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# Strategic Design of Global Supply Chain Configuration: A Literature Research and Empirical Study

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-Pelin Pinar

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## ABSTRACT

The aim of this thesis is first to investigate the global supply chain design problem by deep analysis and classification of research papers by special focus on the topics of global supply chain configurations and affecting drivers and second to extract the global supply chain configurations of some global companies by means of case studies. Literature review is made by clustering the papers into three main categories which are qualitative, quantitative and integrated papers. The summary tables of the reviewed papers are showed in the Appendix part. After the general literature review, we focused our attention to the contemporary literature about existing global supply chain configurations and drivers affecting global supply chain design. In configurations part, possible configurations are discussed and a model which shows all these configurations on it is proposed in order to use it in case studies part of the thesis. In drivers' part, 32 drivers affecting the supply chain design decision is dealt and measurement method for each of them is given. For the case studies part, 47 leading companies in their industry sectors are investigated to extract the global supply chain configurations of them and place the configuration on the model that we developed. Also, with the practice of this study we aim to have a judgment on how companies decide to adopt the most suitable supply chain configuration for them considering their business areas, strategies, constraints and drivers. As a result, the findings related with supply chain practices of the companies are presented and general opinion based on the relation between industry and configuration selection is discussed.



Keywords: global supply chain configuration, global supply chain network, drivers, globalization, global sourcing, global manufacturing, global distribution

## EXECUTIVE SUMMARY

### Introduction

Globalization became a phenomenon in the last decades. It affects our lives from many different aspects such as cultural, business level, political, economic and so on. The irrefutable effects of globalization, inevitably showed itself on companies' decisions affected by the market standardization, free trade areas, improvements in transportation and communication technology, created a big shift for companies to operate in global scale. The willing to expand to new emerging markets, availability to produce in low cost countries, free-trade areas, and the development of information and transportation technology are just some of the reasons of this shift.

With the best of our knowledge after a deep research in the literature, global supply chain is analyzed mainly by focusing on three different processes which are sourcing, manufacturing and distribution. Our focus area is forward supply chain therefore; the scope of the literature review does not comprise reverse supply chain. Although the components of the supply chain are strongly inter-related, there are a few studies handling the forward supply chain as a whole. Deducting from our research in literature, the reason of focusing on different parts of the chain is considered to be caused by being easier to adopt global sourcing and distribution activities rather than manufacturing whose impacts are enormous. Therefore, in real life situations, companies are also focusing on some parts of the chain instead of globalizing completely. It should not be understood as, there is no application for whole chain but many of them prefer to apply in some parts of their activities in order to avoid tremendous risks. The main parts and focus areas of global supply chain are explained below:

#### *Global Sourcing*

Over the last 20 years, global sourcing has evolved from international procurement which was concerning few aspects such as cost savings or availability; meanwhile global sourcing is done in order to gain competitive advantage (M. Kotabe & J. Y. Murray). The distinguished characteristics of global sourcing and international sourcing can be viewed more clearly by comparing two explanations from previous articles as the following: "the acquisition of raw materials, components and subassemblies from international sources for use in fabrication, assembly or for resale, regardless of whether the import source is internal or external to the company" (Kotabe and Omura, 1989). While global sourcing represents something more extensive: "integration and coordination of procurement requirements across worldwide business

units, looking at common items, processes, technologies and suppliers" (Monczka and Trent, 2003).

Main motives for global sourcing is listed as: Offset requirements, currency restrictions, local content and counter-trade, lower-prices, quality, technology access, shorter product development and life cycles and comparative advantage (Cecil Bozarth, Robert Handfield, Ajay Das (1998)) However, there may be some drawbacks come with the global sourcing as well as the benefits such as, difficulties in contact with supplier, higher lead times, more complex maintenance of procurement.

***Global Manufacturing***

For an organization, the most crucial impact of strategically locating the production facilities in a foreign country is gaining comparative advantage against its competitors. According to Brian S. Fugate (2008), global manufacturing can be obtained in two ways: (1) establishing fully owned manufacturing subsidiary in a foreign location (i.e., offshore-insourcing), or (2) entering into a contractual arrangement with an independent manufacturer to create an extension of the firm into different geographic locations (i.e., offshore-outsourcing).

We cannot simply take global manufacturing as the sum of the production in different nations. Companies should consider and overcome two complementary challenges which are adopting the business strategies to local conditions while managing the differences occurring within its supply chain linkages. (Brian S. Fugate, 2008). As Blasquez states (2003), global manufacturing world does not only sell products but also solutions.

When manufacturing is considered, managing the production facilities which are located in different regions, the logistic and planning activities for all becomes a highly complex but strategically important for efficiency and effectiveness (D. Aprile, A. C. Garavelli, I. Giannoccaro (2006)). Therefore, the main concerns in the literature for global manufacturing is mainly concentrated around locations and capacity, product mix and qualities that are assigned to each plant while considering the costs as expected

***Global Distribution***

Improvement in logistics systems and supply chain in global level has driven attention to the globalization of the distribution activities. Mainly, global distribution concerns physical distribution which refers to the range of activities which are involved in the movement of

products from points of manufacturing to final points of sale and consumption (McKinnon, 1988).

Distribution centers play an important role in global distribution. They are located considering the market trends which are accelerated information transfers, changing consumer preferences and rising competition. New structure of supply chain in global scale requires many parts to be integrated. For that reason, distribution centers should act as a bridge between global sourcing and regional distribution. The distribution center has become an interface between the geographies of manufacturing and retailing, so it handles the distribution scale and scope (M, Hesse, Jean-Paul Rodrigue, 2004).

**Objectives**

The objectives of this thesis are arranged as the followings:

1) to analyze how the global supply chain design problem is addressed in the contemporary literature and to review the theoretical and methodological approaches that have been adopted;
2) to review the literature related to the global supply chain configurations and define possible network configurations in order to propose a model for demonstrating the configurations on it;
3) to identify and analyze drivers affecting the global supply chain design problem
4) to extract the global supply chain configurations of some global companies by an empirical study and place these configurations on the model that we developed

Each objective of the paper is achieved by a deep literature analysis and an empirical study and concluded with a summary of results found out and possible future research suggestions.

**Methodology**

In order to obtain the most comprehensive list of articles which can provide a robust knowledge in global supply chain design area, we have applied a systematic review approach. First of all, we have made a research relevant to the generic concept which is global supply chain. The reason that we kept the investigation in too broad is that, not to avoid any relevant work. After producing the primary set of articles which was wide, we have narrowed it down to the design area. In the last iteration of the research, we completely focused on the core research field which is global supply chain configurations and its drivers. In Table 1.1, it can be seen the keywords that we selected for each step of the research. It is worth to note that, research process was an

iterative process which produced new keywords and deeper research with the analysis of previous ones.

| | Research Groupings | Explanation | Keywords |
|---|---|---|---|
| 1 | Generic concept | In order to have a generic knowledge about global supply chain and understand the "current state of art". | Global Supply Chain |
| 2 | Global Supply Chain Design | Focusing on design problems of GSC which is studied on two categories which are design and execution. | GSC design GSC network |
| 3 | Global Supply Chain Configurations | In order to investigate different configurations and different level of globalization. | GSC configurations |
| 4 | GSC Configuration Drivers | In order to extract the factors effecting global supply chain design choices and the level of their influence. | GSC drivers |

Table 1.1 Research contents and keywords used for them

In order to identify the relevant literature, we benefit from e-journal packages and online databases and multidisciplinary indexes, such as Google Scholar, that both of them mostly allow making full text analysis for the relevant keyword. Moreover, we also conducted a careful analysis from the previous literature reviews. The selection of the articles is done by analysis from title, abstract analysis and full text in order.

**Results**

For the first part of the thesis, as it is indicated in the previous section we have identified 74 relevant studies among 87articles published in 37 different journals and 1 conference report between the years of 1995 and 2013 that addressed global supply chain design context.

As a result of the review process, we have identified relevant articles with a careful and systematic examination; we have categorized them according to different criteria in order to provide an overview of the articles describing the bibliometric properties of the research. The table that indicates the main information about the listed articles studies is shown in Appendix which includes the following attributes of studied articles': Name of author(s), publishing year, country, Title, journal name, methodology applied, objective, drivers and scope and length of supply chain.

As a consequence and summary, we have made a review thorough e-journal packages, online databases and multi-disciplinary indexes and they are scanned through in a systematic way in order to confirm the relevance. All the articles are classified according to different attributes in order to have an overview analysis regarding each article. The categories are defined as (1) qualitative papers (2) quantitative papers and (3) integrated papers which have also sub categories within it.

Out of 74 selected articles from literature review, 40 research papers are dedicated to qualitative cluster, 31 based on quantitative approaches and 3 articles are belong to integrated design models.

Within the qualitative papers cluster, the articles are subdivided as (1) general concept and strategies, (2) conceptual design models and (3) global supply chain configurations. Regarding to the quantitative research papers, 31 articles are identified which based on mathematical models in order to solve a wide range of decision issues. They are grouped according to their model techniques employed, objectives of the models and some other characteristics. Apart from qualitative and quantitative papers, there has been identified 3 research papers which adopts both qualitative and quantitative way of conceptualizing named as integrated papers.

For the second part of the thesis, the global supply chain configurations that found in the contemporary literature are identified. Although, the literature is quite limited in presenting the configurations, a few authors focused their attention on it by analyzing the affecting factors to build a supply chain configuration. After reviewing all the existing models which classify the global supply chain configurations, we developed our own model to demonstrate the possible configurations on local and global scales. (See Figure 2.3)

The model indicates to eight different global supply chain configurations and takes operational processes and location selection criteria as basis. Operational processes are defined as sourcing, manufacturing and distribution respectively and location selection is stated as being local or global scales.

The proposed model is suitable for all kind of companies regardless of the industries, target markets and point of origins. Companies just need to decide which configuration is more suitable for them considering their company and supply chain strategy. Level of integration and centralization decisions are highly effects the decision making process.

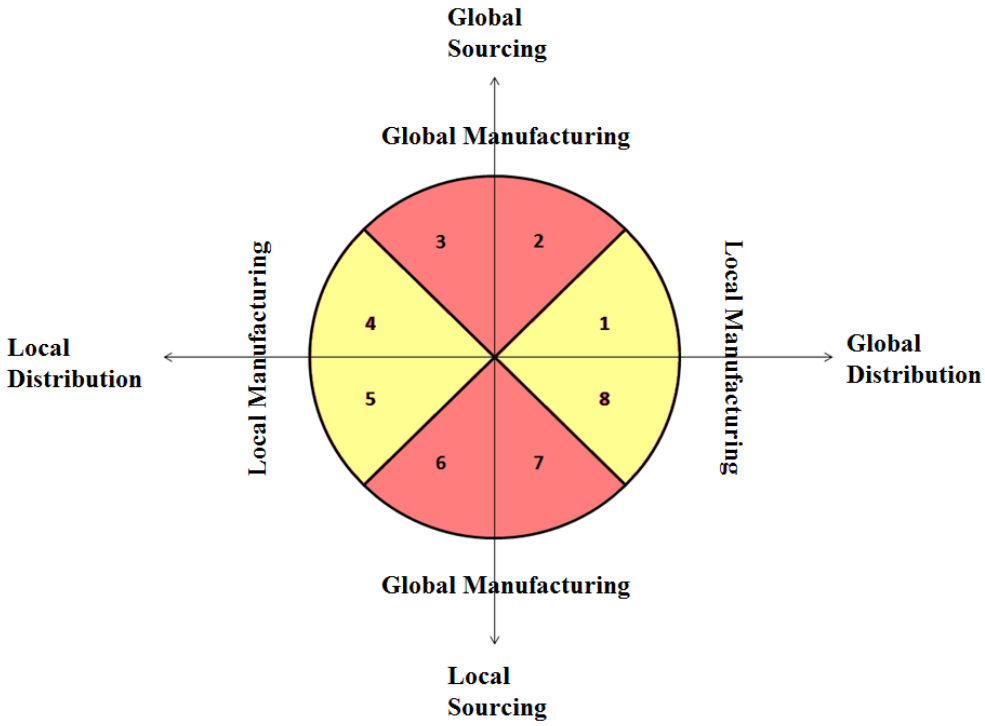



Figure 2.3 Model proposed to show 8 configurations of global supply chain

With the light of literature analysis, 32 drivers are identified which have impact on strategic supply chain decisions regarding location selection. The collected drivers are clustered in five different groups, categorized by means of the features of the impact: product, service, demand, supply and environment features. . In the latter section, a table is proposed (Table 3.5) which indicates the effects of those drivers in terms of costs, global supply chain stage and the risks to be occur if the related enabler is not managed properly. Moreover, table also summarizes the suggested decisions to be taken in the existence of proposed driver.

| Product Features | Cost | Stage | Decision of Globalization Level | Potential Risks |
|---|---|---|---|---|
| Product variety | Inventory carrying cost<br>Economies of scale<br>Material handling cost | Sourcing | Product variety ↑: Global sourcing | High safety stock<br>Duplication of resources<br>Cost increase |
| | | Distribution | Product variety ↑: Global distribution (centralization) | |
| Product value | Inventory carrying cost | Distribution | Product value ↑: Global distribution (centralization) | Lost sale (higher effect)<br>Tie up lots of money to inventory |

| | | | | |
|---|---|---|---|---|
| Product value density | Transportation cost<br>Inventory carrying cost | Distribution | PVD ↑: Global distribution (centralization) | Duplication of resources<br>High transportation cost |
| Product density | Transportation cost<br>Inventory carrying cost | Distribution | Product density ↓: Local distribution | Inefficient usage of transportation and storage modes |
| Obsolescence | Opportunity cost<br>Disposal cost | Distribution | Obsolescence risk ↑: Local distribution | Risk of becoming obsolete before putting on shelf |
| Shelf life | Opportunity cost<br>Disposal cost | Distribution | Shelf life ↓: Local distribution | Excess supply to market<br>Products to be perished on shelf |
| Handling characteristics | Handling cost | Sourcing | Handling requirements ↑: Local sourcing | Damage on product<br>Extreme rise of costs due to specific requirements |
| | | Distribution | Handling requirements ↑: Local distribution | |
| Technology level | Manufacturing cost | Manufacturing | Tech. Level ↑: Local manufacturing | Obsolescence risk |
| Contribution Margin | | Sourcing | Cont. Margin ↑: Global supply | Lost sales |
| | | Manufacturing | Cont. Margin ↑: Global manufacturing | |
| | | Distribution | Cont. Margin ↑: Local distribution | |
| Service Requirements | Cost | Stage | Decision od Globalization | Potential Risks |
| Lead time | Transportation cost<br>Manufacturing cost | Manufacturing | Lead time ↓: Local Manufacturing | Low flexibility and responsiveness risk |
| | | Distribution | Lead time ↓: Local Distribution | |
| Completeness (item fill rate) | Transportation cost<br>Opportunity cost | Manufacturing | Completeness ↑: Local manufacturing | Duplication of resources<br>High level of safety stock |
| | | Distribution | Completeness ↑: Local distribution | |

| | | | | |
|---|---|---|---|---|
| Delivery reliability | Transportation cost<br>Administration cost | Supply | Reliability ↑: Local supply | With the longer chain, less accuracy and more uncertainty risks increase |
| | | Manufacturing | Reliability ↑: Local manufacturing | |
| | | Distribution | Reliability ↑: Local distribution | |
| Delivery frequency** | Inventory cost<br>Economies of scale<br>Transportation cost | Distribution | Frequency ↑: Local distribution | Inefficient and costly transportation |
| Demand features | Cost | Stage | Decision of Globalization Level | Potential Risks |
| Size of orders | Transportation cost<br>Procurement cost<br><br>Manufacturing cost | Distribution | Demand size ↑: Global distribution | Not being able to fill up the transportation mode |
| Demand predictability | Manufacturing cost<br>Inventory carrying cost | Manufacturing | Predictibility ↑: Global manufacturing | Over or under production<br>Over or under supply to market<br>Low responsiveness |
| | | Distribution | Predictibility ↑: Global distribution | |
| Demand variability | Manufacturing cost<br>Inventory carrying cost | Sourcing | Volatility ↑: Local sourcing | Excessive stock<br>Insufficient responsiveness |
| | | Distribution | Volatility ↑: Local distribution | |
| Market size | Economies of scale<br>Manufacturing cost | Sourcing | Market size ↑: Global sourcing | Losing demand due to being less responsive than local producers |
| | | Manufacturing | Market size ↑: Global manufacturing | |
| Domestic market strength | | Manufacturing | Market strength ↑: Local (Domestic) manufacturing | Being less competitive in worldwide operations |
| Supply features | Cost | Stage | Decision of Globalization Level | Potential Risks |
| Endowment of purchased items | Transportation cost | Sourcing | Endowment in foreign region↑: Global sourcing | Face with scarcity<br>Extreme increase in resources cost due to availability |
| | | Manufacturing | Endowment in foreign region↑: Global manufacturing | |

| | | | | |
|---|---|---|---|---|
| Sources quality | Transportation cost | Sourcing | Service quality in foreign region↑: Global sourcing | |
| Competition of domestic suppliers | Raw material cost | Sourcing | Competition ↑: Local sourcing | |
| Environment features | Cost | Stage | Decision of Globalization Level | Potential Risks |
| Exchange rate | Manufacturing cost | Sourcing | Exchange rate ↓: Global sourcing | Risk of an unexpected increase |
| | | Manufacturing | Exchange rate ↓: Global manufacturing | |
| Labor quality | Manufacturing cost | Manufacturing | Quality ↑ : Global manufacturing | High costs for skilled labor |
| Labor cost | Manufacturing cost | Manufacturing | Cost ↓: Global manufacturing | Change in Country economy effecting labor costs |
| Import tariff and quotas | Transportation cost | Manufacturing | Tariff ↑ or Quota ↓: Global manufacturing | An increase in tariff if global distribution is preferred |
| | | Distribution | Tariff ↑ or Quota ↓: Local distribution | |
| Duty drawback rate | | Distribution | Rate ↑: Global manufacturing | Any change in policies and regulations |
| Tax incentives | Manufacturing cost | Manufacturing | Incentive↑: Global manufacturing | Abandonment of the incentive |
| Political stability | | Manufacturing | Stability ↑: Global manufacturing | An unexpected change in stability |
| Existing infrastructure | Manufacturing cost | Manufacturing | Existing infrastructure ↑: Global manufacturing | An unexpected physical attack or natural disaster |
| Environmental concerns and regulations | Manufacturing cost | Manufacturing | Regulation requirements ↓: Global manufacturing | Change in regulation not goes along with the company's environmental indication results |
| Transfer price | Manufacturing cost Transportation cost | Sourcing | Transfer price ↑: Global sourcing | |
| | | Distribution | Transfer price ↑: Global distribution | |
| Fame of manufacturing country | Manufacturing cost | Sourcing | Fame ↑: Local sourcing | High costs occur Change in fashion Damage in reputation of country |
| | | Manufacturing | Fame ↑: Local manufacturing | |

Table 3.4 Summary table for drivers and their impacts on supply chain stages

For the case studies part, we analyzed 47 companies. 12 companies of them operates in apparel (clothing, footwear and accessories) industry, 11 operates in FMCG, 6 in electronic and household appliances, 3 in the automotive, 4 in computer and communication technologies, 1 in oil, 1 in plastics, 2 in pharmaceuticals,3 in toys and stationery, 2 in cosmetics, 1 in glass and 1 in aviation industries. (See Figure 4.1)

Analysis of the each case study is done first with a brief description of the company with its key outstanding figures, business area that it operates in, products portfolio that it serves to the global market and findings related to the supply chain operations in global level. After the explanations part, supply chain network scheme and the model that we have developed which shows the type of configuration that the company uses are drawn.

| | **Industries** | | | |
|---|---|---|---|---|
| | **Apparel** | **FMCG** | **Electronics & Household Appliance** | **Automotive** |
| **Supply Chain Configuration** | Configurations: 1,2,3,5,7,8 | Configurations: 2,3,4 5 | Configurations: 1,2,3,7,8 | Configurations: 2,3,5 |
| **Dominant Drivers** | Country reputation, proximity to market, lead time, delivery frequency, domestic market strength, Labor cost, supplier competition, tax incentives | Shelf life, lead time, delivery frequency, availability, domestic market strength, proximity to market, supply quality, environmental concern | Obsolescence, proximity to market, supply quality, availability, domestic market strength | sustainability, availability, exchange rate, delivery time, price, supplier's quality, |
| | **Computer and communication technologies** | **Aviation** | **Plastics** | **Pharmaceuticals** |
| **Supply Chain Configuration** | Configurations: 1,2,3 | Configurations: 1 | Configurations: 2 | Configurations: 2 |
| **Dominant Drivers** | Lead time, returnability, service level, delivery reliability, domestic market strength, labor cost, exchange rate, availability, supply quality, size of orders | Availability, technology level, product size, product value, existing infrastructure | availability, lead time, environmental concerns | Market size, endowment of purchased items, product variety, obsolescence |

| | Cosmetics | Toys & Stationery | Oil | Glass |
|---|---|---|---|---|
| **Supply Chain Configuration** | Configurations: 3,8 | Configurations: 2 | Configurations: 1 | Configurations: 1 |
| **Dominant Drivers** | Quality of supply, country reputation, proximity to supplier , availability, lead time, delivery frequency | Proximity to market, Environmental concerns, availability of raw materials, supply quality | Existing infrastructure, power of domestic market, flexibility in sourcing | Domestic market strength, Availability |

Table 4.1 Summary table for configurations and dominant drivers corresponding to the related industry areas investigated in empirical study part

For the conclusion part, we have suggested some topics that we identified as the gaps in the literature review. For the future research areas, the suggestions are showed as the followings.

1. There should be more industry settings for the models in order to be a guide for other type of industries for leading them to be involved in global supply chain design.
2. Global supply chain models should be broadened by integrating multiple tiers which enable to integrate decisions and investigate the interactions within the whole length of the supply chain.
3. There should be more focus on the development of an overall global supply chain area which is enhanced by multiple inter-related models capable of including qualitative factors and uncertainties. Also, there should be effective use of information technologies and adequate database management to be able to have a successful design structure.
4. Existing knowledge should be expanded on each configurations of global supply chain. Benefitting from the real-life case studies of the companies could be an ideal way to explore more about the configurations
5. Defining the globality level would be an interesting improvement on our study. Identifying companies on the basis of not only being global or local but how much global or how much local in terms of different stages.
6. A study should be conducted in order to identify relationships between supply chain configuration and the total supply chain cost. For example, within our work, there is a conclusion regarding the most preferred supply chain configuration for a specific sector.

However, it is not known which configuration is most costly or cheapest one. Therefore, we could conduct empirical study to study the relationships between supply chain configuration and supply chain cost.

7. Relations between the drivers should be investigated. During our research, we realized that there are some links within those drivers which may be either two sided or dominated by one. To clarify, shelf life dominates the decision of frequency and order size due to the constraint it creates. In order to avoid perished unsold goods, order size is decreased which leads higher frequency. Those links should be established between the drivers and the degree of influence on each other should be measured.

# 1. Literature Review about Global Supply Chain Design

The aim of this chapter is to provide a comprehensive literature review concerning the global supply chain design problems which have been dealt by researchers, authors and practitioners recently. For the clarity of the analysis, the papers reviewed are classified according to being qualitative, quantitative and integrated. The literature review given in this work is based on 74 articles published from 1995 to 2013 in international academic journals.

## 1.1 Scope of the Analysis

Before starting to conduct literature review and classification of the papers, we defined the subject, scope and objectives of our analysis.

Increasing trend in globalization in last two decade has driven the companies also globalized in their supply chain organizations. The main reasons of the globalization of supply chain organizations are the need of companies to be both effective in terms of responding to customer demands and efficient in terms of decreasing the supply chain related costs.

A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers (Ganeshan and Harrison, 1995). When the globalization term enters to the frame, we need to consider sourcing, manufacturing and distribution facilities in global perspective. In the literature, global and local terms are distinguished by emphasizing on the number of regions that the company has facilities in. Local is considered as what takes place within the same region therefore, an international supply chain within the same region is still considered as local by definition. (R. Cagliano, F. Caniato and G. Spina, 2008)

In this study, the focus area of global supply chain design problem is just forward supply chain, therefore, reverse supply chain design problems are out of scope.

Although, many researchers and practitioners are highly interested in the topic of global supply chain, since it is a very recent phenomena, there are very limited researches solely focused on the whole length of global supply chain. On the other hand, most of the studies have been done on the main operation processes of global supply chain separately which are global sourcing, global manufacturing and global distribution respectively. Global sourcing refers to the management of supplier relationships from a global perspective (e.g., Murray et al. 1995); global manufacturing refers to the management of manufacturing activities distributed all over the world (e.g.,

MacCarthy and Atthirawong 2003); and global distribution shows how companies manage their sales and distribution channels globally (e.g., Bello et al. 2004).

A supply chain design problem is about making decisions about the physical characteristics of the facilities such as the number and location of the facility, capacity of each facility, the markets that it is going to serve to, supplier selection for the components and raw materials, appropriate distribution channels and so on (Chopra and Meindl 2004). Global supply chain is the extended version of this definition, which also includes the decisions about locating the facilities at different from the home country, especially across the regions and the special factors that affects making decisions to decide centralizing or decentralizing the decision making processes.

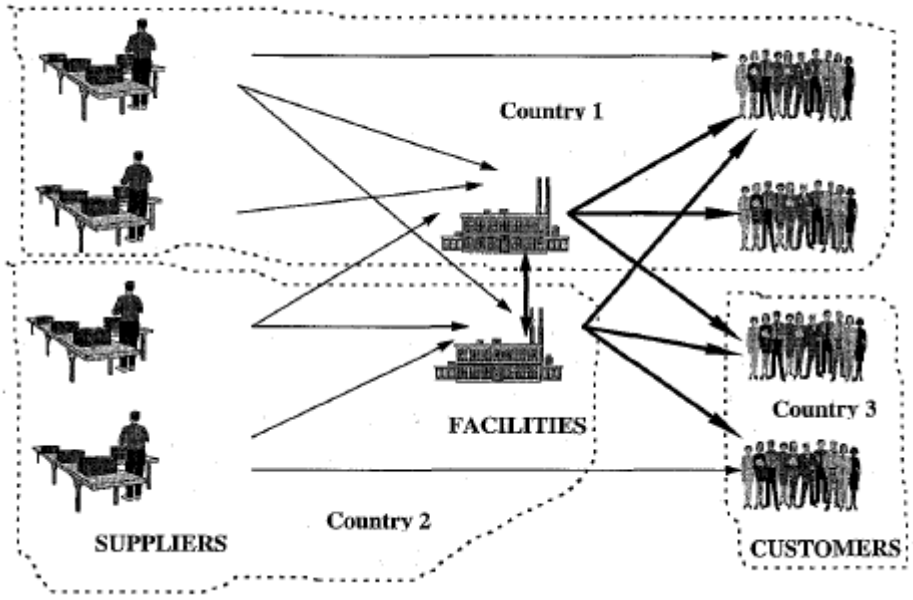



Figure 1.1 Typical global supply chain (C. Vidal, M. Goetschalckx, 1997)

Designing a global supply chain makes the companies have superior advantages especially in the competitive business environment. They can increase their competitive position, reputation, reliability and profitability by benefiting from the tariff and trade concessions, low taxes, accessing high quality materials and components at lower costs, low labor and logistics costs, serving to the foreign markets by meeting the customer demand on time (Ferdows, 1997).

On the other hand there are also difficulties and challenges to establish a global supply chain across the regions because maintaining that global supply chains are more difficult to manage than domestic supply chains (Dornier et al., 1998; Wood et al., 2002; MacCarthy and Atthirawong, 2003). Due to the geographical distances from the suppliers to facility locations or from the facilities to customers, there can be increase in transportation cost. The only matter that makes the decision making process complicated is not only the increase in the costs but also the

cultural, political and legal differences affects to design of global supply chain and make the managers think on the trade-offs related with establishing it or not.

The literature about the challenges of global supply chain states that there are risks of transportation delays, the lack of technology and capacity of the host country sources, the lack of proper inventory management systems, cultural and language differences, foreign exchange rate fluctuations, duty/customs regulations, trade regulations, quality assurance, the lack of knowledge of foreign business practice, nationalism and political and economic stability. (Boyce, 1999; Bradley et al., 1998; Birou and Fawcett, 1993; Cotteill, 1999; Davis et al., 1974; Garten, 1998; Gill, 1999a, b, c; Hickey, 1999; Kendall, 1999; Lanier, 1999; Min and Galle, 1991; Monczka and Giunipero, 1984; Radosevich, 1999; Schneider, 1999; Smith, 1993; Sowinski, 1999). All these challenges and risks affect the performance of the established global supply chain. In order to be able to solve the problems identified by many researchers those are mentioned above, many global supply chain design models are developed.

Global supply chain design is an important area of supply chain research and practice. In order to be able to solve the design problem of it, T. Harrison (2001) split the solution methods into three categories: (1) optimization, (2) heuristics and (3) simulation.

Optimization methods refer to the linear and integer programming, dynamic programming, stochastic programming and others. Compared to the other methods, they guarantee the best solution providing a measure of how much the solution may deviate from the best possible. Heuristics are based on common sense knowledge that usually generate good, but not the best solution. Simulations are a good representation of the supply chain applications of the firms but they only assess the performance of a previously identified design models, they cannot generate a new design. Considering the methods mentioned above, even though optimization methods are the preferred ones, the combination of optimization with simulation techniques is a subsidiary way to improve decision making for global supply chain (T. Harrison, 2001).

About the recent concerns in global supply chain design, M. J. Meixell, V., G. Gargeya (2005) mentioned about three emerging issues in their article. First issue states that supplier selection decision plays a fundamental role in supply chain design problem since supplier selection is based on buyer's perception of the supplier's ability to meet their demand in terms of quality, quantity, price and service needs of the firm (Leenders et al., 2002). Also supplier contracts have a powerful effect on the design problem structure since it shows the compliance of the suppliers to the criteria or restrictions stated by the buyer firm (Pan, 1989). Second emerging issue that

affects the design problem is integrating and coordinating the decisions across the supply chain. The need for the integration between the facilities has been discussed by several authors in the literature (Dornier et al., 1998; Brush et al., 1999; Trent and Monczka, 2003), since they advocate that, for the firms which is important to have a competitive advantage in the competitive business environment they need to establish an integrated and well-coordinated global supply chain which is not easy to duplicate. Finally, the third emerging issue is mentioned by Meixell and Gargeya (2005) is that, the definition of the supply chain performance can be broadened by considering that each product has different values to the customers.

Another notable research about the global supply chain design has been conducted about the problem of coordination between the layers within the supply chain. Therefore, most of the models have been formulated for the strategic design of supply chain. An early review of the main facility location model is done by Aikens (1985) which shows the single-echelon multi commodity capacitated model that supports sufficiency of applying deterministic model on the expected value of demand. Later, Bhatnagar et al. (1993) presents a research on models for multi-plant coordination which stands for two levels of coordination. First level of coordination deals with integrating the decisions of different operation processes of the supply chain such as sourcing, production and distribution. The second level refers to linking the decisions within the same operation process for different layers. This level addresses mainly to the production planning and try to solve the problems of demand nervousness, lot sizing and safety stock.

Thomas and Griffin (1995) made a literature review about the coordination of two or more of the main stages of the supply chain which are procurement, production and distribution. Furthermore, Verter and Dincer (1995) touch on the importance of the facility location decisions of multinational organizations. They claim that, for global companies to gain a competitive advantage they need a well-established coordination among all international levels.

On the other hand Verter and Dincer (1995) states that there are only a few researches conducted about the strategic design of supply chain models in global scenario. They claim that existing researches only consider the feasible configurations that are identified by managements previously and they do not represent the most of the uncertainties and the dynamics of global environment completely.

### 1.2 Methodology

In order to obtain the most comprehensive list of articles which can provide a robust knowledge in global supply chain design area, we have applied a systematic review approach. This approach

helps us to screen most of the articles included in our research field and select the best available relevant ones. In order to identify the papers to include to our study, we have taken the following steps:

First of all, we have made a research relevant to the generic concept which is global supply chain. The reason that we kept the investigation in too broad is that, not to avoid any relevant work. After producing the primary set of articles which was wide, we have narrowed it down to the design area. In the last iteration of the research, we completely focused on the core research field which is global supply chain configurations and its drivers. In Table 1.1, it can be seen the keywords that we selected for each step of the research. It is worth to note that, research process was an iterative process which produced new keywords and deeper research with the analysis of previous ones.

| | **Research Groupings** | **Explanation** | **Keywords** |
|---|---|---|---|
| 1 | Generic concept | In order to have a generic knowledge about global supply chain and understand the "current state of art". | Global Supply Chain |
| 2 | Global Supply Chain Design | Focusing on design problems of GSC which is studied on two categories which are design and execution. | GSC design GSC network |
| 3 | Global Supply Chain Configurations | In order to investigate different configurations and different level of globalization. | GSC configurations |
| 4 | GSC Configuration Drivers | In order to extract the factors effecting global supply chain design choices and the level of their influence. | GSC drivers |

Table 1.1 Research contents and keywords used for them

In order to identify the relevant literature, we benefit from e-journal packages and online databases (e.g. science direct, JSTOR, Emerald and etc…) and multidisciplinary indexes, such as Google Scholar, that both of them mostly allow making full text analysis for the relevant keyword. Moreover, we also conducted a careful analysis from the previous literature reviews. The selection of the articles is done by analysis from title, abstract analysis and full text in order. Once a related article is identified by context, the investigation is followed also by analyzing the bibliographies and citations. Moreover, this literature review is done among only English written articles.

As a result of the review process, we have identified relevant articles with a careful and systematic examination; we have categorized them according to different criteria in order to provide an overview of the articles describing the bibliometric properties of the research. The table that indicates the main information about the listed articles studies is shown in Appendix which includes the following attributes of studied articles': Name of author(s), publishing year, country, Title, journal name, methodology applied, objective, drivers and scope and length of supply chain.

As a consequence and summary, we have made a review thorough e-journal packages, online databases and multi-disciplinary indexes and they are scanned through in a systematic way in order to confirm the relevance. Moreover, references and the citations acted as guideline to follow deeper and connected further studies. With this approach, we have identified 74 relevant studies among 87articles that had been found in the initial research that addressed global supply chain design context. All the articles are classified according to different attributes in order to have an overview analysis regarding each article. The categories and the findings are explained detailed in the next section:

### 1.3 An Overview of Literature

This section gives the outcomes of the articles' main features in order to have an insight of the body of knowledge.

#### 1.4.1 Research volume over time

According to the trend observed in Figure 1.2, it can be concluded as the interest on global supply chain has gradually increased over years and became a hot topic among researchers. With the expansion of globalization and drastic changes in supply chain led authors to focus in this topic over a decade ago and as it is visualized in the graph that the number of the studies increased year by year. With the best our knowledge from literature review, it can be deduced that there is still a deficient area for further research in this field which takes the attention of practitioners.

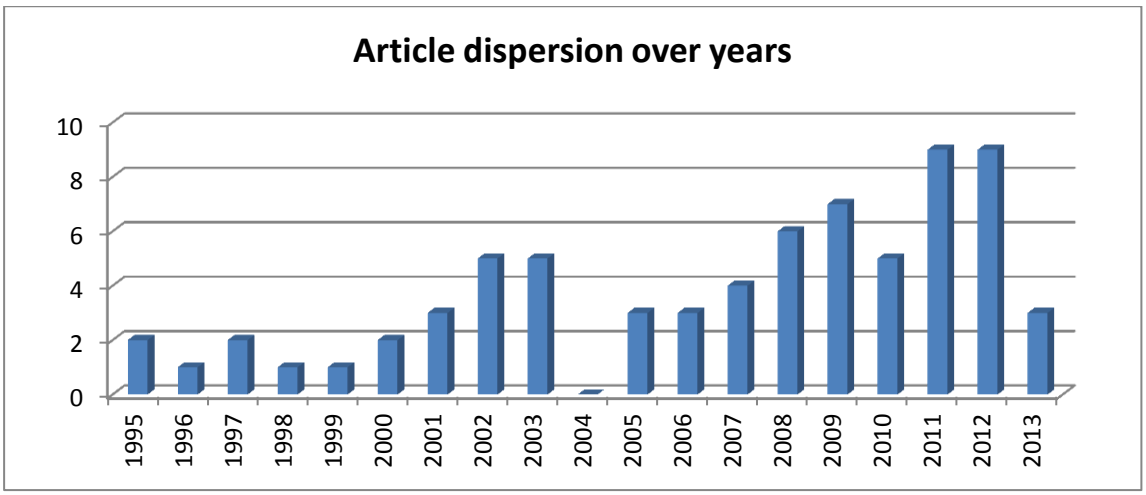



Figure 1.2 Article dispersion over time

### 1.4.2 Geographies

When the article dispersion over countries is observed, it can be easily seen that, as expected, USA has a big dominance over other countries. After USA, the following countries that made contributions to literature are UK and Italy.

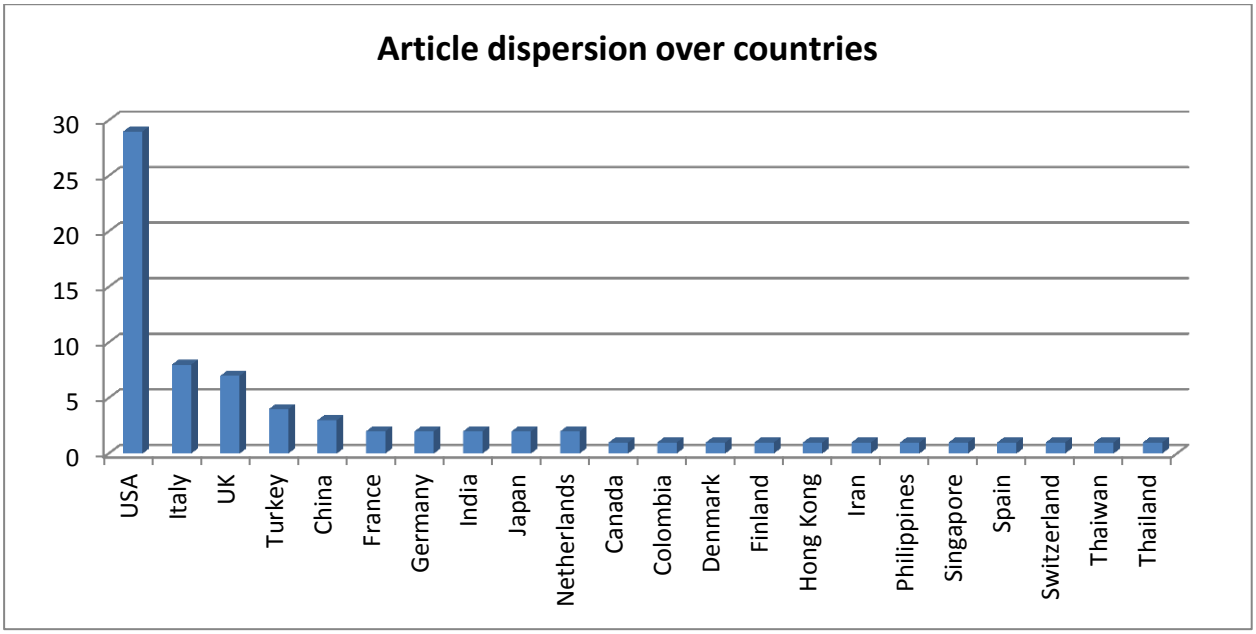



Figure 1.3 Article dispersion over countries

### 1.4.3 Methodologies

- Literature review
- Quantitative
- Qualitative
  - ✓ Conceptualizing and defining

- ✓ Theoretical- models, proposition building
- ✓ Configuration

- Integrated

### 1.4.4 Journals Consulted

| Journals | Articles |
|---|---|
| Journal on Systemics, Cybernetics and Informatics | 1 |
| Annals of Operations Research | 1 |
| Applications of Evolutionary Computing | 1 |
| Business Process Management Workshops | 1 |
| Computers & Chemical Engineering | 1 |
| Decision Support Systems | 1 |
| Texas A&M University | 1 |
| European Journal of Operational Research | 8 |
| European Journal of Purchasing & Supply Management | 2 |
| Expert Systems with Applications | 1 |
| Fuzzy Sets and Systems | 1 |
| Harvard Business Review | 1 |
| IIE Transactions | 1 |
| Ind. Eng. Chem. Res | 1 |
| Information Systems Frontiers | 1 |
| Institute for Operations Research and Management Sciences | 1 |
| International Journal of Business and Management | 1 |
| International Journal of Operations & Production Management | 2 |
| International Journal of Production and Economics | 11 |
| International Journal of Production Research | 2 |
| International Marketing Review | 1 |
| Journal of Business Logistics | 1 |
| Journal of Intelligent Manufacturing | 2 |
| Journal of Manufacturing Technology Management | 2 |
| Journal of Purchasing & Supply Management | 3 |
| Journal of Supply Chain Management | 4 |
| Georgia State University-Marketing Dissertations | 1 |
| Omega | 1 |

| | |
|---|---|
| Operations Management Research | 1 |
| Rapid Modeling and Quick Response | 1 |
| Regional Science | 1 |
| Supply Chain Management: An International Journal | 3 |
| SYMPHONYA Emerging Issues in Management, | 1 |
| The International Journal of Advanced Manufacturing Technology | 3 |
| The International Journal of Logistics Management | 1 |
| Transportation Journal | 1 |
| Transportation Research Part E 41 | 2 |
| **Conferences** | |
| Proceedings of the Asia Pacific Industrial Engineering & Management Systems Conference | 1 |

Table 1.2 Name of Journals used for literature review

Eventually, this approach results in 74 articles, published in 37 different journals and 1 conference report between the years of 1995 and 2013.

