer to an operational activity of the buying process. He has described the concept of purchasing model that includes six main steps (see Graph 10): determining specifications such as the quality and quantity of goods to be bought, the selection of the best possible supplier, the negotiation and agreeing the contract terms and legal issues between parties, ordering, expediting and evaluation that belongs to monitoring and control of supplies, and, finally, following-up that is about settling claims, keeping records, supplier rating and audit ranking. (Van Weele, 2009)



GRAPH 10. Buying process by Van Weele (2009)

Cousins (2008) determined 4 main stages (see Graph 11) associated with the choice of strategic supplier selection to increase the level of value creation. At the first stage called Initial Supplier Qualification, an organization has to select and narrow the list of potential suppliers who meet the minimum initial requirements which can be product quality, specific standards and ability to support long-term business partnership. Request for quotation, request for proposal and request for information are the most known methods of obtaining information from vendors (see APPENDIX 2). (Cousins, 2008).



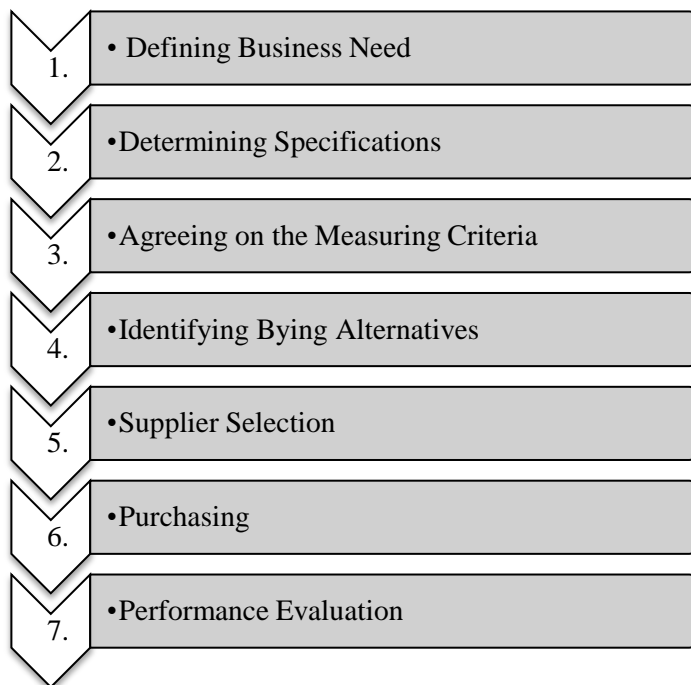
GRAPH 11. Strategic supplier selection by Cousins (2008)

The next stage is identifying the measurement criteria. One of way to evaluate the selection criteria is to weigh them against the price and find a balance between the so called “quality and quantity” or in management language “total cost approach”. Obtaining the information is needed to compare the suppliers according the criteria and to each other, and prepare a basis for a final step of selecting the best possible supplier based on quantitative and qualitative result. (Cousins, 2008).

4.1. The Main Stages in the Process of Supplier Selection

As one can see from the previous chapter there is no single way for purchasing and selecting the supplier. The process can differ as well as some of specific steps. On the basis of the information above I decided to create a “hybrid” process of obtaining goods with the main

focus on supplier selection. The graph below represents my personal vision of how a company can evaluate and select the supplier/vendor to achieve better results and improve the quality of both internal and external processes as well (see Graph 12). Some of the stages can be proceeded by procurement department and sourcing department while the actual obtaining of goods can be made by purchasers. However, in smaller companies all the process can be run in one department, for ex. in purchasing department. While running the buying process of goods or services, in my opinion, it would be beneficiary to have close collaboration between all employees working on the same project to have a clearer picture of the hidden risks that can occur at any stage of the process. This would help to minimize time and effort for risks mitigation. As one can see, the purchasing process includes 7 steps: defining the business need, determining specifications, agreeing on the measuring criteria, identifying buying alternatives, supplier selection, and purchasing and performance evaluation.



GRAPH 12. Purchasing process (source: author)

4.1.1. Defining Business Need

The first and one of the most challenging steps is defining the importance of some business need. The decision can be simple or complicated. While someone can simply answer the question “Do we need it?” another (with his different point of view) can continue with the question “Why do we need it?”, and finally the last person would argue with “Do we really need it?”. The dilemma always takes place in many situations, and purchasing is not an exception. From the very beginning it is necessary to understand the full picture of the actions that are going to be done, to realize the current situation and the problem that requires solution, to identify the initial risks in the procurement process, and make sure that development is relevant for the business need. The question of who will take responsibility for the positive or negative result that surely will influence the company from inside and, of course, what is the desired outcome need to be solved. This step is not only about achieving the strategic fitness, but also defining how and which resources company is ready to spend such as money, personnel, technology, third parties and etc. to achieve better results. The borders should be strictly estimated by the evaluating company’s ability to provide specific inputs for an expected output in a limit timescale. Obviously, defining the right business needs is paramount as business goals and objectives is the output that every company is trying to fulfill.

4.1.2. Determining Specifications

At the stage Determining Specifications a company identifies specific issues concerning the expected product or service. This stage is about estimating what the company would like to get at the end or so called “ideal end product”. On this basis the company will later evaluate and select the supplier to make an order. In other words, determining specifications is the information that can describe the product and set a minimum\maximum requirement. It will be delivered to the potential vendor to continue negotiation in case if minimum conditions are satisfied. Thus, the information should be full and clear, realistic and be presented in an official form. It can also include limitations concerning the product or service as well as some

of statistical or historical data about the previous experience (for instance, customer preferences or demand planning that can be significant for the decision making).

4.1.3. Agreeing on the Measuring Criteria

Supplier selection and evaluation criteria topic attracted many researchers to investigate what the most important factor that affects supplier selection is. Even perfect planning and evaluation based on data collected from suppliers does not guarantee 100% success.

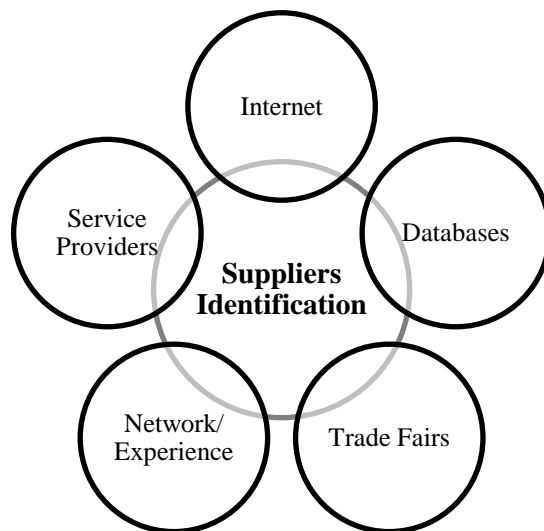
Hedderich et al. (2006) cited in one of his work:

“Generally, applicable criteria for supplier selection include export experience, references, size, English communication skills, adequate production capabilities, quality management skills and logistics fit. The buyer’s overall impression of the management’s product know-how, customer orientation, flexibility and reliability (e.g., short response times) is also highly relevant. The buyer should evaluate certificates with utmost care. On the one hand, many certificates originate from “dark back alleys,” and, on the other hand, even real certificates do not guarantee a certain standard, as suppliers frequently do not adhere to the certified quality system in daily business. The “relationship factor” — soft criteria such as trust in the supplier and a compatible entrepreneurial spirit — should not be underrated.”

Nowadays companies tend to build efficient partnership that should be positive for both organizations in the long run. For this it is crucial to investigate and set the selection criteria to compare partners not only in B2B sales. In purchasing the measuring criteria firstly used to eliminate suppliers that would not meet the minimum requirements. After all criteria are listed, they need to be prioritized and a scoring mechanism needs to be developed at this stage. This should be done in order to minimize the time for later criteria evaluation and automate the process. The stage of Agreeing Measuring Criteria can also include preparation of questionnaire, sending a RFI or any other relevant documentation to be issued.

4.1.4. Identifying Buying Alternatives

The stage four in my purchasing process is Identifying Buying Alternatives. There are two main questions to be covered during this stage: who are the potential suppliers and where to get information about them, and which sourcing strategy to choose. The first question is quite simple. There are many sources how to obtain information. The easiest way is, of course, the internet. Another question is how reliable that information is. Nowadays it would not be a major problem to find a reliable source of information on the Internet. The Graph 13 shows some specific Information Sources for Supplier Identification provided by Hedderich et al. (2006).



GRAPH 13. Information sources for supplier identification (adapted from Hedderich et al., 2006)

The sourcing strategy and the location of the supplier can be the next issue to be reviewed before making a decision: will it be local or global provider, what specific requirements are there for the global supplier, transportation, and tax and money exchange rate. All these play an important role for any business. The sourcing decision is important because the cost of the

end-product is formed over throughout the whole supply chain and it affects the overall effectiveness and efficiency of operations and processes that take place within a circuit between its participants (Smirnova, 2009). Therefore, an organization must decide what elements are appropriate to include into the supply chain and whether to use only single supplier or multiple suppliers. According the Cousins (2008) four primary sourcing structures that can be identified (with some amount of variation): single, multiple, delegated and parallel (Cousins, 2008).

4.1.5. Supplier Selection

Supplier Selection is part of the purchasing process and procurement strategy (see Chapter 3, p18). It requires significant work in the area of management and includes several steps such as creating the initial list of potential suppliers, evaluating its suitability to the organizational goals and objectives, supplier pre-selection, negotiation, final supplier selection, negotiating terms of agreement and contract, and, as final step, the reviewing and approval of decision. First of all it is required to list all the potential suppliers and from the very beginning to shorten the list by eliminating those who would not meet the basic criteria such as product specification and availability, standardizations certificates absence, specific terms and other primary factors that mostly affect the decision of supplier selection. The idea of this step is to shorten the list to exclude companies who would not succeed. This step should be made in a logical sense and be based on real facts and data. After the pre-selection step one can compare the result and evaluation time takes place. Nowadays there is a large variety of different methods applied to measuring the supplier performance. Most of those methods are based on multi-criteria decision analysis where the selection criteria are converted to a numerical model and the scoring, weighing and comparison is made. Today, the actual mathematical step is mostly proceed electronically using special software, but the simpler mathematical calculations can also be made using MS Excel or just a calculator and a pencil. The specific models of supplier selection will be discussed more in Chapter 5.

4.1.6. Purchasing

The last two stages are about negotiation and agreeing on the terms of contractual agreement, and, finally, approving of the choice that was made. As Van Weele (2009) cited, one of the purchasing functions is to terminate negotiations with the supplier with the writing up the contract or placing an order. Since the contract agreement is one of the most valuable legal documents, it secures the rights for all parties and should include every aspect in detail as well as supportive documents. It covers many issues such as information about the partners, a full description of product/-s and quantity, pricing, payment terms, discounts available, delivery time, limitations, returns, transportation, warranty, maintenance, conditions for breaking contract and many others. After negotiation is done and the final step of agreeing on the contract terms is finalized, the supplier can be approved by the manager, and the operational process of physical obtaining goods can be started.

Van Weele (2009) separated Contracting and Ordering into two steps in the purchasing process. I have decided to call the actual obtaining of goods as the Stage of Purchasing that includes the final negotiation, agreeing contract terms and legacy of operation, ordering and receiving the physical goods. The technical contents of the purchasing contract vary upon the product type as well as specific commercial and legal terms and conditions (Van Weele, 2009). One of the important steps in this stage is to manage all the documentation regarded money, physical and information flow between the buyer and the seller. As only this information proves the legacy of operations based on contract agreement, the documentation should be kept properly and the management of those records should be controlled in advance.

4.1.7. Performance Evaluation

The last stage represents Performance Evaluation and continuous improvement. The objective of this stage is to reduce the future risks connected to purchases and to both new and already known suppliers, to reduce costs, to save time by automating the purchasing process, to mitigate the negative effect in case of uncertainty. The performance criterion is used to

evaluate the partnership including all aspects starting from the negotiation process to the final results. This is not only about the quality of product and fast delivery time, but about the organization, communication style and ethical issues. From one side it can be seen to be the easiest question to say was it good or bad. However, there are also some challenges such as standardization of procedure of supplier performance measurement and its automation, reporting and the way of presenting a feedback. Dr. Michael Hammer, Re-Engineering the Corporation told:

“You can’t improve what you can’t measure”.

