Sustainable Supply Chain Management in Automotive Industry, obstacles and challenges: The case of Volkswagen Sarajevo

Faculty of Civil and Industrial Engineering
Master in Transport Systems Engineering

Amina Ćurovac
Matricola: 1727194

Supervisor: prof. Luca Persia
Co-supervisor: prof. Andrea Campagna

2018/2019
This thesis is done in cooperation with Volkswagen d.o.o. Sarajevo. As the thesis contains internal data of the Volkswagen group and Volkswagen Sarajevo on proceeding processes, procedures, plans, and objectives, this work may not be published, nor distributed to third parties without explicit approval of the VW Sarajevo public relations department. The supervising professors of Faculty of civil and industrial engineering, Sapienza University of Rome, undertake to maintain silence about the content of this work.

______________________________  ________________________________
Prof. Luca Persia               Prof. Andrea Campagna
ABSTRACT

The automotive industry, as one of the largest manufacturing sectors with large and complex supply chain, is prominently changing, leaving great impact on the environment and society. The automotive supply chain requires sophisticated management techniques, information technology and close coordination.

As customers are becoming more environmental conscious and governments are making stricter environmental regulations the automotive industry is forced to consider the environmental and social impacts in addition to their economic status, leading automotive industry businesses to adopt Sustainable Supply Chain Management practices.

The Control Tower concept is operations model that is used for a while worldwide and has become a new trend in logistics. CT is becoming a critical tool for on-time delivery whenever conventional logistics fails, and in managing complex Supply Chains as automotive industry SCs.
CONTENTS

ABSTRACT ......................................................................................................................... 3

1. INTRODUCTION ........................................................................................................... 6
1.1 The problem of research ............................................................................................. 6
1.2 The subject of research ............................................................................................... 7
1.2.1. Categorical - conceptual system ........................................................................... 7
1.3 The objective of the research ..................................................................................... 8
1.4 Method of research ...................................................................................................... 9
1.5 Time (and spatial) determination of the research ....................................................... 9
1.6 The structure of the research ..................................................................................... 10
1.7 Terminology ............................................................................................................... 13

2. THE THEORETICAL FRAMEWORK FOR SSCM ......................................................... 14
2.1 Defining the Supply Chain Management .................................................................... 14
2.2 7 principles of SCM .................................................................................................. 20
2.3 Difference between Logistics and Supply Chain Management ................................ 25
2.4 Defining the Supply Chain Control Tower ................................................................. 27

3. CONCEPTUAL MODEL OF THE SCM ........................................................................ 31
3.1 Supply Chain Process Reengineering ........................................................................ 31
3.2 Development of the SCOR model ............................................................................. 32
3.3 The SCOR model ....................................................................................................... 33
3.4 Processes of SCOR ..................................................................................................... 36
3.4.1. Demand/Supply Planning and Management ...................................................... 36
3.4.2. Sourcing Stocked, Make-to-Order, and Engineer-to-Order Product .................... 37
3.4.3. Make-to-Stock, Make-to-Order, and Engineer-to-Order ..................................... 37
3.4.4. Order, Warehouse, Transportation, and Installation Management for Stocked, Make-
        to-Order, and, Engineer-to-Order Product ............................................................ 37
3.4.5. Return of Raw Materials (to Supplier) and Receipt of Returns of Finished Goods (from
        Customer), including Defective Products, MRO Products, and Excess Products ........ 38
3.5 SCOR levels ................................................................................................................ 38
3.6 A SCOR-Based Method for SCPR ............................................................................. 44
2.6 1. Description and Analysis of “As Is” Supply Chain Process .................................... 44
3.7 Performance of Supply Chain Process and Benchmarking ....................................... 47
3.8 “To Be” supply chain process reengineering and application software .................... 49
3.9 Special Applications - SustainableSCOR ................................................................. 51
3.10 Setting the hypothesis .............................................................................................. 52

4. EMPIRICAL MODEL OF THE SCM: THE CASE OF VW SARAJEVO ....................... 54
4.1 Volkswagen Group ...................................................................................................... 54
4.2 Structure of VW AG .................................................................................................... 55
4.2.1. Locations of production ....................................................................................... 55
1. INTRODUCTION

Automotive supply chain requires sophisticated management techniques, information technology and close coordination of all parties involved, directly or indirectly, in fulfilling a customer request. A supply chain is dynamic and involves the constant flow of information, product, and funds between different stages that includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves.