## 1.4 Qualitative Studies

In order to investigate the qualitative research papers systematically, we subdivided research into three main categories:

(1) General Overview: Research question is "How global supply chain design problem is dealt by the firms in the literature?"
(2) Conceptual Design Models: Research question is "What are the conceptual design models that solve global supply chain design problem?"
(3) Global supply chain configurations: Research question is "Which supply chain configurations can be adopted in global perspective?"

### 1.4.1 General Concept and Strategies

At this part of our qualitative design analysis, we investigated how the articles deal with the design problem of global supply chain in terms of different aspects such as characteristics of global environment, strategies adopted and suitable supply chain governance models applied. For this category of the research we analyzed 9 articles.

Most of the researches discuss the benefits and challenges of a supply chain in a global environment. For example, J. Cho and J. Kang (2001) discussed that topic considering global sourcing for retail firms in US. By conducting a survey among 148 apparel firms, they identified three main benefit factors, which are competitive advantage, quality assurance and service enhancements, and four challenge factors, which are logistics, regulations, cultural difference and country uncertainty. They also claimed that, the level of benefits and challenges perceived by the firms can differ according to the product type, import volume, experience and region of sourcing.

Another term mentioned in the literature related with global supply chain is "global value chain" which is the expanded version of the global supply chain and explains how the value is captured. G. Gereffi and J. Lee (2012) discussed that issue as referring to the previous studies of G. Gereffi on the governance model of global value chain. Governance of value chain which is managed by the vertical integration deals with the organization and coordination of lead firms and the global industries. He defined five types of governance model which shows different levels of power application for the coordination of the suppliers. (Figure 1.4)

(1) Market governance: There is a little coordination between buyers and suppliers and price is the central governance mechanism.
(2) Modular governance: Suppliers make products according to the supplier demand. This kind of information exchange reduce the coordination cost
(3) Relational governance: Due to the complexity of the information, it is not easily transmitted between the parties. Mutual trust and social ties between them is important for the coordinating relational chains.
(4) Captive governance: there is a group of small suppliers that work with one or a few buyers in the market and they operate under conditions and specifications set by the buyers which
(5) Hierarchical governance: It is characterized by vertical integration of the chains and the power is highly belong to the leading firm.

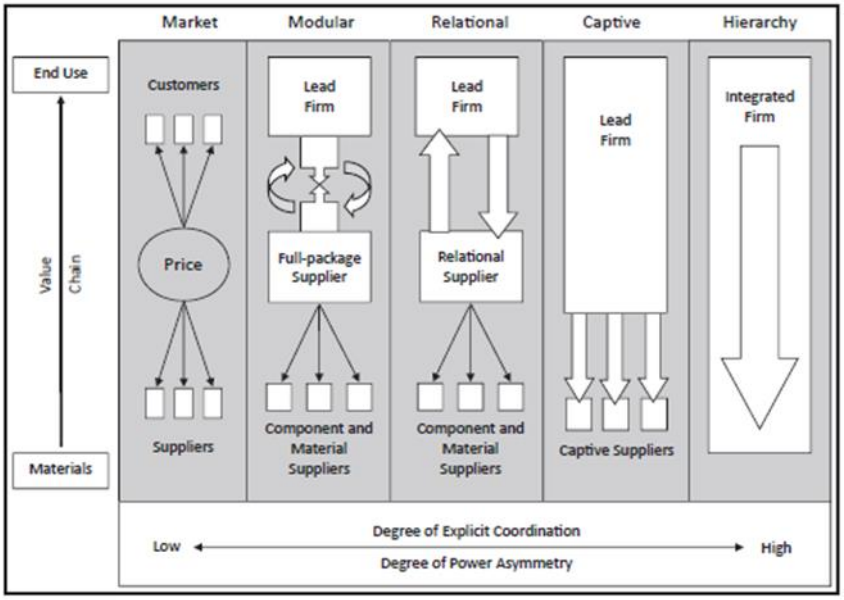



Figure 1.4 Five types of global value chain governance

There are also research papers which focus on the importance of strategy selection to solve the design problem of global supply chain. Researchers and practitioners agree on the issue that it is crucial to select the appropriate strategy which refers to the different demand and supply characteristics in the supply chain. M. Christopher et al. (2006) addressed that topic by presenting taxonomy of appropriate supply chain strategies. As different form the previous taxonomies which are only focused on the nature of the product and life-cycle, this taxonomy developed by Christopher et al. (2006) stated the key dimensions as replenishment lead-times and predictability/variability of demand. The authors also studied on the type of supply chain strategies which are lean, agile and hybrid (i.e. agile) strategies by enriching the concepts with the dimensions mentioned above.

Another matter about the design problem of global supply chain is the nature of the products. M. Ficher (1997) states in his article that, supply chain design strategy differ according to the type of product being innovative or functional. Functional products are the products which satisfy the basic needs and can be found in wide range of retail outlets. They have stable, predictable demand and long life cycle, but they generally lead to low profit margins due to the competition in the market. On the other hand, innovative products are the products that they give reason to the customers to buy them even if they do not refer to the basic needs. They generally have high profit margins but have to deal with the demand uncertainty.

In order to devise the ideal supply chain strategy for the companies, Fisher developed a two dimensional matrix depending on the type of products. According to this matrix functional

products require efficient supply chain process which stands for lean supply chain strategy whereas innovative products require responsive supply chain process which refers to the agile supply chain strategy.

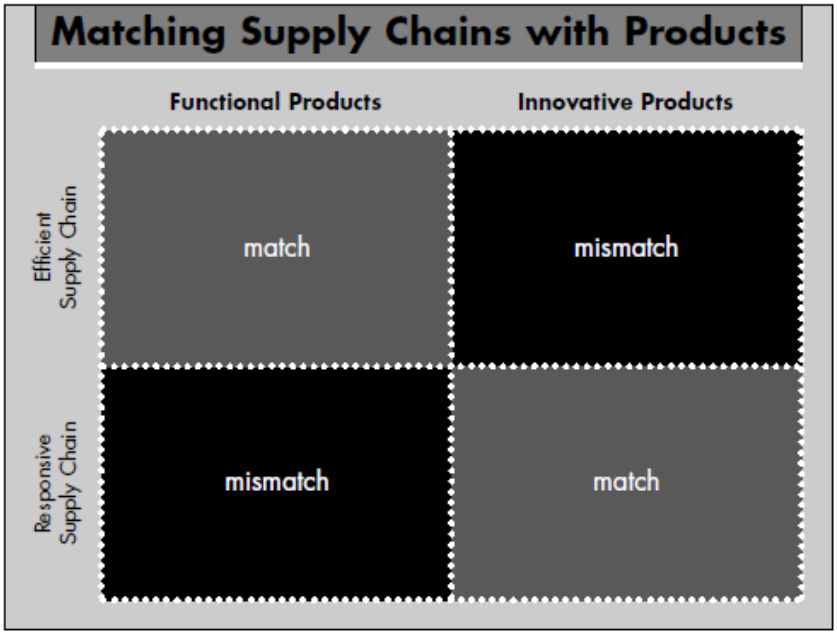



Figure 1.5 Supply Chain Strategy Matrix

Since choosing the right strategies for global supply chains is a significant topic for our work, we also reviewed the articles about global supply chain risk management which is highly related with the strategies adopted in order to eliminate the uncertainties. I. Manuj and J. Mentzer (2008) made a comprehensive research in order to bring together the concepts, frameworks and insights from several disciplines to propose a risk mitigation model for global supply chains. They proposed a linear and hierarchical five-step process which allows to a constant information flow to identify, assess and plan for risk. The authors also stated that this framework for global supply chain management provides three main benefits: (1) stimulate out-of-box thinking, to generate appropriate strategies, (2) considers both qualitative and quantitative dimensions of risk, (3) explicitly recognize the presence of the dynamic environments in which global supply chains operate.

The cost versus responsiveness are the growing global supply chain design problem especially for the markets in which there is demand uncertainty and shorter product life cycles. R. Stratton and R. Warburton (2006) developed a conceptual model which proposes three conceptual approaches to supply chain improvement and demonstrates the trade-off concept. (Figure 1.6) They analyzed three case analyses by using these three conceptual approaches as framework for

each of them. The research has identified how and why strategies may be practically classified as means of reducing, restricting or managing variation and uncertainty

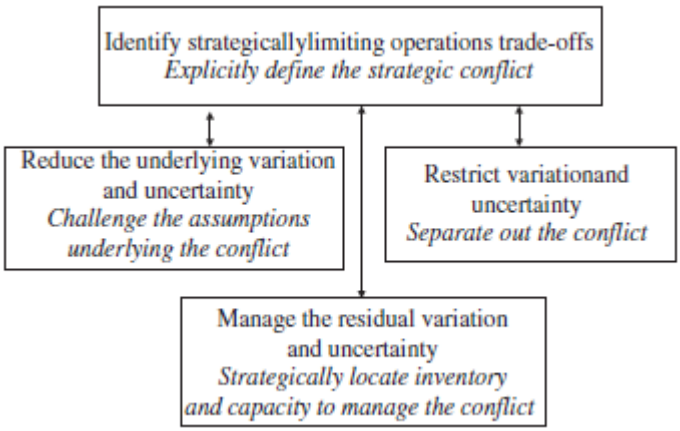



Figure 1.6 Proposed conceptual model for strategic supply chain improvement

### 1.4.2 Conceptual Design Models

Conceptual design models analysis is made to investigate the tools or models exist in the literature which help to the decision making process of building a global supply chain. For this analysis we reviewed 10 articles which deal with the design problem of global supply chains in different perspectives.

As adopting a responsive strategy is crucial for building a global supply chain to have a competitive position in the market, many authors discussed the issue of agile supply chain strategy in their articles. P. Swafford et al. (2000) presented a framework for analyzing global supply chain agility and its possible impacts on the performance. In this study, global supply chain agility is defined as a measure of the supply chain's ability to adopt rapidly changing global competitive environment. The article stated model with four flexibility components; product development flexibility, sourcing flexibility, manufacturing flexibility and logistics flexibility. Model enables to determine which flexibility dimension has the greatest effect on global supply chain agility.

J. Smith (1999) investigated the factors that affect the purchasing decision by examining some cases and he proposed a decision matrix model (figure 1.7) that identifies the items which can be beneficially procured from abroad and items which can be best obtained locally. He also applied that model to a number of items and presented a broad guideline for selecting an appropriate procurement strategy.

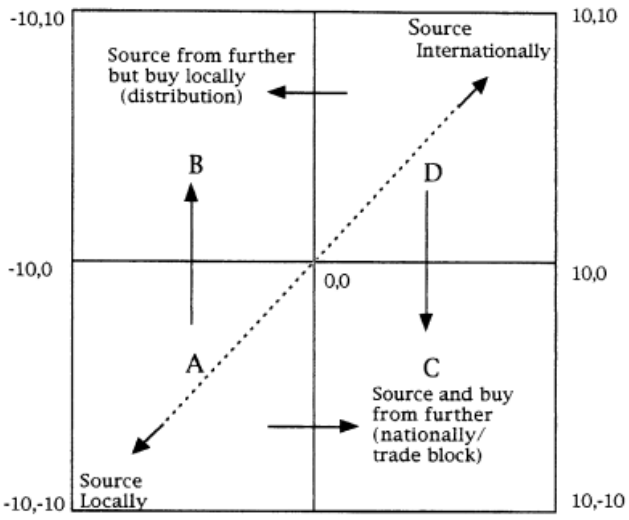



Figure 1.7 Decision matrix model proposed by J.Smith, 1999

M. J. Meixell, V., G. Gargeya (2005) made a study about global supply chain design models by doing model-based literature review in order to show how many design models exist in the literature from 1982 to 2005. Their review also assess if the existing models support the global supply chain design decisions by considering globalization challenges, outsourcing, integration and strategic alignment. In order to reach that purpose they used four dimensions which are decision variables, performance measurement, supply chain integration and globalization consideration. The results are presented in their paper.

According to the results of the existing models, the authors (M. J. Meixell, V., G. Gargeya 2005) took the attention to the missing parts about the models. Firstly, they stated global supply chain design models should be extended to include both internal manufacturing and external supplier locations. Secondly, they conclude that global supply chain models need broader emphasis on multiple production and distribution tiers in the supply chain. Thirdly, the performance measures used in global supply chain models need to be broadened in definition to address alternative objectives. Lastly, more industry settings (different than electronics, apparel, and textile and automotive) need to be investigated in the context of global supply design.

Another topic discussed by J. Collin et al. (2009) is designing the supply chains according to the customer demand's chain in order to increase the customer satisfaction which has recently become the crucial consideration for companies to increase the profitability. After giving the relevant literature about the topic, they proposed a step model for designing customer and product aligned supply chains. The model has four steps (1) decide the type of the product if it is innovative or functional, (2) understand customer demand chain (3) design alternative supply chains, (4) select the best one for each customer.

R. Hammami et al. (2008) focused their attention on the delocalization problem of global supply chain design. By definition, delocalization means transferring one or more operation activities from developed countries to developing countries, therefore the problem considered in their article is about determining which operations should be delocalized and in which country or site, and making related decisions. By taking this consideration as the basis, they proposed a conceptual approach for modeling supply chains in the delocalization context which takes into account the decision variables, cost of factors, financial parameters and constraints.

Jeremy B. Brann (2008) wrote a dissertation by proposing a conceptual model for supply chain designs by using text mining as the tool. As a result, text mining highlighted two main dimensions for the supply chain management literature: supply chain strategy and supply chain operations. The subsequent runs of text miner clustered the articles under these two categories. The author improved his conceptual model by adding sub-dimensions related to these two main dimensions as it is shown on the Figure 1.8

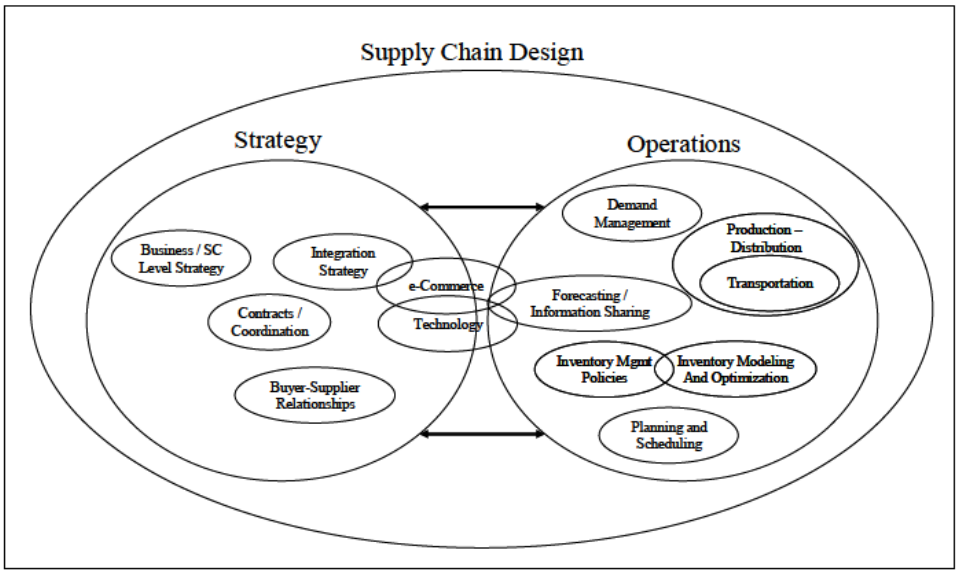



Figure 1.8 Supply Chain Design Conceptual Model

Measuring the performance of the supply chain management has been a critical research area by being parallel to the increased attention to the topic of supply chain design. A. Theeranuphattana and John C.S. Tang (2008) proposed an innovative performance method for supply chain management which is the expressed as the combination of two existing methods: Chan and Qi's models and the supply chain operations reference (SCOR) model. According to the Chan and Qi's side of the model, the performance attributes are defined as reliability, responsiveness, flexibility, cost and assets. In addition to that SCOR model offers a framework of processes and metrics. In that way, the new constructed model enables the practitioners to identify and select pertinent measures.

The most recent research has been made about the implementation of responsive supply chain by James Roh et al. (2013). The authors presented a research model which defines the drivers, strategy and practices of responsive supply chain and the performance outcomes in global complexity. By using the data collected from the IV International Manufacturing Strategy Survey (2005), the authors concluded their study by indicating a multi-dimensional integration is the most significant characteristics of a responsive supply chain in global environment. According to the findings they concluded the dimensions such as: (1) a responsive supply chain strategy put socio-relational integration into effect which refers to being customer-centric by adding value to customers by cutting the non-value added activities throughout the supply chain. The aim is to increase the responsiveness/adaptability to the changing customer demands and enhancing the relations with the suppliers and customers (2) a responsive supply chain also supports techno-process integration which refers to the advanced manufacturing and pull production (3) and finally a responsive supply chain integrates socio-relational and techno-process integration toward time-based performance outcomes because the purpose of the responsive supply chain is to increase the responsiveness of the company to the market dynamics through being customer-oriented, enhancing collaboration with suppliers and supporting the use of advanced manufacturing technology. To sum up, this kind of multi-level integration stimulate the involvement of all three supply chain partners (suppliers, customers, company itself) to create synergy which makes the model differ from the other one-dimensional integration models.

Considering the existing models discussed above, future research should concentrate on the development of an overall global logistics framework, supported by multiple inter-related models capable of representing qualitative factors and uncertainties.

### 1.4.3 Global Supply Chain Configurations

Analyzing all the research papers for our study, we identified 7 articles solely focused on the global supply chain configurations.

After analyzing and evaluating all relative articles about possible global supply chain configurations, we have deducted that there is a huge gap in this field covering whole length of supply chain linking the features and different drivers to those configurations to help strategic decision making process. Although all stages of global supply chain is inter-related, most of the studies are focused on the topic partially and discusses a specific part of the chain. Therefore, the links between those studies are still waiting to be given attention. For our work, we came out with that there is a necessity to make a study which pools all those different angles of studies, and discuss the area in holistic approach.

The paper of Knudsen and Servais (2007) is one of the rare studies in the literature applying a comprehensive approach from suppliers' perspective. The internalization configuration is evaluated from a different perspective. It should be noted that in the article, the term "internalization" is used in accordance with the definition of "globalization" as we explained in previous sections. In the paper, the distinguishing features of different configurations in terms of different structural and behavioral attributes are tried to be understood. The discussion is done by analyzing Danish industry where a survey is conducted in order to collect data which investigates import and export numbers of Danish companies. As a result, authors could identify four configurations by comparing import and export amounts: Locals, globals, sourcers and sellers. Afterwards, they deepened his study by analyzing the structural (company size, turnover, etc.) and behavioral (how the firm carries out international business) variables in order to discuss why not all companies stay local or be completely global. By highlighting each configuration's distinguishing features in terms of psychical distance, risk, and control, he enables to frame the base characteristics of some possible configurations by identifying the outcomes and advantages of each type.

Jurong Zheng studied on the features and factors of possible supply chains configurations. He maps the possible configuration in 9 different cluster which are categorized in terms of different value chain activities (sourcing, production and marketing) and geographical dispersal of those activities (local, international and global). Although this study composes in a comprehensive approach for our study by considering 3 main activities of global supply chain, and interrelated links in between, he limits the study by small and medium sized companies whose behavior in global level is substantially different from large scale firms. He classifies internalizing SMEs (small and medium size enterprises) in three groups as early vs. late internationalization (1), type of new international ventures (export, multinational traders, geographical-focused and global start-up) (2), and internalized SMEs as born-global and non-born global (3) in order to study the topic from different angles.

Federico Caniato studied different possible configurations in electric motors market which can be considered as a representative sample due to capability of being highly global. He suggested four configurations with respect to three stages of global supply chain which are global sourcing, manufacturing and distribution. These categories are named as locals (all stages are operating local), global purchasers (only sourcing is global), global sellers (only distribution is global) and global (all stages are operating in global level). An interesting outcome of the study is that there could not be any global manufacturing with local supply or distribution is identified. Author discusses the reason as being more critical to implement and generally implemented coherently

with other stages, not alone. Moreover, author summarized the characteristics of configurations in terms of level of globalization. Lower globalization makes the company to operate more flexible and more competitive in delivery based factors while higher globalization leads cost and after sales advantage.

Another study done in this area is the paper of A.Claudio Garavelli (2003) who covered the issue with flexibility concerns. He proposes 9 different configurations in order to achieve different levels of flexibility by focusing mainly global sourcing and distributions. The flexibility of the global supply chain and its distribution stages are divided in three policies which are defined as; (1) totally local - one supplier/market assigned to the party- not flexible, (2) limited - more than one and (3) global - all suppliers/customers can be reached by every manufacturing facility. The probable outcomes of the different combinations of these 3 different levels of the facilities are investigated in the paper. A simulation model is applied in order to evaluate the effects of each configuration by measuring work in progress and lead time performances of the clusters, which gives the opportunity to quantify the performance of different configurations considering demand variability and plant reliability. The conclusions of the study is stated as, having equal policies in both stages (supply and distribution) it yields better performance than focusing on just one. But still, it is stressed that as the flexibility increases in upstream stage, it has more benefits when considering the bullwhip effect.

One methodology to distinguish the global supply chain configurations is developed by Rafaella Cagliona et al. (2008) by using the longitudinal data collected from a sample of companies that are obtained by the IV International Manufacturing Strategy Survey (2005). On the basis of their results they defined the configurations with four possible configurations in terms of global vs. local sourcing and distribution considering the strategy adopted: (1) local supply chain (2) global seller (3) global purchaser (4) global supply chain. At the end of their analysis they stated that there is not the best configuration for companies to follow. Each company decides the configuration according to its own supply chain strategy.

Although, there is a fact that the processes global sourcing, global manufacturing and global distribution are interrelated, some companies have difficulties to make relations and operate them simultaneously. Therefore, considering their strategic decisions, they adopt different supply chain managements. They may decide stay local in some operations and extend global in some others. Considering the level of globalization of the company in terms of sourcing, manufacturing and distribution, Caniato, Golini and Kalchshmidt (2012) identified the supply chain configurations as 4 clusters: locals, shoppers, barons and global. According to this clusters,

shoppers are characterized by high level of global sourcing and local distribution, whereas barons are characterized by local sourcing, local manufacturing and global distribution. Locals and globals, as the name implies, refer to be local or global in all three operation process.

In a very recent paper, Federico Caniato had studied on the moderating effect of GSC configurations by using International Manufacturing Survey which is very large panel of data gathered in 2009. In his paper he extends the studies that was done before which were focused on the topic partially. In this study, he examines the relationships between the different global supply chain configurations and different variables effecting or being effected by SC improvement programs.

### 1.5 Quantitative Studies

For many years, the analytical design and optimization of supply chain has been an active area of research. It is quite common to find different modeling approaches addressing especially single component of the chain as purchasing, production and scheduling, inventory, warehousing, or transportation.

In order to achieve the most comprehensive strategic problem, which is the optimization of full supply chain, the design needs to determine the number of sites, location, capacity, and type of manufacturing plants and warehouses to use, the set of suppliers to select, the transportation channels to use, the amount of raw materials and products to produce and ship among suppliers, plants, warehouses and customers, the amount of raw materials, intermediate products, and finished goods to hold at various locations in inventory.( Vidal and Goetschalckx,1996)

With the considerable expansion of globalization in the last decades, the logistics management in global scoped emerged as a new discipline, and the role of these models of Global Logistics Systems became a significant issue (Vidal and Goetschalckx, 1996). However, these models differ from domestic models with its vulnerability and difficulty of coordination. Therefore, global supply chain models are more complex to apply. There are many attributes to include in the model which are emerged with the trend of globalization. In many papers, these factors are listed as different taxes, exchange rates, transfer prices, etc. Also with the wide range of many uncertainties and risks entering to the frame, the model expands in a more complex way.

After investigating many articles in the preliminary research, we have selected 31 articles that discuss the topic in global level including the new emerged factors as it is mentioned above. These articles can be categorized in some different ways.

First of all, the literature review has shown that the models in the articles differ according to many criteria such as models employed, objective of the model, decision issues, etc. The findings related to some categories are given below.

***Models Employed***

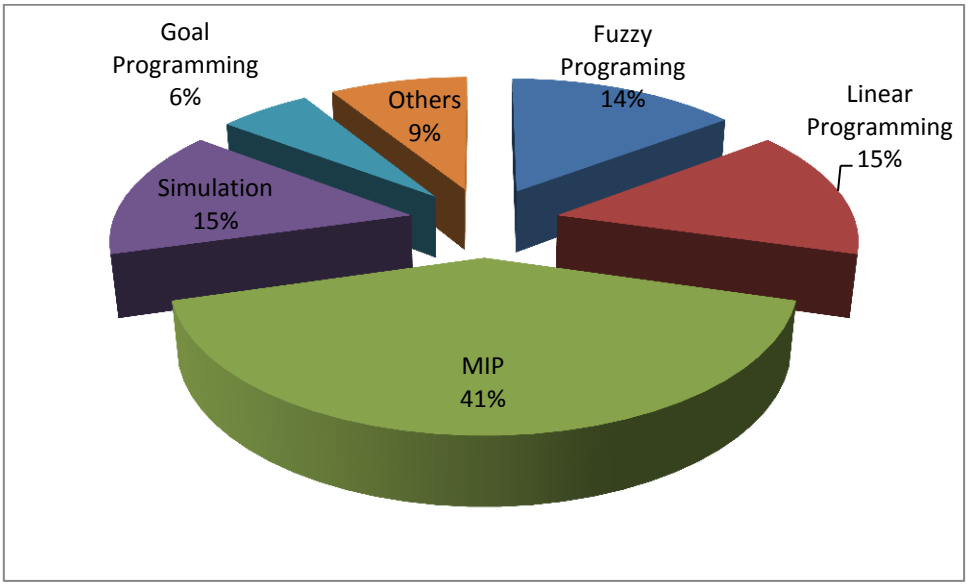



Figure 1.9 Type of programming models presented in the papers

When the models which are applied to problems are analyzed, it is seen that, mostly MIP is preferred although many other programs are also widely used. Some of the studies have used 2 stages in order to optimize the objective which led them to use more than one models. By this way, they were able to support one model with the other one in order to compensate the weak points of the first. For instance, fuzzy programming and simulation are two techniques which are widely used to support other techniques in order to complete deficient points of mostly used techniques such as in order to include uncertainties or risks into the model.

***Decision Issues***

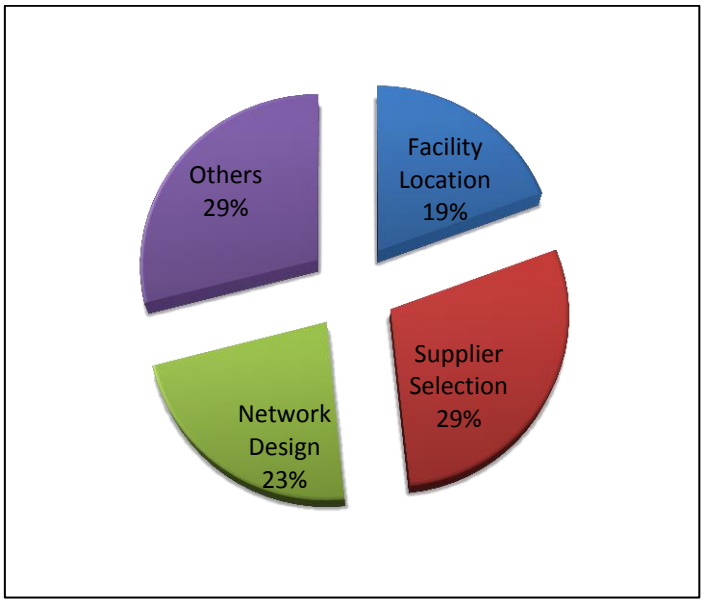



Figure 1.10 Type of supply chain design problems tackled in the papers

Although studies are widely varied, it is obvious that the main attention is given to supplier selection problems, then facility location and network design problems, respectively. Since global supply chain requires long term relation and reliable ties with the suppliers, supplier selection is remarked as one of the most significant concerns of the company. In addition to that, network design and location decisions are quite strategic and there are many conflicting factors that affect the decision. Designing or renewing a network is modeled and optimized in the studies with varied priorities and enablers. Moreover, other decision issues can be counted as product flow optimization, sourcing strategy defining and production planning.

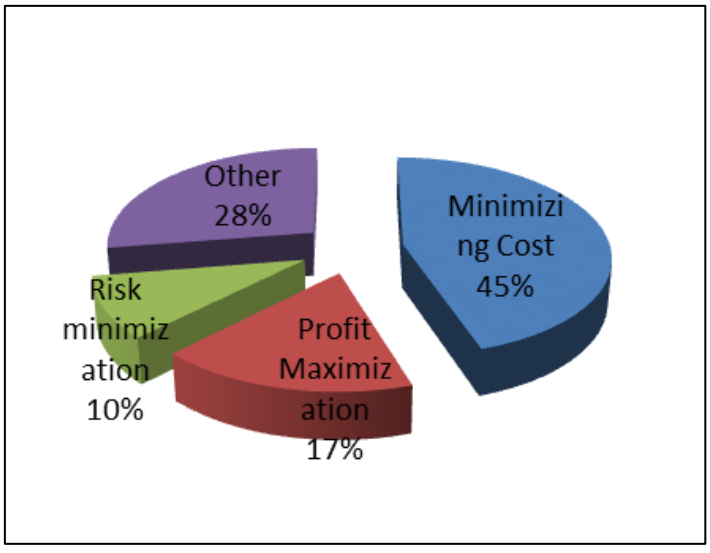



Figure 1.11 Decision issues referred by objective functions

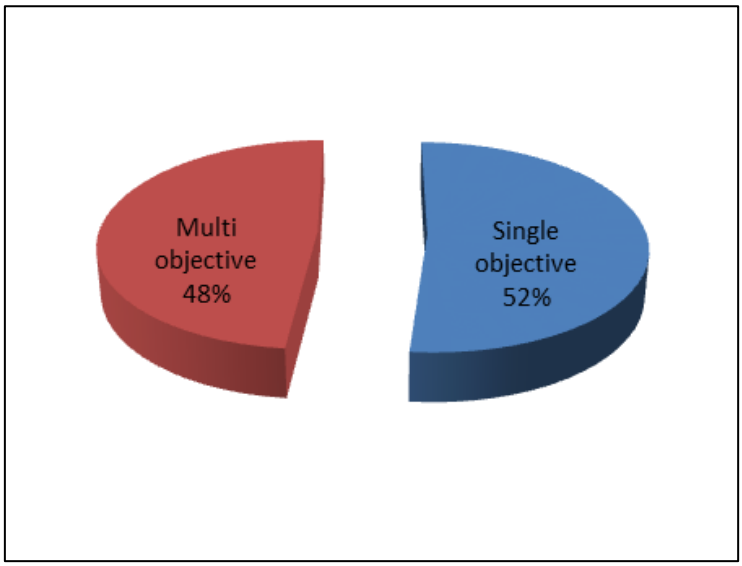



Figure 1.12 Dispersion of multi objective and single objective functions mentioned

Speaking with the knowledge gained by the review, models applied in articles are not clustered in single focused method, instead it is seen that each decision issue is modeled with wide variety of approaches. As it is visualized with the graphs above, single and multi-objective models are given equal importance. By analyzing the correlation of chosen method and the decision issues, there cannot be seen any dominant approach preferred for a specific decision issue. The most noticeable outcome that can be deducted from analysis is that, as it is indicated in Figure 1.11, objective function of the models are mostly concerned about the economical results which are minimizing cost or maximizing profit. When it is analyzed with being single or multi- objective, it can be seen, most of the single objective articles are focused on either profit or cost. However, when the problem is modeled as multi-objective, non-financial concerns of the company/institution are included in the objective as well according to their priorities. These objectives are optimized but also economic dimension is concerned compatibly. So to give an example, for environmental concerning problems are not aimed to just minimizing the carbon release. Instead, optimal solution is reached by taking the cost side of the problem into the frame and reaches minimum carbon release that can be achieved with the minimum cost. As it is shown in example, most of service or environmental related objectives are studied under the restriction of cost concerns. Most preferred objectives which are included in multi-objective models besides cost or revenue concerned ones are risk minimization, lead time minimization and customer dissatisfaction minimization.

As it is indicated in previous parts, operating globally increases the risks and uncertainties significantly. Although there are many deterministic models, a high number of authors took those uncertainties into consideration in order to model the problem closer to real life situations.

Mostly included uncertainties are demand and supply side uncertainties due to the fact that these factors are unable to control completely. Other commonly considered uncertainties are lead time and cost uncertainties.

It is clear from our research that facility location and the supplier selection problems are ones the most considered and studied topic in academic world. Although locating facilities is a critical issue in domestic supply chain also, it becomes more crucial when the borders are exceeded and many conflicting drives come to frame to determine the best possible solution. The paper of You and Grossmann (2008) is worth to discuss by being one of the most comprehensive models taking many criteria into account. The supply chain in the model consists of multi-site facilities, with multi-product dedicated to them. It is a multi-objective model by aiming net present value optimization and lead time minimization. The remarkable feature in the model is that while measuring the economic criteria is measured by net present value, it measures also the responsiveness by transportation times, residence times and cyclic schedules and inventory management as well. Besides determining the location of facilities, this model is able to define production levels, process technology selection, scheduling and determining inventory levels.

Also it should be noted that, multi-objective models are highly studied due to the fact that, there are many conflicting independent entities trying to maximize their own objective functions or interests in a supply chain. With best of our knowledge after the review, we can conclude that multi-objective criteria are generally preferred in order to add more considerations based on firms' strategy such as environment, flexibility, service level while economical objective is still the part of main issue such as cost minimization and profit maximization. In his paper, Errol Pinto states that, on the contrary to the most of the studies that aims to optimize single objective such as cost, service level or responsiveness, a multi-objective model can include all. Accordingly to this statement, he proposes a multi-objective model using three stages which are suppliers, manufacturing plants and customer zones according to their contributions to the supply chain by using the Non-dominated Sorting Genetic Algorithm-II (Liu and Papageorgiou, 2012). Papageorgiou proposes a multi-objective mixed integer linear programming in order to optimize the production, distribution and capacity planning in the process industry with considerations of cost, responsiveness and customer service level simultaneously.

Based on literature research, we have deduced that also global sourcing problems are studied so exhaustively, due to increasing complexity and importance of purchasing decisions (De Boer, 1998). (Liu & Nagurney (2011), Kouvelis and Milner (2002), Nagurney (2011), Hammami) have developed models considering outsourcing, supplier selection problem and sourcing problems

under stochastic demand. One of the most outstanding and current articles among them is Liu and Nagurney (2011), that differs among the others, expanding the studies by allowing multiple suppliers, multiple manufacturers, and multiple demand markets to interact under both demand and cost uncertainty considering recent trends of global supply chain which are off-shore-outsourcing, and in-house quick response production. This model aims to maximize the expected profit across all scenarios which capture the behavior of multiple, competing decision makers who are faced with two stage stochastic problems, but also have to cooperate with other decision makers. (Variational inequality model is used). Also, there has been great attention shown in order to develop vendor selection supporting models, such as multi-criteria optimization model (Ravindran (2009), Dulmin (2003)), simulation (Wu (2008), Gobaco (2012)) and fuzzy programming (Yücenur (2011), Kilincci (2011)). Yücenur, made a comprehensive study regarding this topic , that is used fuzzy AHP in order to select suppliers by giving weights to 4 main categories and several sub-criteria related to these categories that can consider both qualitative and quantitative criteria effecting the supplier selecting process.

Since the expansion of the supply chain to the global level, increases the uncertainties enormously, it also became an exhaustively studied area. There are many articles that consider the uncertainties mostly in risk managements. According to David Peidro (2009) the source of uncertainties are clustered in three main groups which are demand, process/manufacturing and supply. There are several different models in the literature considering different uncertainties and approaching the topic from different angles. F. You (2008) explained stochastic approach where uncertainties exists as optimizing the average of the total expected performance based on scenarios and he proposed a stochastic linear programming in order to achieve midterm planning of a large scale multiproduct supply chain under freight rate uncertainty. Mark Goh(2007) has developed a unified multi-stage stochastic model including as many risks as possible discussed in Cohen and Huchzermeier (1999b) of one product within the global supply chain network of companies such as Red Bull by aiming the maximum after-tax profit. David Peidro (2009) claims that most of the SC planning research models with probability distributions for uncertainties are usually predicted from historical data. However, whenever statistical data are unreliable or not available, stochastic models may not be the best choice (Wang and Shu, 2005). He offers fuzzy set theory (Zadeh, 1965) and possibility theory (Dubois & Prade, 1988; Zadeh, 1978) to deal with SC uncertainties. In his article, it is stated that fuzzy modeling can be applied on many areas of supply chain both strategic and tactical such as, SC inventory management, vendor selection, Transport planning, and etc. In the model he developed (2009) he studies on a fuzzy mixed-integer linear model where data are ill-known. He uses triangular fuzzy numbers

and provides alternative decision plans for different degrees of satisfaction by centralizing the multi-node decisions simultaneously while using the resources optimally within the determined time and minimum cost. Mostafa Maleki Someah Lu (2010) proposes a fuzzy mixed-integer linear programming; aiming finding the optimum amount of transportation between suppliers and manufacturers and also between manufacturers and distributors is identified under uncertain demand.

With the increasing conscious of global warming, greenhouse effect, and the alarming future effects of pollution, many parties are pushed to consider and take precautions regarding this issue. Companies that are trying to be eco-friendly for environmental or competence concerns, arise of new regulations such as Carbon tax has led this criterion to be included in the main attributes. Although the studies are not so deep and there is a long way to go, this topic is also trending due to the reasons stated above. Considering this the article written by Fan Wang (2011), designs a multi-objective mixed-integer model with environmental concerns. It is important because it is the first to consider environmental investment decision in the supply network design phase. They tried to figure out the tradeoff between cost and the environmental impacts of the activities held by applying normalized normal constraint method. The very new decision variables are introduced to literature such as the environmental protection level. Thi Phuong Nha Le, Tzong-Ru Lee (2011) develops a multi-criteria optimization model that aims to minimize cost and environmental effects simultaneously by proposing a new configuration that hires best possible transportation routes, inventory levels, shipment quantity, and transportation modes solutions in terms of both economic and environmental benefits. In the end of paper, he applies the model to a real case.