Purchasing performance evaluation must see results that were initially planned and which were obtained in the end. The performance should be checked periodically and be officially reported. In fact, purchasing management of performance quality process is a continuous process of improvement. (Van Weele, 2009).

4.2. Selection Criteria

Supplier selection is a competitive area as the supplier should offer more than just a product according to some specifications. First of all, the supplier is a partner that will bring success or make one’s business fail.

4.2.1. Literature Review

During economic development, many authors have dedicated their research work to the role of supplier selection in supply chain content and certain selection criteria. Since the 1960s scientists mostly focused on the purchasing process and performance analysis. Prior to the 1970s supplier selection had been done mostly on the basis of obtaining the best price and taking into account only a few other factors, such as quality and delivery (Javanmardi et al., 2011).

One of the well-known works was written by Dickson (1966) who presented 23 criteria that should be investigated and taken into the account regarding the vendor selection. His research was based on a questionnaire sent to 273 purchasing agents and managers from the United States and Canada selected from National Association of Purchasing Managers members list (Lyès, Ding, and Xie, 2003).

His study is still relevant and gives a good base for further development of approaches for specific industries to adopt his idea for relevant needs. APPENDIX 3 shows Dickson's selection criteria. It includes the list of the criteria itself, importance value and relative importance where the criteria are grouped according their relevance. Therefore, his methods have some weak points as the evolution of business environment is changing towards new technologies and innovations.

Lately Weber et al. (1991) investigated 74 published papers and works since 1966 and concluded that price, delivery, quality, production capacity, and location are the most often mentioned criteria.

Based on Dickson's approach, APPENDIX 4 provides information about how preferences of purchasers are changing with time. The column „Current Rank“ indicates the position that each criterion holds in this study (based on the number of papers that criterion occurred in) and the column „Previous Rank“ refers to the rank the criterion held in Weber et al. (1991) study. However, Cheraghi et al. (2004) proved that some of the previously used criteria specified by Dickson and Weber between 1990-2001 are no longer relevant (Aguazzoul, 2012).

Another important work proposed by Ford for automotive industry was to focus on the use of a policy approach as opposed to the business approach and the cost based approach including delivery reliability, technical capability, cost-effectiveness and the financial stability of the supplier (Ford et al., 1993).

Banker and Khosla offered strategic standards for supplier evaluation as a part of operations management based on total quality management, zero defect, process improvement, statistical process control, and continuous process improvement (Banker and Khosla, 1995).

In 2004 Talluri and Narasimhan (2004) identified eleven selected features containing both subjective and objective features such Quality Management Practices and systems, Documentation and Self-audit, Process/Manufacturing Capability, Management of the firm, Design and Development capabilities, Cost Reduction Capability, Quality, Price, Delivery, Cost Reduction Performance (CRP) and other. (Talluri and Narasimahan, 2004)

The current situation has changed and many of the earlier studies gave a profound base for today's research. There are many related articles and reviews about different vendor selection and evaluation criteria. To date, many works related to purchasing are based on the theories of founders which are used to adapt new strategies for the future market.

4.2.2. Selection Criteria

Based on the information above and the review of different classifications of supplier selection criteria (See Chapter 4.2.1, p. 31), I have identified the hierarchical structure that can be used for some purchasing items. In my opinion there are 8 main categories of criteria shown in the APPENDIX 5. Each category has sub-categories that will be described further. Surely depending on the company size, structure, preferences, policies and product required, this hierarchy can differ but it is useful to have a basic idea before modification.

The most obvious criterion that is easy to compare among several of suppliers is the cost price per product unit. The unit price is simply obtained from the supplier's reply to an RFQ. However, the total cost is also affected by the exchange rates according to the location of the supplier and the taxes to be paid for the product. Pricing terms refer to the agreement of discounts and payment terms. (Cousins, 2008)

Discount is a changeable criterion as it can be considered at both price terms and flexibility service offered by supplier. There are many types of discounts used today. Van Weele (2009) listed cash discount, quantity discount, seasonal production, promotional discounting system and volume bonus as the most well-known ones. Moreover, payment term describes how the payment should be proceeded and in what period of time (Cousins, 2009).

Nowadays more companies tend to focus on the quality of products to be ordered and the quality of service rather than only on the price that can include many hidden risks (Cousins, 2008). The quality of a product may be defined as “its ability to fulfill the customer’s needs and expectations” (ISO 9004:2009). Van Weele cited IBM’s explanation in his book that tells:

“Quality is the degree in which customer requirements are met. We speak of a quality product or quality service when both supplier and customer agree on requirements and these requirements are met.”

A minimum quality requirement is to meet the specifications agreed between the buyer and the seller. Quality features might include physical design characteristics such as dimensions of length, width, thickness; material properties such as type of raw materials, overall appearance that can be color, print, size; durability and resistance, and etc.

Another way to evaluate the supplier’s ability to provide good products is to analyze its resources. Are there enough resources to execute the work and is there contingency in resource planning? “Customer interface” can open eyes on different types of problems and technological issue is not an exception. (Haughey, 2014).

The quality of a product includes the manufacturing process that can be a significant factor for some specific range of products. For instance, what type of machinery was used and what techniques (printing, dying, coloring in textile industry)? Systematical quality control and reporting from the supplier’s side increase trust and reliability. It generates continuous improvement in internal organization and among all supply chain tiers.

The service level will have a significant impact on the final decision. Thus it creates the need to evaluate many aspects under the criteria of service. Often manufacturer and sellers in B2B sales environment prefer to set a minimum order quantity for purchases in order to reduce the expenses in scope of manufacturing, transportation, warehousing and management. This is also quite relevant in case of high customization level provided by the supplier. Customization can refer to the ability to provide a variety of size, shape, color, design, packaging options, production under the brand name, Original Equipment Manufacturer (OEM) and etc.

In global marketing the essential and critical issue is communication, for example, the language and the ethical norms while doing business with a foreign company. At the stage of negotiation it can be valuable that the information is accurate, enough detailed and transparent. One of the questions that can be asked before signing for a long-term partnership is how honest your partner is about problems faced and overcome, and if he is ready to communicate openly and freely internally, to be audited and give adequate, consistent feedback?

Flexibility and commitment are factors that define how well the schedules and changes are handled under the high level of uncertainty. Quick response time increases efficiency and speeds up the overall process of purchasing. Industry knowledge improves the image of a company and shows its professionalism in dealing within industry.

The term of delivery refers to the actual movement of physical goods between organizations including return management. When talking about delivery it is necessary to focus on the lead-time that is well-known from logistics and operation management where the maintenances of safety inventory require the supplier to proceed deliveries in a certain period of time without delays. In other words, lead time is the time between placing the order and dispatching the product based on the agreement in an oral or written form. On-time performance of the right delivery is typically measured by percentage (Cousins, 2008). Often the lead time depends upon the location of companies and it can be influenced by third parties such as transportation Service Company or by custom regulation services.

Today many of international and local companies can afford their own transportation trucks. However, for some reason many companies prefer to use a third party provider for organizing and implementing delivery transportation. The Incoterms is a set of pre-defined internationally recognized standard published by International Chamber of Commerce (ICC) and used worldwide in international and domestic contracts for the sale of goods (ICC, 2014). The following Table 3 describes the transportation models offered in Incoterms 2000. More information can be found in the official web-page of ICC as well as Incoterms 2010 that also describe some new terms.

TABLE 3. Incoterms 2000 (source Van Weele, 2009)

CODE	NAME	STAGE
EXW	Ex Works	Departure
FCA	Free Carrier	Type of contract: Main Carriage Unpaid
FAS	Free Alongside Ship	
FOB	Free on Board	
CPT	Carriage Paid To	Type of Contract: Main Carriage Paid
CIP	Carriage and Insurance Paid To	
CFR	Cost and Freight	
CIF	Cost, Insurance, Freight	
DAF	Delivered at Frontier	
DES	Delivered Ex Ship	Arrival
DEQ	Delivered Ex Quay	
DDU	Delivered Duty Unpaid	
DDP	Delivered Duty Paid	

For most of the companies the trust is the key to a successful partnership. Credibility and company image are key factors for many successful organizations when evaluating potential supplier. Present partners also help to see what the quality and range of their formal partnerships is (Haughey, 2014). It is an intuitional signal that companies that choose strategic direction toward developing a long-term relationship are more reliable in business. First of all, it is useful to check who are the present customers, sub-suppliers and other partners of the potential vendor. It would be beneficial if the vendor already had experience in international work in a global environment with the country of the buyer or supplier has their representative office to provide a higher level of support and easier communication. Reference clients help to explore business and people working in organizations. Today there is a large variety of on-line directories where it is possible to find reviews and ratings of companies' performance, official publications, public exhibitions and events where a company can participate to improve its image and gain positive feedback. Another way of obtaining reference clients is a direct message to management of supplier. Moreover it will show the serious attitude to long-term co-operation.

Strong financial stability in future perspective is the key of business success in the future. Traditionally, financial issues are a single factor that mostly influence on the sourcing activities. (Haughey, 2014). Obtaining of enough relevant information supported with official

documentation from vendors about their financial situation and financial activities for the previous few years provides the ability to accomplish service according to the contract. Moreover, statistical data on change in cash flow and credit history build a secure supply chain and ensure positive results from the purchase for all partners.

The suppliers' ability to keep up with competent technical facilities improves the quality of service and develops successful technical infrastructure. The technical dimensions of the criteria can include several factors including R&D investment of an organization, IT development, the ability to support e-commerce and information security. E-commerce is an important element of online activity. The ability of a supplier to support online commerce gives real-time information about the purchasing process. Interactive service consists of electronic purchase orders, receipts, operational information, invoicing and payment as well as monitoring the delivery stage. Operating systems and modern IT software applications are used to support competitive management and increase the overall quality level. The technology criteria became a relevant issue in the global market place as it increases partners' interaction, shortens the lead time and eases the inventory level management.

In trading it is obvious that companies have to share information and resources in between to achieve better results and customer satisfaction. Here the question of security and how to protect information that you obtain becomes important. Security investments by their nature are built to protect assets, activities and operations. It helps to prevent problems connected to additional costs occurring caused by information liquidity. Security assurance is a fundamental criterion that can be performed by partner auditing. Thus it is mandatory to maintain the overall supply chain security as well as to maintain the required level of protection inside each organization.

Another criterion concerns about business ethics and a company's attitudes toward ethics, environment and sustainability. Nowadays it is becoming more significant that companies are able to support building the so-called Green supply chain that covers different aspects of protecting nature by relevant use of natural resources and waste minimizing. The supportive documentation assures the quality and motivates for continuous improvement (See Chapter 5.2, p.41). Today there are many organizations that can help to benefit the company by improving

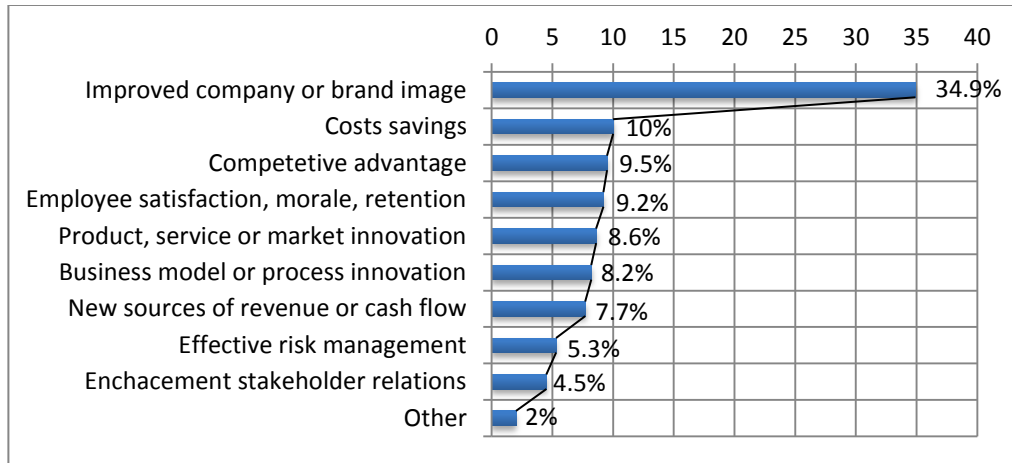
its processes, develop professional culture, increase both employee and customer satisfaction, improve efficiency by saving money as it also helps to achieve international recognition. One of the most well-known standards is ISO series but many of other internationally recognized standard certification can be obtained from many organizations. (ISO, 2014)

Corporate Social Responsibility (CSR) is a business strategy that protects society, environment and all other participants impacted by the business. CSR focuses on the areas where the company has greatest impact. It promotes the organization to take responsibility for its activities and to encourage consumers, employees, stakeholders and all other members to follow their own responsibility for the protection of the world (See Chapter 5.1, p.40). (CSR Europe, 2014)

5. THE FUTURE OF STRATEGIC DECISIONS: ETHICS, ENVIRONMENT AND SUSTAINABILITY

Nowadays the situation in the market has significantly changed as well as the common legal regulation and the preferences of consumers. Most of businesses have already achieved high level of success, but in today high competition they still need to invent new strategies and adapt innovative solutions in many aspects such as quality and management security. That is why the term of business ethics is quite common today. It is a philosophy of moral principles and values, which requires distinguishing the right behavior from a wrong. Social values include qualities such as conscience, respect, justice, trust, support etc. From the perspective of commerce, it corresponds to the quality of product or service, customer satisfaction, compliance in specification, health and safety issues. Business ethics is based on respecting the interests of a firm, its partners, customers and society as a whole. It is obvious that the formation of ethical norms must begin within a specific organization. The world's business community has accumulated certain experiences that help firms with adopting codes of conduct and different rules and standards that support management systems in an individual organization.