1.1 The problem of research

The topic that is presented in this research is: „Sustainable Supply Chain Management in Automotive Industry, obstacles and challenges: The case of Volkswagen Sarajevo“.

With globalization has come the realization that supply chains have become very complex very fast. Complexity describes a system of multiple parts, interconnected in a non-linear style. Supply chain complexity is therefore a system with a broad range of variations. A typical example would be a globally operating corporation with multiple production sites, all of which are in contact with numerous distribution centers worldwide, supplying thousands of end points.

Indeed, the supply chains in automotive industry are among the most complex in the world. Each vehicle has about 30,000 parts, counting every part down to the smallest screws, originating from thousands of different suppliers.

The research should examine the automotive supply chain and provide the guidelines to make the supply chain as efficient as possible, without forgetting sustainability as an imperative for future generations.

Volkswagen Group, as one of the world's leading manufacturers of vehicles, should represent a good example to companies, that an efficient and optimized supply chain can increase profits, while preserving the balance with environment and society. The focus of the research is Volkswagen Sarajevo factory, as a part of Volkswagen Group.
1.2 The subject of research

The paper should answer the following questions:

1. What is the Supply Chain and what is its structure?
2. How is the Supply Chain managed?
3. What is the meaning of positioning "sustainability" in the concept of supply chain management?
4. What are the obstacles and challenges that supply chain managers face in managing the supply chain in the automotive industry, with particular emphasis on "sustainable" supply chain management?
5. What is SCOR reference model and how it can be applied?
6. What is the significance of "visibility" in the supply chain and what is the difference between today's supply chains and traditional supply chains?
7. What are the challenges the Volkswagen Sarajevo is facing in attempt to optimize the supply chain?
8. How is the supply chain of Volkswagen Sarajevo included in the VW Group's strategy "Together 2025"?
9. What is the VW ONE.KBP platform?

1.2.1. Categorical - conceptual system

- **Logistics**: “Planning, execution, and control of the procurement, movement, and stationing of personnel, material, and other resources to achieve the objectives of a campaign, plan, project, or strategy. It may be defined as the 'management of inventory in motion and at rest.'”

- **Logistics Management**: “The management process which integrates the movement of goods, services, information, and capital, right from the sourcing of raw material, till it reaches its end consumer”

- **Supplier**: “A party that supplies goods or services. A supplier may be distinguished from a contractor or subcontractor, who commonly adds specialized input to deliverables.”

---

1 [http://www.businessdictionary.com/definition/logistics.html](http://www.businessdictionary.com/definition/logistics.html)
2 [https://keydifferences.com/](https://keydifferences.com/)
3 [http://www.businessdictionary.com/definition/supplier.html](http://www.businessdictionary.com/definition/supplier.html)
– **Supply chain**: “A supply chain is a system of organizations, people, activities, information, and resources involved in moving a product or service from supplier to customer.”

– **Management** – “The organization and coordination of the activities of a business in order to achieve defined objectives. Management is often included as a factor of production along with machines, materials, and money. According to the management guru Peter Drucker (1909-2005), the basic task of management includes both marketing and innovation. Practice of modern management originates from the 16th century study of low-efficiency and failures of certain enterprises, conducted by the English statesman Sir Thomas More (1478-1535). Management consists of the interlocking functions of creating corporate policy and organizing, planning, controlling, and directing an organization’s resources in order to achieve the objectives of that policy.”

– **Visibility (in terms of SC)** – “Supply chain visibility is the ability of parts, components or products in transit to be tracked from the manufacturer to their final destination. The goal of SCV is to improve and strengthen the supply chain by making data readily available to all stakeholders, including the customer.”

– **Sustainability** – “A process of change in which the exploitation of resources, the direction of investments, the orientation of technological development and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations”.

### 1.3 The objective of the research

Research should prove or deny the following hypotheses:

**H1**: Real time information and end-to-end visibility through “SCM Control Tower” can streamline logistics costs and improve supply chain efficiency

---

5 [http://www.businessdictionary.com/definition/management.html](http://www.businessdictionary.com/definition/management.html)
6 [https://searcherp.techtarget.com/definition/supply-chain-visibility-SCV](https://searcherp.techtarget.com/definition/supply-chain-visibility-SCV)
7 The World Commission on Environment and Development; [http://www.globalfootprints.org/sustainability/](http://www.globalfootprints.org/sustainability/)
H2: In order to optimize the SC, simultaneous optimization of all the SC components is a must, which can be achieved by establishing an adequate CT

H3: SSCM can drive growth and reduce costs by creating, protection and growth of long-term environmental, social and economic value for all stakeholders involved

1.4 Method of research

The application of the methodology, as a science on methods and method of scientific research, is indispensable in the analysis and study of all processes in the supply chain.