### 1.6 Integrated Studies

Integrated approach employs both quantitative and qualitative models. There are many papers in literature proposing different integrated approaches to supply chain problems, however, it is recently started to be adapted to global context. This situation disabled us to investigate large number of articles on the contrary of quantitative and qualitative studies separately. Relying on a few numbers of related articles that we could reach in our review, it can be concluded that, integrated approach is widely used in supplier and location selection problems due to the fact that they both are evaluated in terms of quantitative concerns –mainly cost- as well as qualitative enablers that should be taken into account. To give an example, the cheapest site would not be preferable if there is a high terrorism risk on chosen area. Therefore, some integrated models are

developed considering the two side of the problem. The findings in the literature are stated below:

Lin (2011) proposes an integrated model for the supplier selection problem which is to be considered many criteria included and solved in uncertain environment due to the absence of precise information. The studied model adopts the fuzzy analytic network process (FANP) approach in order to identify the most preferable suppliers according to the defined criteria and handling the uncertain data. Afterwards, this approach is integrated with fuzzy multi-objective linear programming in order to find the optimum among possible suppliers. In order to define best possible suppliers, author includes the criteria of quality, price, delivery precision and technique (which consider flexibility and support). It is claimed that the difference of this model from other integrated ones is allowing DMs to give an insight about allocating the optimal quantity of orders of selected suppliers. Furthermore, the model can be used also to monitor suppliers in order to improve relationships.

Another paper considering supplier selection is discussed by Cebi and Bayraktar (2003) that the model can be employed at local or global level. In order to cope with various and conflicting tangible and intangible criteria, authors proposed a supplier selection model which has been structured as an integrated lexicographic goal programming( LGP) and analytic hierarchy process (AHP) in order to optimizing the conflicting objectives of conflicting objectives that are quality, delivery, cost, and utility. Developed AHP model considers qualitative factors that are clustered in 4 main groups which are logistics, technology, business and relationship factors. These factors are evaluated as either to develop successful supplier management or to eliminate the alternative. And with LGP the objectives are optimized mathematically which are quality, cost and delivery. The difference of this paper than other studies which use the similar approach is adding constraints related to the financial strategies of the company.

Sarkis & Sundarraj (2002) applied an integrated model to Digital Equipment Corporation, which is a very interesting and complex case study in terms of degree of globalization of the company and the enormous number of goods. In their paper, a model is studied which locates repair-parts warehouses of the company. The two considerations of this facility location problem were to develop long-term strategic issues meanwhile ensuring that the facility would be viable from cost perspective. These two objectives require handling the problems by applying both quantitative and qualitative approaches. The corporation is highly globalized that operates in over 100 countries with more than 65% of the revenue outside US. Being as a large company, they had to consider 4000 parts and 21 potential site locations in order to start up an setting up facilities in

Acia Pacific region. Selected criterias involves costs as being the main concern of most of the companies, as well as other qualitative factors. By considering these requirements, it is designed a model which develops a formulation taking all possible quantitative factors into account (such as location cost, insurance cost, taxes, cash flows and etc…), while ensuring the results correspond to managers' qualitative concerns (such as political environmental social and labor issues). In order to solve this facility location problem, a model is proposed as in the following. First of all, a measured judgemental approach is used to select the site by rating them according to the deficincies that management described which is concluded by the elimination of 18 possible sites and remained 3 for further evaluation in cost manner. API model is applied aiming to minimize the sum of the fixed costs of possible sites and the transportation cost of products while determining the site number, their locations and product quantities to be moved between those sites.

### 1.7 Conclusion for Literature Review Part

In this chapter, we tried to give a detailed literature research about the global supply chain, its design problem and existing configurations. Overall we saw that, although many of the research has tackled some of the challenging global supply chain issues, a few articles have addressed to the global supply chain design problem as a whole by considering the all parts of the chain. Instead of handling the whole length of supply chain, the authors preferred to focus on mainly global sourcing, global manufacturing and facility location. On the other hand, global distribution is not so widely discussed in the literature.

After analyzing the literature in terms of qualitative, quantitative and integrated models for global supply chain design problem, we concluded that the main drawback of these models is that uncertainties are not so covered in the formulations or they are ignored. In addition the effects of some international factors, such as taxes, exchange rates, transfer pricing, custom duties, trade barriers, regulations are not discussed comprehensively by the existing models.

Among the articles investigated, it is also seen that, just a few industries are dealing with global supply chain design which are electronics manufacturing, apparel, fiber and textile, and automotive. Therefore, there should be more industry settings for the models in order to be a guide for other type of industries for leading them to be involved in global supply chain design.

Another emphasis should be made on increasing the number of tiers within supply chain in terms of supply, production and distribution. Global supply chain models should be broadened by

integrating multiple tiers which enable to integrate decisions and investigate the interactions within the whole length of the supply chain.

Considering all the existing researches, we conclude, there should be more focus on the development of an overall global supply chain area which is enhanced by multiple inter-related models capable of including qualitative factors and uncertainties. Also, there should be effective use of information technologies and adequate database management to be able to have a successful design structure.

## 2. Global Supply Chain Configurations

The main purpose of this chapter of our work is first to provide the contemporary literature review related with global supply chain configurations and then propose a model for classification of possible configurations.

### 2.1 Global Supply Chain Configurations presented in Literature

In this chapter of our research, we identified the global supply chain configurations that found in the contemporary literature. Although, the literature is quite limited in presenting the configurations, a few authors focused their attention on it by analyzing the affecting factors to build a supply chain configuration. After reviewing all the existing models which classify the global supply chain configurations, we developed our own model to demonstrate the possible configurations on local and global scales.

The literature lacks clear evidence in terms of explaining the evaluation of global supply chain configurations adopted by manufacturing firms over time. Despite Meixell and Gargeya (2005) made a literature review on supply chain design focusing on the globalization topic, they did not cite any research adopting an evolutionary approach on the topic. Moreover, Power (2005) found only one contribution by Stuart (1997), who adopted a longitudinal perspective in his work. Recently, there have been made more contributions regarding the evaluation of global supply chain trend. Most of the authors (Webb et al. (2006), Kim and Shin (2002), Magnani and Prentice (2003)) pointed out the effect of globalization on supply chain designs especially in manufacturing companies with different approaches.

Companies are looking for the solution to the questions of, where to source the raw materials or where to do assemblies, where to locate the facilities and which markets to serve. In order to be able to answer these questions, supply chain managers and top management should do decision

making considering the design of the supply chain configuration adopted or will be adopted in the future. However, there is a limited research performed to analyze the interdependencies of the steps of whole supply chain therefore in literature decision making processes are investigated separately regarding to sourcing, manufacturing and distribution, respectively.

As it has been discussed in the scope of analysis, steps of global supply chain are defined as global sourcing, global manufacturing and global distribution respectively. In defining the configurations of the global supply chain, strategic location selection of the facilities regarding these three supply chain steps, plays the most important role, because it decides the level of globalization of the facilities of whole supply chain.

Global sourcing can be defined as " the acquisition of raw materials, components and subassemblies from international sources for use in fabrication, assembly or for resale, regardless of whether the import source in internal or external to the company" (Kotabe and Omura, 1989). According to this definition it can be extracted that, it is crucial to schedule, coordinate and synchronize the goods and information flows from the source to the target destination. From those points of view, logistics and transportation play an important role for the strategic redesign of the supply chains. Global sourcing requires an efficient plan of logistics networks and intercontinental transportation. Kruger (2002) stated that, geographical distances are not only increasing the transportation cost, but also they also creates difficulty for solving the trade-off between inventory and physical distribution costs. Low-cost off-shore sourcing strategies can end up as high-cost supply chain outcomes (Christopher et al., 2006). Therefore, the choice of transport mode and logistics networks configuration should be arranged or changed in order to obtain the best supply chain outcome.

Practitioners and authors have made their research about configurations on the basis of three main subcategories: strategic alignment of the supply chain, coordination of the players operating in the global supply chain and design of the global logistics network (A. Creazza et al., 2010).

Strategic alignment of the supply chain focuses on the facility location selection strategies and vertical integration issues. Depending on the level of vertical integration, there can be different supply chain configurations (Hong and Holweg, 2002). In order to be responsive and agile towards to the market demand fluctuations, strategies about production facility location and distance from the final markets should be selected carefully.

The second research area focus on the management side of the global supply chain which is more complicated compared to the local ones. The difficulty of the management of global supply chain stems from the differences in cultures, languages, habits and practices since they are the obstacles in doing accurate demand forecasting and material/production planning. To deal with the problems in demand planning or production-distribution, various mathematical models have been introduced. The most sophisticated ones take into account price/exchange rate and risk effect (Cohen and Huchzermeier, 1996).

The last research stream deals with the configuration of global logistics networks considering the most appropriate international transport mode (ocean container, shipping, airfreight, etc.), the design of infrastructure for freight consolidation and for serving end markets and the definition of the number of echelons composing the logistics network (Kruger, 2002). Previously, the analyses of global logistics network were subdivided into two perspectives: from global carriers' point of view or manufacturers' point of view. (A. Creazza et al., 2010) First one deals with the use of transport infrastructures or logistics models like hub and spoke, whereas the other one pays little attention to the structure of the transport service and to the relative implications on the entire supply chain, because manufacturers consider the transportation system just as an origin-destination process (e.g. Cohen and Lee, 1989).

In the literature, some studies about the redesign of logistics network on global scale have been developed but generally they do not give a generalization of the results (Arntzen et al., 1995; Bhatnagar and Viswanathan, 2000; Chung et al., 2004). However, it is seen that, recent studies have started to do a deeper analysis on the possible configurations for the logistics networks. As an example to one of the most recent studies, Cheong el al. (2007) evaluated a configuration, which refers to the adoption of consolidation facilities in Asian sourcing countries which are required to collect shipments coming from several suppliers. They also considered the delivery of the consolidated shipments to the manufacturing plants located worldwide. In addition to the studies made on this research area, there are also case studies about logistics configurations discussed in the literature which can be used as a guideline for choosing the potential options for designing a global supply chains.

Regarding possible configurations for the logistics networks, A. Creazza et. al. (2010) proposed five configurations which considers direct shipment, one echelon and two echelon logistics networks that defined as the following: (Figure 2.1)

***Configuration 1***- Direct Shipment with full container load: A single supplier (S) ships a FCL to a regional warehouse (RW) located in another region. Transportation is provided first from supplier to a loading port (LP) from which haulage made via ocean shipping, then from the unloading port (UP) to the warehouse.

***Configuration 2*** – Direct shipment with groupage container: First transportation of the goods are done by road haulage as LCL to the loading port where the containers are consolidated to carry it via ocean shipping, then after reaching unloading port, the containers are deconsolidated and carried as LCL to one or more regional warehouses.

***Configuration 3*** – One-echelon logistics network with consolidation hub (upstream): By road haulage goods are carried with LCL to the consolidation hub of the company in which goods are both consolidated and stored. Later the goods are shipped by FCL from LP to the regional warehouses.

***Configuration 4*** – One-echelon logistics network with central warehouse (downstream): There are many suppliers in one region which performs shipping with FCL to a single UP in another region close to the CW. After the deconsolidation of the containers in CW, the goods are shipped to the final destinations.

***Configuration 5*** – Two-echelon logistics network with consolidation hub and central warehouse: Goods are shipped with LCL to the consolidation hubs via road transportation. In the hub, containers are consolidated and shipped from LP via ocean shipping to UP close to the CW. After the deconsolidation in CW, the goods are shipped to the regional warehouses.

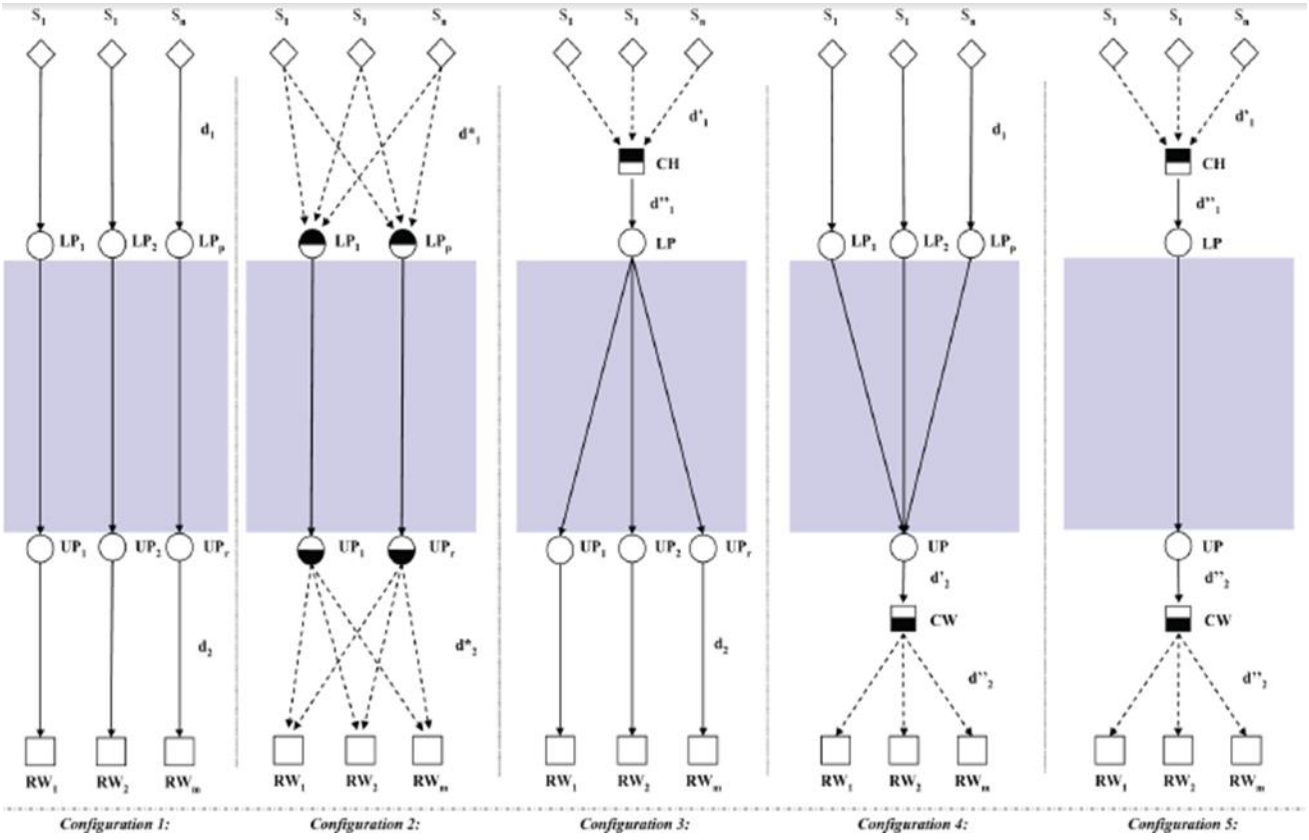



Figure 2.1 Configurations for logistics network proposed by Creazza et. al., 2010

These five proposed configurations are different from each other in terms of cost structure, supply lead times, risk of delay and operational complexity, i.e. the intensity of the effort necessary for logistics network planning and control (A. Creazza et. al., 2010).

Regarding to the cost structure, configurations are differ from each other in terms of transportation cost, handling cost and inventory cost and order preparing cost.

Transportation cost must be evaluated by considering not only the distances between the facilities but also considering if the configuration is based of FCL or LCL rates. In terms of handling activities, the existence of CW and CH is important. In configuration 1 and 2, the handling activities take place in RW, whereas the other configurations also deal with the handling activities in CW or CH additionally. Also, there is the issue of safety stock which is held only in RWs. However, C. Ballou (2001) stated that the different amount of safety stocks in the RWs, related to demand and lead time distribution, therefore it is accepted that order processing cost is just the function of each RWs and it is independent from the configurations.

One of the most important decision factors to select the suitable configuration for companies is lead time which stands for the time difference between replenishment order by a RW and receiving of the goods ordered from a supplier. Therefore, regarding to supply lead time,

configuration 1 has the lowest mean lead time among the others, whereas configuration 2 and 5 have the longest mean lead times. If the numbers of transit nodes are increased, then the mean lead time for configuration 3 and 4 also gets longer. Likewise, as the number of nodes increased also the risk of delay and operational complexity increase from configuration 1 to configuration 5.

According to the business environment and the strategy adopted, the companies should analyze and select which configuration is more suitable for their supply chain. Generally, most of the companies chose configuration 1 because of its low operational complexity and transportation cost, even though it is not the most cost-effective configuration.

In order to evaluate the cost-effectiveness of the configurations, A. Creazza et. al. (2010) used the framework derived from Zeng and Rosetti (2003) which consists of three main steps: (1) defining the input parameters to calculate OLC (overall logistic cost) , (2) Making the simulation of physical logistics flows for a given time horizon and calculating the related OLC, (3) applying a sensitivity analysis to observe the effect of key parameters on OLC.

Besides evaluating the most cost-effective configuration by the help of the framework mentioned above, there is also a need to taxonomy for the selection of the most suitable global logistics network configurations. In literature, there have been developed some classification schemes in order to guide the selection process (Fisher, 1997; Christopher et al, 2006, Lovel et al., 2005). In addition to their classification methods, A. Creazza et al. (2010) proposed a two-dimensional classification whose dimensions are such as:

(1) Overall annual demand (low-high): sourced volume by RWs from a specific geographical area

(2) Demand between suppliers and RWs (low-high): each RW's yearly demand sourced from a single supplier

The matrix of the taxonomy with the proposed configurations is drawn as it is seen on Figure 2.1 below.

According to the taxonomy, in case of shortage in purchases from international suppliers, i.e. the sourced volume is low, it is better to rely on LCL services which implies to the configuration 2. On the other hand, if the overall annual demand increases, companies can adopt configuration 3 or 4 which suggest owning a central warehouse or central hub. The decision of adopting CW or

CH depends on the suppliers' dispersion, and percentage difference between handling cost in sourcing and in destination countries. In case of low suppliers' dispersion and high percentage of handling cost difference leads the companies to adopt CH and choose configuration 3, otherwise, it is more appropriate to adopt a CW which is close to the end market by choosing configuration 4. If the demand between supplier and RW in each linkage in terms of sourcing volume is high, no matter if the overall annual demand is low or high, it is more suitable to use configuration 1 which suggest using FCL.

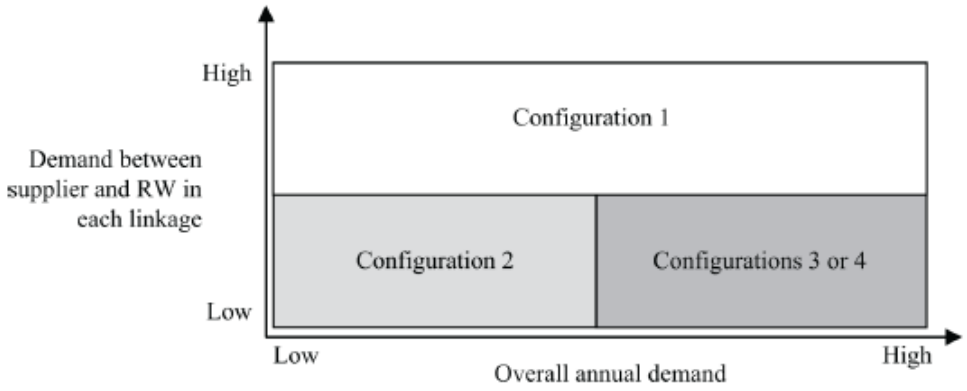



Figure 2.2 Taxonomy for the logistics network configurations by A. Creazza et al., 2010

## 2.2 Proposal of a Model for Classification of Global Supply Chain Configurations

The literature review on the area of global supply chain configurations that we have conducted so far has showed us that there is a research gap in the design and classification of the configurations considering the whole length of the supply chain at global scale. Generally, the researchers focused their attention to a part of the supply chain which is mainly global sourcing and global manufacturing, and they almost have not touched to the issue of global distribution in designing the configurations. Therefore, regarding to the research gap in the classification of global supply chain, at this part of the chapter, we developed and proposed a classification model for the global supply chain configuration.

A good model for distinguishing and classifying the configurations should answer the questions of: where to source raw materials or components, where to locate the production or assembly facilities and which market to serve. Therefore, the proposed model as shown in Figure 2.3 takes the location selection and operational processes as the basis. This model presents the existing configurations as general scheme. Each pie of the model stands for different configuration whose characteristics can be easily read from the corresponding location type and operational processes as showed in the graph. The model can be applied to any companies regardless of the industries and point of origins. To investigate and understand each configuration more deeply, we have

explained them separately depending on the integration and centralization strategy of the supply chain of company.

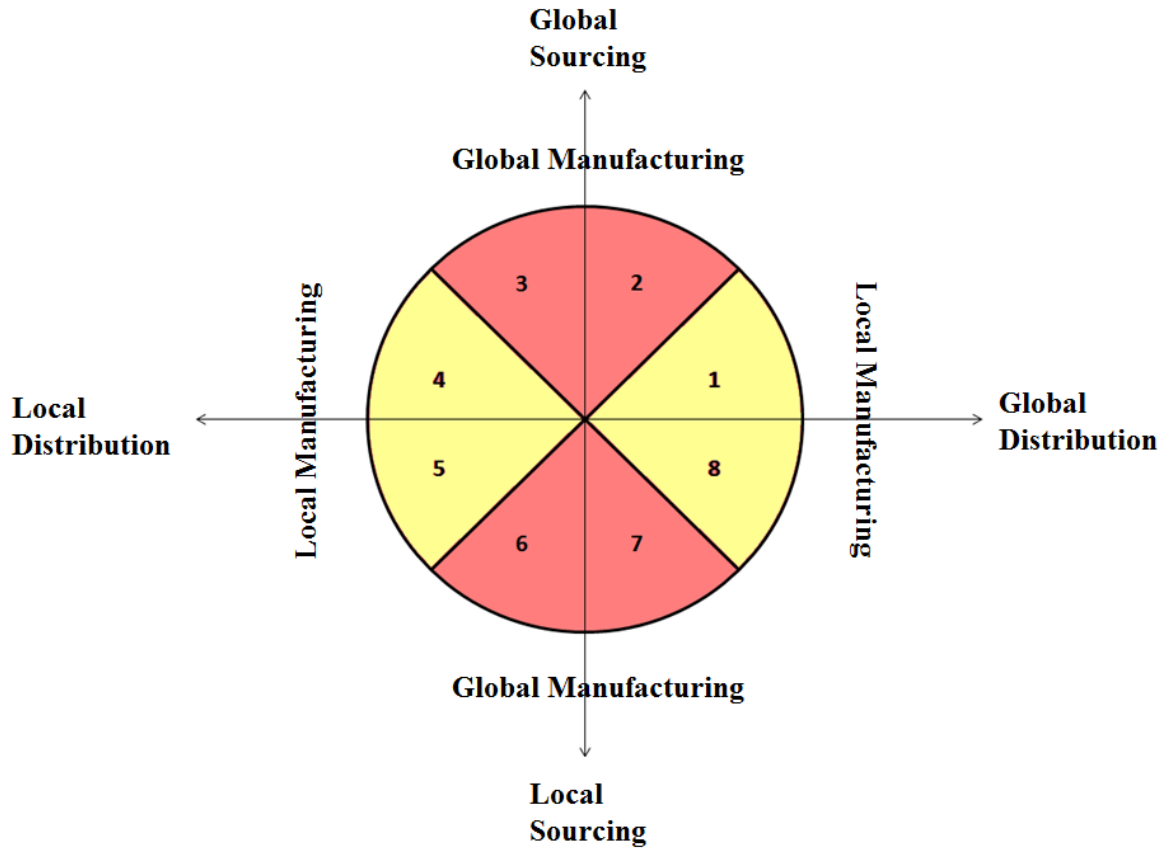



Figure 2.3 Model proposed to show 8 configurations of global supply chain

**Configuration 1**

This part of the model is in the area of global sourcing, local manufacturing and global distribution which is implemented by the global brands that makes huge investments on research and development. After the deployment of sourcing globally, the raw materials are sent to the focalized production/manufacturing facilities which are specifically designed to produce the complex and sophisticated products. After the production, distribution is made in global scale in order to provide the pay back of the investments.

**Configuration 2**

This configuration represents the truly global supply chain where the sourcing is made worldwide, plants are located in replenished in different regions, and the distribution is performed by using multi-echelon logistics network from one region to another. This configuration is also called as “hybrid” or “mixed” and it is characterized by the highest level of

complexity in terms of organization, management, planning and coordination. It is generally adopted by global and large scale companies.

**Configuration 3**

The pie of the cake is in the area of global sourcing, global manufacturing and local distribution. This configuration is adopted by the companies which develop their sourcing and manufacturing globally in order to be able to serve to their local market in a best possible way possible. On the other hand, profitability of this configuration is doubtful since it requires large volume in local market to be served in order to be able to pay back investments on it.

**Configuration 4**

It is in the area of global sourcing, local manufacturing and local distribution which stands for the purely global sourcing. The companies which adopt this configuration do shopping around the world and the other supply chain operations are made in local scale. The reason laying behind this configuration is benefitting from the cost and quality advantage of foreign sources in order to be able to get superiority in the competitive business environment and to serve to the local market in best way possible.

**Configuration 5**

This part of the model stands for the truly local supply chain whose operational processes are located within the same region. This configuration is generally adopted by the companies which have rigid manufacturing facilities, high inventory cost and high transportation cost which does not enable the high-volume cross-border flows. For this reason, companies focus their strategy as being close to the local market which is shorter and simpler than foreign markets. The local market size also should be big enough for the company to benefit from the economies of scale. The supply chain in this case has low complexity and internalizes cost efficiency strategy in its operations.

**Configuration 6**

This configuration is characterized by local sourcing, global manufacturing, local distribution which represents the typical strategy related with offshoring the production facilities in global scale. Companies locate their production facilities worldwide and re-import their own products in order to meet the local demand. Production facilities source the raw materials and components from the local suppliers of home country and each plant works almost interdependently from

each other. Locating production plants worldwide provide company comparative advantage in terms of low labor cost, low taxes, better environmental norms and regulations, etc.

**Configuration 7**

At this configuration, despite from the localization of sourcing, production facilities are located worldwide and distribution activities are done at global scale. Each plant works with a limited or almost no dependency to each other. This configuration is adopted when the global brands needs a unique source of raw materials or parts which can only be obtained from a single region and accepted as value –added because of its uniqueness. Configuration suggests adopting global distribution to be close to the foreign markets. This configuration is appropriate for the companies which produce different product families around the world and which has the capability to serve worldwide in order to get competitive advantage.

**Configuration 8**

This configuration is characterized by local sourcing and local manufacturing whereas it takes advantage of global distribution in order to maintain the proximity to the customers all around the world. This type of configuration is adopted by strong global brands which creates the value by their local roots. The aim of the company is to create the perception of uniqueness by the customers. However, in real life, due to the complexity in operations and high cost, it is tough to maintain this advantage.

## 2.3 Conclusion to Global Supply Chain Configurations Part

Depending on the literature analysis about the topic of identifying and distinguishing the existing global supply chain configurations, we have developed our own model to present a clear understanding of the configurations. The model indicates to eight different global supply chain configurations and takes operational processes and location selection criteria as basis. Operational processes are defined as sourcing, manufacturing and distribution respectively and location selection is stated as being local or global scales.

The proposed model is suitable for all kind of companies regardless of the industries, target markets and point of origins. Companies just need to decide which configuration is more suitable for them considering their company and supply chain strategy. Level of integration and centralization decisions are highly effects the decision making process.

Regarding to the existing researches and our proposed model, for the future research area, we would suggest expanding the existing knowledge on each configurations of global supply chain. Benefitting from the real-life case studies of the companies could be an ideal way to explore more about the configurations. Moreover, there should be made a detailed study which can integrate the drivers of the global supply chain design into the decision making about choosing the suitable supply chain configurations.

## 3. Drivers effecting Global Supply Chain Design

With the light of literature analysis, 32 drivers are identified which have impact on strategic supply chain decisions regarding location selection. The collected drivers are clustered in five different groups, categorized by means of the features of the impact: product, service, demand, supply and environment features. Each driver is described and the impacts on supply chain decisions in global level are explained below. Furthermore, for each driver, a measurement proposal is made in order to quantify the weight of the factor for the company. In the latter section, a table is proposed (Table 3.5) which indicates the effects of those drivers in terms of costs, global supply chain stage and the risks to be occur if the related enabler is not managed properly. Moreover, table also summarizes the suggested decisions to be taken in the existence of proposed driver.

### 3.1 Product Features

***Product variety*** is described as the amount of different product attributes and characteristics in the complete portfolio of the company. Product variety has different effects on different stages of the global supply chain. Firstly, having high variety, leads supplying wider range of raw materials and components which increases the number of the suppliers, more dispersed both locally and globally in order to provide increased number and diversity of supply needs. Furthermore, it has considerable effects on manufacturing by increasing replenishment lead time, which will end up with cost increase (Thonemann, Bradley (2001)). Therefore, centralization is a preferable option for the companies producing high variety of goods in order to decrease the amount of duplication. Finally, transportation cost will be higher for both supply and distribution stages because of the fact that higher number of suppliers dispersed globally will be worked with and there will be more products to be managed to deliver.

- ✓ *Measurement:* Number of codes in company portfolio

***Product value*** is the assessment of the worth for a good or service. It may be also measured by the price on shelf. With the increase in product value, an increase in inventory carrying cost is

observed correspondingly due to keeping more valuable goods in stocks. Moreover, if the "opportunity cost" is also taken into account, effect on inventory carrying cost is considered to be more significant. Therefore, in order to decrease this cost, duplication of the resources should be avoided by centralization and lead times should be decreased.

- ✓ *Measurement:* Price of the product (€)

***Product value density(PVD)*** is defined as the ratio of product value divided by chargeable weight. To compare, products having low value densities such as cement, are usually distributed close to market to many local catchment areas; while high value density products such as precious stones, perfumes or microchips are manufactured and distributed from few large scale facilities (Cooper, 1993). The reason behind it is the raise in holding cost of inventory going in parallel with PVD. By centralizing, benefits such as stock reductions and risk pooling are targeted to be realized. With the centralization option, although transportation cost is increased because of moving away from market, minimizing the holding cost and avoiding duplication and risks overweighs it. On the other hand, as PVD decreases, a more decentralized approach becomes preferable in order to be closer to market to avoid high transportation costs caused by high weight/volume.

- ✓ *Measurement:* $\frac{\text{Product Value (€)}}{\text{Chargable Weight (kg)}}$

***Product density*** is measured with the ratio of mass per unit volume. High density is aimed to be reached in order to achieve high utilization of transportation and storage facilities. Therefore, high product density products present a more efficient transportation and storage cost performance while low density products occupy a big place although it cannot reach the weight limit causing inefficient area usage. As density decreases, facilities should be closer to market in order to minimize the cost occurred due to inefficient utilization of transport modes. Moreover, product density has also an effect on warehousing cost. The higher density, the more weight can fit into an area of warehouse space. Therefore, storage area can be used in a more efficient way. In their study, Langley, Gibson and Novack (2008) indicates how transportation and warehousing cost is influenced as it is shown in Figure 3.1.

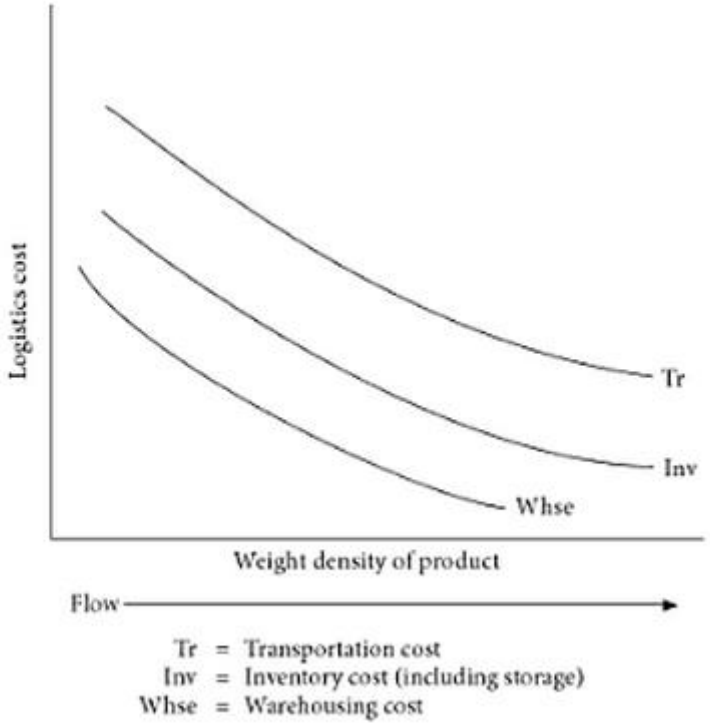



Figure 3.1 The general relationship of product density to logistics costs

- ✓ *Measurement:* $\frac{\text{Mass(kg)}}{\text{Unit Volume } (m^3)}$

***Obsolescence*** concerns the life cycle of a process, product or technology until become outdated, and no longer competitive in market place. The main products which are affected significantly from obsolescence risk are mostly technology based products impacted by fast change of the technology and customer requirements correspondingly. This risk can affect revenues and potential earnings dramatically. Main mitigation for obsolescence is to reduce lead time by this means cutting down the time in transportation and launch the product to market in the least possible time. Furthermore, Chopra and Sodhi (2004) discuss in their paper that, for high rate of obsolescence, a preferable strategy may be using redundant suppliers in order to prepare company for disruptions without building up fast-depreciating inventory.

- ✓ *Measurement:* Expected duration for a product to be demanded in market (days-months-years… )

***Shelf life*** refers the period during which a stored commodity, as food, drugs or chemicals remains effective, useful, or suitable for consumption. Similarly to obsolent products, shelf life has an important impact on the selection of most suitable supply chain configuration due to the time constraint they present. Products with short shelf life would require networks that holds low levels of inventory and utilize faster transport modes (A. Lovell et al., 2005). Therefore, a local distribution should be employed in order to decrease lead time to be in market.

- ✓ *Measurement:* Duration for a product to be perished and become unsuitable for consumption (days-months-years… )

***Handling Characteristics*** refers different requirements of tackles, gadgets and equipment while maintaining the material handling in safe and economical means. It has a strong impact on selecting the most appropriate solution because different material and handling characteristics may lead extra costs on supply chain. For instance, differences in the weight of the product, temperature constraints or the level of safety requirements of the vehicle can establish global supply chain network barriers (Rushton et al., 2000). As in global supply chain, the distances and therefore lead times are longer compared to local; this factor forms a significant constraint for selecting storing and transporting mode of the product. Furthermore, damages and losses are likely to occur as the requirements cannot be met.

- ✓ *Measurement:* An evaluation of the constraint in terms of special requirements

| **Score** | |
|---|---|
| **1** | Traditional handling methods and no special requirement |
| **2** | Some special requirements with easy and widely-used solution packages |
| **3** | Modarate requirements |
| **4** | Difficult and highly costly to satisfy requirements |
| **5** | Many or special (difficult to provide) handling requirements |

Table 3.1 Score table for measurement of handling characteristics driver

***Technology level*** is described with the relation between the products' innovation level. In his study Marshall L. Fisher (1997) defined the bottom and top level of technology level with functional and innovative products. The bottom point of technology level is the functional products which satisfies the basic needs which are relatively stable and predictable with demand and having long life cycles such as grocery and gas station. However, innovative products offer additional services in order to give a reason to customers to choose their brand/company as it widely preferred in fashion or technology sector. As all the outcomes of operating in high technology level is considered (unstable demand, higher margins, shorter life cycle), flexibility and responsiveness become the priority than cost considerations. Therefore, reduction in lead time gains importance with increasing level of technology (Huang (2003). Moreover, the firms offering high technology level, prefer to manufacture within national borders in order to protect its technology, skills and intelligent property.

- ✓ *Measurement:* An evaluation of innovation level

| Score | |
|---|---|
| **1** | Functional Product |
| **2** | Functional product with some basic additional services |
| **3** | Hybrid product |
| **4** | High level of innovation but still there is a gap for more |
| **5** | Innovative product |

Table 3.2 Score table for measurement of technology level driver

***Contribution margin*** is a relation between the production cost and the price of the product sold and is expressed in percentage. Lost sales will affect company more if the contribution margin is high. In order to prevent this situation, the products with higher contribution margins, are preferred to deliver with faster transportation modes or produced close to market in order to avoid lost sale (Fisher (1997)). Moreover, in the same way that contribution margin has effects on supply chain; choice of supply chain configuration may have effects on contribution margin as well. By supplying raw materials and components globally which will decrease the cost significantly, correspondingly it will increase the contribution margin of the same product which is highly desirable for the company.

- ✓ *Measurement:* $\frac{Price\ of\ the\ product - Cost\ of\ the\ product}{Price\ of\ the\ product}$

### 3.2 Service Requirements

***Lead time*** is defined as a time bucket from the moment of arrival of customer order till the moment of receipt of the goods by the customer. Lead time has a direct effect on responsiveness by means of being able to adapt to changes quickly or to be fast in new product launching (E. Hong and M. Holweg, 2002). In order to keep lead time in the minimum level, locating plants near to market would be an appropriate solution by means of increased respond for variations and change production plan immediately (A. Harrison and R. van Hoek, 2008). From distribution point of view, keeping distribution as local rather than global will also decrease lead times and improve responsiveness because of shortening the distance considerably(M. Christopher and D. Towill, 2001).

- ✓ *Measurement*: Duration between customer order and service completion (days)

***Completeness (item fill rate)*** refers the probability of having a product in stock when an order arrives. Due to the characteristics of demands which is very volatile and unpredictable, selecting the most appropriate supply chain structure is a challenge for firms, because this driver affects the overall delivery reliability within the network (Lovell, Saw and Stimson, 2005). In order to

increase this level, centralization can be used among inventories in order to pool the risk and increase reliability.

- ✓ *Measurement:* $\frac{number\ of\ orders - number\ of\ stock\ out}{number\ of\ order}$

***Delivery reliability*** refers to the capability of a firm for making the deliveries without any errors in term of regarding time, place, price, quantity and/or quality. It has a direct effect on customer satisfaction level. Whole supply chain has an effect on reliability. From supply point of view, supplier selection plays an important role on delivery reliability (Vonderembse, Tracey, 1999). Global supply would increase the lead time and decrease flexibility by means of quantity and time. Next, location of manufacturing and inventory facilities has an important effect on delivery punctuality. In general, overall configuration of global supply chain by means of number of echelons and length of chain, determines the reliability. A longer chain leads more uncertainties and mistakes which causes more cost and less accuracy correspondingly due to increased handling activities and transportation time.

- ✓ *Measurement:* Accepted quantity/Ordered quantity

Accepted and ordered quantity ratio is selected as a measurement although it seems it is related only with the right quantity and it ignores the other factors to make a reliable delivery. However, a delivery with less quality level than promised, or an unacceptable time delay will cause reject of the delivery which will reflect the outcome of the measurement.

***Delivery frequency*** is defined as the amount of deliveries performed in the certain time unit (week, month, and year). As Kraemer (2010) stated in her paper, deliveries with high frequency is attractive to customers because it keeps inventory holding costs low. On the other hand, it will entail higher transportation costs (frequency effect). If the reverse scenario is considered which is low frequency, it will lead an increase in the number of products to deliver which gives the opportunity to exploit the benefits of full container shipment as being more economical. Moreover low delivery frequency will bring less transportation cost which is favorable in global supply chains where distances are long. Therefore, in order to operate in most efficient and economical way is to prefer local distribution for frequent deliveries to be close to market and decrease the transportation distance.

- ✓ *Measurement:* number of deliveries performed in a certain time unit

### 3.3 Demand Features

***Size of orders*** defines the average quantity of orders. It is an important factor for determination of supply chain configuration. As the transport unit is filled up with the order size, by benefiting from the increased efficiency, longer distances and direct delivery can be adopted. By this way, both economies of scale and extra costs caused by unnecessary handling and inventory costs would be avoided. However, if the saturation cannot be reached, placing intermediary facilities would help to decrease local distribution costs. This solution will put additional inventory costs but on the other hand, transportation cost of the upstream stages will decrease dramatically. Van Ryzin (2001) emphesizes that size of orders has also an effect on procurement and manufacturing cost due to potentiality of achieving significant supplier volume discounts or decreesed manufacturing set-up costs creating similar economies of scale.

- ✓ *Measurement:* Average number of order units

***Demand predictability*** is a measurement of the error in the demand forecast. Schnaars (1997) discussed many factors effecting demand forecast accuracy in his paper. Among them, 3 factors are specifically related with the supply chain characteristics which are time horizon, product type and level of aggregation. First of all, level of globalization increases, distances and correspondingly lead time increases. Most authors agree on that, the longer the time horizon, the less accurate the forecast. Locating the facilitations closer will increase the accuracy by shortening the time horizon of forecast. Second, product type has a significant effect on prediction accuracy as Fisher (1997) stated in his paper that the average margin error for functional products is around 10% while it rises dramatically (between 60% to 100%) for innovative products. Finally, level of aggregation has an impact by pooling the demand variations from different areas. Therefore, an appropriate solution for unpredictable demands would be locating the distribution facilities closer to market although it will increase the inventory level.