From an organization's point of view the purpose of developing such strategies as green supply chain, ethics and environment protection demonstrates how these practices can actually save money by achieving cost reduction, increasing operational efficiency and flexibility, reducing delivery time, increasing sales and improving the overall company image and customer value enhancement. At the same time environmental sustainability programs require integration of broad range of processes in company operations. The Graph 14 below shows main drivers for adopting green strategies based of MCG AND CII survey. The data is based on 1560 responses from business leaders who participated in a survey on their preferences (BCG, 2009).



GRAPH 14. Benefits of applying green strategies (source: the Sustainability Initiative 2009 Survey. BCG and MIT Sloan Management Review)

5.1. Corporate Social Responsibility

Corporate responsibility covers a variety of issues, but the major concept covers ethics, human well-being, environment, sustainability, equality and fairness. One of the reasons why the concept has become so popular in recent years is because first of all consumers are willing to pay for a reliable product that is safe for them and for the planet where they live. The European Commission defines Corporate Social Responsibility (CSR) as:

“...the responsibility of enterprises for their impacts on society”.

According to European Commission report CSR at least covers human rights, labor and employment practices (such as training, diversity, gender equality and employee health and well-being), environmental issues (such as biodiversity, climate change, resource efficiency, life-cycle assessment and pollution prevention), and combating bribery and corruption. Other aspects promoted by CSR include the integration of disabled persons, community development, and privacy, promotion of social and environmental responsibility through the supply-chain. In addition, the Commission promotes the three principles of good tax

governance: transparency, exchange of information and fair tax competition. (European Commission, COM (2011), 2011)

Carroll and Buchholtz (2008) stated that all companies, especially large ones, have multiple stakeholders that are affected by an organization's policies, procedures and actions (Carroll and Buchholtz 2008). Table 4 shows that stakeholders can be divided into two categories: primary and secondary stakeholders.

TABLE 4. Primary and secondary stakeholders (adapted from Carroll and Buchholtz, 2008)

ORGANIZATION	
PRIMARY STAKEHOLDERS	SECONDARY STAKEHOLDERS
Shareholders (Owners)	Local, State, and Federal Government
Employees	Regulatory Bodies
Customers	Civic Institutions and Groups
Business Partners	Special Interest Groups
Communities	Trade and Industry Groups
Future Generations	Media
The Natural Environment	Competitors

In terms of primary stakeholders, an organization has legal and moral obligations to its owners for attempts to obtain adequate return on their investment. Employees have legal and moral claims to an organization where they work. Firm has responsibilities for its production and marketing to their customers including safety and other specific features. Communities and partners are also affected by an organization as well as future generation and environment. Secondary stakeholders often try to ensure the organization to take the responsibility for primary stakeholder and other groups that might suffer from the organization's actions and its reputation. (Barnett, 2014)

5.2. Documentation to assure CSR

Currently, in many countries worldwide the role of documents containing regulations, political lines and official procedures that ensure social corporate responsibility is increasing in company management. In international practice, there are about 25 different models that can be conducted for reporting social reporting and five of which are the most widely used at the moment include GRI (Global Reporting Initiative), AA1000 (Liability - AccountAbility 1000), Global Compact and SA 8000 " Social Responsibility" and ISO 26000 " Guidance standard on Social Responsibility ". The table presents the list of Standards that are widely practicing in worldwide business industry (see APPENDIX 6). The full name and short abbreviation is shown in the column one and two respectively; the short description is given as well in the right column. (Katanaev, 2006)

6. MODELS AND TECHNIQUES IN SUPPLIER EVALUATION

The final supplier decision making process would be extremely simple if only single criterion was used for comparing several potential suppliers. However, it is a risky step and approaches with evaluation of the range of criteria are more reliable even if they have some limitations. A variety of studies have been made to prove the efficiency of the analysis based on multi-criteria decisions. Tahriri et al. (2008) presented how preferences of methods for evaluation have changed for years. He categorized all the existing methods into quantitative and qualitative.

Quantitative researches are adopted from mathematics, physics and statistical sciences to evaluate strengths and weaknesses. Quantitative studies involve gathering data in the numerical form to quantify the problem so as it can be categorized, ranked or measured in units. It tests hypothesis in one reality: statistics is measurable and logical. As the researcher remains emotionally separated from the research, the quantitative method has an objective nature of the results. Quantitative methods are normally more structured than qualitative ones.

Qualitative methods might include tools for visualizing the perception as well as tools for brainstorming alternative solutions (De Boer, 1998). Qualitative research by definition has an exploratory nature. It is used to help in developing clear understanding of a situation. Its objectives are to explore, discover, and describe the reasons and motives. The focus of qualitative method is to examine the depth and breadth of phenomena as well as the importance of nuances associated with the problem. In qualitative research a high level of subjectivity is expected as the researcher is part of process. Often qualitative data is presented in a form other than numbers. It is assumed that "the whole is greater than the sum of its parts", as Aristotle stated.

Today both methods are used in integrated models built for supplier selection in comparison to the time before 2003 when quantitative methods were mostly applied (Tahriri et al., 2008). In multi-attribute decision making, the problem is decomposed into smaller and less complex sub-problems that are organized into a hierarchy structure (Pal, Gupta and Garg, 2013). The

existing supplier selection techniques described in literature can be divided into a few categories based on their methodology as well as on the purpose for use that is shown in the Table 5 below.

TABLE 5. Models and techniques in supplier evaluation (source: author)

TYPE/ USE	PRE-QUALIFICATION	FINAL SELECTION
Statistical/Probabilistic	Cluster Analysis	Fuzzy set theory and other models
MADM	Categorical Method	AHP ANP TOPSIS Outranking(ELECTRE, PROMETHEE)
Mathematical Programming	DEA	
Artificial Intelligence		
Methods Based on Costs		ABC TCO

6.1. Cluster Analysis

Cluster Analysis (CA) was firstly reported by Hinkle et al. (1969). CA is a basic method of classification the criteria into clusters so that the differences within a cluster are minimal and the differences between criteria from different clusters are maximal (De Boer, 1998).

Typically, the practical use of cluster analysis simultaneously accomplishes several objectives that can be developing classification, investigating of various systems for grouping subjects, research and hypothesis testing based on the data available, facilitating of complexity of the given information and its better understanding and visualization.

6.2. Categorical Method

Categorical Method belongs to the group of qualitative models. Its idea is to rate suppliers based on their performance and sort them into the positive, neutral or negative group. After suppliers have been evaluated using all the criteria, an overall rating is given by the buyer. (De Boer, 1998). The advantage of Categorical Method is that it helps to structure the evaluation process. However, it generalise all the information in a logical way and ignores some of factors that can be significant for a buyer.

George Bernard Shaw in John Bull's Other Island (1904) told:

“There are only two qualities in the world: efficiency and inefficiency, and only two sorts of people: the efficient and the inefficient”.

6.3. Data Envelopment Analysis

Data Envelopment Analysis (DEA) evaluates comparative effectiveness, efficiency and productivity. The efficiency is determined on the ratio of two criteria: the weighed sum of outputs to the weighed sum of its inputs as it is shown at Equation (1). According to DEA, the supplier has a relative efficiency of 100%, if it generates a set of output factors that are not produced by other suppliers with a given set of input factors (De Boer, 1998). Thus, basically it represents a concept of categorizing suppliers as efficient or inefficient.

$$Efficiency = \frac{Weighed\ Sum\ of\ Ouputs}{Weighed\ Sum\ of\ Inputs} \quad (1)$$

6.4. Analytical Hierarchical Process

Analytical Hierarchical Process (AHP) was developed by Thomas L. Saaty in the 1970s and it has gained wide popularity since that time. AHP uses a hierarchy to structure and prioritize

multiple criteria into specific clusters and elements and specify levels that usually consist of goal setting, criteria and sub-criteria alternatives (Saaty, 2005). The method combines quantitative and qualitative criteria (Pal, Gupta and Garg, 2013). AHP is a well-defined mathematical calculation technique to structure multiple choice criteria, to compare criteria in a natural pair wise mode and to generate true or approximate total weights to assist the decision making and rank alternatives of potential suppliers.

AHP is a beneficiary method because it allows ranking choices between competing options. The calculations are not mathematically complex but allow solving the problem effectively to meet the main objective. However, AHP uses matrices of the same mathematical form known as a positive reciprocal matrix (see Equation (2)).

$$A = \begin{bmatrix} 1 & a_{11} & a_{1n} \\ 1/a_{11} & 1 & a_{2n} \\ 1/a_{1n} & 1/a_{2n} & 1 \end{bmatrix} \quad (2)$$

To create such a matrix a number scale from 1 to 9 is used. To show that 'A is absolutely more important than B' number 9 is used, and 1/9 to show how 'B is absolutely less important than A'. Many researches interested in AHP propose changing the rating scale to observe the changes in result. Thus, if the same method with a different scale gives the same final result, then the choice would be twice proven. (Coyle, 2004)

6.5. Analytical Network Process

Analytical Network Process (ANP) is a theory that extends the AHP concept. ANP uses a grid/network structure instead of a hierarchy to decompose the problem. Saaty (2005) developed a method that allows dependence and feedback both within clusters and between them. Similar to AHP, a pair wise comparison is used to measure the weights of the components of the structure, and then rank the alternatives. (Silva et al., 2009)

6.6. TOPSIS

The concept of the Techniques for Order Preference by Similarity to an Ideal Solution (TOPSIS) developed by Hwang and Yoon in 1981 is based on the principle of finding the optimal solution that should have the 'shortest distance from the positive ideal and the farthest distance from the negative ideal solution'. Thus the ideal and optimal solution should lie in between of the positive and negative alternatives and at the same time the ideal and optimal solution does not necessary be the same nearest to positive ideal as farthest to negative. (Hwang and Yoon, 1981)

6.7. Outranking models

It can be seen that most of the techniques used to solving the problem of supplier selection are based on mathematical science and ignore intuition and emotional feelings. Outranking models do not dictate which criteria should be used, which weights should be applied and which information should be gathered. More often the buyer's feelings and experience would be a driver for decisions. (De Boer, 1998)

The origin of the outranking method is France where around 1968 Bernard Roy originally developed ELimination Et Choix Traduisant la Réalité (ELECTRE). Later in 1980 Promethee and Gaia presented the framework that helps to identify main alternatives and improve problem structure by separating and quantifying conflicts and clusters (Figueira, Greco and Ehrgott, 2005). Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) outranking method is usually used as an effective supportive tool for eliminating alternatives of the problem to shorten the list for further use of another Multiple-criteria Decision Analysis (MCDA) technique to make the final decision.