Despite the increasing interest in supply chain management within the academy and industrial environment, there is still a lack of academic literature on topics such as methodologies to guide and support SCM evaluation.

The collected information and data on the supply chain will be examined and presented using the following methods:

- Analysis method - by which an analysis of the basic concepts and all other elements that are the subject of this research will be carried out;
- Synthesis method - will be used to study the subject of research in its entirety, to describe, link and systematize data and information;
- SCOR reference model for analyzing the supply chain of the VW Sarajevo
- Comparative method - will be used to compare the obtained data on the supply chain in the VW Sarajevo
- Statistical methods - to which VW Sarajevo data will be processed and displayed
- Collection of secondary data - through the research and analysis of scientific papers and articles, books and internet sources.

1.5 Time (and spatial) determination of the research

The time frame of the research covers the period from 2006 when the VW Group drew up a "Sustainability and Supplier Relations" scheme with a focus on the
period from 2016 when VW launched strategy „Together 2025“. However, the older information and data on VW Group and VW Sarajevo is also used.

The spatial framework of the research can’t be limited because the VW Group's supply chain is global and includes all the world's continents. However, the biggest focus is on 71 European VW production plants, Volkswagen Sarajevo plant and its suppliers.

1.6 The structure of the research

Chapter 1: Introduction:
In the first chapter the problem, the subject and the objects of the master thesis research are elaborated. Also, the scientific and practical goals that the research sought to achieve, and the scientific methods used in the theoretical and empirical part of the work are described.

Chapter 2: Theoretical framework
The theoretical framework for SSCM is the title of the second chapter. The first part elaborated in detail the relevant theoretical knowledge and the emergence of the explored concept of SCM and the automotive industry.

Different theoretical approaches are presented to the interpretation of supply chain concepts and SCM, historical assumptions about its origin, and the relationship between logistics and the supply chain is explained. Particular attention was given to the analysis of the elements of evaluating the performance of the supply chain operations.

The following is the consideration and positioning of the concept of the Supply Chain Control Tower in the context of SCM and the presentation of the basic CT elements and the way of functioning. The chapter concludes with the discussion of sustainable management in modern business conditions and market competition.

Chapter 3: Conceptual model
The conceptual model of the SCM in the automotive industry and its relationship with CT and SSCM is the title of the third chapter. The first part elaborates elements
that influenced the development of the supply chain model: importance and exchange of data and information, information technology, integration, transparency, cooperation, standardization and etc. Second part deals with the process of analyzing and improving supply chain systems through SCOR reference model, which starts with mapping all processes from production to retail, ending up to creating general schemes of the supply chain in and its bounds with CT, adding the “sustainability” into the complete concept. The chapter concludes with the explanation of the set scientific hypotheses.

Chapter 4: Empirical model
Empirical determination of the SCM through SCOR reference model in the automotive industry and its relationship with CT and SSCM on the example of the VW Sarajevo is the title of the fourth chapter. In the first part of the chapter the methodological aspect of empirical research is elaborated, describes the research protocol and explains the basic characteristics of the sample. The research plan, the method of data collection and their processing are explained. The last part contains a detailed presentation of the results of the empirical research of the VW Sarajevo SCM. The analysis of the results was carried out in the context of the set hypotheses of the research, and thus their judgment was made.

Chapter 5: Conclusions
Conclusion, future research, and research limitations is the title of the last, fifth chapter in which the synthesis of the research results and the discussion of them is presented. Theoretical and empirical knowledge as a result of testing of the proposed SC model was evaluated and scientific and practical contributions of the conducted research were presented. Finally, the limitations and proposed guidelines for further research are presented.

The complete structure of the research is presented schematically on the Figure 1.1.
Figure 1.1.: Scheme of the research
1.7 Terminology

The abbreviations used in research are represented in the following table (Table 1.1.).