- ✓ *Measurement:* Average error = (Predicted demand – Actual demand)/number of forecasts

***Demand variability*** defines how the amount of demand varies over time. It represents how demand pattern is in relation with average demand. High variability increases cost, because high levels of safety stock and additional pipeline is required in order to cope with this fluctuation. Demand volatility is highly correlated with product type. According to Fisher (1997), innovative products have higher demand variability; therefore, it requires more responsive and agile supply chain. On the other hand, demand volatility is one of the key factors for centralized configuration due to relatively decreasing the impacts of variation by pooling. Demand volatility should be watched out and possible negative outcomes especially bullwhip effect should be avoided. As

globalism level of a firm increases, the influences of demand variation is observed more because of long lead times increasing the risk of stock out and significant reductions in service level.

- ✓ *Measurement:* Variance of the demand in unit time

***Market size*** refers to the penetration rate for the specific category of the product. A global company can exploit economies of scale more because of the potential market size for globally generic products. However, to compete with local firms, it has to be responsive to local customer needs, too (Cohen and Mallik, 2009). As the dimension of market increases, global sourcing and manufacturing takes more place due to reduced purchasing and operating costs.

- ✓ *Measurement:* number of countries that the company penetrated into

***Domestic market strength*** identifies the ratio between the demand level in domestic market and the global demand of a firm. Delocalize production processes depends not only on production and trade costs but also on the potential size of the domestic/regional market (Nicita, Ognivtsev, Shitotori (2011). As domestic market strength increases, domination in homeland increases as well compared to worldwide activities. On the other hand, if the company operates in a global level without any dominance in domestic market, facilities should be located overseas in order to be closer to the foreign market.

- ✓ *Measurement:* number of customers in domestic market / number of worldwide demand

### 3.4 Supply Features

***Endowment of purchased items*** defines the availability of resources. From resources point of view, some countries/regions have geographical, technological or underground sources advantages and availability, while some of them face with scarcity and risk of "running out". In this case, manufacturing facilities should be located overseas near suppliers in order to have easier and cheaper access to the sources. According to Alonso, Field, Gregory & Kirchain, there are three different possible actions against material unavailability which are related to technological, geographic and operational outcomes that are explained below:

1. Technological: Supply chain stakeholders may redesign their products to use less or substitute materials.
2. Geographic: The upstream supply chain may reconfigure to tap into new sources
3. Operational: Downstream firms may alter inventory practices or work to recover alternative materials streams.

When it is not possible to redesign the product which is not so unlikely such as food products (e.g. coffee, cacao), only option is to source from other regions where the material is available.

- ✓ *Measurement:* In order to compare domestic resources with other countries, a ratio between the regions based on cost of those resources can be used. It would be an indicator for a firm to find out home country's position in the global market in terms of availability by supposing the cost will be lower in markets whose availability of the resource is higher.

***Sources quality*** is a similar driver with endowment of purchased items since low quality (such like low availability) directs firms to seek out foreign locations aiming to reach higher quality supplies. Quality standards became one of the key elements in value chain. With increasing product differentiation, ensuring quality became a critical element of market success (Gerrefi and Lee (2012)). The quality of products obtained from the domestic market may not meet the requirements of buyers. The quality of domestic goods may not be sufficient for the manufacturers to sell their products to international markets where higher standards may apply. In addition to the quality of the goods themselves, maybe the supplier cannot provide satisfactory warranties or after-sales services to the manufacturers. (Jiang, Tian (2010). Moreover, cost factor can support this choice as well if the same or higher quality is available for a better cost in foreign regions. Therefore, a company chooses to source globally from foreign sources when domestic resources are not satisfying the quality standards of the firm or if there is any better option offering the same quality level with more appropriate price which will be still cheaper when transportation costs are included.

- ✓ *Measurement:* Although measurement of quality can be highly subjective caused by different perceptions of "what quality is", a comparison of different regions in terms of quality can be made by use of quality metrics proposed by Juran.

***Competition of suppliers*** is an instance that influences the purchasing cost since the competition level is highly affecting factor of the price. As Jiang & Wang (2010) suggest in their article, in a supply channel, there are three main competitive forces interact with one another to affect the price and quality which are (1) the direct competition that is each supplier produces the same component, (2) the indirect competition among the suppliers producing the set of complementary components needed for assembling the final product, and (3) the vertical interaction between the assembler and the component suppliers. In their study, it is shown that in a supply chain, the independent suppliers face with those competitive forces which results in taking decisions and improvements regarding price, quality and performance. Since, measuring the price and assessing it if it is fair in terms of the quality and availability of it is difficult, evaluation of

competition of domestic suppliers can be the driver in order to estimate the economic performance of the purchased items. Therefore, as the competition level increases within domestic suppliers, sourcing should be in favor of them particularly if the price is the main driver.

- ✓ *Measurement:* Measuring the competition level is highly complicated and depends on companies' perception. Therefore, in order to define competition level, concentration level index can be used which is set according to market concentration of specified industry/ sector and place the suppliers' to the suitable scale. It should be remembered concentration level effects competition reversely such as total concentration refers no competition in the market.

| Score | |
|---|---|
| **1** | Total concentration- Perfect competition |
| **2** | High concentration – between 80% to100 %, ranges from oligopoly to monopoly |
| **3** | Medium concentration- between 50% to 80%, likely to oligopoly |
| **4** | Low concentration – 0% to 50%, ranges from perfect competition to oligopoly |
| **5** | No concentration - Monopoly in the market |

Table 3.3 Score table for measurement of supplier competition driver

### 3.5 Environment Features

***Exchange rate*** can be defined as the price of one country's currency expressed in another country's currency which is taken as American dollar in most of the financial papers. It is uncontrollable and has significant effect on companies' profitability. Zsidisin (2003) states that currency fluctuations carry a big supply risk because of having an important effect on Earnings Before Interest and Taxes (EBIT). It is one of the reasons for preferring operating globally in order not to be dependent on one country's exchange rate trend and decrease the risk by distributing it. Concerning this, hedging is one of the solutions to eliminate or at least mitigate the risk of currency fluctuation. Berger (2004) proposes dual sourcing against the risk, however, warning that this strategy will require more investment than single sourcing. Moreover, hedging will require assuring same quality and servicing level across multiple facilities and supplying chain partners. In brief, global supply will require higher investments while offering a great benefit which allows companies to control the situation when an unexpected change happened in exchange rate.

Beside the fluctuation risk of currency, strength of an exchange rate is also a strong factor affecting the decision to make supply, manufacturing or distribution operations in that country. A

weak currency might offer much cheaper offers in terms of supplies and manufacturing than the domestic market offers as well as it may decrease the labor cost for manufacturing.

- ✓ *Measurement:* Value of the currency against US dollars.

  Although this measurement is meaningful itself, it is not adequate to calculate it once because it is fluxional and required to be followed as time series in order to be aware of the current situation and take precautions on time.

***Labor quality*** refers to how skilled the workforce is. Skilled workers are characterized by a higher level of education, having often been through specializing courses in order to perform more complex activities. These are the workers which effectively create economic value for the organization, especially for their ability to develop and produce innovative goods, and thus are particularly important for companies working with non-commodity products. Therefore, organizations must assess whether there is availability of skilled workforce in their homeland according to their needs. Alternatively, they must consider bringing the adequate workers from abroad or even establishing facilities in other countries where the offer of skilled workers is more abundant.

- ✓ *Measurement: World bank index of employee percentage of primamary / secondary / tertiary education*

***Labor cost*** refers to the average expenditures with workforce, which is straightly connected to the availability of workers in the market. The higher the offer of workforce, fewer workers will be willing to receive to work, and thus the less labor costs organizations will face. Labor cost is considered as one of the most significant enablers to operate on global level. Labor costs compose a relatively high share in manufacturing, handling and order processing costs and depend on the productivity, whereas the latter is generally inversely related to labor costs (E. Hong and M. Holweg, 2002). Therefore, consisting of mostly companies operating in labor intensive industries, can gain drastic cost savings by moving their production to countries with low labor cost.

- ✓ *Measurement:* World bank index of employee participation rate

In this measurement, there is an assumption made to notice, which is the higher the rate, lower the average labor salaries. Average salary is not taken as the indicator due to being very difficult to reach the accurate data of the salaries of a country or region.

***Import tariff and quotas:*** Import tariff is the tax imposed on imported goods or services and quotas are the restrictions the quantity of imports. It is worth to note tariff rate quotas (TRQ) as

well, which are two level tariffs, with a limited volume of imports permitted at the lower "in quota" tariff and all subsequent imports charged the (often much) higher "out of quota" tariff (Ingco 1996, OECD 2001). These tools are established in order to shape trade policy of a country. Tariff and quotas are imposed by governments in order to either raise revenue from trade or to protect domestic production from foreign competitors. A high tariff or a low quota put a barrier against foreign producer to export its goods. Therefore, this obstacle is achieved by moving the facility within the borders and by this way being excluded from those barriers. These two drivers are the factors affect the companies' globality level of their operations.

Within an empirical study conducted by Helpman, Melitz & Yeaple (2003), firms which are serving foreign markets are analyzed in order to relate the company and sector feature with the selection of produce in the market or export to the market. The result is that the most productive firms in the group choose to invest in foreign markets while the less productive firms choose to export. As a result, it predicts that foreign markets are served more by exports relative to FDI sales when trade frictions are lower. We can conclude that, companies operating in big scale will prefer operate in global level in order not to be restricted by those additional costs.

Moreover, free trade areas such as EU and NAFTA which eliminates or reduces the tariff, quotas other restrictions between the signatories, might be the key factor to move facilities and change configuration in the direction of more globalized level in order to take the advantages of possible benefits.

- ✓ *Measurement:* Tariffs and quotas determined by each country

***Duty drawback rate*** is used in order to reduce or eliminate the duties paid on imported intermediaries or raw materials that are used production of exports (O. Cadot et al., 2003). They are used in highly protected, developing economies in order to provide exporters with imported inputs at world prices, while still protecting the final good producers from the worldwide competition (Ianchovichina, 2004). Companies should protect themselves against this factor by allocating the part of the manufacturing activities abroad. By this way, they can import and re-export the goods so as to reduce cost of duty refund.

- ✓ *Measurement:* Defined duty drawback rates for sectors per year

***Tax incentives*** states a deduction, exclusion or exemption from a tax liability, offered in order to encourage or support specific courses of action such as investment in capital goods for a given time period. Regarding that tax rates has an important effect on after tax profit, by establishing the global facilities and therefore the operations in the countries with lower tax rate or having advantageous incentives for investments drives a company to operate there in order to enjoy higher net profit. In order to exemplify, it is not a coincidence that in 1985–94 foreign direct

investment grew in the Caribbean and South Pacific which were tax heavens and Ireland's tax incentives have been recognized as key in attracting international investors over the past two decades (Morisset, 2003). Moreover, the effectiveness of tax policy and incentives depend on the companies' activity level and its motivations for investing abroad. For example, tax incentives seem to be a crucial factor for mobile firms or firms that operate in multiple markets because they can exploit better the different tax regimes across countries (Morisset et al. (2000)).

- ✓ *Measurement:* World Bank indicator of total commercial tax rate.

***Political stability*** has critical importance on the decision of operating in the given country. Political instability is likely to shorten decision makers' horizons, moreover, it may lead to more frequent switch of policies which creates volatility (Zouhaier & Kefi, 2012). Therefore politically instable countries can lead loss or reduction of production which may cause huge loss in profit which is less attractive and more costly to operate in those particular countries. Furthermore, security concerns and changes in regulatory environment or regime, may affect firms long term plans unfavorably and even cause big troubles, which makes companies to avoid investing or operating in unstable countries due to possible undesirable outcomes.

- ✓ Measurement: Political instability index

***Existing Infrastructure*** is an important factor for supply chain design decisions. It is evaluated with from two perspectives. First one is transportation infrastructure, transport modes availability and reliability such as level of development of roads, interchanges and junctions and the availability of loading ports and storage facilities, etc. Second one is the level of telecommunication development and market penetration. Concerning the first parameter, operating in global level, requires higher lead times and higher costs depending upon higher distances that leads utilizing more than one transport mode. Selecting the most efficient and cost saving mode is an important determinant for companies among those possible combinations of road, ocean and air. Moreover, poor infrastructure of the country will require more investment and will be more costly to maintain operations and transportation activities compared to countries with more developed infrastructure. E. Hong and M. Holweg (2002) states that nowadays there is little reason for production cites to be near natural resources or transport hubs for being easily supplied with goods, therefore the possible effect of the transport infrastructure development is the densification of firms in the vicinity of the infrastructure.

- ✓ *Measurement:* Logistics performance index

***Transfer price*** is the price of a purchase of product or service from another business unit or subsidiary of the same company. These prices are intra-company charges and are not transparent

for the information of outsider firms then the company itself. It is an important factor due to influencing the income tax paid, and the variations in transfer prices may affect the after tax profitability of a company due to different tax policies in different countries and this situation's impact on transactions within each other

- ✓ *Measurement:* Transfer prices defined by corporate level or business units. (€)

***Environmental concerns and regulation*** refers the degree of the environmental concerns to conform. Different countries have different levels of regulations which shape both the design and operational decisions of a supply chain in order to conform to emission quotas, sewage purification and wastes recycling requirements. According to Xing and Kolstad (1998), strong regulations leads; (1) drive up in production costs by requiring certain equipment; (2) decrease waste disposal capacity; (3) prohibit certain factor inputs or outputs; that in all of the cases, the bottom line of production cases are increased. It will obviously have strong influence on firms' decisions of facility location.

- ✓ *Measurement:* Country rankings in terms of environmental outcomes and policies

  There are different studies in order to establish a report on country performances of environmental responsibility and regulation. In our work we have taken the reference as the paper of Esty D. C & Porter M. E (2001).

***Fame of the manufactured country:*** Some countries are famous with specific features, such as Italy and France with fashion, Switzerland with chocolate and United States with technology. Producing goods in those related countries add value to the product, because of increasing reliability of the design/production/creativity quality of the products. It provides an identity to the brand, therefore, it is generally preferred by exclusive brands. Hence, companies trying to increase their brand perception by customers may stay local in terms of production in order to enjoy the benefits of its label written "Made in … ".

### 3.6 Conclusion for Drivers Part

32different drivers are presented in part 3, clustered in 5 different categories named as product, service, demand, supply and environment. Their impact on supply chain configuration selection in terms of globality/locality level of supply, manufacturing and distribution stage is tried to be identified, which resulted in a exploring the links in between drivers and supply chain configurations. Moreover, a measurement method is proposed for each driver in order to realize the importance of its effect and to use the drivers for quantitative approaches in order to define optimum supply chain configuration. Only exception for the measurement proposals is the fame of country which is a unique driver among the others given in the chapter because of obtaining

this driver as an outcome of case studies given in chapter 4,. It is deducted while investigating companies and added to the list during the iterative process of reviewing previous findings.

To support and facilitate this decision, a further study is carried out in order to investigate the costs to be occurred and risks possible to encounter. In Table 3.5, the outcome table is presented in terms of drivers' impact on globality level decision with the correlated costs and risks to be assessed in those decisions.

Cost impact of drivers provides an analytical tool in order to evaluate the supply chain configuration stage selection. Costs are essential attribute for driver selection due to having significant impact on company profitability which can be counted as prior objective of the company. Decreasing supply chain cost as possible enables company to gain a competitive advantage by lower product costs which will result in higher margin or lower prices attracting more customer. Main costs related with the drivers can be listed as manufacturing cost, transportation cost, inventory cost, handling cost, opportunity cost, disposal cost and administrative costs.

In the following, the summary table of impacts of drivers on supply chain stages is given. In the first attribute, the correlated stages of the supply chain with the given driver are indicated. After on, the influence of the driver as it increases from low impact to high or vice versa on company's supply chain globality level.

Finally risks are identified whose likelihood and impact is affected by any strategic decision given by taking into account the related enabler. Risks are substantial evaluation criteria for the companies' strategic supply chain choices as they may have drastic damages for both operational and strategic goals. Moreover, involving risk criteria of the driver enables companies to take precautions such as mitigation studies, transferring risk or to avoid it if it is too high for company's risk appetite.

According to defined criteria stated above, the company chooses a set of key drivers which are prior to design the most optimum possible supply chain specific satisfying its spesific needs and tackling different problems occurred by different activities of the company and sector characteristics and requirements while taken into account assuring to perform within defined level of efficiency and effectiveness. By assessing all those considerations with potential risks and related costs, a supply chain unique to the company is ultimately designed.

| Product Features | Cost | Stage | Decision of Globalization Level | Potential Risks |
|---|---|---|---|---|
| Product variety | Inventory carrying cost<br>Economies of scale<br>Material handling cost | Sourcing | Product variety ↑: Global sourcing | High safety stock<br>Duplication of resources<br>Cost increase |
| | | Distribution | Product variety ↑: Global distribution (centralization) | |
| Product value | Inventory carrying cost | Distribution | Product value ↑: Global distribution (centralization) | Lost sale (higher effect)<br>Tie up lots of money to inventory |
| Product value density | Transportation cost<br>Inventory carrying cost | Distribution | PVD ↑: Global distribution (centralization) | Duplication of resources<br>High transportation cost |
| Product density | Transportation cost<br>Inventory carrying cost | Distribution | Product density ↓: Local distribution | Inefficient usage of transportation and storage modes |
| Obsolescence | Opportunity cost<br>Disposal cost | Distribution | Obsolescence risk ↑: Local distribution | Risk of becoming obsolete before putting on shelf |
| Shelf life | Opportunity cost<br>Disposal cost | Distribution | Shelf life ↓: Local distribution | Excess supply to market<br>Products to be perished on shelf |
| Handling characteristics | Handling cost | Sourcing | Handling requirements ↑: Local sourcing | Damage on product<br>Extreme rise of costs due to specific requirements |
| | | Distribution | Handling requirements ↑: Local distribution | |
| Technology level | Manufacturing cost | Manufacturing | Tech. Level ↑: Local manufacturing | Obsolescence risk |
| Contribution Margin | | Sourcing | Cont. Margin ↑: Global supply | Lost sales |
| | | Manufacturing | Cont. Margin ↑: Global manufacturing | |
| | | Distribution | Cont. Margin ↑: Local distribution | |

| Service Requirements | Cost | Stage | Decision od Globalization | Potential Risks |
|---|---|---|---|---|
| Lead time | Transportation cost<br>Manufacturing cost | Manufacturing | Lead time ↓: Local Manufacturing | Low flexibility and responsiveness risk |
| | | Distribution | Lead time ↓: Local Distribution | |
| Completeness (item fill rate) | Transportation cost<br>Opportunity cost | Manufacturing | Completeness ↑: Local manufacturing | Duplication of resources<br>High level of safety stock |
| | | Distribution | Completeness ↑: Local distribution | |
| Delivery reliability | Transportation cost<br>Administration cost | Supply | Reliability ↑: Local supply | With the longer chain, less accuracy and more uncertainty risks increase |
| | | Manufacturing | Reliability ↑: Local manufacturing | |
| | | Distribution | Reliability ↑: Local distribution | |
| Delivery frequency** | Inventory cost<br>Economies of scale<br>Transportation cost | Distribution | Frequency ↑: Local distribution | Inefficient and costly transportation |
| **Demand features** | **Cost** | **Stage** | **Decision of Globalization Level** | **Potential Risks** |
| Size of orders | Transportation cost<br>Procurement cost<br>Manufacturing cost | Distribution | Demand size ↑: Global distribution | Not being able to fill up the transportation mode |
| Demand predictability | Manufacturing cost<br>Inventory carrying cost | Manufacturing | Predictibility ↑: Global manufacturing | Over or under production<br>Over or under supply to market<br>Low responsiveness |
| | | Distribution | Predictibility ↑: Global distribution | |
| Demand variability | Manufacturing cost<br>Inventory carrying cost | Sourcing | Volatility ↑: Local sourcing | Excessive stock<br>Insufficient responsiveness |
| | | Distribution | Volatility ↑: Local distribution | |

| | | | | |
|---|---|---|---|---|
| Market size | Economies of scale Manufacturing cost | Sourcing | Market size ↑: Global sourcing | Losing demand due to being less responsive than local producers |
| | | Manufacturing | Market size ↑: Global manufacturing | |
| Domestic market strength | | Manufacturing | Market strength ↑: Local (Domestic) manufacturing | Being less competitive in worldwide operations |
| **Supply features** | **Cost** | **Stage** | **Decision of Globalization Level** | **Potential Risks** |
| Endowment of purchased items | Transportation cost | Sourcing | Endowment in foreign region↑: Global sourcing | Face with scarcity Extreme increase in resources cost due to availability |
| | | Manufacturing | Endowment in foreign region↑: Global manufacturing | |
| Sources quality | Transportation cost | Sourcing | Service quality in foreign region↑: Global sourcing | |
| Competition of domestic suppliers | Raw material cost | Sourcing | Competition ↑: Local sourcing | |
| **Environment features** | **Cost** | **Stage** | **Decision of Globalization Level** | **Potential Risks** |
| Exchange rate | Manufacturing cost | Sourcing | Exchange rate ↓: Global sourcing | Risk of an unexpected increase |
| | | Manufacturing | Exchange rate ↓: Global manufacturing | |
| Labor quality | Manufacturing cost | Manufacturing | Quality ↑ : Global manufacturing | High costs for skilled labor |
| Labor cost | Manufacturing cost | Manufacturing | Cost ↓: Global manufacturing | Change in Country economy effecting labor costs |
| Import tariff and quotas | Transportation cost | Manufacturing | Tariff ↑ or Quota ↓: Global manufacturing | An increase in tariff if global distribution is preferred |
| | | Distribution | Tariff ↑ or Quota ↓: Local distribution | |
| Duty drawback rate | | Distribution | Rate ↑: Global manufacturing | Any change in policies and regulations |
| Tax incentives | Manufacturing cost | Manufacturing | Incentive↑: Global manufacturing | Abandonment of the incentive |
| Political stability | | Manufacturing | Stability ↑: Global manufacturing | An unexpected change in stability |

| | | | | |
|---|---|---|---|---|
| Existing infrastructure | Manufacturing cost | Manufacturing | Existing infrastructure ↑: Global manufacturing | An unexpected physical attack or natural disaster |
| Environmental concerns and regulations | Manufacturing cost | Manufacturing | Regulation requirements ↓: Global manufacturing | Change in regulation not goes along with the company's environmental indication results |
| Transfer price | Manufacturing cost Transportation cost | Sourcing | Transfer price ↑: Global sourcing | |
| | | Distribution | Transfer price ↑: Global distribution | |
| Fame of manufacturing country | Manufacturing cost | Sourcing | Fame ↑: Local sourcing | High costs occur Change in fashion Damage in reputation of country |
| | | Manufacturing | Fame ↑: Local manufacturing | |

Table 3.4 Summary table for drivers and their impacts on supply chain stages

## 4. Case Studies

In this part of the thesis, it is tried to be extracted the supply chain configurations of some global companies by investigating their corporate websites, annual publications such as annual reports and sustainability reports, the interviews with authorized managers published on journals and interviews that we have conducted with companies via e-mail.

The aim of this chapter is to extract the global supply chain configurations of big global companies and place the configuration on the model that we developed. Also, with the practice of this study we aim to have a judgment on how companies decide to adopt the most suitable supply chain configuration for them considering their business areas, strategies, constraints and drivers.

Companies are selected considering different kinds of criteria. First, the companies are tried to be selected from different type of industries that we think they use global supply chain tools effectively. It is considered that, each sector has its own constraints and challenges that can affect the design of global supply chain configuration. Second, we took into consideration if the supply chain parts of the companies operate globally in terms of sourcing, manufacturing or distribution. In other words, it is given attention if supply chain organization processes are managed in one region or different geographical region. Another selection criterion is the size of

the company. It is important to select big companies for analysis because they are more aware of the market situation in order to take the possible advantages that global environment serves.

For the case studies part, we analyzed 47 companies. 12 companies of them operates in apparel (clothing, footwear and accessories) industry, 11 operates in FMCG, 6 in electronic and household appliances, 3 in the automotive, 4 in computer and communication technologies, 1 in oil, 1 in plastics, 2 in pharmaceuticals,3 in toys and stationery, 2 in cosmetics, 1 in glass and 1 in aviation industries. Distribution chart of the business sectors of the selected companied are showed in Figure 4.1 as following.

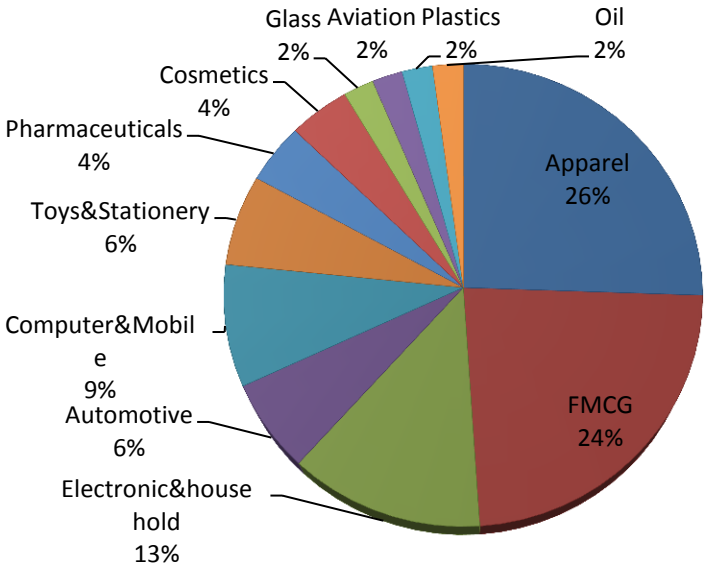



Figure 4.1 Distribution of the business sectors

Analysis of the each case study is done first with a brief description of the company with its key outstanding figures, business area that it operates in, products portfolio that it serves to the global market and findings related to the supply chain operations in global level. After the explanations part, supply chain network scheme and the model that we have developed which shows the type of configuration that the company uses are drawn.

### 4.1 Companies and their global supply chain configurations

#### 1. Candy Washing

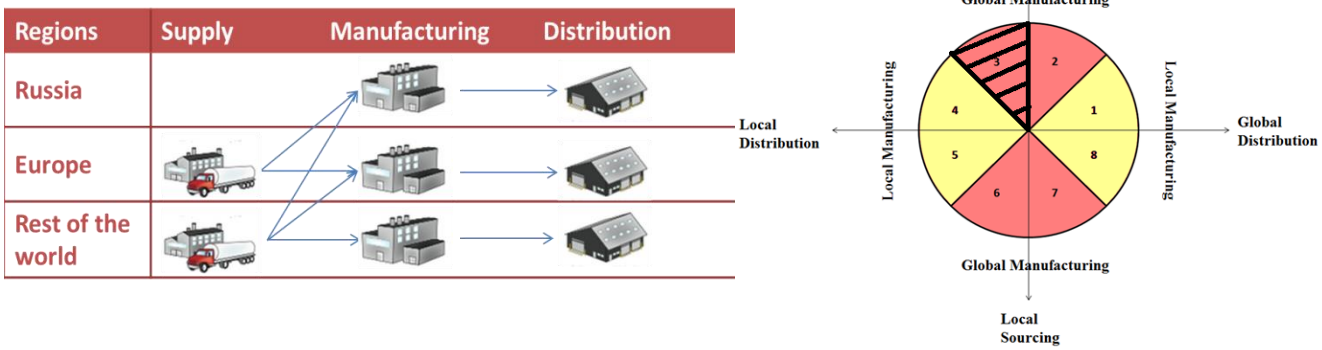
Business Sector: Household appliance

Products: Washing machines, dishwashers

Supply Chain Configuration: Global sourcing, global manufacturing, local distribution

Candy Group is an Italian based company established in 1945 which produces domestic appliances. It has three main product groups: Candy washing which refers to the products of washing machines, dishwashers; Candy cooling which refers to the products of refrigerators, freezers; and Candy cooking which consist of dryers, cookers and ovens. The Group operates through two international brands, Candy and Hoover, and the national ones: Rosières, Iberna, Jinling, Otsein, Süsler, Vyatka, Zerowatt, Hoover-Helkama, Hoover-Grepa.

Manufacturing strategy of Candy consists in locating plants close to where the demand is. It has plants in Italy, France, Spain, Czech Republic, Russia, China and Turkey. Material sourcing for Candy washing appliances are made globally but it also source 20% finished products from Europe and 80% of finished products from Turkey. As market it serves all around the world. In Europe, it mainly serves to Italy, France and UK (50%), in Western Europe its main market is Russia (3.5%) and for the rest of the world, crucial markets for Candy are China, Turkey, Morocco, Iran, South Mediterranean countries, India and Argentina (16%). It can be deducted that the drivers that affect the supply chain strategy and configuration of Candy washing are mainly availability and quality of labor force, proximity to the suppliers and served markets.



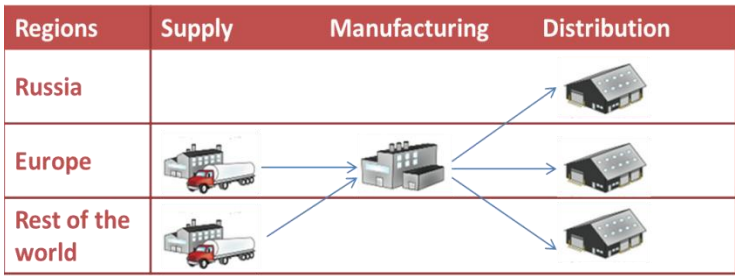
## 2. Candy Cooling

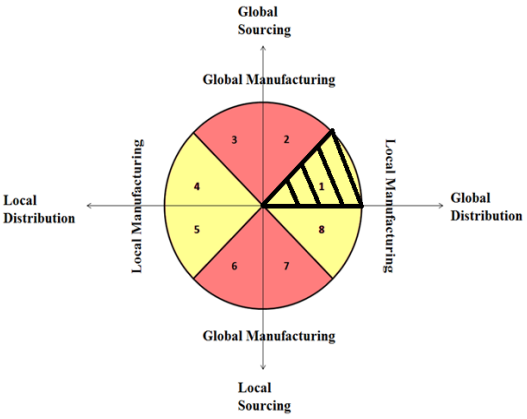
Business Sector: Household appliance

Products: refrigerators, freezers

Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

In Candy Cooling case, it is observed that, sourcing is made from many countries while production takes in only Europe. Centralization is applied for production and is distributed to whole world from Europe.



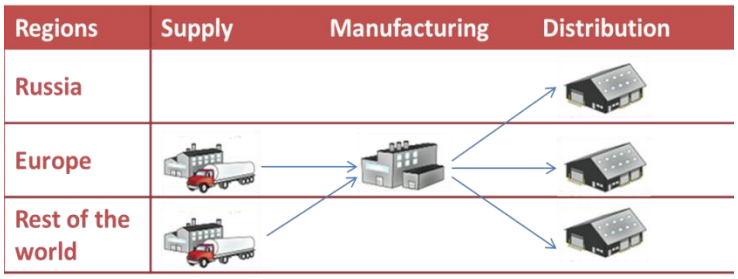

## 3. Candy Cooking

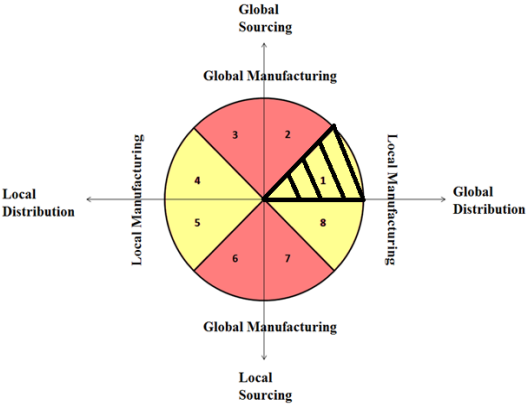
Business Sector: Household appliance

Products: Dryers, cookers and oven

Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

In Candy Cooking case, it is observed that, sourcing is made from many countries while production takes in only Europe. Centralization is applied for production and is distributed to whole world from Europe.




## 4. Chicco Toys

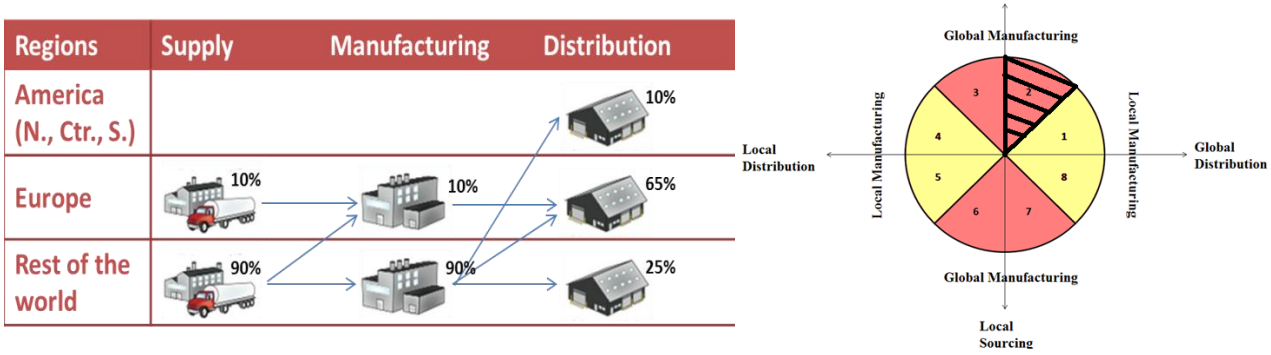
Business Sector: Toys

Products: Toys

Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

Chicco is an Italian baby care brand established in 1958 and it is the most important brand of Artsana, an Italian company founded in 1946. Chicco specializes in making clothing and equipment for babies and toddlers, including strollers, high chairs, car seats and toys. Chicco is a multinational company that is present in more than 170 different countries through its offices or licensed distributors. Other than Italy, the biggest markets for Chicco products are Spain, USA, Portugal, France, Brazil, Germany, Greece, Russia and Ukraine. There are over 400 Chicco shops in the world.

Chicco operates in a highly globalized level. It sources, manufactures and distributes globally although its major market is in Europe. It supports Europe with 10% production which makes it more reactive to changes, but most of the goods are transported from other regions.




### 5. Parah Underwear & Beachwear

Business Sector: Fashion Industry

Products: Underwear, Beachwear

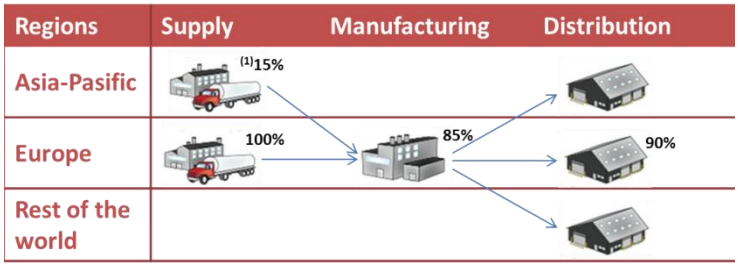
Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

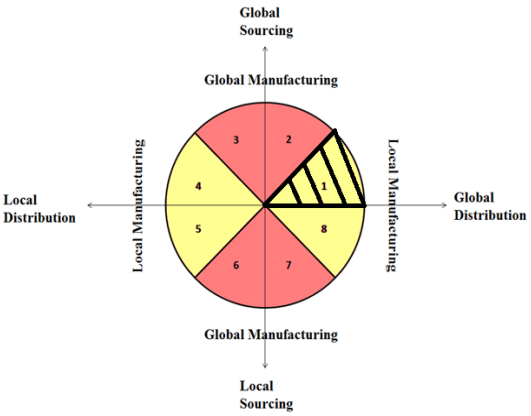
Parah was founded in the 1950s in Italy and became a huge success in the fashion industry in the 1970s. It has wide range of swimsuit and underwear products for both men and women. There are 6 different brands belong to the company: Parah, Impronte Parah, Parah new generation, Parah Online, Parah Uomo and Sabbia. Every step of the production process, from style design to manufacturing with cutting-edge machinery, is done in Italy so Parah can guarantee its customers products that are 100% made in Italy. Parah supplies 15% of finished products from Asia and produce 85% of products at its plants in Europe. It supplies 100% of materials from Europe.

By analyzing supply chain of Parah, it is deduced that the company adds value to its product with the label written “made in Italy”, benefiting from the fashion reputation of Italy. Some parts

are brought from Asia-Pacific countries due to cost reasons but it is within the interval that is not dominating its main strategy of being an "Italian" brand by supplying and manufacturing totally within Europe, mostly in Italy. Moreover, the majority of the market that Parah serves is comprised of EU countries which results in proximity to main market to follow the changes, decrease lead time and increase delivery frequency. Being a fashion company, by locating its production facilities close to market enables them to follow the trend closely and be able to operate in a more flexible way.

Dominant Drivers: Country's reputation, proximity to market, lead time, delivery frequency, domestic market strength




### 6. BasicNet

Business Sector: Apparel

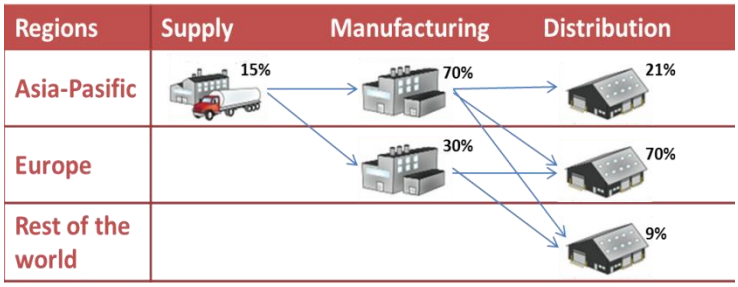
Products: Casual, sportswear

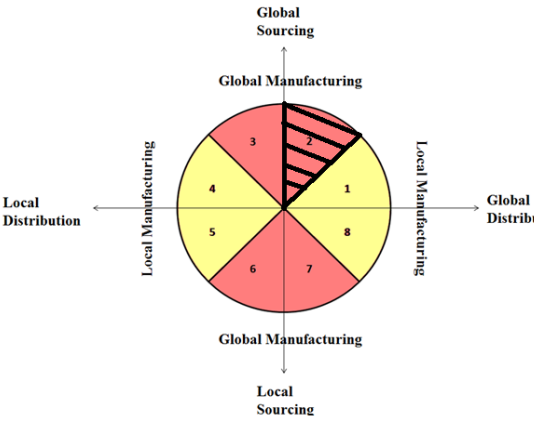
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

The group was born in 1995 by Marco Boglione which is headquartered in Turin and publicly quoted in Italy. The group is a major participant in the sector of branded leisurewear and sportswear, footwear and accessories with a collection of market-leading registered trademarks, including Kappa, Robe di Kappa, Jesus Jeans, Lanzera, K-Way, Superga, AB Besson and Sabelt.

BasicNet Group is not engaged in manufacturing so it outsources to third parties. Indeed, the BasicNet Group supervises and optimizes, via dedicated Sourcing Centers, all manufacturing phases on behalf of the licensees, capturing significant economies of scale by seeking out the production sources more appropriate (in terms of cost and standard of quality) at the worldwide level. By way of recognition of all this, the BasicNet Group receives sourcing commission on purchases. With the light of this information, we can deduct that the company mostly seeks out cheap production which leads them to give priority to the factors of low labor cost, exchange rate, competition of domestic suppliers and product value. All those factors enables company to seek sources and 3rd party producers in order to have the minimum cost possible, without any major quality concern.