6.8. Total Cost of Ownership

During the period of time when the price was a driver for a business the Total Cost of Ownership (TCO) gained high popularity. The idea of TCO is to help the buyer to investigate both direct and indirect costs involved in the purchasing process from the price of product to all the underlying operational costs. Depending on the industry, location and many other factors TCO can include a wide variety of costs: transportation insurance for a specific product, safety packaging, expenses connected to language and certified translation, customer-oriented supplier visits or quality inspections. (Aguezzoul, 2012). The calculation methodology of TCO first of all reveals the cost structure. Despite the fact that most of the costs can be predicted with a high accuracy, some costs are probabilistic in nature, which leads to the risk of significant deviations of the forecasted actual costs. Today, TCO analysis is considered as a supportive tool for planning decisions. Basically, it deals with one type of problems of total costs and computerized cost accounting systems monitor costs across all the processes in an organization.

6.9. Activity Based Costing

Activity Based Costing (ABC) is an analytical model that identifies activities in an organization and assigns resources to that specific activities, business processes, products or suppliers according to the actual consumption (Aguezzoul, 2012). In the supplier selection the ABC costing method is useful for investigating which of the suppliers would be able to help minimizing the total additional costs associated with the purchase and related activities.

6.10. Artificial Intelligence

Artificial Intelligence (AI) models are based on computer-aided systems that in some way can be "trained» to integrate qualitative factors and human expertise in the selection process. Only a few examples of AI methods applied to the supplier evaluation problem can be found in the

literature. They combine expert knowledge, literature information, and historical data and are able to simulate the functions of a human brain. AI can handle well problems with high complexity and uncertainty. (Aguezzoul, 2012, Pal et al., 2013, De Boer, 2001)

6.11. Mathematical Programming

Mathematical Programming models often consider only the quantitative criteria (Pal, Gupta and Garg, 2013). Mathematical Programming evaluates a set of available alternatives in a certain range with regard to specific parameters (criteria in supplier selection problem) to find the best option and to optimize the result based on either single or multiple objectives.

6.12. Fuzzy set theory

Basically, supplier selection and purchasing processes can have a very high level of uncertainty. Most statistical methods based on the data gathered from the empirical studies deal with random uncertainty. One of the well-known ones in statistics is the Fuzzy method. For the words like fast and slow, tall and short or young and old there is no single quantitative value that can clearly define those words. Let us have an example of defining the meaning of "tall". For some people, 180cm is tall, and for others, 160cm is also tall. For a 7-year-old girl, 150cm person is tall and 170cm is very tall, whereas for me the height between 150-170cm is normal, not tall and not short. As one can see, the concept 'tall' has no clear boundaries and its understanding depends on parameters in which it is described.

The Fuzzy set theory is widely applied to situations when decision making under the uncertainty takes place. Zadeh (1965) was the first who proposed the theory of fuzzy logic. Mathematical frameworks known before did not allow solving phenomena of multi-valued and inaccurate character. Using fuzzy sets it is possible to define terms such as "fast" or "good". To formulate the definition of a fuzzy set it is necessary to specify the so-called areas

of reasoning. For example, when estimating the speed of a car, the range of X is restricted (see Equation (3)).

$$X = [0, V_{max}] \quad (3)$$

, where V_{max} - maximum speed the vehicle can reach.

As one can see, there are many of methodologies for the problem of supplier selection proposed over a time. If earlier the simpler versions were enough effective, today however the business environment for some industries can be very competitive. That creates the need for re-evaluation and re-thinking of how to deal with the supply chain process and how to improve the result. Supplier selection is one of the questions that companies prefer to focus more nowadays in order to achieve the best possible results at the end. That is why the integrated models that combine several models into one process of supplier selection are adopted. Integrated models that are mostly known from the literature are based on the combinations of Fuzzy logic, AHP, ANP and TOPSIS or can also include different approaches to build a strong mathematical tool. In addition to this methods based on costs are widely used in computerized systems as a supportive tool. Thus a company can select a variety of options and adapt an effective tool for the supplier selection decision-making with regard to the objectives and goals, and resources to be spent.

7. CASE STUDY

The given chapter presents a step-by-step description of the actions that were done in order to describe the practical application of the process of supplier selection. It includes a description of the case, data collection and actual supplier evaluation using one of the methods for analyzing the suppliers' performance.

7.1. Description and Data Collection

The case study presents a work that applies theoretical framework in practice. The process of supplier selection was taken as the basis of the case study (see Chapter 4.1, p.20). First stage was defining the business need. I have decided to operate within textile industry. That is why the product that was used as an example is "bedding sets". This product was chosen as home textiles are in continuous need among consumers. Most of super markets specialized in different products offer home textiles, including Ylivieska region as well as any other area in Finland and worldwide. Analyzing the product within home textile sector can give me a good experience that can be used in my career. Moreover, trends are changing fast, technology is developing and there is a need for introducing new designs to provide consumers with modern products of high quality and to be competitive in the market.

The next step is to determine specifications (see Chapter 4.1.2, p.21). The supplier should satisfy a set of minimum requirements for being considered as a potential option and to be brought to pre-selection stage. The estimated minimum is, first of all, location. Due to the lack of knowledge about the whole Asian market, the country of China was the only one selected as a location of manufacturer and wholesaler. Secondly, the product type of material that can be accepted is cotton. Linen and other organic materials are beneficial, but not essential. The availability of a catalogue and sampling is required too. MOQ should not exceed 2000 sets per order. The company has to provide clear information about payment methods accepted and transportation options. The lead time over 45 days is not accepted. The supplier should also provide full information about the standardization and the working

conditions of employees. One of the last issues, but not least, is the response time after sending a RFI. Replies no longer 5 days are considered as satisfactory.

After analyzing many factors that can influence the choice, the measuring criteria were identified (see Chapter 4.2, p.25) based on the information available from the suppliers, literature and other sources related to supplier selection and textiles. The selection criteria include many issues from product specification to a historical review of the supplier's performance, from certificates available to the terms of delivery and customer services. For the full list of selection criteria see APPENDIX 5.

There are many sources of obtaining information about potential suppliers (see Chapter 4.1.4, p.22). Due to the lack of information about the suppliers of home textile production I have decided to focus on, first of all, investigating companies that provide bedding sets. After reviewing a few companies I realized that the main problem is that I do not have enough information about them. Thus those sources were considered as unreliable. Because of that fact I mostly focused on online marketing web-sites that provided enough information about their visitors, companies and products. Online databases provide ratings of suppliers and their performances. It is also possible to view what activities companies support such as participating in different trade fairs. Finally, I concluded that globalsources.com would be the best option for me.

After registration at globalsources.com I prepared a list of potential options for further evaluation. Based on the filters available on the web-page, the companies that did not meet the minimum requirements were automatically eliminated. Thus I got a list of suppliers that were sent an automatically organized RFQ and questionnaire through the web-page service. Further communication was continued by e-mails but most companies offered phone call service and on-line video chat too. All together 40 questionnaires were sent and about 20 replies within 5 days were received. Most of the companies provided about the same information. Thus 4 suppliers than seemed to me more beneficial and reliable based on the reviews, the years of operation and pricing terms were selected for further evaluation.

The supplier selection stage is described in more detail in the next chapter (see Chapter 7.2, p.43). Steps such as the actual purchasing (see Chapter 4.1.6, p.24) and performance evaluation (see Chapter 4.1.7, p.25) were not applied to the case due to the fact that they were not performed.

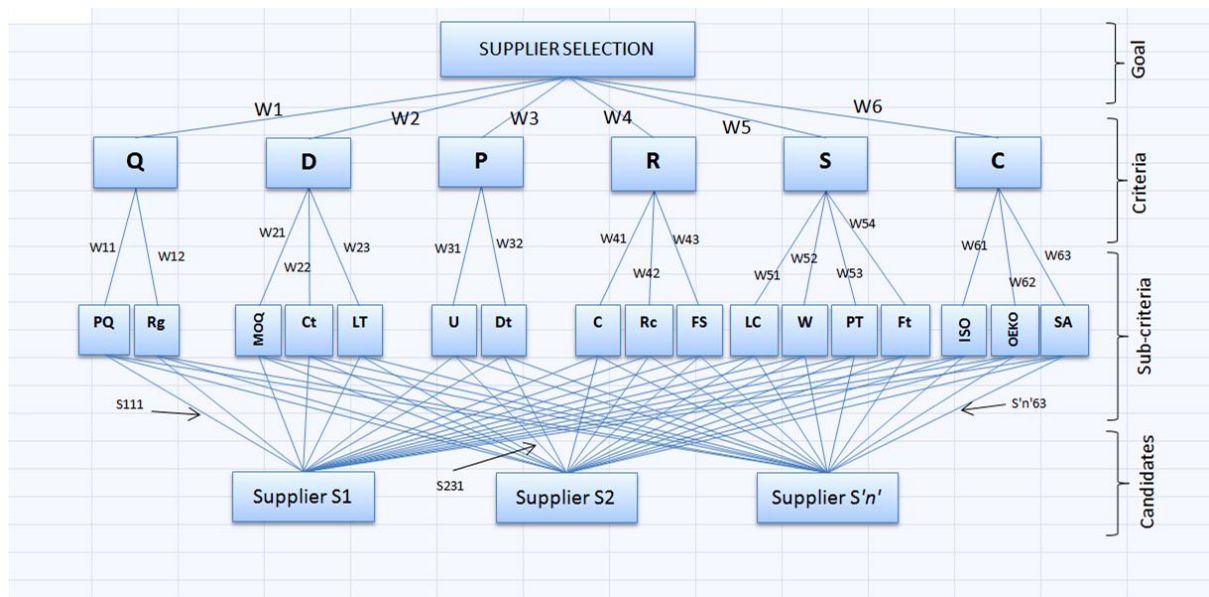
7.2. Application of AHP

For the case study I decided to apply the AHP method for analyzing the potential suppliers in order to make the final selection. AHP was gained a wide popularity in many fields such as governmental decisions, business projects, healthcare and etc. The result of AHP may be applied as an effective method for evaluating the right potential match among several options when multi-criteria decision takes place (see also Chapter 6.4, p.45). However, there is specific software developed for the method. It is also possible to use MS Excel for calculations as they are not very complex and have a repeating character.

AHP includes several steps. First of all, it is required to structure a hierarchy tree that may include several levels. The second stage is to weigh and prioritize each criterion using a pairwise comparison. The essential and important part of AHP is to check the relevance of the step by calculating the consistency index. The major problem at this stage is that often the consistency index can be higher than acceptable 10%. In this case the priorities and weights should be re-evaluated. A similar process should be made with all sub-criteria and their sub-criteria in order to weigh each element of the hierarchy. Some authors offer to find the global weights of all sub-criteria, while many sources skip this step to facilitate the process. In the thesis I use variation with applying the local weight for further total priority weight calculation. The next step in AHP is to rate all the alternatives on the basis of each criterion and sub-criterion based on pairwise-comparison. The final step is to obtain the total/overall rating for each potential alternative. The supplier that achieves the highest total score can be considered as the most appropriate match.

7.2.1. Structure Hierarchy

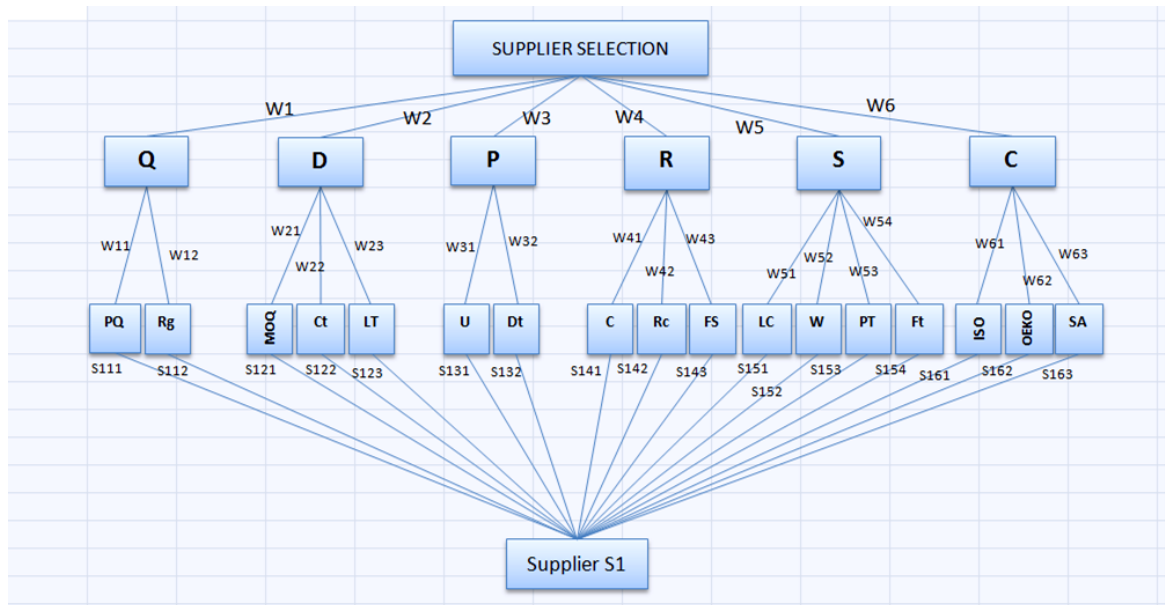
The basic knowledge about AHP is that the problem has to be decomposed into levels to create a model for further decision. The top level of the hierarchy presents the problem and defines the goal. The second level defines the measuring criteria. Each criterion usually consists of various sub-criteria that build the so-called clusters of the hierarchy tree. At the same time each sub-criterion can add many levels as well. At the bottom line all the alternatives/choices that passed the pre-selection are located and create a complex network system.