Dominant factors: Labor cost, exchange rate, competition of domestic suppliers and product value




### 7. Mantero

Business Sector: Apparel

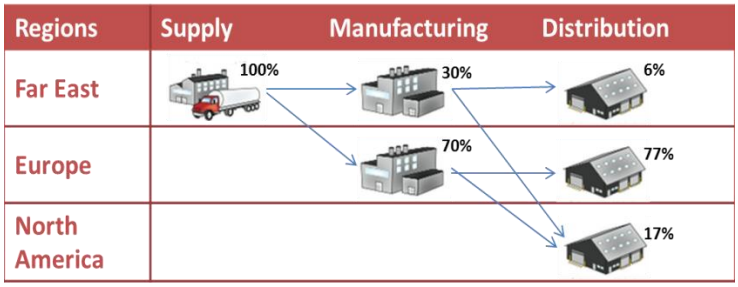
Products: Fabrics, clothing, handbags, lingerie, swimwear, ties, shirts, accessories,

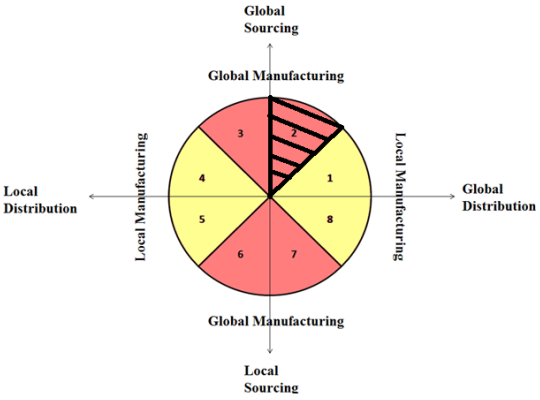
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

The company is founded in Como, in 1902, by Riccardo Mantero. Mantero operates in luxury and fashion industry serving to the international customer portfolio. Its operating structure is divided into two main areas: a Womenswear Division and a Menswear Division. As products, it has jacquards, prints and accessorizes. Its licensed brands are distributed through its own-name branches abroad as well as through a widespread network of agents and distributors. To guarantee the excellence of the finished product, Mantero directly controls each stage of the manufacturing process (hand-finished edges, fringing and other embellishments …) and has an important unit dedicated to quality control which takes place during each and every stage of the production process. A logistics hub and computerized warehouse have been developed to better manage and fulfill individual customer requirements.

All the raw materials, semi-finished products and finished products are sourced from China and sent to the plants in China and Italy. Therefore, we can make a deduction of company's priority is to source cheap. Therefore, it sources its supplies from far east in order to benefit from mainly exchange rate and supplier competition. In manufacturing side, different drivers dominate with accomplishing the aim of high quality products and being more flexible. It can be seen that high percentage of the production is done in Europe where the main market exists, which enables company to be close to the market and decrease lead time which is important for apparel industries due to high pace of change in trends.

Dominant factors: Exchange rate, supplier competition, leads time




### 8. Sergio Tacchini

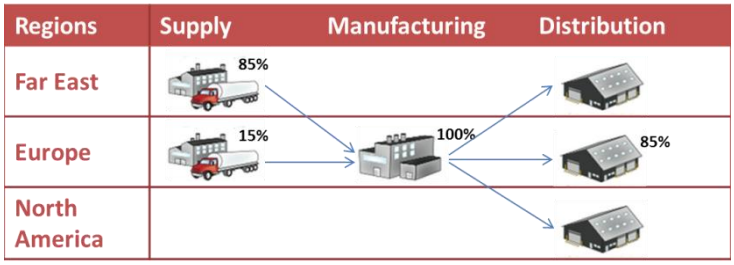
Business Sector: Apparel

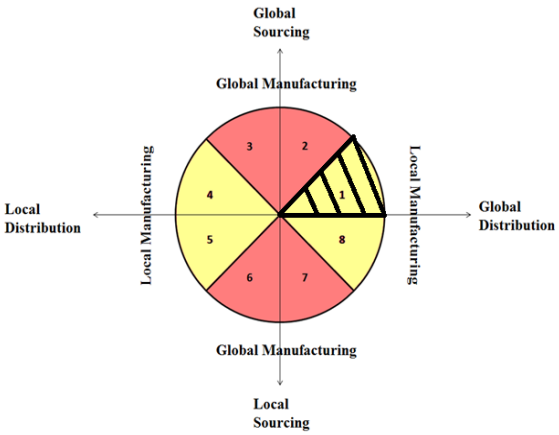
Products: sportswear, footwear, leisure collection, accessories

Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

The Company was founded in 1966 in northern Italy, by Sergio Tacchini, the International Tennis player who was a player in the Davis Cup for Italy from 1959 to 1966. The brand immediately introduced great innovation in style, using colors and stripes at a time when tennis players only wore white. The distribution in Italy is mainly done through monobrand stores, but the brand is well distributed abroad in Countries such as France, Greece, Germany, Czech Republic, Spain, Belgium, Sweden and other main Countries.

Company's priority in decision making about sourcing is the cost. Since raw materials required are cheaper in China it sources majority of the supplies from Far East. Also company takes advantage of low exchange rates and supplier competition. 100% of production is made in Italy which ensures the high quality perception for the customers.




### 9. Patrizia Pepe

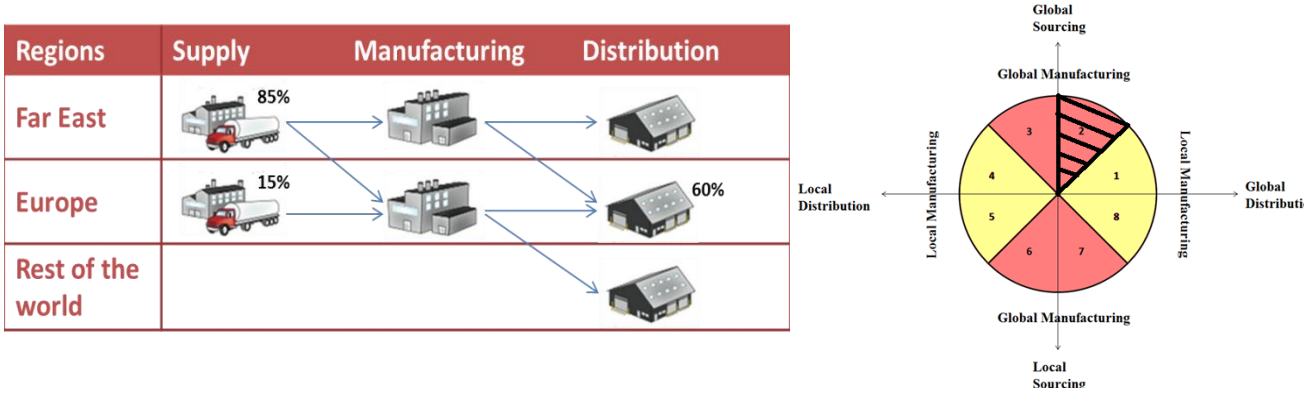
Business Sector: Apparel

Products: female clothing, shoes, bags, accessories

Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

It is an Italian fashion brand founded in Florence, Italy in 1993 by Patrizia Bambi and Claudio Orrea. The line of products includes womenswear, menswear, child, underwear, beachwear. The company has flagship stores around the world from Russia to Japan, the United Arab Emirates to Germany. About 40% of its turnover is gained from the foreign market. The choice of the distribution differentiates the company from its competitors. The clothing lines are distributed through showrooms where the retailer can go to buy the clothes. Apart from Europe, China is the biggest external market for the company. Also it sources the majority of raw materials from China.

For Patrizia Pepe, as it was in Mantero and Sergio Tacchini cases, the cost of the raw material is crucial, therefore, it sources 85% of raw materials from China and send to the plants located both in Far East and Europe. Sourcing from Far East provides company to take the advantage of exchange rate and high supplier competition. About the production part, the company has the strategy of manufacturing both in Far East and Europe in order to be closer to the served markets, to be flexible and to decrease the lead time. Moreover, ensuring the high quality is another reason lying behind the manufacturing side.




**10. Levi Strauss Europe**

Business Sector: Apparel

Products: Jean, pants, sweaters, shirts, T-shirts, sweatshirts, shoes, accessories

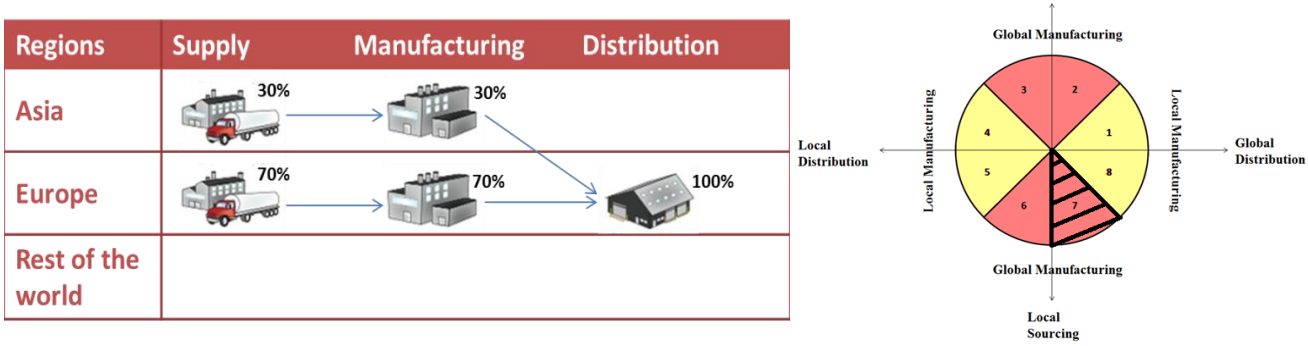
Supply Chain Configuration: Local sourcing, global manufacturing, global distribution

The group company Levi Strauss & Co is founded in San Francisco by Bavarian immigrant Levi Strauss in 1853. Products are sold under the names of Levi's, Dockers, Denizen, and Signature by Levi Strauss & Co. ™ brands. Levi Strauss & Co. is today a well-established global business. It operates in 110 countries, and approximately half of its net revenue comes from outside of the United States. The presence of the company in the United States, Canada, Western Europe and

Japan is well established. In the years ahead, it wants to expand the Levi Strauss & Co. brands in India, China, Russia, Brazil and other emerging markets. Europe division of the company is headquartered in Brussels. Across the region, there are nine sales offices, six distribution centers and three production facilities. Levi's and Dockers brand products are marketed and sold in more than 40 countries in the region.

Analyzing the supply chain, we can see that the company tried to make an optimum balance between quality, proximity and cost which are the main conflicting concerns of most production companies. Most of the production is done in Europe where the market exists while it is supported with the production in Asia. Therefore, it can balance the outcomes of each choice which is decreased cost but increased distance in Asia with decreasing lead time but increasing cost in Europe.

Dominant factors: Exchange rates, labor cost, delivery reliability (Europe), competition of domestic suppliers (China), and lead time.




**11. Whirlpool Europe**

Business Sector: Electric/electronic household appliance

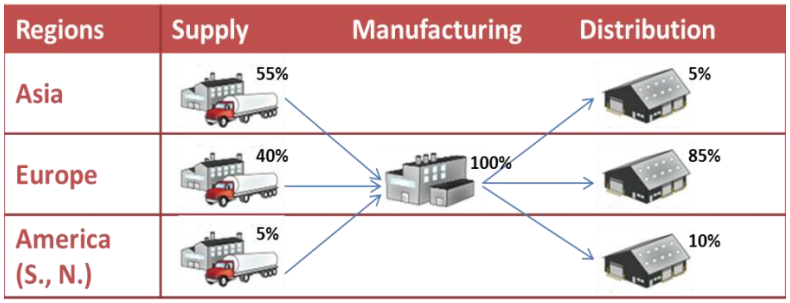
Products: Cooking appliance, refrigerators, dishwashers, washing machines, dryers,

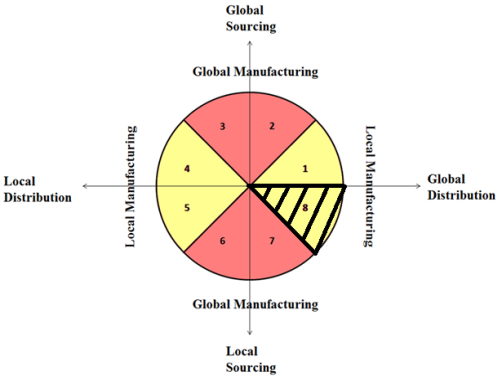
Supply Chain Configuration: Local sourcing, local manufacturing, global distribution

It is an American multinational manufacturer and marketer of home appliances headquartered in Benton Charter Township, Michigan, United States. Company has more than 70 manufacturing and technology research centers around the world. It markets many brands apart from the name whirlpool itself. Europe division headquarter is located in Varese, Italy.

Plants in Europe source globally and distribute its products to Europe, Asia and America markets but basically Europe and Asia. It can be interpreted as balance is tried to be set by enjoying lower cost options in Asia and staying closer to its suppliers which gives a higher control in Europe. White good products contain numerous components differ in terms of prior

characteristics. It's a better choice for some components to source from Asia that can be brought in big amounts, but the others are a better choice to supply from Europe in order to meet technological requirements and shorten the lead time. Brian Hancock, previous Vice President of Supply Chain in whirlpool, explains the market having shift in terms of customer demands. Hancock says a majority of customers had begun to act more quickly, buying new machines because the old ones broke down and had to be replaced or even treating them as somewhat discretionary purchases. "The supply chain needed to be able to get that appliance to [the consumer] within 48 hours," he says. In order to meet this quicker demand, besides applying improvement efforts in inventory management, critical components are procured from close. Delayed sourcing of components would cause delays in the production of a new refrigerator, and thus, a later launch of new products. Within the home-appliance industry, the fierce level of competition meant that any delays in launching new products would result in a loss of sales for the stragglers. Moreover, there is an intense work for greening the supply chain to realize big savings in energy and transportation costs.




**12. Pirelli Tire**

Business Sector: Plastic Components

Products: Care & light truck tire, motorbike tire, truck tire

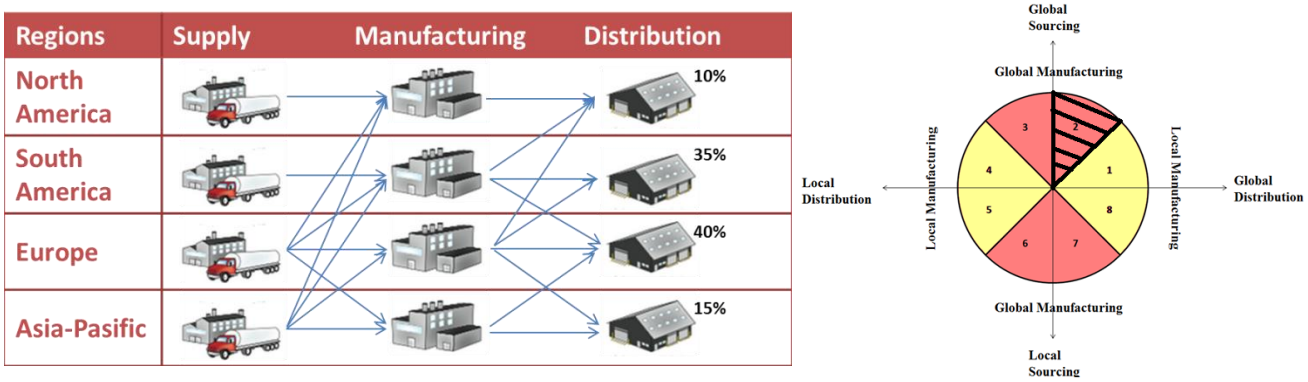
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

Pirelli & C. SpA is a multinational company based in Milan, Italy. The company, the world's fifth-largest tire manufacturer behind Bridgestone, Michelin, Goodyear, and Continental, is present in over 160 countries, has 22 manufacturing sites around the world and a network of around 10,000 distributors and retailers.

Main resources of Pirelli Tire are Natural & Synthetic rubber, Carbon black, chemicals and textiles. Most of the sources are tried to be met by local suppliers as possible. However, some sources are procured from abroad due to availability reasons such as natural rubber. Moreover, it

is stated that, 78% of the suppliers operate locally with respect to the supplied Pirelli Tire affiliates, in accordance with “local for local” logic.

Dominant factors: availability, lead time, environmental concerns




### 13. Hewlett-Packard Europe

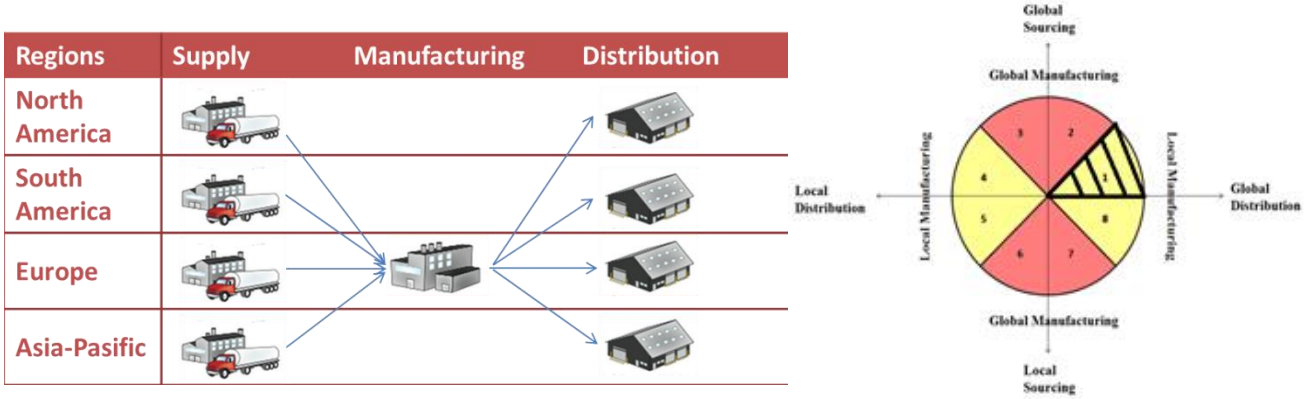
Business Sector: Computer manufacturing and technical support services

Products: Personal system products, imaging and printing devices, technology solutions

Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

The Hewlett-Packard Company or HP is an American multinational information technology corporation headquartered in Palo Alto, California, United States. It provides products, technologies, software, solutions and services to consumers, small- and medium-sized businesses (SMBs) and large enterprises, including customers in the government, health and education sectors. HP serves more than 1 billion customers in more than 170 countries on six continents.

Plants in Europe source and distribute globally. Electronic products contain numerous components differ in terms of prior characteristics. It’s a better choice to source from Asia that can be brought in big amounts, but the others are a better choice to supply from Europe in order to meet technological requirements and shorten the lead time. Therefore, there is no dominant strategy in terms of sourcing stage that can vary depending to the critical characteristics and requirement of the material or component.



### 14. Black & Decker

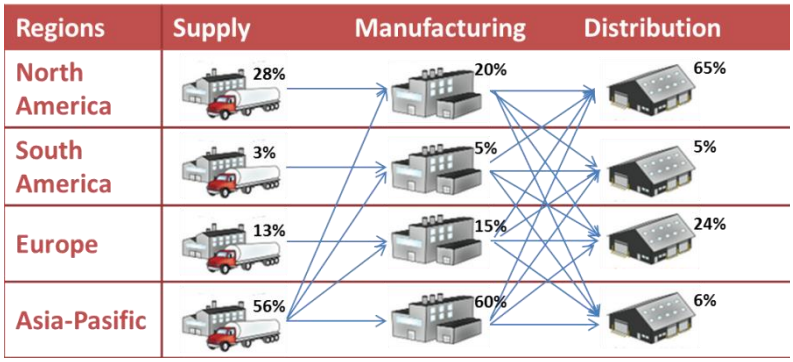
Business Sector: Power tool and electrical machine tool

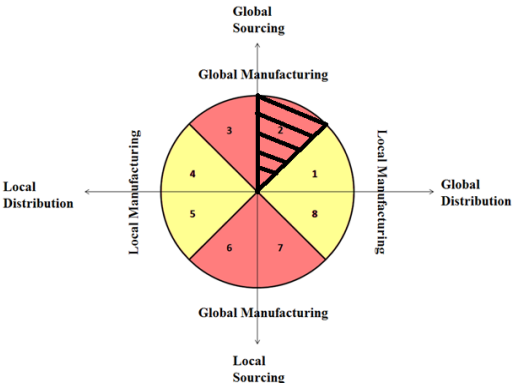
Products: Power tool and accessories, hardware and home improvement products, Fastening systems

Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

Black & Decker Corporation is an American manufacturer of power tools and accessories, hardware and home improvement products, and technology based fastening systems. It is founded in 1910 in Baltimore, U.S.A. On March 12, 2010, Black & Decker merged with Stanley Works to become Stanley Black & Decker.

It operates all over the world in terms of whole length of supply chain. It occupies a mixed sourcing strategy that most of the supplies are coming from Asia-Pacific countries which gives cost advantage to the company meanwhile some sourcing is done locally that gives transportation time saving for some materials. In production and distribution stages, it operates totally global.




### 15. GlaxoSmithKline Ltd.

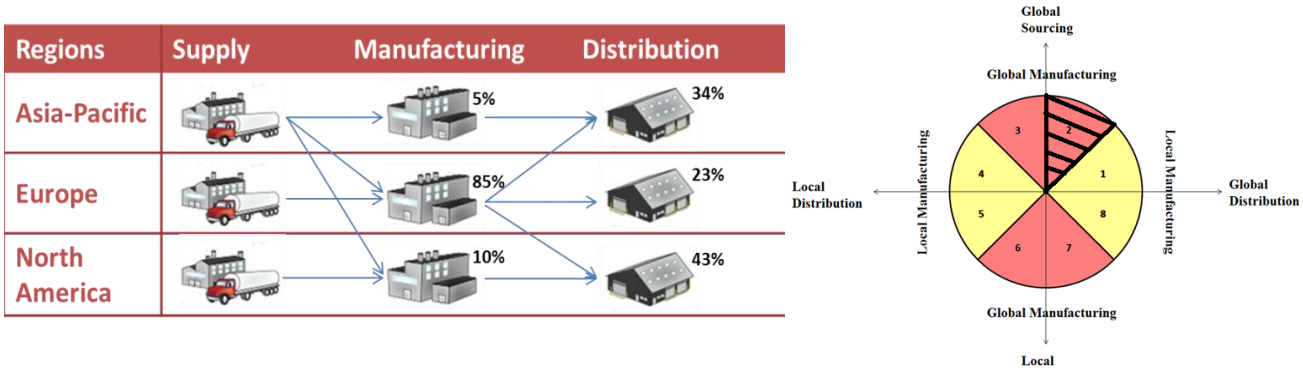
Business Sector: Pharmaceutical & health care

Products: Pharmaceuticals, Vaccines

Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

GlaxoSmithKline (GSK) is a British multinational pharmaceutical, biologics, vaccines and consumer healthcare company headquartered in London, United Kingdom. It is the world's fourth-largest pharmaceutical company. GSK has a portfolio of products for major disease areas including asthma, cancer, virus control, infections, mental health, diabetes and digestive conditions. GSK has a wide geographical reach. It has offices in more than 115 countries, major research centers in the UK, USA, Spain, Belgium and China and an extensive manufacturing network with 87 sites globally.

It is essential for GSK more than any other company in other sectors to have an effective and responsibly managed supply and distribution systems to get high quality products to the right places at the right time for patients because of its critical responsibility to provide medicine. While achieving this, of course, cost is an important factor to consider additional to the main issue of quality. In order to understand the complexity of the supply chain of the company, we believe the necessity to give the following facts: Each year GSK spend around £9 billion on goods and services with 6000 suppliers in 73 countries. The ingredients and materials purchased from suppliers are fed into their network of more than 87 GSK sites in 37 countries. Nearly 28000 products are manufactured and 4billion packages are produced annually. This supply is sourced globally from all around the world from the suppliers conforming GSK standards on ethical conduct, anti-bribery practices, labor and human rights protection, and environmental, health and safety management. Moreover, although global sourcing takes an important place in chain, it is also supports and works on sourcing from local suppliers which helps to comply with the regulations in the markets which is highly diversified from country to country.




**16. Carlsberg Beer**

Business Sector: Beverage

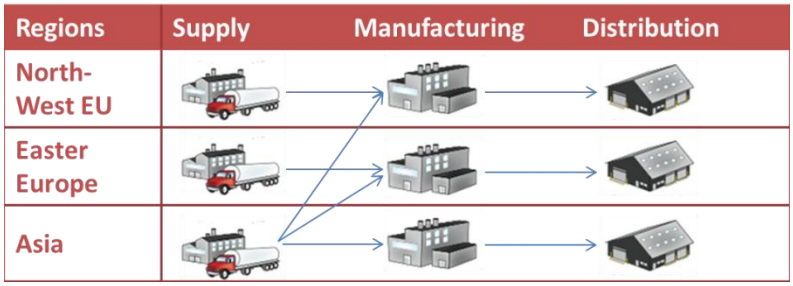
Products: Beer, soft drinks and water

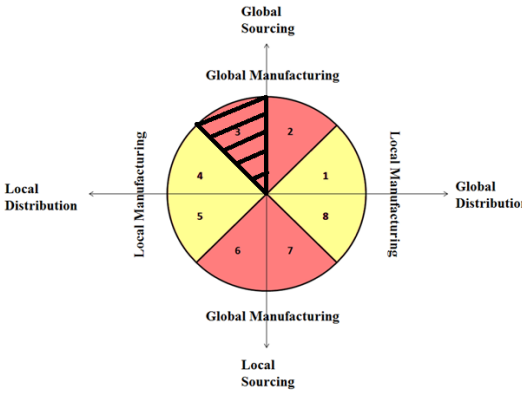
Supply Chain Configuration: Global sourcing, global manufacturing, local distribution

Carlsberg is a Danish brewing company founded in 1847 by J. C. Jacobsen after the name of his son Carl. The headquarters are in Copenhagen, Denmark. The company's main brand is Carlsberg Beer, but it also brews Tuborg as well as local beers. In 2009 Carlsberg became the 4th largest brewery group in the world employing around 45,000 people.

When the ingredients of beer are listed, it is seen that it does not depend on many resources that is difficult to find. A brewery can produce beer if it has water, barley (which is a basic cereal grain), hops (flowering vine to balance sweetness of malt) and yeast (unicellular fungi). Therefore most of brewing raw materials can be sourced directly from nature. Carlsberg,

supplies those raw materials locally due to being available in all existing markets and reducing transportation cost. The Carlsberg Group's business is completely dependent on the availability of quality barley. Malting barley is a niche cereal accounting for less than 2% of world grain production, and further water scarcity and flooding may affect future availability and quality. For these reasons, in order to secure its supply in all regions, the company gives significant importance to its investments on supply. By developed projects, it improves yields and higher the quality of crops, benefiting both farmers and Carlsberg. Moreover, the company prefers global manufacturing to be close to its customers and suppliers, as well as local distribution with mainly same reasons. Beer, as being a fast consuming good, has to follow customer demand and react quickly. Moreover, having a shelf life not very long, leads the product have a fast turn over in the stores and supermarkets. Therefore, refreshment should be made very quickly that makes lead time and frequency of the supply critically important to satisfy customer. This leads being proximate to market quite important for determining distribution strategy. For that reasons, in order to be close to the Asia market, Carlsberg acquired 60% of Parag Breweries in India in 2007. By this acquisition, Carlsberg aims to be a major player in beer industry. Also procurement of beers as finished products is made from India through the other regions.




### 17. Astra Zeneca

Business Sector: Pharmaceutical & health care

Products: Pharmaceuticals, health care

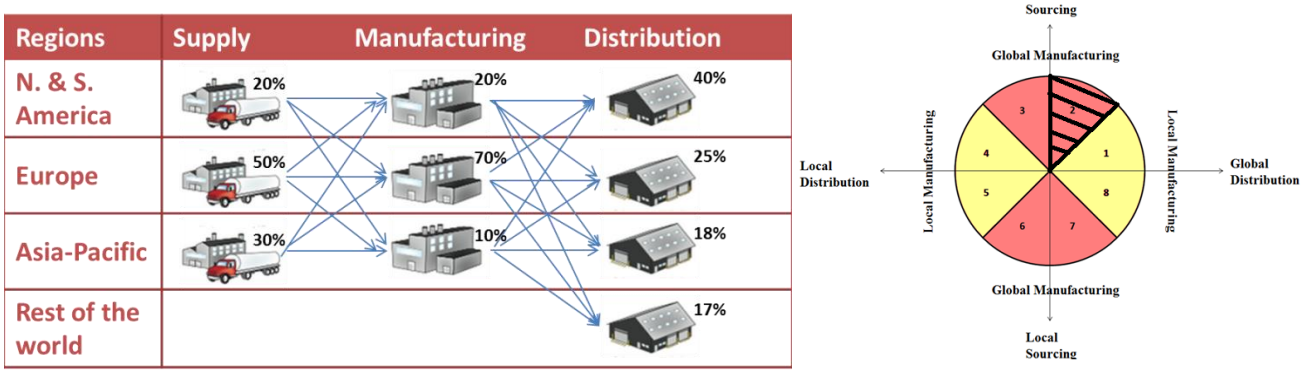
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

AstraZeneca is a British-Swedish multinational pharmaceutical and biologics company headquartered in London, United Kingdom. It is the world's seventh-largest pharmaceutical company (measured by 2009 prescription drug sales). It has a portfolio of products for major disease areas including cancer, cardiovascular, gastrointestinal, infection, neuroscience, respiratory and inflammation. It manufactures in 16 countries and operates over 100 countries to

ensure a reliable supply of medicines where and when they are needed. Sales in 2012 are defined as around $28 billion: 38% in the US, 23% in western Europe, 21% in emerging markets and 18% in the rest of the world.

As being a company operating in high level in terms of globality, it has a notably complicated supply chain network. As it operates in an industry where quality and availability is critical, it places particular importance to have an uninterrupted, complete and fast supply chain meanwhile assuring low level of inventory and low prices of raw material. Analyzing the network, it is observed that it makes global supply due to innumerous variety of supplied materials, that each of them can be found and acquired with desired price and quality in different region of the world. Moreover, having uninterrupted supply is crucial for this sector which is the basic reason for the company to make dual or multi sourcing of key raw materials from different regions to maintain appropriate stock levels in any occasion. These raw materials are sent to production facilities worldwide which are specialized in some areas such as, US (Frederick, Maryland and Philadelphia, Pennsylvania), the UK (Speke), and the Netherlands (Nijmegen) production plants are dedicated to manufacture biologics commercial in the meanwhile UK and Sweden plants are used to manufacture API and UK, Sweden, Puerto Rico and USA to produce tablets and capsules. This is the main reason that facilities are distributing the products globally although the company is trying to maximize the level of local distribution.

Dominant factors: Market size, endowment of purchased items, product variety, obsolescence




**18. Barilla**

Business Sector: Food Industry

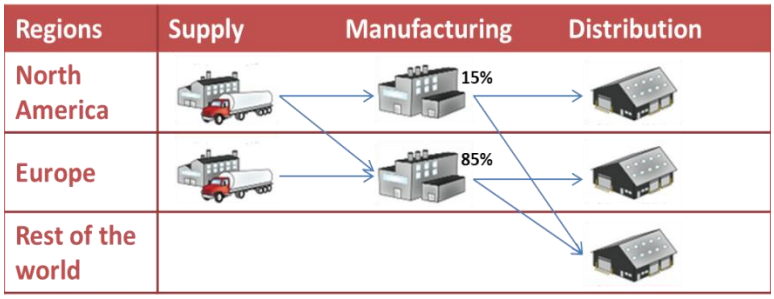
Products: Pasta, Ready-made sauces, bakery products as biscuits, toasted bread, cereals, snacks, pastries, soft bread, brioches, power snacks, cakes and crisp bread

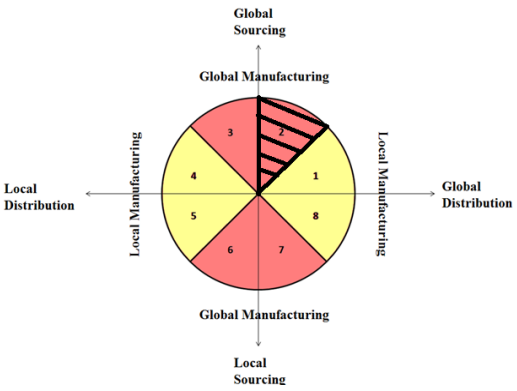
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

Barilla S.p.A. is an Italian and European food company founded in 1877 in Ponte Tarro, Italy by Pietro Barilla. The company is privately held, and remains in the fourth generation of Barilla family ownership. The Group employs over 8,000 people and owns 30 production sites. Barilla owns 13 brands. It produces several kinds of pasta and it is the world's leading pasta maker with 40-45% of the Italian market and 25% of the US market. Barilla Group has 30 production plants all over the world: in Italy, Greece, France, Germany, Norway, Russia, Sweden, Turkey, the United States (in Ames, Iowa and Avon, New York), and Mexico. Over one thousand products, matching different moments of everyday consumption, are distributed to 100 countries.

There are more than 800 raw materials and 50 types of packaging materials that Barilla uses for its portfolio of more than 1000 products. It has strategic materials that it mostly uses which are wheat, tomatoes, eggs, oils, flexible film paper and cardboard. These materials are not difficult to find in local market, taken into account that most of the materials have short life which makes better to source from the region. Moreover, production facilities are located near to market in order to decrease lead time. 25% of Barilla products are fresh, moreover, there is extreme demand fluctuations observed in distributors' order pattern. These facts put pressures in terms of production lead time and perishability of the product. That leads Barilla to produce most of its products in the region where it is consumed.

Dominant factors: Shelf life, lead time, delivery frequency, availability.




**19. Indesit**

Business Sector: Household Appliance

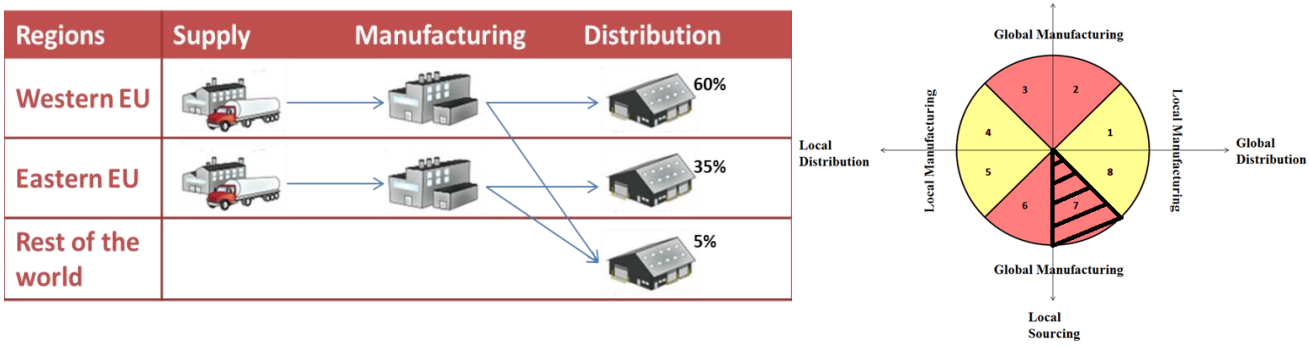
Products: Washing, drying, cooling, cooking

Supply Chain Configuration: Local sourcing, global manufacturing, global distribution

Indesit Company is one of the European leading manufacturers and distributors of major domestic appliances (washing machines, dryers, dishwashers, fridges, freezers, cookers, hoods, ovens and hobs). It is the undisputed leader in major markets such as Italy, the UK and Russia. Founded in 1975 and listed on the Milan stock exchange since 1987, the Group posted sales of

€2.9 billion in 2012. Indesit Company has 8 industrial areas (in Italy, Poland, the UK, Russia and Turkey) and 16,000 employees. The Group's main brands are Indesit, Hotpoint and Scholtès.

Indesit has its major demand in Europe with 95%. Therefore, it produces close to its market which leads to decrease its leading time and have a better delivery performance. It also sources its supplies locally.




**20. Nestle**

Business Sector: Food Industry

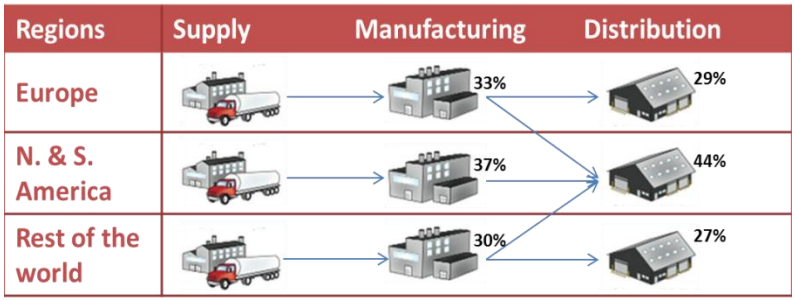
Products: Powered and liquid beverages, water, milk products and ice cream, nutrition and health care, prepared dishes and cooking aids, confectionery, pet care

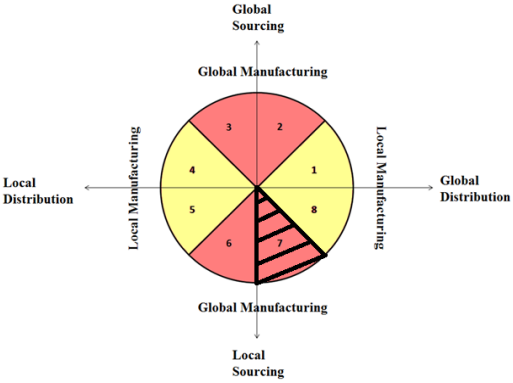
Supply Chain Configuration: local sourcing, global manufacturing, global distribution

Nestlé S.A. is a Swiss multinational food and beverage company, found in 1866 in Vevey, Switzerland. It is the largest food company in the world measured by revenues. Nestlé has around 450 factories, operates in 86 countries, and employs around 328,000 people. It is one of the main shareholders of L'Oréal, the world's largest cosmetics company.

Nestle prefers local sourcing. Considering the perishability of its supplies, the main reason for this choice is understood. Dairy products and most of the ingredients are easy to find in different regions. Therefore, by this way, both the transportation cost can be decreased; meanwhile, frequent and fresh procurement can be made. After production, most of the markets are supplied locally because of the fact that most of the products have short shelf life. Thus, by being close to market, frequent deliveries can be made with low volumes. From other production sites, there is also a support to America to meet its high consumption rate.

Dominant factors: Perishability, availability, delivery frequency, lead time, domestic market strength




### 21. Zara

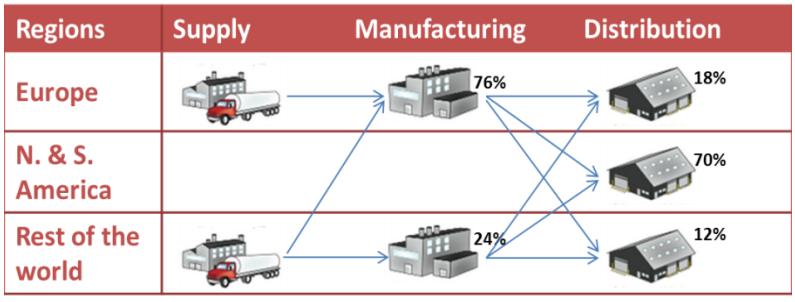
Business Sector: Apparel, fast fashion

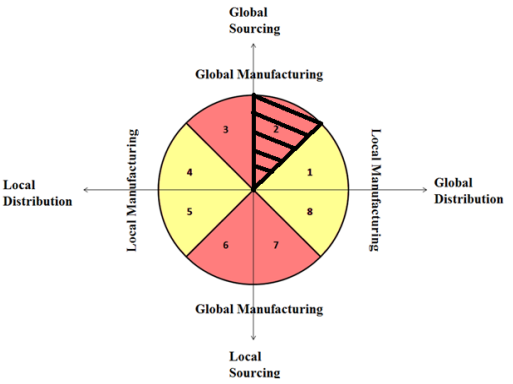
Products: Clothing, accessorizes

Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

Zara is a Spanish clothing and accessories retailer founded in 1975 by Amancio Ortega and Rosalía Mera. It is the flagship chain store of the Inditex group. Inditex is one of the world's largest fashion retailers, welcoming shoppers at its eight store formats which are Zara, Pull & Bear, Massimo Dutti, Bershka, Stradivarius, Oysho, Zara Home and Uterqüe boasting 6.058 stores in 86 markets. The Inditex Group is made up of more than 100 companies operating in textile design, manufacturing and distribution.

In its supply chain, Zara is benefiting from the cost advantages of mostly Asian-Pacific countries. Although its main market is America continent (South & North), it prefers to feed the market globally, without any production facility there.




### 22. Coca-Cola beverage

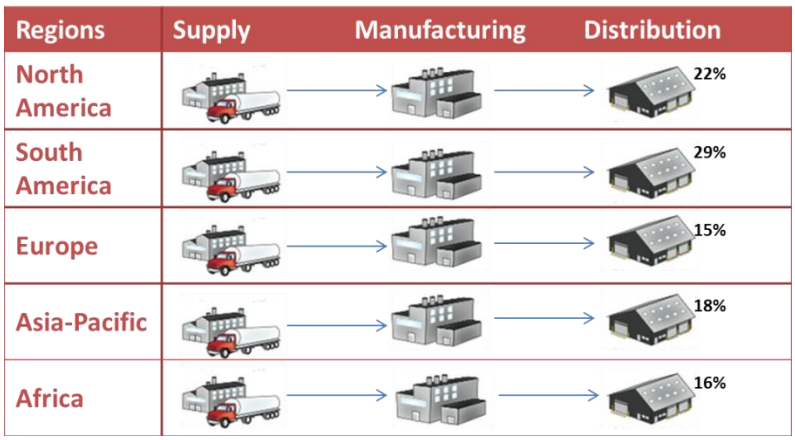
Business Sector: Beverage Industry

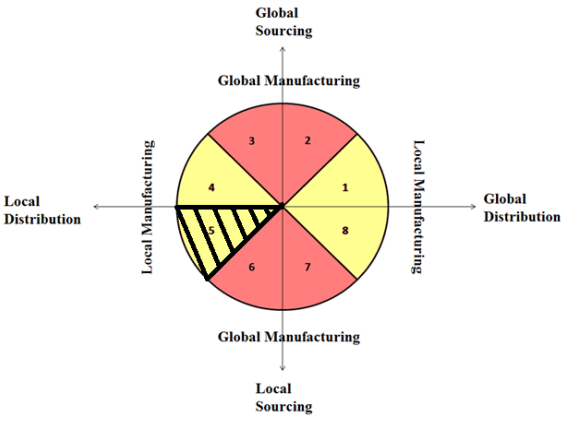
Products: Energy drinks, juice drinks, soft drinks, sports drinks, tea and coffee, water, milk, soup

Supply Chain Configuration: Local sourcing, local manufacturing, local distribution

The Coca-Cola Company is an American multinational beverage corporation and manufacturer, retailer and marketer of nonalcoholic beverage concentrates and syrups, which is headquartered in Atlanta, Georgia. It is found in 1892 in Atlanta by John Pemberton, Asa Griggs Candler. Coca-Cola has been officially available in every country in the world except Cuba and North Korea.

The company does sourcing, manufacturing and distribution independently in each region. Coca-Cola production is not a complicated and various ingredients requiring process. Main activities are to mix water, sweetener and CO2 with Coca-Cola syrup whose recipe is kept as secret known as merchandise "7X". The company produces the concentrated syrup itself which is then sold to licensed Coca-Cola bottlers throughout the world. Bottlers are responsible from combining the syrup with other ingredients, bottling, packaging, merchandising and marketing. Local distribution has substantial benefits to the sales because of the dynamic nature of coke demand. It is very important to replenish shelves in the retail outlets with the maximum fill rate to be available anytime to customer. In order to achieve it, distribution should be made decentralized and thus closer to market. By this way, Coca-Cola shortens the delivery time, decrease transportation cost, bring innovations to market faster, and reduce time to send returns to suppliers.




**23. Gucci Leather**

Business Sector: Apparel

Products: Bags, Shoes

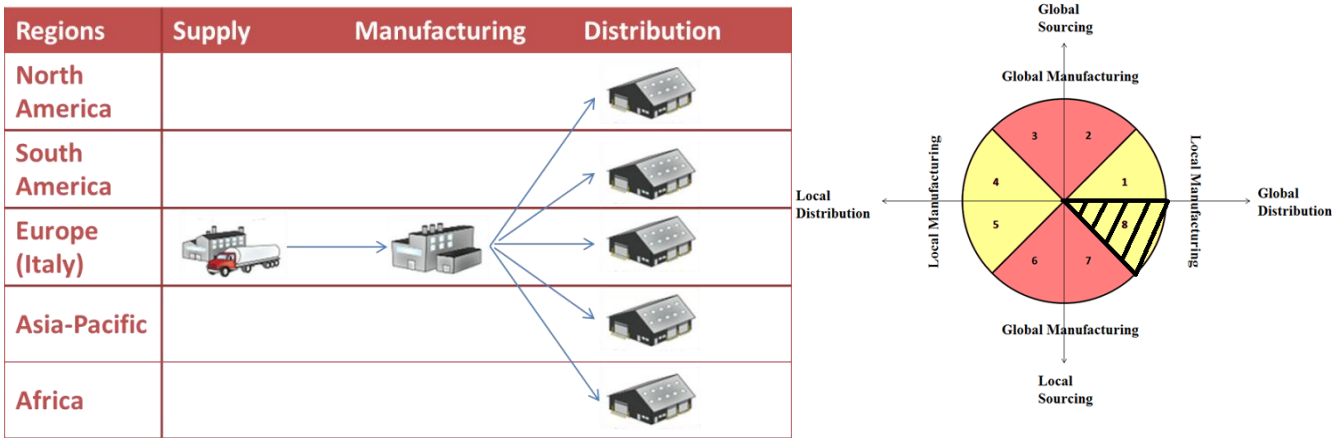
Supply Chain Configuration: Local sourcing, local manufacturing, global distribution

Guccio Gucci, better known simply as Gucci is an Italian fashion and leather goods brand, part of the Gucci Group, which is owned by French company Kering previously known as PPR. Gucci was founded by Guccio Gucci in Florence in 1921. Gucci is also the biggest-selling Italian

brand. Gucci operates about 278 directly operated stores worldwide (as of September 2009) and it wholesales its products through franchisees and upscale department stores.

The brand of Gucci has one main dominant factor to increase its value and perceived quality to its customers: being “Made in Italy”. Italian style, Italian fashion, Italian fabric… The brand image is quite exclusive and price that the customer is willing to pay is high since Gucci serves to top customers. Therefore, quality is its main asset that it cannot overcome any mistrust of decreasing quality. In order to protect this image, Gucci procures all its leather and supplementary materials within Italy assuring the best quality. Moreover, its production is made in Italy as well to represent its fame with fashion. Afterwards, it is distributed worldwide to the stores.

Dominant factors: Reputation of the country




### 24. Apple Hardware

Business Sector: Electronics

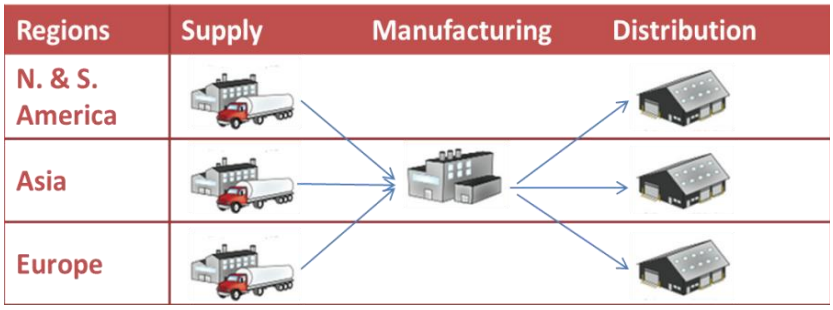
Products: Consumer electronics, personal computer

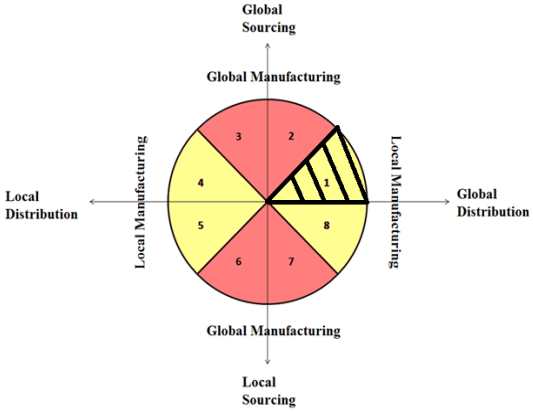
Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

Apple Inc., formerly Apple Computer, Inc., is an American multinational corporation headquartered in Cupertino, California that designs, develops, and sells consumer electronics, computer software and personal computers. Its best-known hardware products are the Mac line of computers, the iPod music player, the iPhone smartphone, and the iPad tablet computer. The company was founded on April 1, 1976. Apple is the world's second-largest information technology company by revenue after Samsung Electronics. Apple maintains 408 retail stores in fourteen countries as well as the online Apple Store and iTunes Store.

When the supply chain is analyzed, the cost is decreased from manufacturing side by carrying out production activities in Asia, benefiting from cheap labor and exchange rate. It may be thought that it is a wrong approach considering it is a technology company but as only assembly is done in the production facility, it cannot be assumed that Apple produce technology in Asia. On the other hand, Apple is one of the most prestigious companies among electronics sector which compels it to protect its perceived quality. Moreover, these products are the part of technology itself, therefore decreasing the material cost and supply from the cheapest cannot be the priority. There are some important components that are produced in limited number of countries that leaves no alternatives but procure from there. Considering distribution, although the value of item is not so low which in fact influences configuration choice shorter distribution network, Apple chose centralized production as size of orders are enough to meet from one region to world, by being able to fill transportation mode. Aggregating all those factors, the big picture of Apple Hardware's supply chain becomes obvious.

Dominant factors: Labor cost, exchange rate, availability, supply quality, size of orders




**25. Dell**

Business Sector: Computer Technology

Products: Computers and related products

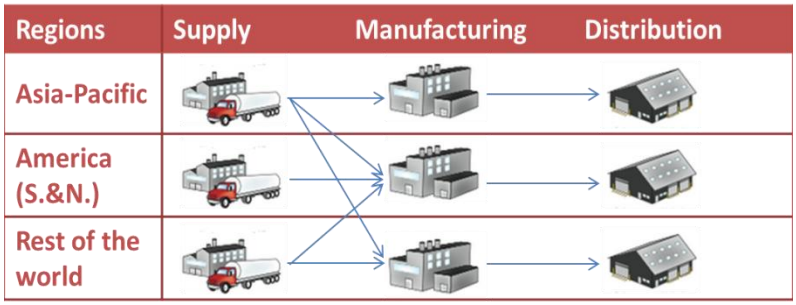
Supply Chain Configuration: Global sourcing, global manufacturing, local distribution

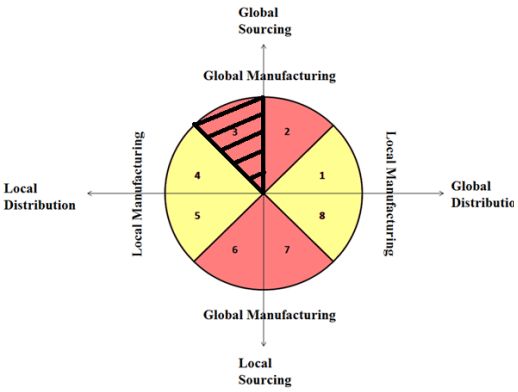
Dell is an American multinational computer technology corporation based in Round Rock, Texas, United States, that develops, sells, repairs and supports computers and related products and services. Bearing the name of its founder, Michael Dell, the company is one of the largest technological corporations in the world, employing more than 103,300 people worldwide

Supply chain of Dell is known as to be the one of the best in the world that it attracts the interest of many researchers due to the Dell's interesting and successful choice of supply chain configuration and demand management strategies. Dell has a different business model than its

competitors which can be identified as “direct model”. It is an approach to sell computers to the consumer through direct distribution by eliminating wholesalers that brings several advantages to the company such as lowering the responsibility of keeping track of the inventories belonging to numerous wholesalers as well as receiving customer orders from the early stage of the chain that protects it form bullwhip effect. Second, DELL’s supply chain is unique due to its build to order strategy. According to this strategy, once the order is placed by the customer, all the configuration details are sent to production floor and then the assembly of the PC begins. Once the computer is built and all the software’s are downloaded it will be shipped to customer by using third party logistics. Since the production is done by pull strategy due to starting production after order releases rather than forecasting and stock, Dell’s delivery to customer time is longer than its competitors. In order to compensate this lag, Dell has to decrease its transportation time. Third, Dell deals with customer complaints and repair services by itself rather than using intermediary retailers that makes the customer to feel more ease knowing that they are dealing directly with the source. All those three issues are significant subjects to induce Dell to be close to market. Therefore, it implements local distribution strategy which fits the most to its unique system. Moreover, on the supply side, Dell required a highly reliable supply of top-quality PC components, which leads Dell to eliminate strictly the suppliers which does not conforms with its high quality and technology standards. Therefore, global supply is preferred although key suppliers are kept near its own assembly plants to allow the company to communicate with supplier inventory hubs in real time for the delivery of a precise number of required components on short notice.

Dominant factors: Lead time, returnability, service level objective, delivery reliability, domestic market strength




**26. Nokia mobile**

Business Sector: Communication and information technology industry

Products: Mobile telephones

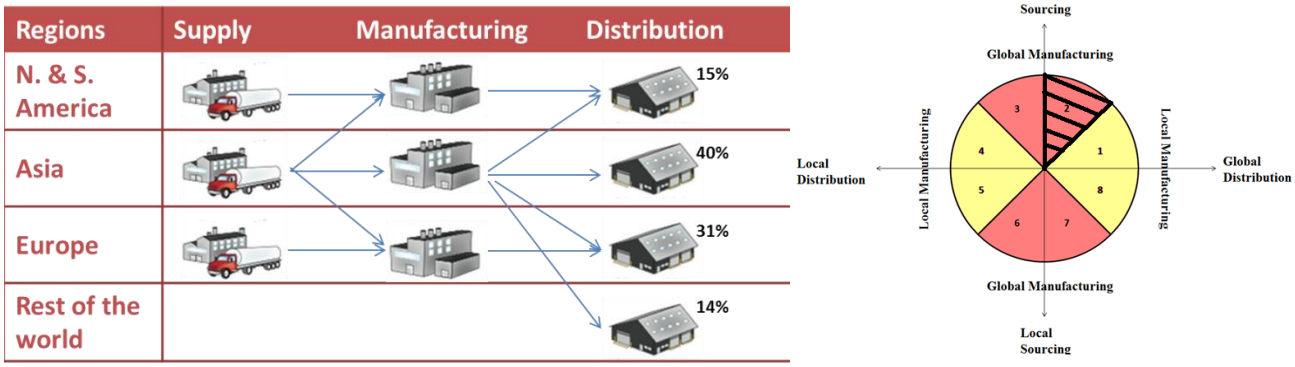
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

The Nokia Corporation is a Finnish multinational communications and information technology corporation that is headquartered in Espoo, Finland. Its principal products are mobile telephones and portable IT devices. It also offers Internet services including applications, games, music, media and messaging, and free-of-charge digital map information and navigation services through its wholly owned subsidiary Navteq. Nokia owns a company named Nokia Solutions and Networks, which provides telecommunications network equipment and services.

As of 2012, Nokia employs 101,982 people across 120 countries, conducts sales in more than 150 countries, and reports annual revenues of around €30 billion.

Nokia has production facilities located all over the world which are located in Brazil, China, Hungary, India, Mexico, South Korea, and Vietnam.

Although there are some local supplies for each facility, the main sourcing is done from Asian countries as well as manufacturing. By this strategy, Nokia is enjoying both low labor and material costs and distribute its products mainly form this region.




**27. Unilever Food**

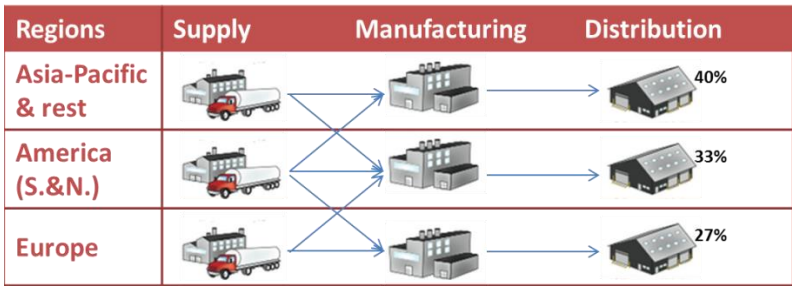
Business Sector: Fast Moving Consumer Goods

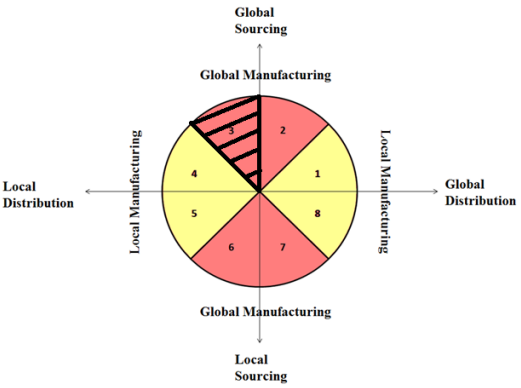
Products: Food, home and personal care

Supply Chain Configuration: Global sourcing, global manufacturing, local distribution

Unilever is an Anglo–Dutch multinational consumer goods company. Its products include foods, beverages, cleaning agents and personal care products. It is the world's third-largest consumer goods company measured by 2011 revenues (after Procter & Gamble and Nestlé) and the world's largest maker of ice cream. Unilever has 400 products which are sold in more than 190 countries, generating sales of €51 billion in 2012.

As it is seen in most of food companies, due to expiration constraint and unpredictable and fluctuating demand trend leads companies to determine a local strategy in terms of distribution. Moreover, some major changes in customers' expectations are observed in this sector more solidly. Therefore, being close to market and follow the changes in the market and serve in accordance with the regions eating habits and culture, is the dominant motivation in determining the supply chain configuration.




**28. General Motors**

Business Sector: Automotive

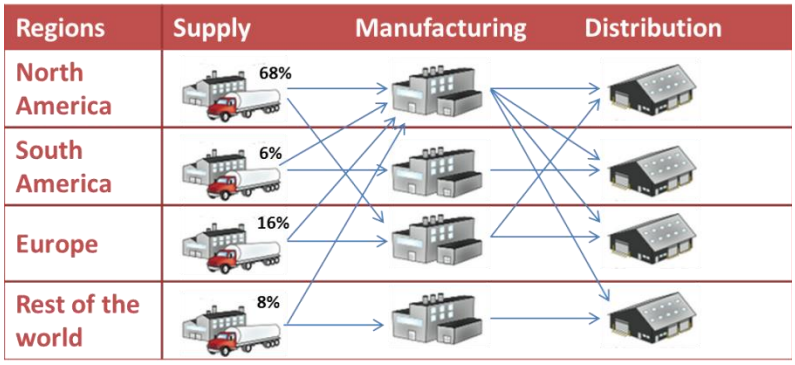
Products: Cars, trucks, crossovers

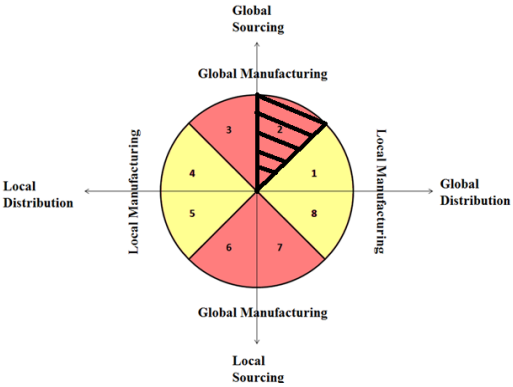
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

General Motors Company is an American multinational holding corporation headquartered in Detroit, Michigan. The company designs, manufactures, markets and distributes vehicles and vehicle parts and sells financial services. General Motors produces vehicles in 37 countries under eleven brands. General Motors employs 202,000 people and does business in 157 countries. General Motors is divided into five business segments: GM North America (GMNA), GM Europe (GME), GM International Operations (GMIO), GM South America (GMSA), and GM Financial.

GM operates one of the world's largest digital supply chains with a network of 182 plants, 650 logistics service providers and 3200 suppliers to build 8.7M vehicles and deliver to over 15,000 dealers worldwide. GM's 182 plants collectively operate as three tiers of an internal supply chain. 71 assembly plants deliver 8.7M vehicles to over 15,000 dealers in 5 continents. Its supplier footprint is global and optimized to minimize total enterprise cost. They buy parts from the best suppliers and best locations globally. One-third of their suppliers deliver to GM plants in more than one region. Therefore, integration of the regions makes GM to operate as one company.

As it is explained above, GM has an excessively complicated and big supply chain network. Every year, it sources $130 billion worth of goods and services. Sourcing decisions vary depending the criteria and availability of each component and material. GM makes global sourcing by giving sourcing decisions ensuring the procured products are benchmarked to world class standards for quality, service, technology and price. Sourcing process of GM allows looking at the entire corporate product portfolio on a worldwide basis to find opportunities for communization, cost savings, mass reduction, quality improvements, and the introduction of advanced technologies. When manufacturing part is investigated, it is seen that majority of the production takes place in North America. It can be explained with the technology level and existing infrastructure that is not easy to carry outside. On the other hand, recently, GM has been passing through a change in strategy in order to adopt world present challenges by implementing localization policy, having benefits in terms of lead time as well as sustainability. Although localization policy has been continuing to be implemented, still the majority of production takes place in North America, meanwhile 72.1% of the sales volume has been generated outside US. That leads North America to support sales in other regions.




**29. Toyota Motor Corporation**

Business Sector: Automotive

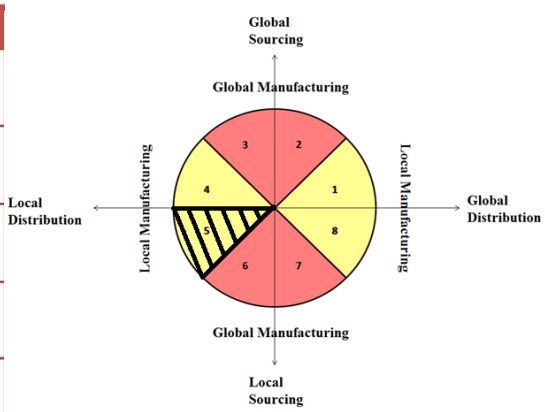
Products: Automobiles, commercial vehicles, engines, motorcycles

Supply Chain Configuration: Local sourcing, local manufacturing, local distribution

Toyota Motor Corporation is a Japanese multinational automaker found in 1937 and headquartered in Toyota, Aichi, Japan. It was defined as the third-largest automobile manufacturer in 2011 by production behind General Motors and Volkswagen Group [official website] As at the end of December 2012, Toyota conducts its business worldwide with 52 overseas manufacturing companies in 27 countries and regions. Toyota vehicles are sold in more than 160 countries and regions.

When supply chain of the company is investigated, it is seen that it could manage to localize its sourcing and distribution unlike its competitors in the same sector. It is achieved by placing regional general managers in charge of localizing car making in each region. By developing ties with local sales and R&D units, Toyota can ascertain the needs of each market and improve both quality and product appeal. Toyota aims for 100% local procurement, rather than procurement from Japan, so as to strengthen its responsiveness to foreign exchange fluctuations. Also in this way, it minimizes the parts procurement risk.

| Regions | Supply | Manufacturing | Distribution |
|---|---|---|---|
| Asia | | 59% | 70% |
| North America | | 16% | 1% |
| South America | | 5% | 8% |
| Europe | | 11% | 6% |
| Rest of the world | | 9% | 15% |




**30. Fiat Group Automobiles S.P.A.**

Business Sector: Automotive

Products: autos, trucks, vehicular equipment and financial services

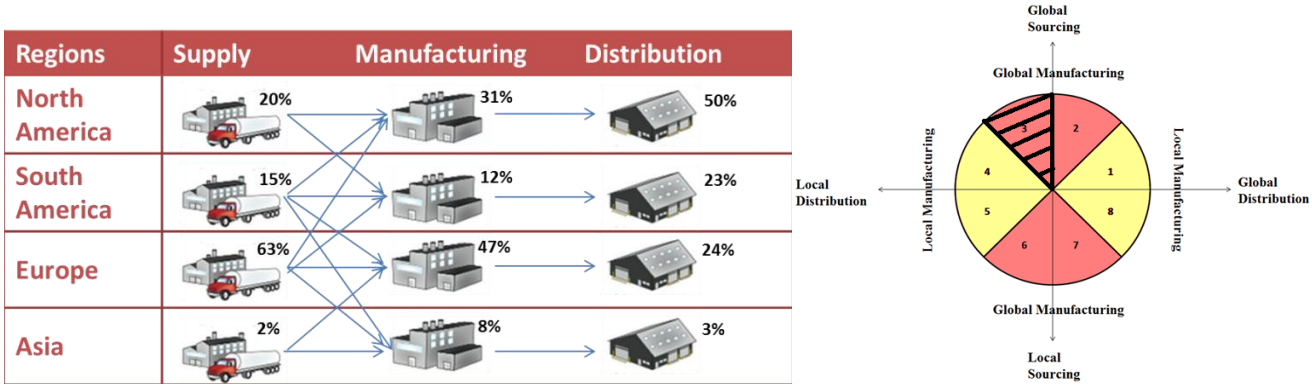
Supply Chain Configuration: Global sourcing, global manufacturing, local distribution

Fiat S.p.A. is an Italian automobile manufacturer based in Turin (Fabbrica Italiana Automobili Torino). Fiat was founded in 1899 by a group of investors. Fiat is an international auto group that designs, produces and sells vehicles for the mass market under the Fiat, Alfa Romeo, Lancia, Abarth and Fiat Professional brands, as well as luxury and performance cars under the Ferrari and Maserati brands. The Group has expanded its global reach through the alliance with Chrysler Group. Fiat is Italy's largest industrial concern. It also has significant worldwide operations, operating in 61 countries with 1,063 companies that employ over 223,000 people, 111,000 of whom are outside Italy.

Sourcing stage of Fiat's supply chain is observed to be global contrary to its distribution. It is caused by the desire to reach worldwide suppliers with high standards of quality, service, and technology with the lowest possible price. This approach allows Fiat to have opportunities for communization, cost savings, mass reduction, quality improvements, and the introduction of advanced technologies. When manufacturing and distribution side is considered, it is observed

that localization took place for environmental and customer proximity reasons. Local distribution strategy is explained in annual report of the company as the way to achieve meeting corporate and customer requirements, striving to maximize efficiency and reducing the impact of transport on the environment. For Fiat Group, the efficiency and environmental sustainability of logistics processes are key factors in creating value. Sustainability criteria have been fully incorporated into the management and selection process for Group suppliers as well. Quality, supply, price and the ability to meet delivery times represent just a few of the areas upon which suppliers are evaluated.

Dominant factors: sustainability, availability, exchange rate, delivery time, price, supplier's quality.




**31. Ermenegildo Zegna S.P.A.**

Business Sector: Apparel

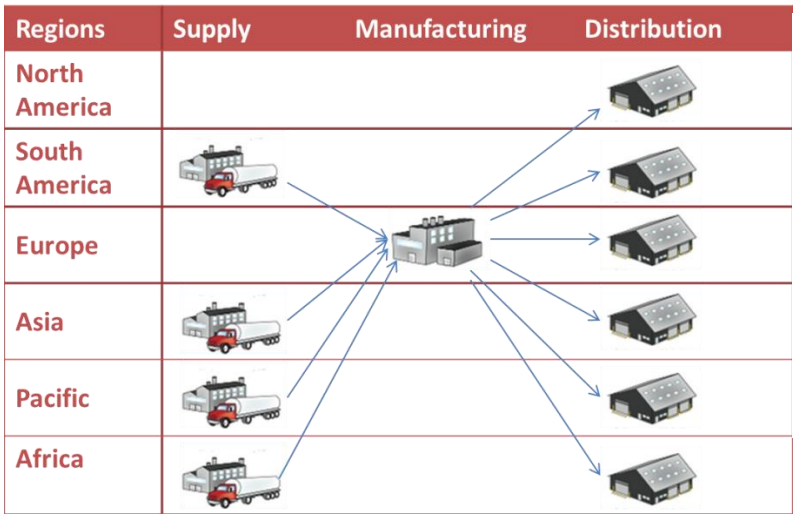
Products: men's wear, suit, shirt, tie, sportswear, shoes, accessorizes

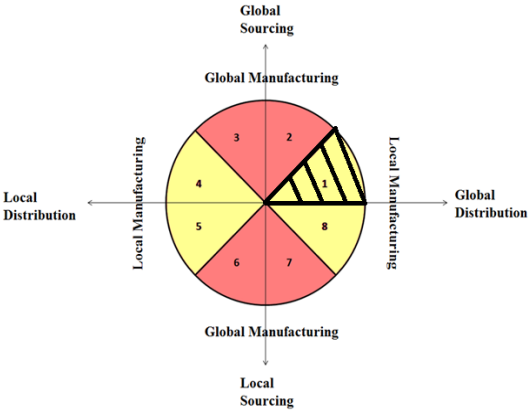
Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

Ermenegildo Zegna SPA is the world's leading luxury men's suit maker which is found in 1910. Based in the mountain village of Trivero, Italy, near the Swiss border, Zegna is a vertically integrated business, producing more than two million meters of fabric, more than 350,000 finished suits, and another two million shirts, ties, sportswear, and accessories per year. Zegna develops its own fabrics from the world's finest wools--although the company does not itself own sheep herds, it works closely with breeders and farmers in Australia, South Africa, and Mongolia to ensure its supply of top-grade cashmere, mohair, and merino wool. This commitment to top quality enables the company to produce fabrics from threads as fine as just 11 microns. Zegna is present in more than 380 shops throughout the world, of which 135 are full-scale retail stores owned by the company, while the others operate as boutiques within department stores.

More than 85 percent of the company's sales are achieved outside of Italy, primarily through the company's own store network. Europe is the company's largest market, at 38 percent of sales, followed by North America, at 33 percent of sales. The company also has a strong presence in the Australasia region, which accounts for 25 percent of its sales and includes China, one of the group's fastest-growing markets.

On supply side, company procures from the countries offering low costs. However in manufacturing side, as most of the brands known as "Italian", prefers to make its production within borders in order to gain value from customers perceived quality from Italian design and fabric. As being a global company which serves different markets around the world, it distributes its products from its centralized production facility.




**32. Alpargatas S.A. (Havaianas)**

Business Sector: Footwear

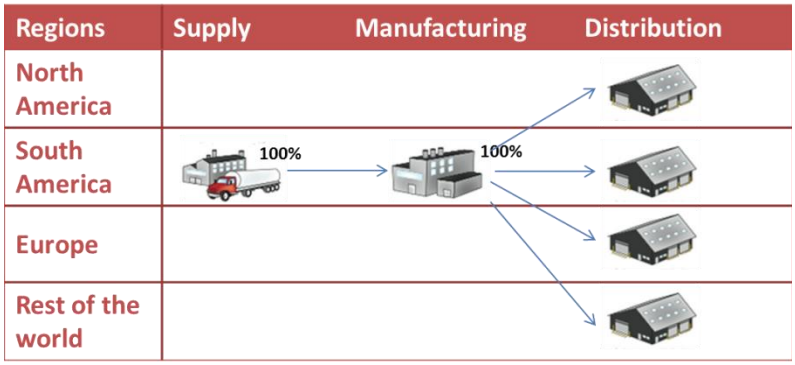
Products: footwear, sandals, sport shoes

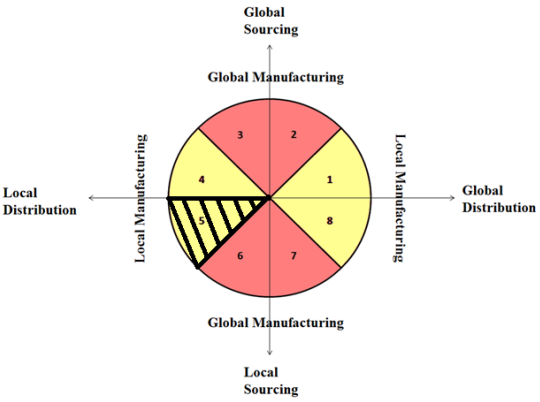
Supply Chain Configuration: Local sourcing, local manufacturing, global distribution

Alpargatas is the largest footwear manufacturing company in Latin America and its growth strategy is focused on the management of brands that are competitive and strategic assets. At the beginning of the 20th century Scotsman Robert Fraser arrived in Brazil and began manufacturing flip flops based on the traditional zori sandals brought to the country by Japanese immigrants. By 1958 he had developed the rubber version known as Havaianas – a name that he trademarked in 1962. After completing 50 years of existence in 2012, Havaianas is the most recognized Brazilian consumer goods brand internationally.

Havaianas are 100% made in Brazil, not even a single pair is made abroad. Sourcing is also made inside of Brazil. Havaianas is known as the national Brazilian brand with the highest global visibility.

Dominant factors: Fame of the country, power of domestic market




### 33. McIlhenny Company (Tabasco)

Business Sector: Food processing

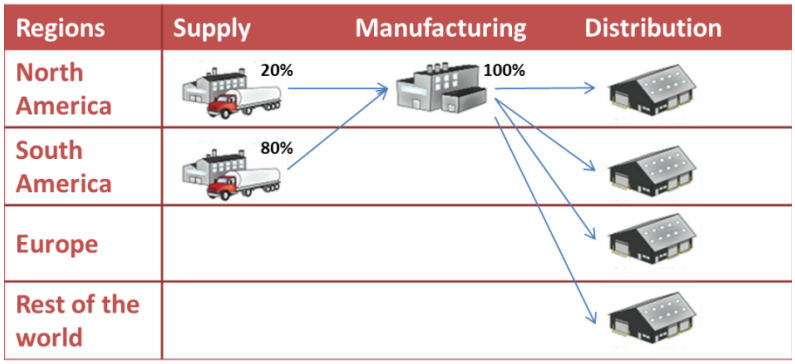
Products: Pepper sauce and other condiments

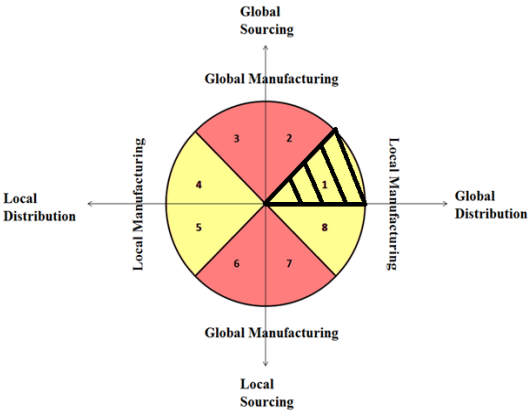
Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

TABASCO® brand products are made by McIlhenny Company, founded in 1868 on Avery Island, Louisiana. To this day, the company is still family-owned and operated on that very same site. TABASCO® brand Pepper Sauce is made from three ingredients: peppers, salt and vinegar. For over 140 years, McIlhenny Company has grown its peppers on Avery Island. It is labeled in 22 languages and dialects, sold in over 165 countries and territories.

In the 1960s, the company looked elsewhere to meet increased need for the peppers. ıt developed test plots in several Latin American countries, and by the early 1980s, more than 80% of its pepper mash was sourced elsewhere. The vinegar is distilled grain beech wood-generated vinegar. The grain is grown in the Midwestern U.S. and processed into vinegar in Texas and Alabama. Salt is sourced primarily from the salt mine located on Avery Island, Louisiana. A single-plant facility located on Avery Island produces and bottles the majority of TABASCO® branded products. Over 140 years later, TABASCO® Sauce is made much the same way except now the aging process for the mash is longer – up to three years in white oak barrels – and the vinegar is high-quality distilled vinegar.

Dominant factors: Availability, quality of the supply




**34. IllyCaffè S.P.A.**

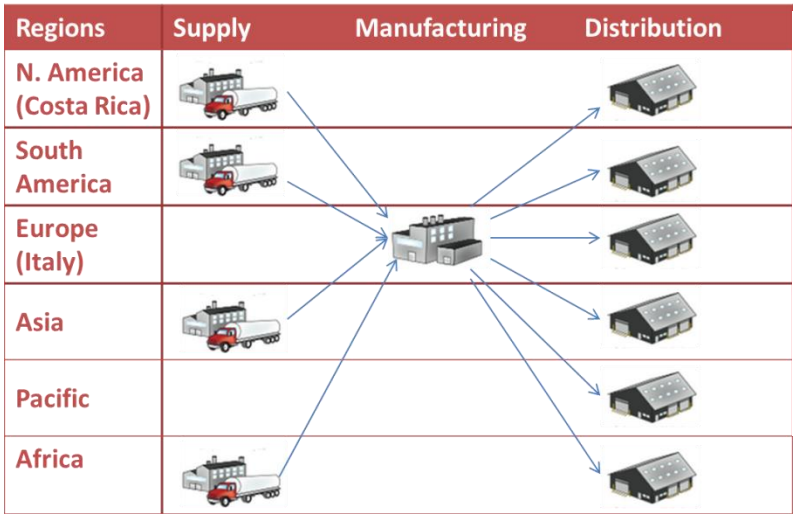
Business Sector: Coffee

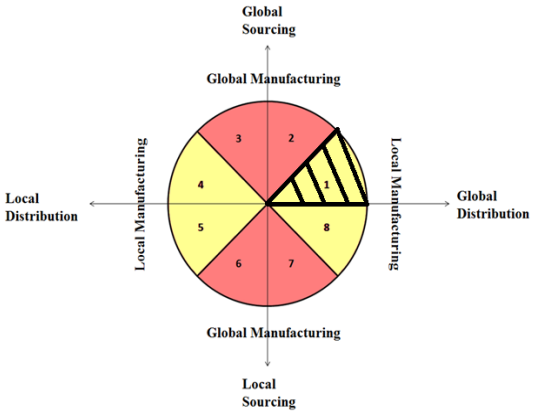
Products: Espresso

Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

The company is based in Trieste and found in 1933. It is led by the third generation of the Illy family: illycaffè S.p.A. belongs (100%) to the Illy family's holding company – Gruppo illy S.p.A. Illycaffe produces and sells worldwide a single blend of premium quality coffee made from nine varieties of pure Arabica beans. A balance of the finest beans from South America, Central America, India and Africa produces the distinctively illy flavor and aroma, consistent cup after cup, wherever it is enjoyed around the world. Illy products are enjoyed in more than 140 countries, on all five continents, and are served in about 100,000 establishments. Illycaffè operates internationally, through a network of corporate offices and subsidiary companies that maintain Illy's strong presence across Europe, North America and Asia.

Quality is important for Illy so it believes quality begins with raw material. In order to guarantee it, the company has been purchasing green coffee for twenty years direct from its source. To this purpose, illycaffè has developed long-term relationships with the best coffee growers in the world, in conformity with its principle that only a relationship of mutual exchange and improvement can guarantee quality, as well as an increase of the product's value. As being a coffee producer, sourcing is the most important stage in this sector where the main value is the taste. In manufacturing side, it adds value by labeling it “Italian” which is famous with good coffee. With the high quality perception created with the steps taken in sourcing and manufacturing, it is distributed to all around the world.




### 35. Tüpraş

Business Sector: Oil and gas

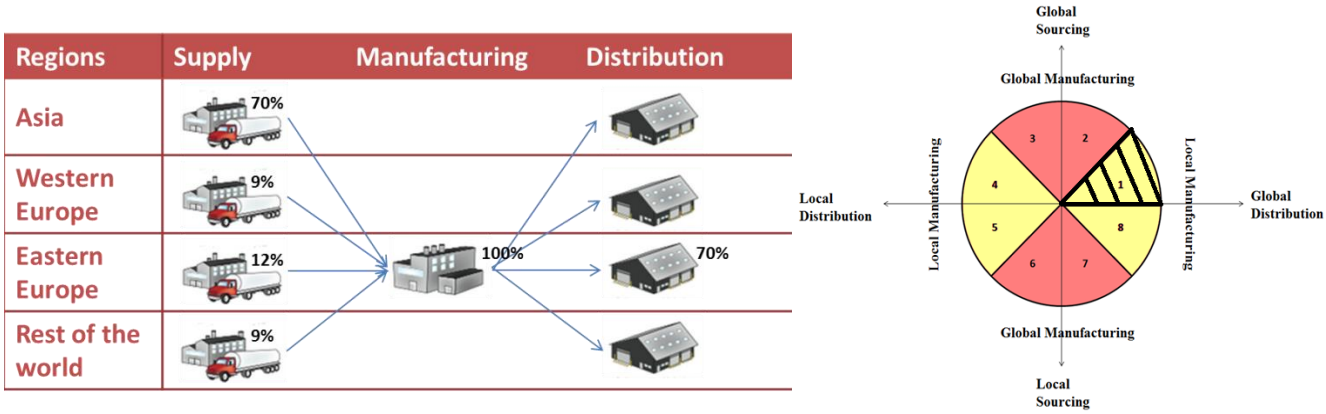
Products: Petroleum products, natural gas, petrochemicals, fuel oil, aviation oils, LPG

Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

Tüpraş is Turkey's largest petrochemical company founded in 1983 in Kocaeli, with 28.1 mn ton crude processing capacity. It is a petrochemical facility, a retail affiliate and a Tanker Operation. Turkey's only company operating in the refining sector and the seventh largest refiner in Europe, Tüpraş has remained turkey's largest industrial corporation for many years. The Company's subsidiaries and vast distribution networks span the entire country. Tüpraş controls all of Turkey's refining capacity and owns 59% of the total petroleum products storage capacity; it also has a strong indirect downstream position through its shareholding in Opet.