GRAPH 15. Supplier selection hierarchy process

The Graph 15 graphically shows the idea of the supplier selection within the AHP model. As one can see, it is divided into four layers: goal definition, six main criteria, seventeen sub-criteria and the final layer of hierarchy is a short list of potential supplier (See Chapter 4.2.2, p 33). Each of criteria is linked to the supplier through its sub-criteria. In the figure one can see

that several suppliers are going to be evaluated. The overall rating for each individual supplier will be calculated separately with regard to the given priorities (see Graph 16).



GRAPH 16. Supplier selection hierarchy process for single alternative

In order to build a hierarchical tree first the problem needs to be defined and a goal needs to be set. Let us assume that we are working in the purchasing department of a small or medium-sized enterprise. Our role is to investigate the market and develop a purchasing process in order to precede the actual purchase. The organization is a local retail store that specializes in different types of products for home usage. The final objective is to present the best possible supplier for the home textiles production, especially bedclothes.

As it was told before, we are looking for home textiles suppliers that would be able to deliver products of good enough quality at lowest possible price. The need is based on the limited number of local home textiles manufacturers and high price. The ideal “end of the story” would be to find a partner in long term perspective to precede continuous supplies in a small quantity.

The specifications of bedclothes are general: king, standard and kid sizes required. The material type of bamboo or 100% cotton is only accepted. The certification of eco-friendly materials that are used for manufacturing would be an advantage. The color prints are chosen from the supplier's catalogue. The seasonal production is also beneficial for the final supplier choice. For further cooperation design customization should be possible. The maximum order of 1000 pieces in total would be perfect if samples are accepted.

Thus based on the specifications the measurement criteria can be defined. I have identified two levels of criteria (see Table 9). The abbreviation of all the criteria and sub criteria are tabulated as presented in APPENDIX 7. It is also worth noting that identical results showed by all suppliers were not considered for the further evaluation. Thus such criterion as transportation that would be done in any case by a third party in the supply chain was not mentioned.

The bottom level is to list all the alternative options that passed the pre-selection stage. In the case I have selected eight suppliers from globalsources.com that meet the minimum requirements. After they were contacted I have collected the information in order to approve four of them.

7.2.2. Assigning weights and priorities

The second stage and one of the most complicated ones is to assign the objective and realistic relative importance to each criterion. Using pairwise comparisons, the relative importance of one criterion over another can be expressed. For presenting a pair-wise comparison the positive reciprocal matrix is an effective tool (see Equation (2)).

The next step requires establishing a scale to give scoring values for each supplier in comparison with sub-criteria. The scale of 1 to 9 was chosen to be used in the case. Qualitative description is presented in Table 6 below.

TABLE 6. Ranking Scale (author: Saaty, 1980)

RANK SCALE	DESCRIPTION
1	Equal importance between elements
3	Moderate importance of one over another of one element over the other
5	Strong or essential importance of one element over the other
7	Very strong or demonstrated importance of one element over the other
9	Absolute importance of one element over the other
2, 4, 6, 8	Intermediate values

Based on the Table 6, I rated the importance of criteria among each other. Thus, quality has a strong importance over the delivery (quality=5, delivery=1) and service provided slight importance over the price per unit (quality=2, price=1), while reliability moderate importance over price (reliability=4, price=1), but certificates moderately less important than quality (quality=3, certificates=1). For more information see Table 7.

TABLE 7. Assigning weights and priorities to criteria using pair-wise comparison

Quality	5	Delivery	1				
Quality	2	Price	1				
Quality	1	Reliability	3	Price	1	Reliability	4
Quality	5	Service	1	Price	5	Service	1
Quality	3	Certificates	1	Price	4	Certificates	1
Delivery	1	Price	4	Reliability	6	Service	1
Delivery	1	Reliability	5	Reliability	3	Certificates	1
Delivery	1	Service	3				
Delivery	1	Certificates	2	Service	1	Certificates	4

Criteria	Quality	Delivery	Price	Reliability	Service	Certificates
Quality	1	5	2	1/3	5	3
Delivery	1/5	1	1/4	1/5	1/3	1/2
Price	1/2	4	1	1/4	5	4
Reliability	3	5	4	1	6	3
Service	1/5	3	1/5	1/6	1	1/4
Certificates	1/3	2	1/4	1/3	4	1
	5.2333	20.0000	7.7000	2.2833	21.3333	11.7500

In order to normalize the reciprocal matrix values into a common scale, each element of vertical columns needs to be divided by its sum. The next step is to set priorities for each of

criteria by dividing the sum of each row by the total number of criteria that were evaluated (see Table 8).

TABLE 8. Normalization of reciprocal matrix values into a common scale

Criteria	Quality	Delivery	Price	Reliability	Service	Certificates	Sum	Avg/Priority
Quality	0.191	0.250	0.260	0.146	0.234	0.255	1.337	0.223
Delivery	0.038	0.050	0.032	0.088	0.016	0.043	0.266	0.044
Price	0.096	0.200	0.130	0.109	0.234	0.340	1.110	0.185
Reliability	0.573	0.250	0.519	0.438	0.281	0.255	2.317	0.386
Service	0.038	0.150	0.026	0.073	0.047	0.021	0.355	0.059
Certificates	0.064	0.100	0.032	0.146	0.188	0.085	0.615	0.102
	1.000	1.000	1.000	1.000	1.000	1.000		1.000

Thus one can see that the reliability and price with value of 0.386 and 0.185 respectively are the most important, and delivery has the lowest importance for the selection. Similarly all sub-criteria are evaluated in order to weight their importance upon each other under the cluster (see APPENDIX 8). Thus the Table 9 below shows the result placed in the order of its relevance.

TABLE 9: Criteria and sub-criteria importance

#	CRITERIA	WEIGHT	SUB-CRITERIA	WEIGHT
1	Reliability	0.386	References	0.564
			Financial stability	0.359
			Company history	0.077
2	Quality	0.223	Product quality	0.8
			Range	0.2
3	Price	0.185	Unit price	0.875
			Discount	0.125
4	Certification	0.102	ISO 9001	0.574
			Sa 8000	0.286
			Oeko tex	0.14
5	Service	0.059	Pricing terms	0.525
			Warranty	0.298
			Flexibility	0.129
			Level of communication	0.048
6	Delivery	0.044	MOQ	0.681
			Lead-time	0.263
			Capacity	0.056

7.2.3. Checking Consistency

The next step is to calculate a Consistency Ratio (CR) to verify how consistent priority judgments are (Equation (4)). The CR computation formula is the ratio between Consistency Index (CI) and Random Consistency Index (RI) for corresponding size matrix.

$$CR = \frac{CI}{RI} \quad (4)$$

CI can be calculated by the formula:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (5)$$

, in which

λ_{max} – computed average from values of divided weighed sum vector elements by associated priority value

n – the number of criteria

RI is the value for the corresponding size of matrix proposed by Saaty (1980) can be found in Table 10.

TABLE 10. Value for Random Consistency Index proposed by Saaty (1980)

Size of Matrix	1	2	3	4	5	6	7	8	9	10
Random Consistency	0	0	0,58	0,9	1,12	1,24	1,32	1,41	1,45	1,49

Thus, in order to calculate CR we need to find an eighteen vector:

TABLE 11. Eighteen vector calculation

	1.000		5.000		2.000		0.333		5.000		3.000		1.537
	0.200		1.000		0.250		0.200		0.333		0.500		0.279
0.223	0.500	0.044	4.000	0.185	1.000	0.368	0.250	0.059	4.000	0.102	4.000	=	1.209
	3.000		5.000		4.000		1.000		3.000		3.000		2.480
	0.200		3.000		0.200		0.167		0.250		0.250		0.315
	0.333		2.000		0.250		0.333		1.000		1.000		0.492

$$\lambda_{max} = (1.537 * 0.223) + (0.279 * 0.044) + \dots / 6 = 6.04 \quad (6)$$

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{6.04 - 6}{5} = 0.009 \quad (7)$$

Finally CR can be calculated:

$$CR = \frac{CI}{RI} = \frac{0.009}{1.24} = 0.07 \quad (8)$$

CR is less than 10% and the judgments can be considered as acceptable (see Chapter 7.5, p.46).

7.2.4. Scoring Alternatives

The stage Scoring Alternatives requires the rating of each potential alternative choice on the basis of each sub criteria using a par-wise comparison as in the previous step. The scores will evaluate the performance of an individual supplier under the term of measuring criteria. In order to implement a comparison, the data obtained from every supplier should be transferred to the single scale from 1 to 9 (see Chapter 7.2.2, p.49). In APPENDIX 9 one can find the information received from the suppliers about products specifications that were adapted to our scaling system. The scored assigned to the suppliers are shown below:

TABLE 12. Scoring alternatives based on collected information

	Supplier 1	Supplier 2	Supplier 3	Supplier 4
References	4	8	8	5
Financial stability	4	5	7	2
Company history	3	7	5	3
Product quality	5	9	5	4
Range	8	9	7	8
Unit price	7	1	3	2
Discount	3	4	7	6
Iso	5	9	9	9
Sa 8000	1	1	5	7
Oeko tex	1	1	1	7
Pricing terms	4	5	1	4
Warranty	5	5	9	1
Flexibility	6	7	3	8
Level of communication	5	6	6	7
Moq	1	9	3	9
Lead-time	1	1	5	5
Capacity	7	1	3	6

Based on the same example as the pairwise comparison of the criteria, the suppliers are further compared with regard to sub-criteria. The calculation below shows the reciprocal matrix for References. After that it was normalized and the priority weight (avg column) was calculated for each supplier. Thus one can see that Supplier 2 and 3 showed the same good performance

in references, and Supplier 4 got 0.131, which is the 3rd rank, while Supplier 1 was evaluated as the option that showed the lowest performance in References. The full calculations of pair-wise comparisons upon all sub-criteria are shown in APPENDIX 10.