Tüpraş optimizes and diversifies its crude oil purchase operations to expand its oil sources, distribute risk along the supply chain and obtain price and freight advantages. Tüpraş makes a large portion of its crude oil purchases via annual contracts with national oil companies. The Company also makes spot purchases to increase supply flexibility and additional options for crude oil types with specifications meeting its product requirements Despite Tüpraş buys 14 different types of crude oil from ten countries, it also source crude oil from domestic sources.

Dominant factor: Existing infrastructure, power of domestic market, flexibility in sourcing




### 36. Colgate-Palmolive

Business Sector: Personal care

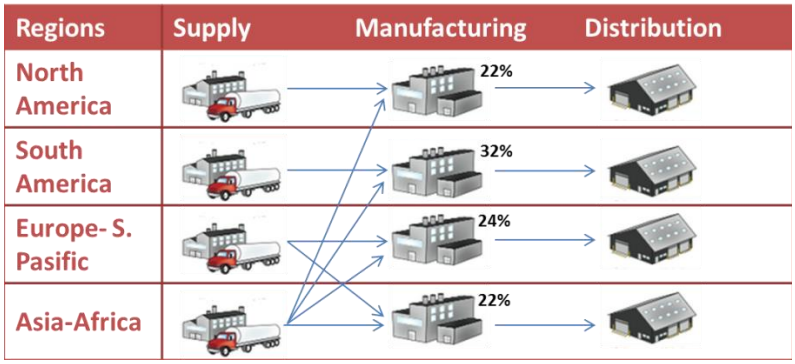
Products: Soaps, detergents, and oral hygiene products

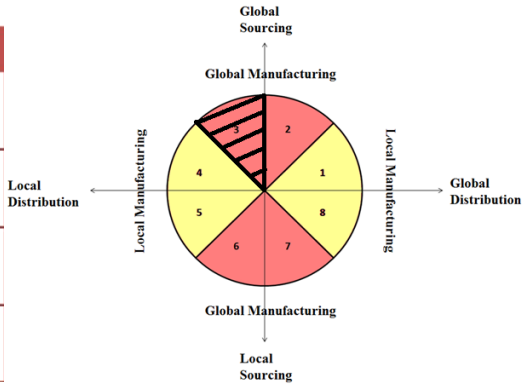
Supply Chain Configuration: Global sourcing, global manufacturing, local distribution

The Colgate-Palmolive Company is an American multinational consumer products company focused on the production, distribution and provision of household, health care and personal products, such as soaps, detergents, and oral hygiene products (including toothpaste and toothbrushes). It is found in 1806 in New York City. Colgate-Palmolive has market leadership around the world, primarily operating in North America, Latin America, Europe, and Greater Asia/Africa.

Colgate Palmolive is a worldwide manufacturer that has operations in several continents. Because of that, there isn't one single distributer for the whole business, but a few key important subsidiaries for each region of operation. Colgate Palmolive has a channel of distribution classified as starting from the manufacturer, then on to an intermediary distributer, and finally to the retailer. Tallow is a key ingredient in bar soap production and is derived from cattle. Colgate sources tallow from suppliers in North America, Latin America and Europe. In addition, sourcing of palm oil, which is an important ingredient for the company, is made from Malaysia, Indonesia and Thailand. It prefers local distribution due to the fact that its demand shows high fluctuation and the product has to be on shelf when customer wants to purchase that product loyalty is low. Therefore, company wants to be close to customer in distribution stage in order to supply market frequently and increase its flexibility in order to adopt changes in customer demand.

Dominant factors: Availability, lead time, delivery frequency




**37. L'occitane en Provence**

Business Sector: Personal care

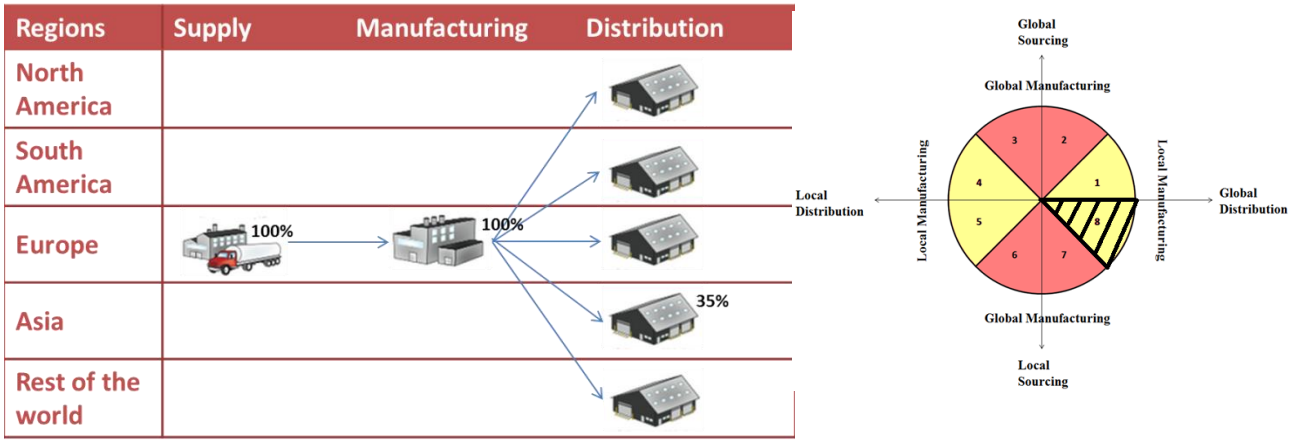
Products: Body, face, and home products

Supply Chain Configuration: Local sourcing, local manufacturing, global distribution

It is an international retailer of body, face, and home products based in Manosque, France. The company was founded in 1976 by Olivier Baussan with the purpose to create a company that celebrates and preserves the traditions of his native Provence. L'Occitane means "the woman from Occitania". L'Occitane has shops in 90 countries in North America, South America, Europe, Asia, and Australia; with 170 shops in the United States.

L'Occitane obtains the raw materials it uses from local producers who use traditional techniques, and develops all of its products in Manosque. The products are formulated with plant active ingredients, following the principles of phytotherapy and making use of local know-how. These formulas combine effectiveness and sensoriality, providing textures and fragrances inspired by the Mediterranean art de vivre. The dominant factor influencing the sourcing and manufacturing strategy of the company is to add value to its products from the France's reputation with luxury cosmetics products. Moreover, L'Occitane sources its raw materials from a unique region which increases perfectionist image in customers' eye. Therefore, supply chain of the company is formed based on this fact and constraint. Moreover, since most of those raw materials are made from plants and fresh materials, production facility is required to be nearby. By the effect of those restrictions, distribution is made from one center to the world.

Dominant factors: Quality of supply, country reputation, proximity to supplier




**38. Lego**

Business Sector: Toy

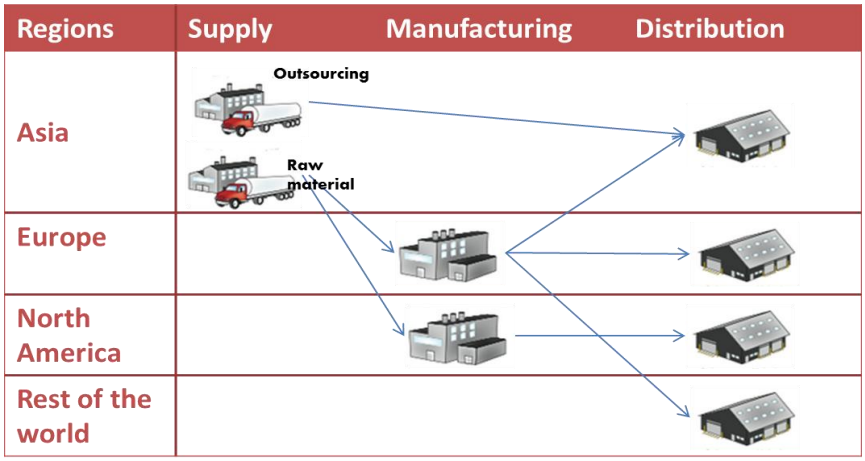
Products: Construction toys

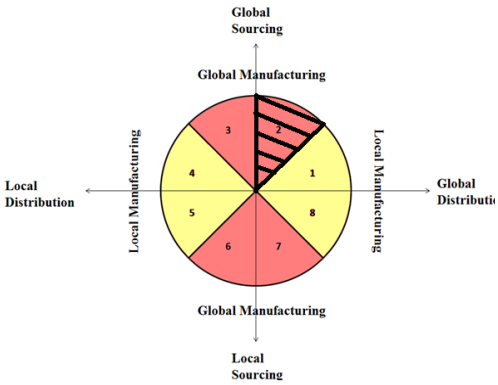
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

The LEGO Group is a privately held company based in Billund, Denmark. The company is still owned by the Kirk Kristiansen family who founded it in 1932. The LEGO Group is engaged in the development of children's creativity through playing and learning. Based on the world-famous LEGO® brick, the company today provides toys, experiences and teaching materials for children in more than 130 countries. The LEGO Group has approximately 10,000 employees, and it is the world's third largest manufacturer of play materials. Its head office is in Billund, Denmark and LEGO products are sold in more than 130 countries.

Lego owns production plants in Denmark (headquarter, still most of R&D studies take place here), Czech Republic, Hungary and Mexico. It has small portion of outsourcing from Asia in order to support local consumption in that region. The main raw material of Lego is crude oil that the company is depended on in order to produce bricks. Crude oil is sourced from Saudi Arabia which is transported to Indonesia in order to obtain plastic granules. By the entry of those plastic granules, major supply of the production is met. Most of the demand of the world is met by the factories in Europe beside North America. That's what the plant in Mexico is dedicated for. Lego makes its distribution to Australia, EU, Asia and European markets as it is seen in the network chart below. The dominant strategy followed can be said as to be closer to market as the main consumption is done in Europe and North America, which the deduction is also supported by the annual report of the company with the statement of "Lego produces where it is used".

Dominant influence: Proximity to market




**39. Boeing**

Business Sector: Aviation

Products: Aircraft

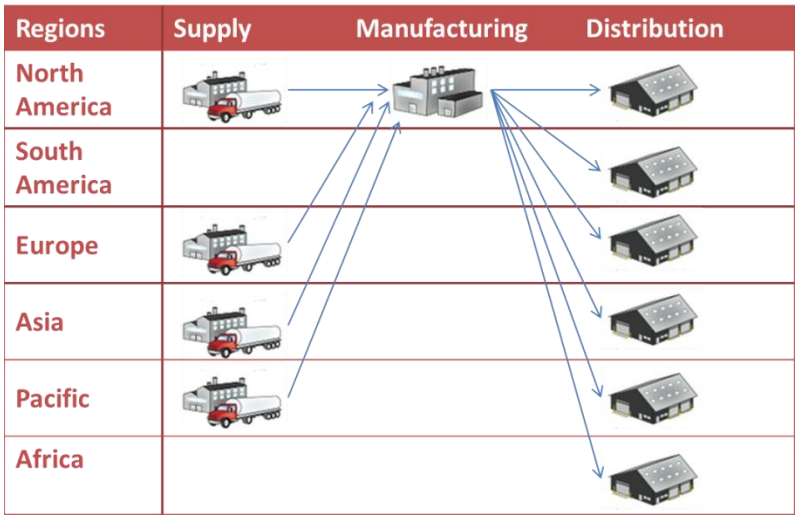
Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

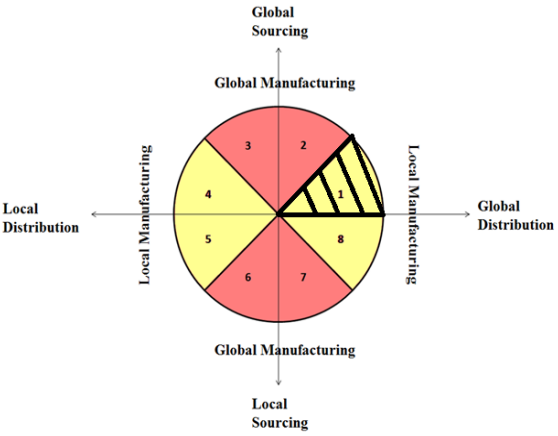
Boeing is the world's leading aerospace company and the largest manufacturer of commercial jetliners and military aircraft combined. It is worth to note that, although in our case study, we had investigated only the supply chain network of the aircrafts, Boeing designs and manufactures rotorcraft, electronic and defense systems, missiles, satellites, launch vehicles and advanced information and communication systems as well. The company also provides numerous military and commercial airline support services. Boeing provides products and support services to customers in 150 countries and thus is one of the largest U.S. exporters in terms of sales. The company has it's headquarter and main production facility in Chicago.

When the supply chain of Boeing is analyzed, it can be deduced that product features dominated the factors to choose the configuration. First of all, due product size of an aircraft is drastic as well as containing excessive number of components and materials which are considerably high in price and volume. That leads company to prefer lowest inventory as possible. Moreover, aerospace industry requires high technology investment and research studies that makes company to keep its technology within the borders. At the same time, it prefers to be close to the area where this kind of technologies is advanced in order to benefit from the synergy to be created and be aware of new developments. Existing infrastructure can be included to the list of factors to prefer local manufacturing considering the amount of a new investment for aircraft production. These are dominant factors to shape the configuration in favor of local production which is in USA. When supply part is considered, it can be deducted

that aerospace manufacturers are much more concerned about getting their materials and components on time and with right quality, than about forcing the suppliers to decrease prices. Therefore, they seek globally the high quality suppliers. Moreover, in this aspect, availability plays an important role for supplying globally due to having limited options to reach companies able to produce within required technological requirements. When distribution is focused, it is realized that its effect on network selection is the least significant because of the ease of its transportation. It is delivered by the motive it is produced for: by flying to anywhere in the world. Moreover, lead time is not an important service quality measure for the company. Therefore, the company is safely operates in global level in terms of supply and distribution.

Dominant factors: Availability, technology level, product size, product value, existing infrastructure.




### 40. Faber-Castell

Business Sector: Stationery

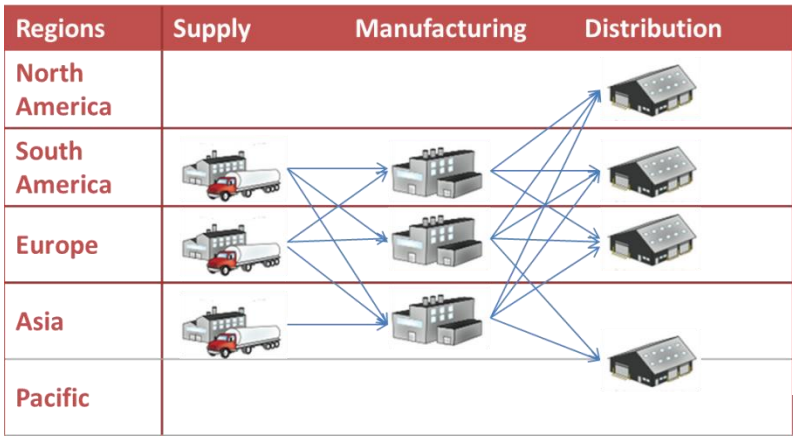
Products: Writing, drawing, creative design and superior decorative cosmetic products

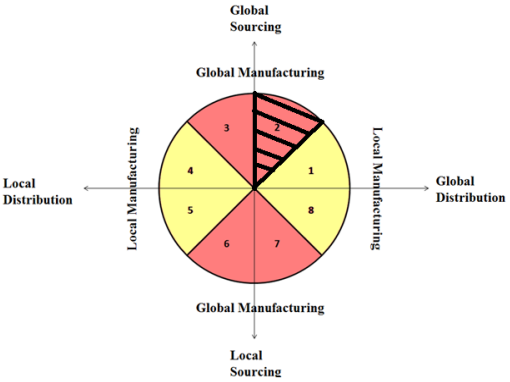
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

Faber-Castell is the world's largest manufacturers of pens, pencils, other office supplies, art supplies, high-end writing instruments and luxury leather goods. Although its production began in Germany, only some of its premium pens are still manufactured there. Worldwide, the group has 15 production sites and 24 sales companies, which are centrally managed in strategically important areas. Production facilities are located in Europe, North America, Latin America and Asia Pacific, meantime the main production takes place in Latin America. The Faber Castell Group does business in over 120 countries.

Faber-Castell's supply chain can be said that having influenced significantly with its environmental concerns. The structure of the manufacturing facilities is in keeping with the corporate policy of manufacturing in the same regions where natural raw materials are found wherever possible. This has an effect of reducing transportation costs, minimizing the environmental impact of transport activities, and increasing process efficiency. Deducting from this information and being stated in company reports, most of Faber-Castell facilities are specialized in terms of produced items which leads global distribution. It has its own forest in Brazil, therefore, major wood-required production is made in the very same region meanwhile other wood supply for other regions are supplied from the same forest due to environmental and supply quality reasons. Another example for being close to raw materials can be given from Malaysia that the availability of local rubber yields are pretty high, that Faber-Castell's biggest rubber producing facility is located in this borders. We can conclude that, the company with having such a varied amount of product range is sourcing globally the materials which are required to be high quality (such as wood from Brazil), at the same time, locating its facilities close to raw materials which leads Faber-Castell to make partly local, partly global sourcing while producing and distributing totally global.

Dominant factors: Environmental Concerns, availability of raw materials, supply quality




### 41. Lindt & Sprüngli

Business Sector: Food

Products: Chocolate

Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

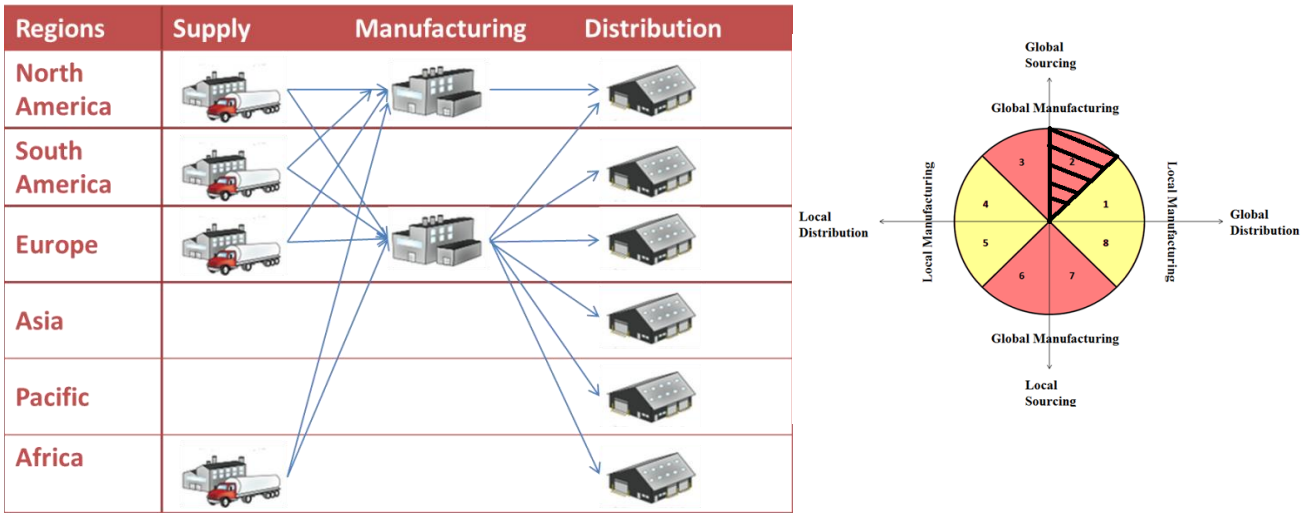
The Lindt & Sprüngli Group is a luxury Swiss chocolate and confectionery company which is globally active, developing, producing, and selling chocolate products in the premium quality segment. The holding company, Chocoladefabriken Lindt & Sprüngli AG, has its headquarters in

Zurich. It has 6 production sites in Europe, 2 in USA, and distribution and sales companies on 4 continents. Lindt & Sprüngli is offering a large selection of products in more than 120 countries around the world with Lindt , Ghirardelli and Caffarel brands . It has also 20 subsidiary companies worldwide which is excluded from our work. At present there are around 200 Lindt shops worldwide. The company serves mostly to North America and Europe with 30% and 63% sales percentage respectively.

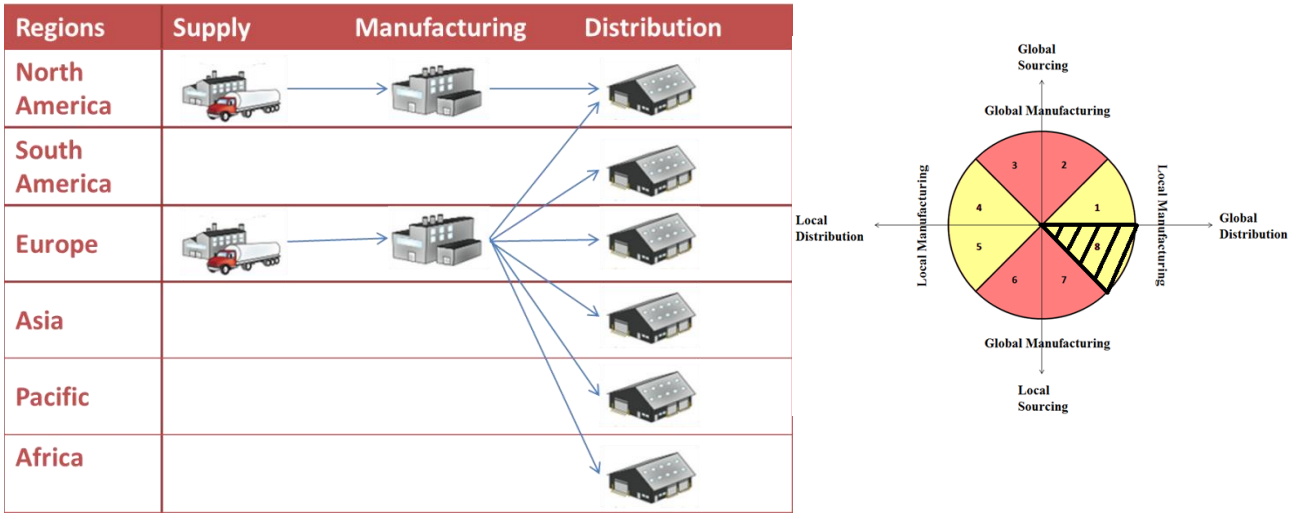
Analyzing Lindt's supply chain configuration, it is realized that the company prefers both local and global sourcing for different types of supplies having different characteristics. The essential raw material of the company is cacao as it can be predicted. Beside this, milk, sugar, hazelnuts and almonds and palm oil are required primarily as ingredient for Lindt & Sprüngli's premium chocolate. These fillings and raw materials are supplied as following: Local sourcing is preferred for dairy products, sugar and packages. Milk and sugar is sourced within the boundaries close to where factories are located because of availability, decreasing transportation cost and shelf life. There is no point supplying milk globally as it is easy to find nearby with the same quality and thus increases the control level which is critical for especially dairy products to be fresh and hygienic. Moreover packaging materials are sources locally because of environmental concerns and decreasing costs. However, other ingredients (cacao, hazelnuts, almond and palm oil) should be procured with different strategy mostly because of availability. These raw materials are not growing everywhere in the world, but specific regions. Combining availability and sustainability concerns, Lindt chooses the locations to obtain these ingredients such as Nuts from Turkey and Italy, cacao from Ghana and Latin America and almonds from USA. In order to acquire high quality supplies and fulfill its environmental and social responsibilities, it makes long term relations with the suppliers applying improvement projects in farms and in region. Analysis related to production facility network, it can be seen that the company prefers to be close to its customers when it is considered that 93% of its sales occur in USA and EU. This preference can be linked with the reasons to decrease lead time and increase delivery frequency It distributes remaining 7% of the products globally from those facilities to the rest of the world.

Dominant factors: Availability, sources quality, environmental concerns, domestic market strength, lead time, delivery frequency

1) Lindt cacao and supplementary supply chain




2) Lindt dairy products, sugar and packaging materials supply chain




**42. The Bridge**

Business Sector: Bag

Products: Bag

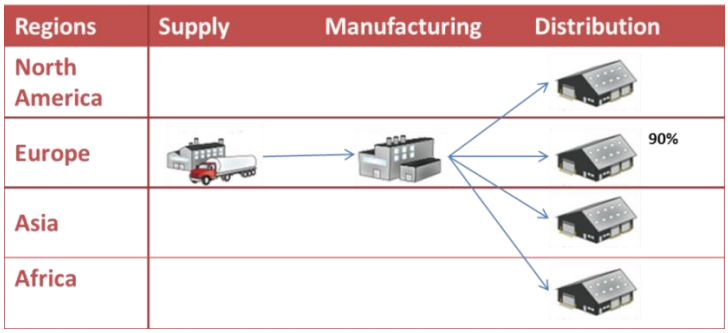
Supply Chain Configuration: Local sourcing, local manufacturing, global distribution

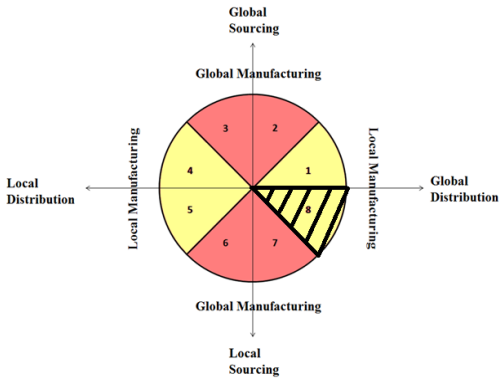
The company Ponte Pelletteria S.p.A is established in 1975, producing the brand of "The Bridge", which stands out for the production and marketing of high-grade leather goods and accessories. The range includes luggage, travel bags, briefcases, ladies handbags and small leather goods for a total of about 700 items, mainly briefcases, doctor bags and lady's shoulder bags. The heart of the market of "The Bridge", is represented by Europe, in particular Italy. Currently, more than 50% of the brand's turnover is realized in Italy while 40% is obtained from

export, especially to countries in the north of Europe such as Germany and the United Kingdom, where the products can be found in personalized corners in several retail stores.

The main drivers for choosing such a supply chain are proximity to market, supply quality and its label of "Made in Italy". The Bridge aims to be recognized as an "Italian" producer due to the relevance to good quality and luxury fashion reputation. The value of the brand comes from this label. Moreover, as it is stated, 90% of the demand is from EU countries, therefore, manufacturing occurs near to market which can ease the adoption to any kind of change in demand. Moreover, company explains the best quality sourcing strategy with these words: "The raw hides are carefully selected from European farms and are worked with traditional techniques which are combined with the latest technological solutions and chemicals which respect the environment. Only the finest fabrics are selected for the linings and threads, ranging from cotton to synthetics depending on the product being created, and German yarn, among the most durable on the market, is used for the stitching". The varieties of raw materials are not excessive and can be found locally with the best quality. Therefore, the company prefers local sourcing.

Dominant drivers: Reputation of the country, proximity to market, sourcing quality.




### 43. ABSOLUT VODKA

Business Sector: Beverage

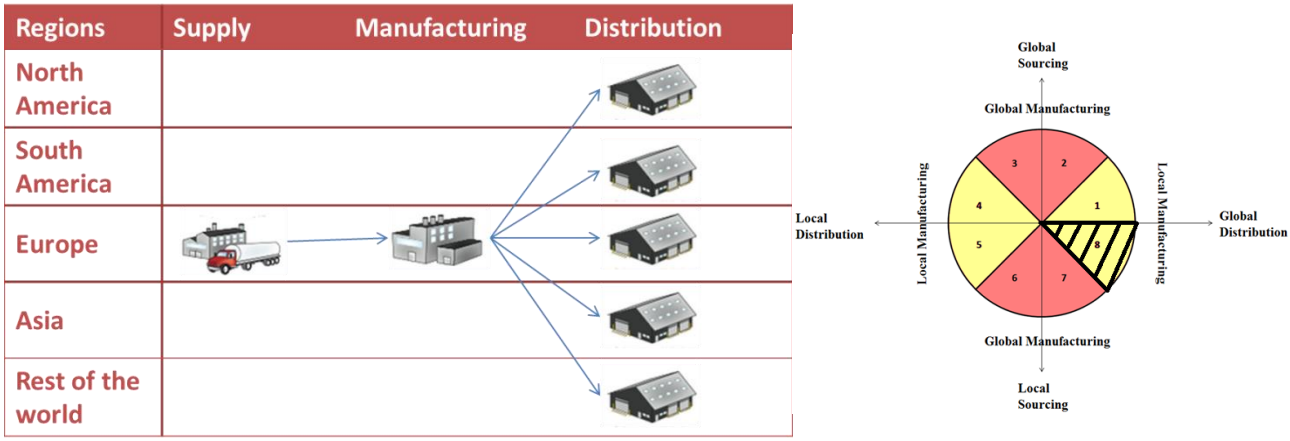
Products: Vodka

Supply Chain Configuration: Local sourcing, local manufacturing, global distribution

Absolut Vodka is a brand of vodka, which is third largest spirits worldwide after Bacardi and Smirnoff. It is sold nearly in 130 countries. The head quarter of the company is in Stockholm, Sweden. Since its launch in 1979, Absolut Vodka has achieved significant worldwide sales

growth, from 10,000 nine-liter cases (90,000 liters) to 11.0 million nine-liter cases in 2010 (99.0 million of liters).

Every bottle of Absolut Vodka is produced in Åhus in southern Sweden. Moreover, sourcing is also preferred to be 100% local by using the hardy wheat grains and water as the main ingredients of the very same region. Åhus provides the distillery with the raw materials to produce the millions of bottles of Absolut Vodka sold around the world because of the quality of the grains which ensures to satisfy the high quality standards of the company. Manufacturing is done in Åhus as well to represent the country Sweden and exploit its recognition with this high quality raw materials and production standarts. Since each bottle is produced in one plant and this is the prior decision of company in terms of its supply chain design and it is consumed worldwide, global distribution is the only option to complete its supply chain and reach all its markets.




**44. Ray-Ban**

Business Sector: Eye Wear

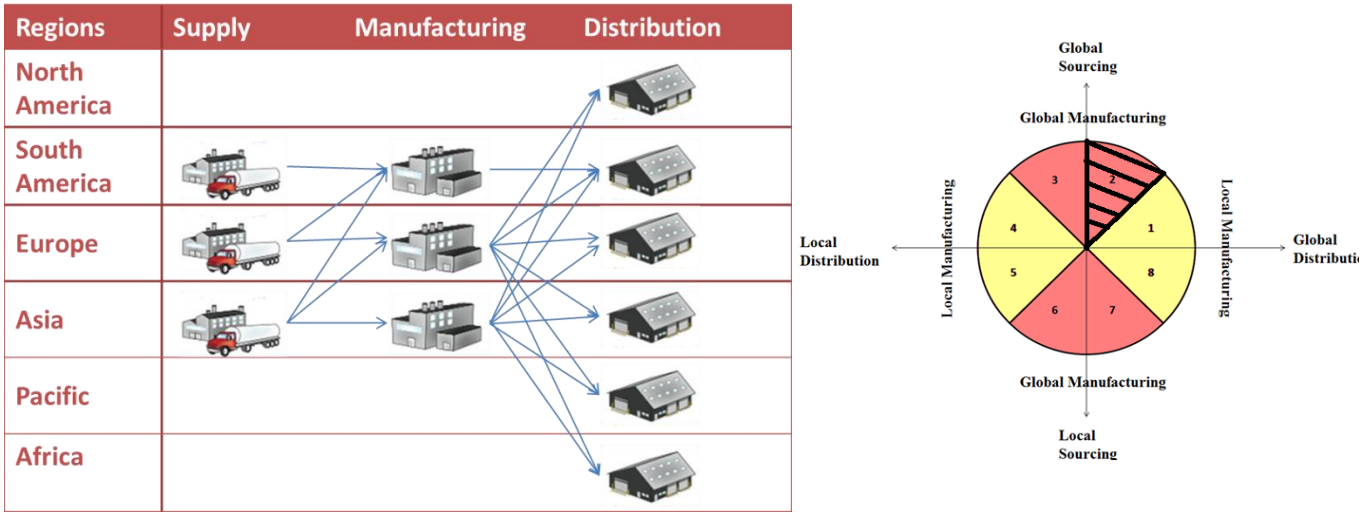
Products: Glasses

Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

Ray-Ban found in 1937, is one of the world's best-selling brands of sun and prescription eyewear. In 1999, it is sold to the Italian Luxottica Group that the brand currently operates under this group. Before acquired by Luxitica, Ray-Ban was enjoying the reputation of being "Italian" sunglass company.

As it is seen in supply chain map below, currently it has been produced in Brazil and China as well as Italy due to cost and market proximity concerns. Those facilities out of Italy provide Ray-Ban a cheaper production by the cheap labor and material offerings of those regions.

Dominant factors: Exchange rate, labor cost, tax incentives (Brazil).




**45. Ben & Jerry's**

Business Sector: FMCG

Products: Ice cream

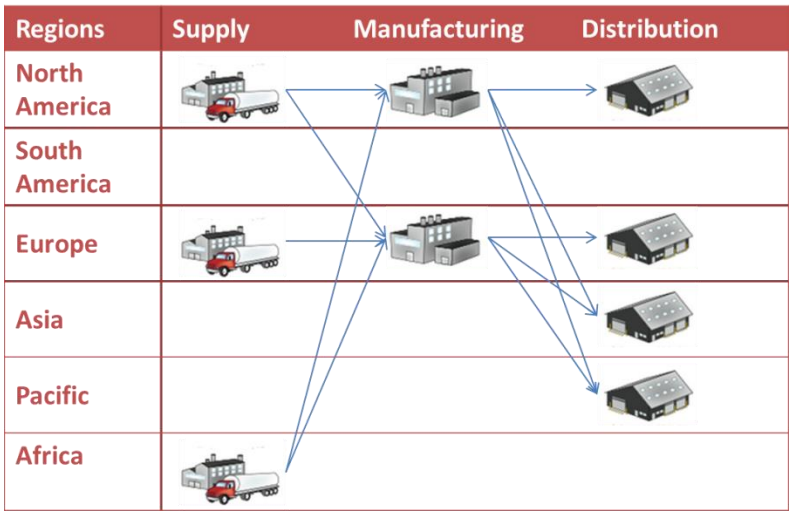
Supply Chain Configuration: Global sourcing, global manufacturing, global distribution

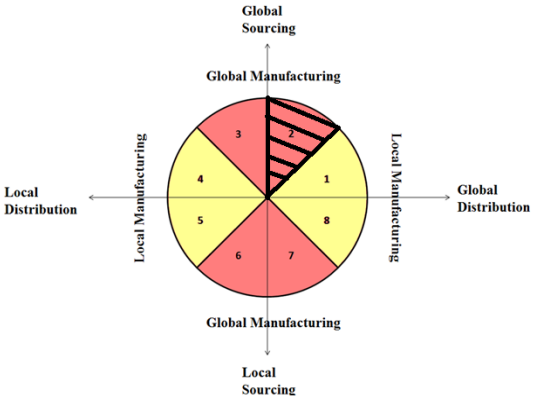
Ben & Jerry's is an ice-cream production and sales company since 1978 which was established in Burlington, Vermont that is where the headquarter of the company locates now. Today, Ben & Jerry's is owned by Unilever, and its packaged ice cream and novelties are sold in more than 30 countries around the world. The products are distributed through supermarkets, grocery stores, convenience stores, scoop shops, restaurants and other venues. Ben & Jerry's ice cream for the North American market is made in manufacturing plants in Waterbury and St. Albans, Vermont and in a Unilever facility in Henderson, Nevada. The company makes Ben & Jerry's ice cream for the European market in a Unilever facility in Hellendoorn, The Netherlands and for the Canadian market in a Unilever facility in Simcoe, Ontario and U.S. frozen novelties are manufactured at a Unilever facility in Sikeston, Missouri.

Supply chain of Ben & Jerry's is mainly affected by the supply quality and availability in supply side and proximity to market in manufacturing side. It has many flavors and ingredients which can only be found in specific regions of the world such as cacao, vanilla, banana, hazelnut and etc… Only dairy products are sourced locally due to its short life and availability close.

Moreover, ingredients are sourced globally with environmental and social concerns as well. Company, makes long term agreements with the suppliers to procure the best quality raw materials, meanwhile providing the sustainability of those agriculture commodities and assuring human rights are not violated by suppliers. Main markets of Ben & Jerry's are North America and EU countries where the manufacturing facilities are located which provides a proximity to customers. Other markets that Ben & Jerry's exist which are Australia and Asia are fed from the plants in USA and Netherlands commonly.

Dominant factors: Proximity to market, availability, supply quality, environmental concern




**46. Paşabahçe**

Business Sector: Glass Industry

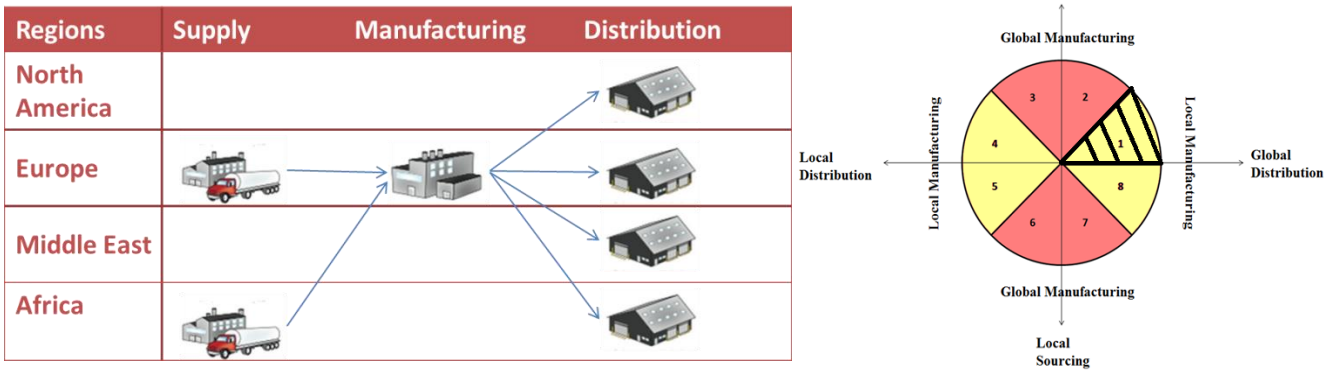
Products: Glass household goods

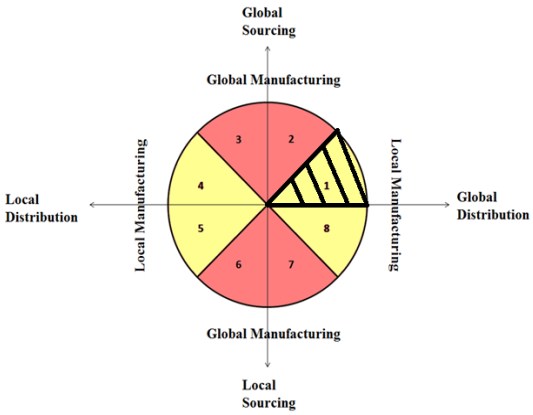
Supply Chain Configuration: Global sourcing, local manufacturing, global distribution

First Paşabahçe glass facility was established in the year of 1935 in Paşabahçe district of Istanbul. Ever since 1935, it has been performing the investment and production to meet the entirety of essential requirements for glass products. Paşabahçe (operating under Şişecam Holding) is specialized in all the essential areas of glass making with its main divisions, namely "Glass Tableware", "Glass Packaging", "Flat Glass" and "Chemicals" In 1960s, Paşabahçe expanded its operations towards the global markets, in order to rank amongst the most prestigious glass producers of Europe and the world. In this context, it initiated investments for production abroad by acquiring glass tableware plant in Russia and launched an automatic glass tableware plant in Bulgaria to provide services to mostly Eastern Europe.

As having only one main raw material to produced glasses which is huge amount of sand, and when considered Turkey (the domestic market) does not have any sand resources within the

borders, it is compulsory to import it. Paşabahçe is making a mandatory global supply by bringing it from Egypt. Remaining materials are brought from the close regions to facilities. The facilities can be considered too close to market because of having most of the demand from Europe. However, it has global distribution as well because of its presence in additional 3 regions which are North America, Middle East and Africa.




**47. Kellogg's – Cereal**

Business Sector: Food

Products: Ready-to-eat cereals, convenience food

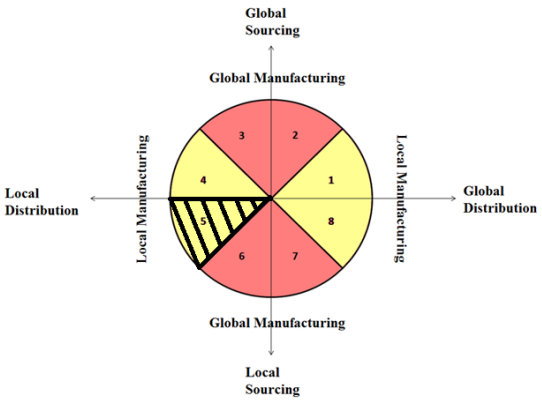
Supply Chain Configuration: Local sourcing, local manufacturing, local distribution

Kellogg Company, founded in 1906 and incorporated in Delaware in 1922, and its subsidiaries are engaged in the manufacture and marketing of ready-to-eat cereal and convenience foods. Its principal products are ready-to eat cereals and convenience foods, such as cookies, crackers, savory snacks, toaster pastries, cereal bars, fruit-flavored snacks, frozen waffles and veggie foods. These products are manufactured by company itself in 18 countries and marketed under the Kellogg's name in more than 180 countries.

When preferred supply chain is analyzed for the cereals produced, it is seen as the flow is done totally local. Raw materials are supplied locally, and facilities are close to market. In order to understand the factors, we should investigate the used raw materials and product features in more detailed way. Raw materials are mostly agricultural commodities which are generally not specific to a region but able to be grown in many places such as corn, wheat and sugar. Some global sourcing can be done such as cacao in small scales but in our study, we emphasized only the main raw materials that are used in the vast majority of whole production process. In the same way, packaging materials which contains mainly carton board, corrugated, and plastic are obtained from local region. Moreover, product has the features of low shelf life and low product-value density which makes worthless to carry the products from another region. Production does

not required high skilled labors and it does not require a high investment to build a facility. These drivers indicate the rightfulness of the company to produce in each market that it operates.

| Regions | Supply | Manufacturing | Distribution |
|---|---|---|---|
| North America | | | |
| South America | | | |
| Europe | | | |
| Asia | | | |
| Pacific | | | |
| Africa | | | |




### 4.2 Conclusion for Case Studies Part

Throughout our research, we have investigated 47 manufacturing companies with the aim of detecting their supply chain network and configuration. These companies are selected on the basis of some criteria. First of all, it is given attention to work on different sectors in order to observe different necessities and priorities of each business as well as its challenges and constraints. Next, companies operating/being managed from different regions are tried to be picked so as to be aware different practices and behaviors of different regions in terms of operation and customer service priorities. Beside variety in terms of region and sector, characteristics of the company are given importance. Big and recognized companies which are important players in their sector regionally or worldwide are tried to be selected in order not to overlook market situation and its requirements because of the fact that a small company may not have the full awareness of the market due to its scale. On the other hand, we believed that we can investigate more innovative supply chain solutions -which can be interesting to study- in big scale companies which tackles more problems due to its size. A big player in the market confronts all possible problems regarding to supply, manufacturing and distribution, and it gives big efforts to operate in the optimum way to overcome the difficulties and constraints that the market offers contrary to small companies may remain in sub-optimum due to its inability to solve it due to company's resources or its limited operation area.

Considering the process, we have gained information by scanning annual or sustainability reports, disclosed information on web, interviews in recognized journals or for some of them by direct interview through mail.

In the case study part, each company and its supply chain is explained as following: a brief description of the company is given including its product characteristics, product range, and market size, headquarter location and regions it operates, and sales volume. Afterwards, our subjective evaluation of the supply chain network and configuration choice is written, with a reference given to the information obtained from our research. Identified supply chain network and configuration choice of each company are given in the bottom part of the company explanation. With the best knowledge we gained from this study, we tried to reveal the motives and dominant factors influenced company to determine its strategy in the direction of given configuration.

In the following part, the outcomes of our case studies, general arguments and our observations regarding to globalization or localization preferences of different sectors and different regions, drivers coming into prominence in which specific cases and dominant enablers influencing configuration choices of companies is discussed.

With the best knowledge we gained from this study, we have noticed that there is an important shift in supply chain strategies of companies due to several reasons. The supply chain planning approach developed in the early 1990's is failing under today's market environment. Today's market requires more coordination and collaboration than strict optimization with the change of customer needs and increasing scale of business. In the current corporate climate, the management of extreme demand volatility of increasing number and variety of products within acceptable costs has become the increasingly challenging.

As supply chain management cost is the significant percentage of the total cost of a company, supply chain executives are aware of the drastic effect of cutting supply chain costs in company's profitability, thus they consider it as priority. On the other hand, customers are becoming more and more demanding that delivery performance, flexibility and service level is gaining criticality in customers' eyes.

Maximizing the supply chain flexibility through its supply chain is becoming the new imperatives for today's business. In order to achieve it, the main action that we had observed in our study is the increasing trend of localization. Regional manufacturing and distribution gives companies a greater flexibility and ease to respond local customers on time and, satisfy and adapt to their requirements. On the other hand, sourcing is the main activity that majority of the investigated companies still prefer to make global mostly because of availability and cost factors. But trend is switching from low-cost country sourcing to best country sourcing, realizing that lead times can give a notable competitive advantage to company.

Another movement regarding this topic we recognized is a heavy invests on sustainable supply chain management. Companies are giving a high attention to environmental and social responsibilities. It allows to increase their company image and this issue is predicted to be more and more important in upcoming years. Therefore, first steps are started to be taken that influences supply chain leg of the total activities of the company as well.

Emerging markets are also a matter having a drastic influence on companies to reshape their supply chains. Contrary to traditional markets with painfully slow growth rates, emerging markets offers a rapid and promising sales growth. Moreover, in sourcing and manufacturing stage, although some of them does not guarantee the lowest cost as China or similar countries known by the lowest costs, they can be a better option for other factors such as proximity or quality.

As an outcome of case study, we have identified a driver which was not included to the list of supply chain design enablers selected through literature review which is reputation of country. With the knowledge we gained by case study, it is realized that reputation of a country related to a specific area such as fashion, technology may become a major decision criteria for designing its supply chain. Therefore, this driver is a special driver, differing from others because of being extracted from case study than literature review as the others.

When sectors are analyzed, different obstacles, different requirements and different solutions are observed as following:

Automotive industry stands out with the effort on localizing its supply chain network. Mostly it is achieved in distribution side in order to be close to market and adapt easier to changes although sourcing part remains global due to technology and cost constraints of supplied materials. Main challenge in this regard is the existing infrastructure which is an expensive investment. Despite this constraint, companies are working on localization where possible.

Industries related to food and beverage prefers a configuration enables them to stay closer to the market as expected. First of all, majority of their products differ from others due to having expiration problem and more dynamic nature of demand. Shelves should be replenished whenever required and factors such as seasonality should be followed carefully. Moreover, in the same way that the products have a probability to perish, so do its ingredients. Therefore, as long as ingredients with desired quality are easy to be found in the region, companies prefer to supply it locally such as dairy products or cereals. On the other hand, it is not so unlikely in this sector to use some fruits/vegetables/etc… growing in specific regions in the world such as coffee,

cacao, palm oil and etc. which gives company no choice but source it globally to manufacturing facilities. In summary, most common supply chain configuration in this sector is local distribution with a mix of local and global sourcing due to availability reasons as it is mentioned before.

In pharmaceutical industry, the main challenge is to manage excessive number of supplies and high quality standards. Proximity to market is important due to serving a customer group which expects top level of delivery performance. Patients cannot wait for the product to be delivered with a delay. However, on supply side, different raw materials can be found in different regions and to assure continuous supply in case of any problem, companies prefer dual or multi sourcing. Furthermore, because of having many different areas in the very same sector, facilities may not serve to all business units but specialized in some areas. Another factor is different regulations in different countries that may lead company to be influenced in deciding about facility location. Considering all those complicated structure of the sector, it can be concluded that companies are making progress to localize mostly its distribution although still it remains to operate in highly global level.

Apparel, cosmetics and other fashion related industries show two different patterns. First one is followed by luxury brands which have its value linked with the fame of the country that is produced. Within our case study, we have observed many companies such as Gucci and Ray-Ban following this strategy, particularly highlighting "Made in Italy" feature, in order to persuade their customers about the quality of their design. These companies, therefore, start to build their supply chain network with a restriction from the very beginning: manufacture facilities to be located in that country. Therefore, they distribute their products globally, ignoring the increased cost. It does not create a significant problem, since this strategy is followed by mainly luxury brands that their customer is willing to pay a higher price because of its brand image and added value by production place. In these companies, we did not observe a particular sourcing behavior that may vary depending on the company. Some of them preferred to represent strongly its value by sourcing its raw materials from the same area as well, while some of them prefer decrease cost by supplying from low cost countries. The second pattern followed in this sector is to concentrate on cost as much as possible and serve in mass market to gain competitive advantage by price. Those companies like Zara, priory select cost related drivers such as exchange rate, low labor cost when designing their supply chain. Therefore, they source and produce global with a lower focus on quality then cost in order to minimize their production cost.

As a future area of research, we would like to suggest different alternatives for measurement methods offering different options for quantifying those drivers. Moreover, quantitative models can be developed considering these drivers aiming to find optimal supply chain configuration that proposes the best consideration of priorities of the company.

| | Industries | | | |
|---|---|---|---|---|
| | **Apparel** | **FMCG** | **Electronics & Household Appliance** | **Automotive** |
| **Supply Chain Configuration** | Configurations: 1,2,3,5,7,8 | Configurations: 2,3,4 5 | Configurations: 1,2,3,7,8 | Configurations: 2,3,5 |
| **Dominant Drivers** | Country reputation, proximity to market, lead time, delivery frequency, domestic market strength, Labor cost, supplier competition, tax incentives | Shelf life, lead time, delivery frequency, availability, domestic market strength, proximity to market, supply quality, environmental concern | Obsolescence, proximity to market, supply quality, availability, domestic market strength | sustainability, availability, exchange rate, delivery time, price, supplier's quality, |
| | **Computer and communication technologies** | **Aviation** | **Plastics** | **Pharmaceuticals** |
| **Supply Chain Configuration** | Configurations: 1,2,3 | Configurations: 1 | Configurations: 2 | Configurations: 2 |
| **Dominant Drivers** | Lead time, returnability, service level, delivery reliability, domestic market strength, labor cost, exchange rate, availability, supply quality, size of orders | Availability, technology level, product size, product value, existing infrastructure | availability, lead time, environmental concerns | Market size, endowment of purchased items, product variety, obsolescence |
| | **Cosmetics** | **Toys & Stationery** | **Oil** | **Glass** |
| **Supply Chain Configuration** | Configurations: 3,8 | Configurations: 2 | Configurations: 1 | Configurations: 1 |
| **Dominant Drivers** | Quality of supply, country reputation, proximity to supplier , availability, lead time, delivery frequency | Proximity to market, Environmental concerns, availability of raw materials, supply quality | Existing infrastructure, power of domestic market, flexibility in sourcing | Domestic market strength, Availability |

Table 4.1 Summary table for configurations and dominant drivers corresponding to the related industry areas investigated in empirical study part

## GENERAL CONCLUSION

Technical progress, liberalization of markets and the diffusion of global production systems are not only creating new opportunities in global market economy but also promoting the improvements in supply chains of the companies at global level. All these improvements are increasing the complexity of global supply chain design problem inevitably; therefore it creates a wide research area for researchers and practitioners to be interested in. In our study, we have tried to investigate the recent studies focused on the topic of global supply chain by adapting the methodology of classifying the papers and then conducting an empirical study in which we extracted the supply chain configurations of the companies.

Our work consists of four main parts. In the first part, we did a comprehensive literature review by clustering the papers as being qualitative, quantitative and integrated. As a result we have pointed out that, just a few articles have addressed to the global supply chain design problem as a whole by considering the all parts of the chain. Instead of handling the whole length of supply chain, the authors preferred to focus on mainly global sourcing, global manufacturing and facility location. On the other hand, global distribution is not so widely discussed in the literature.

In the second part, we have given more attention to the global supply chain configurations by deep analysis of contemporary literature. Under the light of literature review about that topic, we have developed our own model to present a clear understanding of the configurations. The model indicates to eight different global supply chain configurations and takes operational processes and location selection criteria as basis. In the empirical study part, this model is used in order to show the corresponding configuration extracted from the case studies of the companies.

In the third part, we have found the drivers which affect the supply chain design decision. As a result of the study we have extracted 32 different drivers which are clustered in 5 different categories named as product, service, demand, supply and environment. Moreover, their impact on supply chain configuration selection in terms of globality/locality level of supply, manufacturing and distribution stage is tried to be identified, which resulted in a exploring the links in between drivers and supply chain configurations.

Finally, in the last part, which is the empirical study of this thesis, we investigated big global manufacturing companies' supply chain processes in order to extract their supply chain configurations and place theses configuration on the model that we developed. We have given attention to select the companies from different business areas to be able to observe the

differences in configurations for different sectors. Also, for each configuration drawn for the companies we also identified the dominant drivers which we thought might affect the supply chain configuration selected.

As a conclusion to our thesis, we have some suggestions for future research areas:

1. There should be more industry settings for the models in order to be a guide for other type of industries for leading them to be involved in global supply chain design.
2. Global supply chain models should be broadened by integrating multiple tiers which enable to integrate decisions and investigate the interactions within the whole length of the supply chain.
3. There should be more focus on the development of an overall global supply chain area which is enhanced by multiple inter-related models capable of including qualitative factors and uncertainties. Also, there should be effective use of information technologies and adequate database management to be able to have a successful design structure.
4. Existing knowledge should be expanded on each configurations of global supply chain. Benefitting from the real-life case studies of the companies could be an ideal way to explore more about the configurations
5. Defining the globality level would be an interesting improvement on our study. Identifying companies on the basis of not only being global or local but how much global or how much local in terms of different stages.
6. A study should be conducted in order to identify relationships between supply chain configuration and the total supply chain cost. For example, within our work, there is a conclusion regarding the most preferred supply chain configuration for a specific sector. However, it is not known which configuration is most costly or cheapest one. Therefore, we could conduct empirical study to study the relationships between supply chain configuration and supply chain cost.
7. Relations between the drivers should be investigated. During our research, we realized that there are some links within those drivers which may be either two sided or dominated by one. To clarify, shelf life dominates the decision of frequency and order size due to the constraint it creates. In order to avoid perished unsold goods, order size is decreased which leads higher frequency. Those links should be established between the drivers and the degree of influence on each other should be measured.

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## APPENDIX - Classification of the Studies According to the Research Method

### 1. Literature review papers

| | Authors | Year | Country of first author | Title | Journal | Methodology | Objective of article | Length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Mary J. Meixell, Vidyaranya B. Gargeya | 2005 | USA | Global supply chain design: A literature review and critique | Transportation Research Part E 41 | literature review | to assess how well the existing model-based literature supports the global supply chain design problem and to contribute to the development of a classification scheme that is focused on these practical considerations | supplier-customer | global | reliability, responsiveness, flexibility, improving quality, meeting schedule requirements, reducing cost, accessing new technologies, broadening the supply base |
| 2 | C.J. Vidal and M. Goetschalckx | 1997 | Colombia | Strategic production-distribution models: A critical review with emphasis on global supply chain models | European Journal of Operational Research | literature review | to present the existing production-distribution models in the literature with their main characteristics by focusing on the global logistics system and future opportunities in this area. | manufacturer-customer | global | N/A |
| 3 | Arnold Marz | 2012 | USA | Global supply chain other voices | Journal of Supply Chain Management | qualitative | to introduce the views of a leading economist, geographer and sociologist, respectively, on global sourcing and supply chain structure | supplier-manufacturer | global | N/A |

| | Authors | Year | Country of first author | Title | Journal | Methodology | Objective of article | Length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 5 | M.T. Melo, S. Nickel, F. Saldanha-da-Gama | 2009 | Germany | Facility location and supply chain management – A review | European Journal of Operational Research | literature review | to present a literature review of facility location in the context of supply chain management by identifying the basic features which are required for models to support decision making in strategic supply chain planning process. | manufacturer-customer | N/A | |
| 6 | B. M. Beamon | 1998 | USA | Supply chain design and analysis: Models and methods | Int. J. Production Economics | literature review | to provide a focused review of literature in multi-stage supply chain modeling and to define a research agenda for future research in this area | supplier-customer | global | N/A |
| 8 | L. Boer, E. Labro, P. Morlacchi | 2000 | Netherlands | A review of methods supporting supplier selection | European Journal of Purchasing & Supply Management | literature review | to position the contributions in a framework that is done in the supplier selection process from initial problem definition, over the formulation of criteria, the qualification of potential suppliers, to the final choice. | supplier-manufacturer | global | N/A |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 9 | L. Quintens, P. Pauwels, P. Matthyssens | 2006 | Netherlands | Global purchasing: State of the art and research directions | Journal of Purchasing & Supply Management | literature review | to synthesize findings on the central phenomenon, its antecedents and consequences as well on the globalization process of purchasing. | supplier-customer | global | cost advantages, better delivery performances, product quality, technology access, unique or differential products, to assure flexibility, integration of worldwide activities, take advantage of existing logistics systems, diversification of supplier base, market size, labor cost, guard against fluctuations, political stability, legal and economic environment |

## 2. Overview and Strategy

| | Authors | Year | Country of first author | Title | Journal | Methodology | Objective of article | Length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Terry P. Harrison | 2001 | USA | Global Supply Chain Design | Information Systems Frontiers 3:4 | qualitative | describe the important considerations of designing a supply chain from a global (versus domestic) perspective. | supplier-customer | global vs local | profitability, customer service, flexibility and reliability, service time, cross-functional teamwork (coordination), out-of-box thinking, duties, duty drawbacks, local content, taxes, exchange rates, |
| 2 | R. Ganeshan and T.P Harrison | 1995 | USA | An Introduction to Supply Chain Management | Technical Report; Department of Management Science and Information Systems, The Pennsylvania State University | qualitative | to give general information about supply chain management, strategy and participants | supplier-customer | local | cost, customer service, convenience, responsiveness |
| 3 | J. Cho and J. Kang | 2001 | USA | Benefits and challenges of global sourcing: perceptions of US apparel retail firms | International Marketing Review | quantitative | investigates various benefits and challenges that retail firms perceive in global sourcing and how those benefits and challenges differ in terms of firms' demographic and managerial characteristics | supplier-manufacturer | global | competitive advantage, service enhancement, quality assurance, |

| | Authors | Year | Country of first author | Title | Journal | Methodology | Objective of article | Length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Arnold Marz | 2012 | USA | Global supply chain other voices | Journal of Supply Chain Management | qualitative | to introduce supply chain scholars to the views of a leading economist, geographer and sociologist, respectively, on global sourcing and supply chain structure | supplier-manufacturer | global | N/A |
| 5 | Gary Gereffi, Joonkoo Lee | 2012 | USA | Why the world suddenly cares about global supply chain | Journal of Supply Chain Management | qualitative | to understand the governance types of global value chain and investigate the relation of GSC and value chain | supplier-customer | global | shorter production run, quick responses, lower entry barriers, less stringent product and process standards in emerging markets |
| 6 | M. Christopher, H. Pech, and D. Towill | 2006 | UK | A taxonomy for selecting global supply chain strategies | The International Journal of Logistics Management | qualitative | to address to the choice of global supply chain strategy by using a strategy selection matrix to increase responsiveness to customer demand | manufacturer-customer | global | |
| 7 | I. Manuj, J. T. Mentzer | 2008 | USA | Global Supply Chain Risk Management | Journal of Business Logistics | qualitative | to bring together the concepts, frameworks and insights from several disciplines to propose a risk mitigation model for global supply chains | supplier-customer | global | uncertainty of lead time, reliability, accuracy, quality |

| | Authors | Year | Country of first author | Title | Journal | Methodology | Objective of article | Length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 8 | Marshall L. Fisher | 1997 | USA | What is the right supply chain for your product? | Harward Business Review | qualitative | to show that global supply chain design strategy differs according to the product being innovative or functional and to propose a two dimensional matrix to demonstrate the relation | supplier-customer | N/A | demand uncertainty, product life cycle, responsiveness, efficiency |
| 9 | Roy Stratton, Roger D. H. Warburton | 2006 | USA | Managing the trade-off implications of global supply | Int. J. Production Economics | qualitative-empirical | to investigate the trade-off between responsiveness and cost by proposing three conceptual approach to improve strategic supply chain | supplier-manufacturer | global | cost, uncertainty, responsiveness, product life cycle, quality |
| 10 | M. Faraoni, L.Petretti | 2009 | Italy | Market-Driven Management and Global Supply Chain | SYMPHONYA Emerging Issues in Management, | qualitative | a new approach in managing the supply chains and the consequent optimization of material flows | supplier-manufacturer | global | Lead time, cost, rate of turnover, technology access, reaction time for demand change, political and economic risks. |

## 3. Conceptual Design Models and Empirical Studies

| | Authors | Year | country | title | journal | methodology | objective of article | length of SC | scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | B.L. MacCarthy and W. Atthirawong | 2003 | UK | Factors affecting location decisions in international operations – a Delphi study | International Journal of Operations & Production Management | qualitative | Comprehensive set of factors that may influence international location decisions is identified from an analysis of the existing literature. Results are presented from a Delphi study that used a to investigate factors affecting international location decisions to investigate factors affecting international location decisions | Supplier-manufacturer | global | costs, infrastructure, labor characteristics, government and political factors and economic factors |
| 2 | John Meredith Smith | 1999 | UK | Item selection for global purchasing | European Journal of Purchasing & Supply Management | qualitative | to investigate the factors that can affect the decision making for global sourcing and propose a decision matrix which identifies which items should be procured globally which should be obtained locally | supplier-manufacturer | global | cost, quality, wider availability, technological know-how, innovation, improved delivery service, tax and currency opportunities |
| 3 | P. Swafford, S. Ghosh, N. Murthy | 2000 | USA | A Model of Global Supply Chain Agility and its Impact on Competitive Performance | Working Paper | qualitative | to propose related constructs and a model of global supply chain agility by using sound theory building methods | supplier-manufacturer | global | cost, quality, lead time, manufacturing capacity, process capability, development cycle time, delivery time, |

| | Authors | Year | Country of first author | Title | Journal | Methodology | objective of article | Length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | P. Bremen, J. Oehmen, R. Alard, P. Schonsleben | 2010 | Switzerland | Transaction Costs in Global Supply Chains of Manufacturing Companies | Journal on Systemic, Cybernetics and Informatics | qualitative | to analyze the cause-and-effect chain of inter-firm transaction costs concerning global sourcing from low-cost countries and present a model which trace back this causes | supplier-manufacturer | global | transaction cost |
| 5 | Mary J. Meixell, Vidyaranya B. Gargeya | 2005 | USA | Global supply chain design: A literature review and critique | Transportation Research Part E 41 | literature review-qualitative | The aim is to assess how well the existing model-based literature supports the global supply chain design problem and to contribute to the development of a classification scheme that is focused on these practical considerations | supplier-customer | global | reliability, responsiveness, flexibility, improving quality, meeting schedule requirements, reducing cost, accessing new technologies, broadening the supply base |
| 6 | Jari Collin, Eero Eloranta, Jan Holmstrom | 2009 | Finland | How to design the right supply chains for your customers | Supply Chain Management: An International Journal | qualitative | The aim of this paper is to present an approach to identify and design alternative supply chain solutions according to their customers' demand chains | N/A | N/A | |

| | Authors | Year | Country of first author | Title | Journal | Methodology | Objective of article | Length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 7 | James Roh, Paul Hong, Hokey Min | 2013 | USA | Implementation of a Responsive Supply Chain Strategy in Global Complexity: The Case of Manufacturing Firms | Int. J. Production Economics | qualitative | to present a research model that defines the drivers, strategy and practices of a responsive supply chain and its performance outcomes in global environment. | supplier-customer | global | responsiveness, adaptability, customer-oriented |
| 8 | Remzi Hammami, Yannick Frein, A. B. Hadj-Alouane | 2008 | France | Supply chain design in the delocalization context: Relevant features and new modeling tendencies | Int. J. Production Economics | qualitative | to propose a precise definition for the term delocalization, identify different delocalization strategies, review the theoretical background of the delocalization problem and propose a conceptual framework | N/A | global | transfer pricing, low labor and supplier cost, product lifecycle, technology selection |
| 9 | Jeremy M. Brann | 2008 | USA | Supply Chain Design: A Conceptual Model and Tactical Simulations | Dissertation | qualitative | to contribute to the literature by determining which supply chain management dimensions should be considered during the design process and to create a SC design conceptual model by employing text mining | N/A | N/A | inventory cost, demand arrival rate, transportation time |

| | Authors | Year | country | title | journal | methodology | objective of artcile | length of SC | scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 10 | Adisak Theeranuphattana and John C.S. Tang | 2007 | Thailand | A conceptual model of performance measurement for supply chains | Journal of Manufacturing Technology Management | qualitative | to propose an innovative performance measurement method for supply chain management by addressing to the limitations | N/A | N/A | reliability, responsiveness, flexibility, costs, assets |
| 11 | R. Golini and M. Kalchschmidt | 2010 | Italy | Global Supply Chain Management and Delivery Performance: a Contingent Perspective | Rapid Modeling and Quick Response | qualitative | to put light on the effect of these contingencies and to identify strategic patterns followed by companies dealing with different contingent situations | supplier-customer | global | size, complexity, uncertainty |
| 12 | I. Manuj | 2013 | USA | Risk Management in Global Sourcing: Comparing the Business World and the Academic World | Transportation Journal | qualitative | to compare academic research with industry practice in the area of global sourcing risk management and suggest directions for future research to help bridge the gap between the theory and the practice of global sourcing risk management. | supplier-manufacturer | global | Item characteristics, cost, lead time, quality, infrastructure security, political stability, barriers, flexibility, skilled labor |

| | Authors | Year | Country of first author | Title | Journal | Methodology | Objective of article | length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 13 | K.W. Platts and N. Song | 2010 | UK | Overseas sourcing decisions – the total cost of sourcing from China | Supply Chain Management: An International Journal | empirical- case study | to study and compare the true cost of sourcing from China and companies' perceptions of the total cost of their China sourcing projects. | supplier-manufacturing | global | cost |
| 14 | H. V. Nguyen | 2011 | USA | Risk and Visibility in Global Supply Chains: An Empirical Study | Marketing Dissertations | empirical study | to see the critical relationship-specific capability that needs to develop for buying firms to mitigate supplier risk proactively | supplier-manufacturing | global | |

## 4. Global Supply Chain Configurations Papers

| | Authors | Year | country | title | journal | methodology | objective of article | length of SC | scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | R. Cagliano, F. Caniato, R. Golini, M. Kalchschmidt, G. Spina | 2008 | Italy | Supply chain configurations in a global environment: A longitudinal perspective | Oper Manag Res | quantitative | paper aims to provide an overview of how manufacturing companies use global supply chains and identify GSC configurations. | supplier-customer | global | cost, revenue, reliability, effectiveness of business processes, supplier availability and quality, closeness to foreign markets |
| 2 | Federico Caniato, RuggeroGolini, MatteoKalchschmidt | 2012 | Italy | The effect of global supply chain configuration on the relationship between supply chain improvement programs and performance | International Journal of Production Economics | qualitative or quantitative?? | to investigate the moderating effect of GSC configurations on the relationship between SC improvement programs and operational performance improvement, based on data collected from the fifth edition of the IMSS | supplier-customer | global | flexibility, cost, quality, delivery, lead time |
| 3 | Mette Præst Knudsen, Per Servais | 2007 | Denmark | Analyzing internationalization configurations of SME's: The purchaser's perspective | Journal of Purchasing and Supply Management | qualitative | to diagnose the differences between firms in each of the configurations and to find that psychic distance, risk, and control are unimportant factors compared to conventional findings | supplier-manufacturer | global | N/A |

| | Authors | Year | Country of first author | Title | Journal | Methodology | objective of article | Length of SC | Scope of SC | Drivers |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | A. Creazza, F. Dallari, M. Melacini | 2010 | Italy | Evaluating logistics network configurations for a global supply chain | Supply Chain Management: An International Journal | qualitative | to identify and assess different configurations to design logistics networks in global sourcing contexts. | supplier-manufacturer | global | lead time, labor cost, suppliers' dispersion, regional demand |
| 5 | A. C. Garavelli | 2003 | Italy | Flexibility configurations for the supply chain management | Int. J. Production Economic | qualitative | a simulation model is proposed to evaluate the performance of different configurations of a SC | supplier-customer | global | lead times, WIP |
| 6 | F. Caniato, R. Golini, M. Kalchschmidt | N/A | Italy | Global supply chain configurations and management: Evidences from the electric motor industry | N/A | qualitative | to study global SC configurations and management through a set of case studies in the electric motor industry. | supplier-customer | global | lead time, cost competition, company size; market, modular value chain, governance typologies |
| 7 | J. Zheng | N/A | UK | Small Business Involvement in International Supply Chains: Overviews and Research Agenda | N/A | qualitative | to identify some key issues concerning SME strategic approach to international supply chain activities. | supplier-customer | global | N/A |

## 5. Integrated Models

| | Authors | Year | Country | Title | Journal | Methodology of quantitative part | Objective of article |
|---|---|---|---|---|---|---|---|
| 1 | R. H. Lin | 2012 | China | An integrated model for supplier selection under a fuzzy situation | International Journal of Production and Economics | FANP | to adopt FANP approach to identify top suppliers by considering the effects of interdependence among selection criteria and to handle uncertainties. |
| 2 | J. Sarkis, R.P. Sundarraj | 2002 | USA | Hub location at Digital Equipment Corporation: A comprehensive analysis of qualitative and quantitative factors | European Journal of Operational Research | ANP | to locate a repair parts warehouse for Digital Equipment Corporation by considering not only long term strategic issues, but also choosing economically viable locations |
| 3 | F. Cebi, D. Bayraktar | 2003 | Turkey | An integrated approach for supplier selection | Logistics Information Management | LGP | to propose an integrated model for supplier selection. |

## 6. Quantitative Models

| | Author | Year | Country | Title | Journal | Decision Issue | Objective function | Model | Program-Technique | Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F. You, J. M. Wassick, I. E. Grossmann | 2008 | USA | Risk Management for a Global Supply Chain Planning under Uncertainty: Models and Algorithms | AIChE Journal | Production and distribution planning | Cost minimization Risk minimization | multi-objective | LP Simulation | Demand uncertainty Cost uncertainty |
| 2 | E. G. Pinto | 2007 | USA | Supply Chain Optimization using Multi-Objective Evolutionary Algorithms | Applications of Evolutionary Computing | Flow of goods | Cost minimization, Revenue maximization | multi-objective | Evolutionary algorithms | No uncertainty |
| 3 | S. Liu, L. G. Papageorgiou | 2012 | UK | Multi objective optimization of production, distribution and capacity planning of global supply chains in the process industry | Omega | Production, distribution, capacity optimization | cost minimization flow time minimization lost sale minimization | multi-objective | MIP | No uncertainty |
| 4 | Z. Liu, A. Nagurney | 2011 | USA | Supply chain networks with global outsourcing and quick-response production under demand and cost uncertainty | Annals of Operations Research | Outsourcing decisions | profit maximization | single-objective | Variational Inequality Model | Demand uncertainty Cost uncertainty |
| 5 | P.Kouvelis, J. Milner | 2002 | USA | Supply chain capacity and outsourcing decisions: the dynamic interplay of demand and supply uncertainty | IIE Transactions | Level of capacity and outsourcing | profit maximization | single-objective | LP | Demand uncertainty Supply uncertainty |

| | Author | Year | Country | Title | Journal | Decision Issue | Objective function | Model | Program-Technique | Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | A. Nagurney, M. Yu, Q. Qiang | 2011 | USA | Supply Chain Network Design for Critical Needs with Outsourcing | Regional Science | Outsource or in-house production decision | total cost minimization | single-objective | | Demand uncertainty |
| 7 | Ramzi Hammami | 2011 | France | A Mathematical Model for the Global Supplier Selection | Business Process Management Workshops | Supplier selection | minimize total cost | single-objective | LP | No uncertainty |
| 8 | A. Ravindrana , R. U. Bilsela, V. Wadhwab and T. Yangc | 2009 | USA | Risk adjusted multicriteria supplier selection models with applications | International Journal of Production Research | Supplier selection | Total cost minimization lead time minimization minimize risk | multi-objective | Goal Programming | Price uncertainty Lead time uncertainty Demand uncertainty |
| 9 | R. Dulmin, V. Mininno | 2003 | Italy | Supplier selection using a multi-criteria decision aid method | Journal of Purchasing & Supply Management | Supplier selection | | multi-objective | | |
| 10 | D. Wu, D. L. Olson | 2008 | Canada | Supply Chain Risk, Simulation, and Vendor Selection | International Journal of Production Economics | Vendor selection | Analysis of expected costs, quality acceptance levels, and on-time delivery distributions | multi-objective | simulation | Cost uncertainty On-time delivery risk acceptance risk |
| 11 | B. O. Gobaco | 2012 | Philippines | A Simulation Model for a Consumer Electronic SC with Global Sourcing in the presence of Continuous Risks | Proceedings of the Asia Pacific Industrial Engineering | Product flow optimization | Cost minimization, Fill rate, maximization Inventory fluctuation min. | multi-objective | Simulation | |

| | Author | Year | Country | Title | Journal | Decision Issue | Objective function | Model | Program-Technique | Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| 12 | G. N. Yücenur, Ö. Vayvay, N. Ç. Demirel | 2011 | Turkey | Supplier selection problem in global supply chains by AHP and ANP approaches under fuzzy environment | The International Journal of Advanced Manufacturing Technology | Supplier selection | Maximum weighted supplier | single-objective | Fuzzy | No uncertainty |
| 13 | O. Kilincci, S. A. Onal | 2011 | Turkey | Fuzzy AHP approach for supplier selection in a washing machine company | Expert Systems with Applications | Supplier Selection | Maximum weighted supplier | multi-objective | fuzzy analytic hierarchy | |
| 14 | F. You and I. E. Grossmann | 2008 | USA | Design of Responsive Process Supply Chains under Demand Uncertainty | Computers & Chemical Engineering | Facility Location | net present value maximization expected lead time minimization | multi objective | mixed-integer nonlinear programming | Demand uncertainty |
| 15 | M. Goh, J. Y.S. Lim, F. Meng | 2007 | Singapore | A stochastic model for risk management in global supply chain networks | European Journal of Operational Research | Network Design | profit maximization risk minimization | multi-objective | Stochastic Programming | |
| 16 | D. Peidro, J. Mula, R. Polera, J. L. Verdegay | 2009 | Spain | Fuzzy optimization for supply chain planning under supply, demand and process uncertainties | Fuzzy Sets and Systems | Alternative decision plans for different degrees of satisfaction | minimize cost | single-objective | Fuzzy-MIP | |
| 17 | M. M. S. Lu,A. Irajpour, N. Hamidi, R. K. Mavi | 2010 | Iran | Designing Excellent Supply Chain Network in Uncertainty Environment with Fuzzy Logic | International Journal of Business and Management | Network Design | minimize cost | single-objective | Fuzzy-MIP | |
| 18 | F. Wang, X. Lai, N. Shi | 2011 | China | A multi-objective optimization for green supply chain network design | Decision Support Systems | Network Design | minimize total cost minimize CO2 emission | multi objective | MIP | |

| | Author | Year | Country | Title | Journal | Decision Issue | Objective function | Model | Program-Technique | Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| 19 | T. P. N. Le · T.R. Lee | 2011 | Taiwan | Model selection with considering the CO2 emission alone the global supply chain | Journal of Intelligent Manufacturing | Network Design | minimize total cost minimize CO2 emission | multi-objective | Integer linear Programming | |
| 20 | C. Canel, B. M. Khumawala | 1996 | USA | A mixed-integer programming approach for the international facilities location problem | International Journal of Operations & Production Management | Facility Location | Profit maximization with shortages allowed | single objective | MIP | no uncertainty |
| 21 | A. Cakravastia a, I. S. Tohab, N. Nakamura | 2002 | Japan | A two-stage model for the design of supply chain networks | Int. J. Production Economics | Supplier selection | minimize the level of customer dissatisfaction | single-objective | MIP | |
| 22 | A. R. Singh, P. K. Mishra, R. Jain, M. K. Khurana | 2011 | India | Design of global supply chain network with operational risks | The International Journal of Advanced Manufacturing Technology | Facility Location | cost minimization | single-objective | MIP | uncertainty |
| 23 | J. T. Wong | 2012 | China | DSS for 3PL provider selection in global supply chain: combining the multi-objective optimization model with experts' opinions | Journal of Intelligent Manufacturing | supplier selection | minimize deviation of lead time, cost minimization | multi objective | fuzzy integer goal programming | No uncertainty |
| 24 | T. Santoso, S. Ahmed, M.Goetschalckx, A. Shapiro | 2003 | USA | A stochastic programming approach for SC network design under uncertainty | European Journal of Operational Research | Facility Location | cost minimization | single-objective | MIP | uncertainty |

| | Author | Year | Country | Title | Journal | Decision Issue | Objective function | Model | Program-Technique | Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| 25 | P. Tsiakis, N. Shah, and C. C. Pantelides | 2001 | UK | Design of Multi-echelon Supply Chain Networks under Demand Uncertainty | Ind. Eng. Chem. Res | Warehouse and DC location | cost minimization | single-objective | Weighted Linear Model | |
| 26 | Y. Acar, S. Kadipasaoglu, P. Schipperijn | 2009 | Turkey | A decision support framework for global supply chain modeling: an assessment of the impact of demand, supply and lead-time uncertainties on performance | International Journal of Production Research | production schedule optimization | cost minimization | single-objective | Simulation MIP | demand uncertainty supply uncertainty lead time uncertainty |
| 27 | B. C. Arntzen, G. G. Brown, T. P. Harrison, L. L. Trafton | 1995 | USA | Global Supply Chain Management at Digital Equipment Corporation | Institute for Operations Research and Management Sciences | Network Design | cost minimization | single-objective | MIP | No uncertainty |
| 28 | G. Q. Huang, X. Liu, | 2013 | Hong Kong | A supply chain configuration model for reassessing global manufacturing in China | Journal of Manufacturing Technology Management | Facility Location | profit maximization | single-objective | MIP | |
| 29 | S. P.Venkatesan, S. Kumanan | 2012 | India | Multi-objective supply chain sourcing strategy design under risk using PSO and simulation | The International Journal of Advanced Manufacturing Technology | Sourcing strategy defining | Total cost minimization Supplier delivery reliability maximization | multi-objective | Simulation MIP | demand risk Price-exchange rate risk |

| | Author | Year | Country | Title | Journal | Decision Issue | Objective function | Model | Program-Technique | Uncertainty |
|---|---|---|---|---|---|---|---|---|---|---|
| 30 | A.Nagurney , J. Cruz, J. Dong, D. Zhang | 2005 | USA | SC networks, electronic commerce, and supply side and demand side risk | European Journal of Operational Research | Network Flow.. Network equilibrium | Profit maximization, Risk minimization | multi-objective | MIP | demand risk supply risk |
| 31 | A. Cakravasti, I. S. Tohab, N. Nakamura | 2002 | Japan | A two-stage model for the design of supply chain networks | International Journal of Production Economics | supplier selection network design | minimize customer dissatisfaction | single-objective | MIP | no uncertainty |