TABLE 13. Pair-wise comparison for sub-criteria Reference

References	Supplier 1	Supplier 2	Supplier 3	Supplier 4
Supplier 1	1.00	0.20	0.20	0.33
Supplier 2	5.00	1.00	1.00	4.00
Supplier 3	5.00	1.00	1.00	4.00
Supplier 4	3.00	0.25	0.25	1.00
	14.000	2.450	2.450	9.333

References	Supplier 1	Supplier 2	Supplier 3	Supplier 4	sum	avg
Supplier 1	0.071	0.082	0.082	0.036	0.270	0.068
Supplier 2	0.357	0.408	0.408	0.429	1.602	0.401
Supplier 3	0.357	0.408	0.408	0.429	1.602	0.401
Supplier 4	0.214	0.102	0.102	0.107	0.526	0.131

7.2.5. Obtaining Overall Ratings

After all the steps are finished we get a full description of each component in the hierarchical tree. The criteria and their sub-criteria have been assigned weights as well as evaluated. The scores of suppliers' performance to each of criteria and sub-criteria were defined too. Now the calculations can be finalized by establishing the total weights of individual suppliers using Equation (9).

$$\sum_{i=1}^a W_i \times \sum_{j=1}^{ns} w_{ij} \times S_{ktj} \quad (9)$$

, in which

W – Priority weight of criterion

i – Criterion’s number ($i = 1, 2, \dots, 8$)

w – Priority of sub-criterion

j – Number of sub-criterion ($j=1, 2, \dots, ns:j \in 1$)

S – Supplier’s ranking score

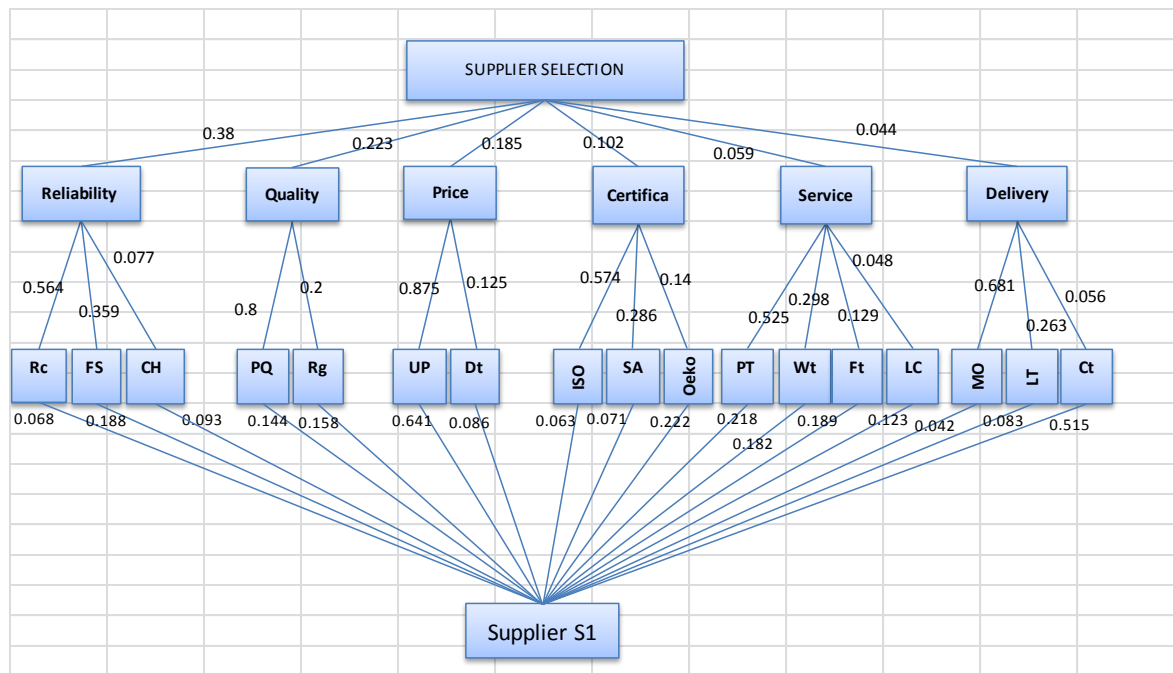
k – Candidate supplier Number ($k = 1, 2, \dots, m: k \in 1$)

‘ ns ’ = Total number of sub-criteria for certain criterion. The number of sub-criteria range from 2 to 8 or a particular criterion in a given formulated matching algorithm.

‘ m ’ = is the total number of supplier candidates applications

The values of ‘ k ’ are:

For Supplier 1(S1) $k=1$, for S2 $k=2$, for S3 $k=3$ and so on.



GRAPH 17. Supplier selection hierarchy process for single alternative with numerical weight

To calculate the overall priority weight the Equation (9) is used:

$$\begin{aligned}
 S1 = & W_1(W_{11} \times S_{111} + W_{12} \times S_{112}) + W_2(W_{21} \times S_{121} + W_{22} \times S_{122} + W_{23} \times S_{123}) \\
 & + W_3(W_{31} \times S_{131} + W_{32} \times S_{132}) \\
 & + W_4(W_{41} \times S_{141} + W_{42} \times S_{142} + W_{43} \times S_{143}) \\
 & + W_5(W_{51} \times S_{151} + W_{52} \times S_{152} + W_{53} \times S_{153} + W_{54} \times S_{154}) \\
 & + W_6(W_{61} \times S_{161} + W_{62} \times S_{162} + W_{63} \times S_{163})
 \end{aligned}$$

$$S1 = 0.206$$

$$S2 = 0.365$$

$$S3 = 0.260$$

$$S4 = 0.165$$

The result shows that the first priority in preceding the purchase was given to Supplier 2 who earned 0.365, the Supplier 3 and Supplier 1 will be considered as the 2nd and 3rd option, and the worst option according to the performance showed is assigned to Supplier 4 whose total weight priority is 0.165. Applying the AHP method into the problem of supplier selection gave an adequate acceptable result. However, there are some limitations in the method such as inaccurate weighting and insufficient scale for some cases. Nevertheless, AHP is a powerful tool to assist in decision making for complex and unstructured problems.

8. CONCLUSION

It is obvious that effective modeling of supply chain networks is critical for an enterprise. To maintain competitiveness, a company must demonstrate good results in every process within a company and outside it. The present study explained that managing the supply chain activities including actual supplier selection opens completely new perspectives toward better resource allocation, mitigation of risks associated with purchasing and minimizing costs by saving time, money and effort.

The purpose of the thesis was to enhance the understanding of the role of supplier selection process for an organization within supply chain. Initially the concept of supply chain takes its origin from military services. With time, a new science, supply chain management was created and such activities as purchasing, procurement and sourcing were identified. To date many techniques exist to evaluate supplier suitability, one of which I have used.

One of the important topics I have covered too is the importance of CSR in today's business environment. I decided to focus on ethical, environmental and sustainability issues because by integrating policies and standards a company can gain the greatest value by proving to its customers and stakeholders the intention for better and safer life.

Based on the literature reviewed I have created a purchasing process to follow while implementing the solution for a real life case problem. I have identified the most important measuring criteria for the textile industry sector. After that, the AHP method was used to structure the problem and to score suppliers with regard to criteria and sub-criteria to find overall ratings. According to the result, the AHP method was sufficient and reliable for the given case. Moreover, it can be also applied to similar cases having multi-criteria decision-making nature.

To conclude, I would like to say that the goals set in the beginning of the work were achieved and I have recognized new areas for further research.

REFERENCES

- Aguezoul, A. (2012). Overview on supplier selection of goods versus 3PL selection. *Journal of Logistics Management*, 2012; 1(3): 18-23. Available: <http://article.sapub.org/10.5923.j.logistics.20120103.02.html>. Accessed 15 January 2014.
- APICS Dictionary (1995). Falls Church: American production and inventory control society, 8th edition.
- Banker, R. D., & Khosla, I. S. (1995). Economics of operations management: A research perspective. *Journal of Operations Management*, 12(3), 423-425.
- Barnett, T. (2014). Corporate Social Responsibility. Available: <http://www.referenceforbusiness.com/management/Comp-De/Corporate-Social-Responsibility.html#ixzz2s7HjF5kI>. Accessed 16 January 2014.
- BCG (2009). The Boston Consulting Group. *The Business of Sustainability: Imperatives, Advantages, and Actions*. Available: <http://www.bcg.com/documents/file29480.pdf>. Accessed 22 April 2014.
- Carroll, A. B., & Buchholtz, A. K. (2008). *Business and Society: Ethics and stakeholder management*, 7th. Edition. South-Western Cengage Learning.
- Cheraghi, S. H., Dadashzadeh, M., & Subramanian, M. (2004). Critical success factors for supplier selection: an update. *Journal of Applied Business Research*, 20(2).
- Chopra, S., & Meindl, P. (2007). *Supply chain management. Strategy, planning & operation*. Gabler.
- Christopher, M. (1999). *Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service*. Financial Times: Pitman Publishing. London.
- Cousins, P., Lamming, R., Lawson, B., & Squire, B. (2008). *Strategic supply management: principles, theories and practice*. Pearson Education.
- Coyle, G. (2004). The analytic hierarchy process (AHP). *Practical strategy: Structured tools and techniques*. Pearson Educated Limited. Available: http://www.booksites.net/download/coyle/student_files/AHP_Technique.pdf. Accessed 23 April 2014.

CSR Europe (2014). The European Business Network for Corporate Social Responsibility. Available: <http://www.csreurope.org/>.

da Silva, A. C. S., Nascimento, L. P. A., Ribeiro, J. R., & Belderrain, M. C. N. (2009). ANP and ratings model applied to supplier selection problem. In *International Symposium on the Analytic Hierarchy Process*. Available: [http://www.isahp.org/2009Proceedings/Final Papers/56 da Silva Nascimento ANP Ratings Supplier Selection REV FIN.pdf](http://www.isahp.org/2009Proceedings/Final%20Papers/56%20da%20Silva%20Nascimento%20ANP%20Ratings%20Supplier%20Selection%20REV%20FIN.pdf). Accessed 23 April 2014.

De Boer, L., Labro, E., & Morlacchi, P. (2001). A review of methods supporting supplier selection. *European Journal of Purchasing & Supply Management*, 7(2), 75-89. Available: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.208.5061&rep=rep1&type=pdf>. Accessed 22 April 2014.

De Boer, L., van der Wegen, L., & Telgen, J. (1998). Outranking methods in support of supplier selection. *European Journal of Purchasing & Supply Management*, 4(2/3), 109-118.

Dickson, G.W. (1966). An analysis of vendor selection systems and decisions. *Journal of Purchasing* Vol 2 no.1.

Dobler, D. W., Burt, D. N., & Lee, L. (1996). *Purchasing and supply management: text and cases*. New York: McGraw-Hill.

European Commission, COM (2011), 2011. EUROPEAN COMMISSION, Brussels, 25.10.2011 COM (2011) 681 final. A renewed EU strategy 2011-14 for Corporate Social Responsibility. Available: <http://ec.europa.eu/>. Accessed 16 January 2014.

Figueira, J., Greco, S., & Ehrgott, M. (Eds.). (2005). *Multiple criteria decision analysis: state of the art surveys* (Vol. 78). Springer.

Ford, D., Cotton, B., Farmer, D., Gross, A., Wilkinson, Ian (1993) Make-or-Buy Decisions and their Implications. *Industrial Marketing Management*, 22, pp. 207-214.

Handfield, R. B., & Nichols, E. L. (1999). *Introduction to supply chain management* (Vol.1). Upper Saddle River, NJ: Prentice Hall.

Haughey, D., (2014). Supplier Selection Checklist. Available : <http://www.projectsmart.co.uk/docs/supplier-selection-checklist.pdf>. Accessed 22 April 2014.

Hedderich, F., Giesecke, R. and Ohmsen, D. (2006) Identifying and evaluating Chinese suppliers: China sourcing practices of German manufacturing companies, volume 9,

Available: http://www.econbiz.de/archiv/myk/whumyk/controlling/suppliers_china_practices.pdf . Accessed 15 January 2014.

Hinkle, C. L., Robinson, P. J., & Green, P. E. (1969). Vendor evaluation using cluster analysis. *Journal of Purchasing*, 5(3), 49-58.

Hugos, M. H. (2011). *Essentials of supply chain management* (Vol. 62). John Wiley & Sons.

Hwang, C.L.; Yoon, K. (1981). Multiple Attribute Decision Making: Methods and Applications. New York: Springer-Verlag.

ICC (2014). International Chamber of Commerce. Available: <http://www.iccwbo.org/> .

Investopedia US (2014) Available: <http://www.investopedia.com/terms/v/valuechain.asp>. Accessed 22 April 2014.

ISO (2014), International Organization for Standardization. Available: <http://www.iso.org/>.

Javanmardi, N., Kaboli, A., Mahdavi, I. & Shirazi, B. (2011). An Economical Multi-Criteria Decision-Making Process for Supplier Selection, *International Review of Business Research Papers* Vol. 7. No. 5. September 2011. Pp.168-183. Available: <http://www.bizresearchpapers.com/14.%20Neda-FINAL.pdf> . Accessed 22 April 2014.

Katanaev (2006). Translated From Russian. Катанаев С. Ю, РОЛЬ СОЦИАЛЬНОЙ ОТВЕТСТВЕННОСТИ В СИСТЕМЕ МЕНЕДЖМЕНТА ПРЕДПРИЯТИЙ ЛЕСОПРОМЫШЛЕННОГО КОМПЛЕКСА. Издательство Сибирского Государственного Технологического Университета, *Красноярск*. Available: http://science-bsea.bgita.ru/2006/leskomp_2006/katanaev_rol.htm. Accessed 16 January 2014.

Lambert, D. M., & Cooper, M. C. (2000). Issues in supply chain management. *Industrial marketing management*, 29(1), p.68.

Lawrence D, Fredendall., and Hill, E. (2000). *Basics of supply chain management*. CRC Press.p.4.

Linkedin (2014). What is the difference between Sourcing and Procurement? Available: <http://www.linkedin.com/groups/What-is-difference-between-Sourcing-139021.S.133200449> . Accessed 15 January 2014.

Lyes, B., Ding, H. and Xie, X. (2003). Supplier selection problem :selection criteria and methods. Institut National De Recherche En Informatique Et En Automatique. INRIA-Lorraine, MACSI Project. Available: <http://hal.inria.fr/docs/00/07/18/60/PDF/RR-4726.pdf> . Accessed 22 April 2014.

Lünendonk, 2011. *Procurement Excellence: the future of purchasing*. Publication of Lünendonk GmbH. Available: <http://www.helbling.ch/hbaen/publications/publications/lue-themendossier-procurement-eng-f200711.pdf/download>. Accessed 22 April 2014.

Monczka, R., Handfield, R., Giunipero, L., & Patterson, J. (2011). *Purchasing and supply chain management*, 5th Edition. Cengage Learning.

Pal, O., Gupta, A. K., & Garg, R. K (2013). Supplier Selection Criteria and Methods in Supply Chains: A Review. World Academy of Science, Engineering and Technology. *International Journal of Social Human Science and Engineering Vol:7 No:10*. Available:<http://www.waset.org/publications/16944/supplier-selection-criteria-and-methods-in-supply-chains-a-review>. Accessed 16 January 2014.

Porter, Michael E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*. New York.: Simon and Schuster.

Purchasing Insight (2014). Purchase to Pay, Purchasing & Procurement Process, Electronic Invoicing. *The Procurement Process*. Available: <http://purchasinginsight.com/resources/the-procurement-process/> . Accessed 22 April 2014.

Saaty, T. L. (1980). The analytic hierarchy process: planning, priority setting, resources allocation. *M cGraw-Hill*.

Saaty, T. L. (2005). *Theory and applications of the analytic network process: decision making with benefits, opportunities, costs, and risks*. RWS publications.

Shah, J. (2009). *Supply chain management: Text and Cases*. Pearson Education India.

Smirnova (2009). Translated From Russian. Смирнова Е.А, учебное пособие: Управление Цепями Поставок, Издательство Санкт-Петербургского Государственного Университета Экономики и Финансов. Available: http://elibrary.finec.ru/materials_files/307649144.pdf . Accessed 22 April 2014.

Tahriri, F. et al. (2008). A Review of Supplier Selection Methods in Manufacturing Industries. *Journal of Science and Technology*. 15(3), 201–2008.

Talluri, S., & Narasimhan, R. (2004). A methodology for strategic sourcing. *European Journal of Operational Research*, 154(1), 236-250.

Van Weele, A. J. (2009). *Purchasing & supply chain management: analysis, strategy, planning and practice*, 5th Edition. Cengage Learning EMEA.

Webster Jr, F. E., & Wind, Y. (1972). A general model for understanding organizational buying behavior. *Journal of marketing*, 36(2).

Weber, C. A., Current, J. R., & Benton, W. C. (1991). Vendor selection criteria and methods. *European journal of operational research*, 50(1), 2-18.

Zadeh, L. A. (1965). Fuzzy sets. *Information and control*, 8(3), 338-353.

EVOLUTION OF SUPPLY CHAIN AND PURCHASING FUNCTIONS

STAGE	PERIOD OF TIME	DESCRIPTION
Logistics and Activity Fragmentation	1940–1960	Logistics takes its origin from the military practices when the battles and wars have been won and lost based on the ability of the supply lines to deliver reliably and on time. As a business discipline, logistics initially focused on improving the productivity within the factory/plant. During that time most of the activities (from purchasing raw materials to finished product in the hands of customer) within the company are fragmented and there is no integration between them. As a result the cost of finished products (transportation cost, inventory cost etc.) were high. Over the time logistics was able to expand and it became the forerunner to formal procedure in the purchasing departments.
Purchasing as an Administrative Function	1970-1980	To the mid of 1970s the importance of the purchasing was recognized at general level. Throughout the 1970s the purchasing played a passive role in the organization and its function continued to be seen as more administrative than strategic. The role of purchasing was to be the service provider for other functions within the company, with the main task of buying goods and services from approved sources. This view of the purchasing as a department performing clerical role has been challenged by the pressures of the economic environment.
Creation of Supply Chain Management	1980-1990	The buyer and the supplier began to appreciate the potential of benefits in cooperative relationship offers. There is a need for a new concept of business management ideas to coordinate flows not only within a single company, but also in a number of firms interconnected to the chain. Porter (1980) emphasized the importance of the purchasing in his five forces model of competitive advantage. During this period, the term of supply chain management was faced for the first time. However the concept of "supply chain management" in its content is only slightly different from the extended interpretation of integrated logistics. Organizations had to share long-term demand schedules and inventory levels throughout their entire supply chain (at least in theory).New terminology began to appear to describe the business goals and strategies.

Separation of Supply Chain Management from Logistics	1990-2000	By the 1990s, there is a separation between the Supply chain Management and functions of logistics, transportation, purchasing and physical distribution. The need to systematize used concepts and terms of the logistics and supply chain management has changed the way of purchasing deals with suppliers. Buyers have moved towards the long-term collaborative relationships with fewer suppliers. Supplier management, strategic cost reduction, long-term collaboration, shared databases, product lifecycle, sourcing and total cost of ownership (TCO) have become commonplace. These often generated 10-20 percent of savings of total purchase costs.
Integration of Classical Concept of Supply Chain Management	2000-2005	The difference between integrated logistics and supply chain functions was clearly identified. Better control, coordination and interaction let to build more complex networks and flows. Overall theoretical experience and practical knowledge accumulate and form training courses on new discipline. IT system Electronic data interchange (EDI) is replaced by ERP. ERP focus on both managing resources of the individual firm as well as resources of the integrated supply chain.
Modern Theory	2005-2014...	All activities are fully integrated and the adaptation of supply chain management to different specific markets occurred. Modern chain management focuses on global concepts related to building sustainable co-operation where customer satisfaction becomes a key driver for the evolution. Resource optimization leads to cost reduction, improvement of material, cash and information flows, it shorten product development process, fasten order availability and increases customer satisfaction.

METHODS OF OBTAINING INFORMATION FROM VENDORS

TYPE OF REQUEST	DESCRIPTION
Request for Quotation (RFQ)	An RFQ is issued to procure an item, product or service and available specifications. Buyer obtain information for comparison of items and prices from different suppliers. In some practices the buyer can issue RFQ to allow supplier to give quotation based on info from supplier.
Request for Proposal (RFP)*	An RFP is document with more specific and complete description of products, prices and availability complete or partial design input from the supplier. If the contract requires negotiation rather than competitive bidding an RFP maybe used. If these are satisfactory negotiations will begin.
Request for Information (RFI)	An RFI is issued when an organization wishes to collect more information regarding a product or supplier such as the supplier's capacity or capability to supply an item, product or service. An RFI may lead to the issuing of an RFQ or RFP.

AGGREGATE FACTOR RATINGS

NUMBER	FACTOR	MEAN	RELATIVE IMPORTANCE
1	Quality	3.508	Considerable Importance
2	Delivery	3.417	
3	Performance History	2.998	
4	Warranties and Claims Policies	2.849	
5	Production Facilities and Capacity	2.775	
6	Price	2.758	
7	Technical capability	2.545	
8	Financial Position	2.514	
9	Procedural Compliance	2.488	Average Importance
10	Communication System	2.426	
11	Reputation and Position in Industry	2.412	
12	Desire for Business	2.256	
13	Management and Organization	2.216	
14	Operating Controls	2.211	
15	Repair Service	2.187	
16	Attitude	2.120	
17	Impression	2.054	
18	Packaging Ability	2.009	
19	Labor Relations record	2.003	
20	Geographical Location	1.872	
21	Amount of Past Business	1.597	Slight Importance
22	Training Aids	1.537	
23	Reciprocal Arrangements	0.610	

CRITERIA RANK OF SUPPLIER SELECTION FROM 1966 TO 2001

CRITERIA	1966	1966-1990	1990-2001
Quality	1	3	1
Delivery	2	2	2
Performance history	3	10	13
Warranties and claim policies	4	15	--
Production facilities & capacity	5	4	6
Price	6	1	3
Technical capability	7	5	5
Financial position	8	9	7
Procedural compliance	9	14	17
Communication system	10	13	12
Reputation & position in industry	11	8	29
Desire for business	12	14	--
Management & organization	13	7	8
Operating controls	14	11	--
Repair service	15	10	4
Attitude	16	8	11
Impression	17	12	18
Packaging ability	18	11	--
Labor relations record	19	13	30
Geographical location	20	6	14
Amount of past business	21	15	--
Training aids	22	13	--
Reciprocal arrangements	23	13	19
Reliability	--	--	9
Flexibility	--	--	10
Consistency	--	--	15
Long-term relationship	--	--	16
Process improvement	--	--	20
Product development	--	--	21
Inventory costs	--	--	22
JIT	--	--	23
Quality standards	--	--	24
Integrity	--	--	25
Professionalism	--	--	26
Research	--	--	27
Cultural	--	--	28

SUPPLIER SELECTION HIERARCHY USED FOR CASE STUDY

CRITERIA	DESCRIPTION
PRICE	Unit price Pricing terms Exchange rates Taxes Discount
QUALITY	Quality features: material, dimensions, design, durability Variety: range of product selection Production quality: production lines, manufacturing techniques machinery, Quality system Continuous improvement
SERVICE	Customization: size, shape, color, design, packaging, OEM, design service, label service Minimum order quantity Communication: respond time, information accuracy/transparency/details, language Industry knowledge Flexibility Response to change, Supply capability Warranty and maintenance
DELIVERY	Lead-time On-time performance Fill rate Returns management Location, Transportation, Incoterms
RELIABILITY	References: buyers feedback Financial stability: capital, annual turnover Supplier reputation Past and current business partners Company organization/personnel Diversity of ownership Cultural awareness
TECHNOLOGY	R&D IT software e-commerce Security
BUSINESS ETHICS, ENVIRONMENT AND SUSTAINABILITY	Green Supply Chain Quality Systems: standardization and Certification CSR: Environment sustainability, Personnel: safety and health work conditions, legal regulations, trainings, Product: safety materials, utilization norms

DOCUMENTATION TO ASSURE CSR

#	CODE	NAME	DESCRIPTION	ORGANIZATION
1	AA1000	AccountAbility's AA1000 series	Principles-based standards developed through a multi-stakeholder consultation process to help organizations become more accountable, responsible and sustainable	http://www.accountability.org
2	APEC	APEC Code of Business Conduct	Projects to support sustainable economic growth and prosperity in the Asia-Pacific region	http://www.apec.org
3	Amnesty	Amnesty International's Human Rights Guidelines for Companies	Principles to protect and respect internationally recognized human rights	http://www.amnesty.org
5	BBS	Balanced Business Scorecard	BSI helps to increase focus on strategy and results, improve organizational performance by measuring what matters, align the work people do on a day-to-day basis with strategy, focus on the drivers of future performance, improve communication of the organization's Vision and Strategy, and prioritize in tough economic times	http://www.balancedscorecard.org
6	Caux	Caux Round Table Principles for Business	Worldwide vision of principles for ethical and responsible corporate behavior	http://www.cauxroundtable.org/
7	DJSI	Dow Jones Sustainability Index	The stock performance of the world's leading companies in terms of economic, environmental and social criteria. The indices for investors who integrate sustainability considerations into their portfolios, and provide an effective engagement platform for companies who want to adopt sustainable best practices	http://www.sustainability-indices.com/

APPENDIX 6/2

8	EFQM	EFQM Business Excellence Model	Principles to inspire organizations to achieve sustainable excellence by engaging leaders to learn share and innovate using the EFQM Excellence Model.	http://www.efqm.org/
9	Bench Marks	Principles for Global Corporate Responsibility Bench Marks for Measuring Business	Comprehensive sets of social and environmental criteria and business performance indicators. The purpose is to promote positive corporate social responsibility	http://www.bench-marks.org/
10	EMAS	Eco-Management and Audit Scheme	The EU Eco-Management and Audit Scheme (EMAS) is a management instrument developed by the European Commission for companies and other organizations to evaluate, report, and improve their environmental performance	http://www.ec.europa.eu
11	ETI	Ethical Trading Initiative Base Code	An internationally recognized code of labor practice	http://www.ethicaltrade.org
12	Eco-Label	EU Eco-Label Criteria	The EU Eco label helps to identify products and services that have a reduced environmental impact throughout their life cycle, from the extraction of raw material through to production, use and disposal	http://www.ec.europa.eu
13	FSC	Forest Stewardship Council's Principles and Criteria for Forest Management	<u>The FSC Principles and Criteria set out best practices for forest management</u>	http://www.ic.fsc.org
14	FTSE4Good	FTSE4Good Selection Criteria	Indexing and analytic solutions. FTSE helps investors worldwide make informed investment decisions and benchmark the performance of their investments.	http://www.ftse.com
15	GRI	Global Reporting Initiative Guidelines	GRI promotes the use of sustainability reporting as a way for organizations to become more sustainable and contribute to sustainable development	https://www.globalreporting.org
16	IFOAM	IFOAM Basic Standards	Worldwide adoption of ecologically, socially and economically sound systems, based on the Principles of Organic Agriculture	http://www.ifoam.org

APPENDIX 6/3

17	ISO 9000 SO14000	International Organization for Standartization	ISO (International Organization for Standardization) is the world's largest International Standards. ISO ensure that products and services are safe, reliable and of good quality. For business, they are strategic tools that reduce costs by minimizing waste and errors and increasing productivity. They help companies to access new markets, level the playing field for developing countries and facilitate free and fair global trade	http://www.iso.org
18	OECD	Organization for Economic Co- Operation and Development Guidelines for Multinational Enterprises	OECD aims to promote better policies for better lives by providing a forum in which governments gather to share experiences and seek solutions to common problems	http://www.oecd.org/
19	SA8000	Social Accountability 8000	SAI works to protect the integrity of workers around the world by building local capacity and developing systems of accountability through socially responsible standards. SAI mission is to advance the human rights of workers around the world	http://www.sa-intl.org/
20	Sullivan	Global Sullivan Principles	Principles cover- human rights, worker treatment, equal opportunity, child labor, freedom of association, health, safety, compensation for basic needs, fair competition, community development and female abuse	http://www.thesullivanfounda tion.org
21	TNS	The Natural Step	Expertise in sustainability, solutions-oriented innovation and transformational change processes	http://www.naturalstep.org
22	UN GC	UN Global Companct	Strategic policy initiative for businesses that are committed to aligning their operations and strategies with ten universally accepted principles in the areas of human rights, labor, environment and anti-corruption	http://www.unglobalcompact. org
23	WHO/UNICEF	WHO/UNICEF International Code on Marketing of Breast- milk Substitutes	WHO providing access to data and analyses for monitoring the global health situation	http://www.who.int

ABBREVIATION: CRITERIA NAME		
Q: Quality PQ: Product Quality Rg: Range D: Delivery MOQ: Minimum Order Quantity Ct: Capacity LT: Lead Time P: Price UP: Unit Price Dt: Discount R: Reliability CH: Company History		Rc: References FS: Financial Stability S: Service LC: Level of Communication Wt: Warranty PT: Pricing Terms Ft: Flexibility C: Certification ISO: ISO OEKO: Oeko Tex SA: SA 8000
W_1	W_Q	Weight value of Quality Criterion
W_{11}	W_{PQ}	Weight value of Product Quality sub –criterion
W_{12}	W_{Rg}	Weight value of Range sub –criterion
W_2	W_D	Weight value of Delivery Criterion
W_{21}	W_{MOQ}	Weight value of Minimum Order Quantity sub –criterion
W_{22}	W_{Ct}	Weight value of Capacity sub –criterion
W_{23}	W_{LT}	Weight value of Lead Time sub –criterion
W_3	W_P	Weight value of Price Criterion
W_{31}	W_{UP}	Weight value of Unit Price sub –criterion
W_{32}	W_{Dt}	Weight value of Discount sub –criterion
W_4	W_R	Weight value of Reliability Criterion
W_{41}	W_{CH}	Weight value of Company History sub –criterion
W_{42}	W_{Rc}	Weight value of References sub –criterion
W_{43}	W_{FS}	Weight value of Financial Stability sub –criterion
W_5	W_S	Weight value of Service Criterion
W_{51}	W_{LC}	Weight value of Level of Communication sub –criterion
W_{52}	W_{Wt}	Weight value of Warranty sub –criterion
W_{53}	W_{PT}	Weight value of Pricing Terms sub –criterion
W_{54}	W_{Ft}	Weight value of Flexibility sub –criterion
W_6	W_C	Weight value of Certification Criterion
W_{61}	W_{ISO}	Weight value of ISO sub –criterion
W_{62}	W_{OEKO}	Weight value of Oeko Tex sub –criterion
W_{63}	W_{SA}	Weight value of SA 8000 sub –criterion
S_{k11}	S_{PQ}	Ranking Score of Product Quality for kth supplier
S_{k12}	S_{Rg}	Ranking Score of Range for kth supplier
S_{k21}	S_{MOQ}	Ranking Score of Minimum Order Quantity for kth supplier
S_{k22}	S_{Ct}	Ranking Score of Capacity for kth supplier
S_{k23}	S_{LT}	Ranking Score of Lead Time for kth supplier
S_{k31}	S_{UP}	Ranking Score of Unit Price for kth supplier
S_{k32}	S_{Dt}	Ranking Score of Discount for kth supplier
S_{k41}	S_{CH}	Ranking Score of Company History for kth supplier
S_{k42}	S_{Rc}	Ranking Score of References for kth supplier
S_{k43}	S_{FS}	Ranking Score of Financial Stability for kth supplier
S_{k51}	S_{LC}	Ranking Score of Level of Communication for kth supplier
S_{k52}	S_{Wt}	Ranking Score of Warranty for kth supplier
S_{k53}	S_{PT}	Ranking Score of Pricing Terms for kth supplier
S_{k54}	S_{Ft}	Ranking Score of Flexibility for kth supplier
S_{k61}	S_{ISO}	Ranking Score of ISO for kth supplier
S_{k62}	S_{OEKO}	Ranking Score of Oeko Tex for kth supplier
S_{k63}	S_{SA}	Ranking Score of SA 8000 for kth supplier

EVALUATION CRITERIA

Quality	PQ	Range	Quality	PQ	Range	Sum	Avg/Priority
PQ	1.000	4.000	PQ	0.800	0.800	1.600	0.800
Range	1/4	1.000	Range	0.200	0.200	0.400	0.200
	1.250	5.000		1.000	1.000		

Delivery	MOQ	Capacity	Lead-time	Delivery	MOQ	Capacity	Lead-time	Sum	Avg/Priority
MOQ	1	9	4	MOQ	0.735	0.529	0.778	2.042	0.681
Capacity	1/9	1	1/7	Capacity	0.082	0.059	0.028	0.168	0.056
Lead-time	1/4	7	1	Lead-time	0.184	0.412	0.194	0.790	0.263
	1.361	17.000	5.143		1.000	1.000	1.000		

Price	Unit Price	Discount	Price	Unit Price	Discount	Sum	Avg/Priority
Unit Price	1	7	Unit Price	0.875	0.875	1.750	0.875
Discount	1/7	1	Discount	0.125	0.125	0.250	0.125
	1.143	8.000		1.000	1.000		

Reliability	Com.Hist	Ref-ces	F. Stability	Reliability	Com.Hist	Ref-ces	F. Stability	Sum	Avg/Priority
Com. Hist	1	1/6	1/6	Com. Hist	0.077	0.100	0.053	0.230	0.077
Ref-ces	6	1	2	Ref-ces	0.462	0.600	0.632	1.693	0.564
F.Stability	6	1/2	1	F.Stability	0.462	0.300	0.316	1.077	0.359
	13.000	1.667	3.167		1.000	1.000	1.000		

Reliability	Com.Hist	Ref-ces	F. Stability	Reliability	Com.Hist	Ref-ces	F. Stability	Sum	Avg/Priority
Com. Hist	1	1/6	1/6	Com. Hist	0.077	0.100	0.053	0.230	0.077
Ref-ces	6	1	2	Ref-ces	0.462	0.600	0.632	1.693	0.564
F.Stability	6	1/2	1	F.Stability	0.462	0.300	0.316	1.077	0.359
	13.000	1.667	3.167		1.000	1.000	1.000		

Service	Level.Com	Warranty	Price Term	Flexibility	Service	Level.Com	Warranty	Price Terms	Flexibility	Sum	Avg/Priority
Lev.Com	1	1/6	1/7	1/5	Lev.Com	0.053	0.038	0.085	0.018	0.194	0.048
Warranty	6	1	1/3	5	Warranty	0.316	0.229	0.199	0.446	1.190	0.298
Price Term	7	3	1	5	Price Term	0.368	0.687	0.597	0.446	2.098	0.525
Flexibility	5	1/5	1/5	1	Flexibility	0.263	0.046	0.119	0.089	0.518	0.129
	19.000	4.367	1.676	11.200		1.000	1.000	1.000	1.000		

Certificates	ISO	SA	Oeko	Certificate	ISO	SA	Oeko	Sum	Avg/Priority
ISO	1	3	3	ISO	0.600	0.692	0.429	1.721	0.574
SA	1/3	1	3	SA	0.200	0.231	0.429	0.859	0.286
Oeko	1/3	1/3	1	Oeko	0.200	0.077	0.143	0.420	0.140
	1.667	4.333	7.000		1.000	1.000	1.000		

APPENDIX 9

RATING SUPPLIERS

Scale	references	financial stability	company history	product quality	range	unit price	discount	ISO	SA 8000	Oeko Tex	payment terms	warranty	flexibility	level of communication	MOQ (sets)	lead-time (days)	capacity (units monthly)
1	no references	financial report available	>3 years operating	basic	cotton production	extremely high ≤30\$	no discount	no	no	no	Once, advanced, T/T	basic, 15 days for claims	customization	Basic	<1000	<30	2,000
2	+web-page buyers Feedbacks		international partners								twice, advanced /before shipment, T/T		+1**	Acceptable			
3	+1**	+1**	<5 years	good	+1**	20\$	for 1000 pieces low discount				50/50, 15/30 days, T/T		+2**	+1**	800	15	
4	+2**	+2**	international partners				for 1000 pieces high discount	similar	similar	similar	50/50, 15/after receive, T/T,Western Union		+3**	+2**			
5	+3**	+3**	<15 years	good, certified	+2**	15\$					in advance in 15 days, L/C	30 days return/change on care of buyer	+4**	+3**	500	10	5,000
6	+4**	+reliable shareholders	international partners				for 500 pieces low				Once, advanced, L/C		+5**	+4**			
7	+5**	+parent company	reputation gained	excellent	+3**	12\$	for 500 pieces high	yes	yes	yes	50/50 in 15 days and 30 days L/T		+6**	+5**	400	7	
8	+Personal buyers feedback				+4**	10\$	for 200 and less low				50/50, 1 /after receive, L/T			+6**			
9	more	+market leader		excellent, certified	+babmoo and linen	very low ≥8\$	for 200 and less high	+additional	+additional	+additional	flexible, L/C	30 days return/change on care of seller	full purchase/delivery assistance	+trust with person and company	>200	>5	20,000

** can be chosen from the table

references	+other online sources	+fairs Participation	+catalog	+project participation	+projects leading	
financial stability	+framework agreements	+high capital	+high turnover			
range	+different sizes	+different sets	+different prints	+customized design		
flexibility	+ catalogue available	+Loading instruction	+packaging customization	+Care instructions	+sample availability	+flexible shipment opportunities
level of communication	+Fast	+informative	+advanced language	+Accuracy	+Professionalism and culture awareness	+email, phone, video conference available