Table 1.1.: List of abbreviations used in research

<table>
<thead>
<tr>
<th>ABBREVIATION</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPR</td>
<td>Business process reengineering</td>
</tr>
<tr>
<td>CT</td>
<td>Control Tower</td>
</tr>
<tr>
<td>DAP</td>
<td>Delivered at Place</td>
</tr>
<tr>
<td>DAT</td>
<td>Delivered at Terminal</td>
</tr>
<tr>
<td>DCOR</td>
<td>Design chain operations reference model</td>
</tr>
<tr>
<td>EXW</td>
<td>Ex Works</td>
</tr>
<tr>
<td>FCA</td>
<td>Free carrier</td>
</tr>
<tr>
<td>IT</td>
<td>Information technology</td>
</tr>
<tr>
<td>KPI</td>
<td>Key performance indicators</td>
</tr>
<tr>
<td>MRO</td>
<td>Maintenance, Repair and Operations</td>
</tr>
<tr>
<td>ONE.KBP</td>
<td>ONE Konzern Business Platform</td>
</tr>
<tr>
<td>SC</td>
<td>Supply Chain</td>
</tr>
<tr>
<td>SCC</td>
<td>Supply Chain Council</td>
</tr>
<tr>
<td>SCM</td>
<td>Supply Chain Management</td>
</tr>
<tr>
<td>SCOR</td>
<td>Supply chain operations reference</td>
</tr>
<tr>
<td>SCPR</td>
<td>Supply chain process reengineering</td>
</tr>
<tr>
<td>SSCM</td>
<td>Sustainable Supply Chain</td>
</tr>
<tr>
<td>SOX</td>
<td>Sarbanes- Oxley (SOX) risk mitigation</td>
</tr>
<tr>
<td>SWOT</td>
<td>Strength, Weakness, Opportunity, Threat</td>
</tr>
<tr>
<td>TAS</td>
<td>Tvornica Automobila Sarajevo (car factory Sarajevo)</td>
</tr>
<tr>
<td>VCG</td>
<td>Value-Chain Group</td>
</tr>
<tr>
<td>VCOR</td>
<td>Value chain operations reference model</td>
</tr>
<tr>
<td>VW AG</td>
<td>Volkswagen group</td>
</tr>
<tr>
<td>WMS</td>
<td>Warehouse Management System</td>
</tr>
</tbody>
</table>
THEORETICAL FRAMEWORK FOR SSCM

2.1 Defining the Supply Chain Management

Simply because of its importance in functioning of the companies, the concept of supply chains is becoming more and more dominant. Especially when it comes to making tactical and strategic decisions in companies, the supply and supply chains became special scientific field of management, defined as supply chain management. The development of this field became progressive in the end of 20th and at beginning of 21st century.

It is very difficult to define the term "supply chain management". A large number of experts in this field gave their definitions, but even the Council of Supply Chain Management Professionals did not precisely define what exactly SCM is.

The word “definition” itself comes from the Latin word “definire” which means “to limit” or “to set limits or boundaries”. Defining “supply chain” is first step in order to be able to define the difference between a “supply chain” and a supply chain that is “managed”.

“A supply chain consists of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves. Within each organization, such as a manufacturer, the supply chain includes all functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance, and customer service.”

Supply chain can also be defined as follows: “Supply chain represents a cluster of physical elements, their activities and processes through which their mutual interaction takes place, with the aim of making the flow of material goods from the initial supplier to the end user possible.”

---

In another definition of supply chain\textsuperscript{10}, the term supply chain is understood as flow of materials, information and finances which pass through and among organizations connected by a certain number of factors such as relationships, processes, activities and integrated information systems.

To provide the definition of SCM first it is necessary to have underlying theory and the opposite, to be able to develop theory the definition of the object under study must be provided. Only few of many different definitions of SCM are presented in this paper. SCM looks like quite simply to define, yet it is hard to find a shared definition of SCM. Many authors gave their definitions that are quite different and might be confuse to those who are trying to imagine the concept of SCM itself.

“The supply chain management profession has continued to change and evolve to fit the needs of the growing global supply chain. With the supply chain covering a broad range of disciplines, the definition of what is a supply chain can be unclear”\textsuperscript{11}.

\textsuperscript{11} CSCMP, 2016
For most of these definitions, there was no underlying theory because no theory had been developed.

Carter, Rogers, and Choi addressed the concept of ‘supply chain,’ used a conceptual theory building approach to identify six foundational premises about the structure and boundary of the supply chain. These premises are:

1. The supply chain is a network, consisting of nodes and links;
2. The supply chain as a network operates as a complex adaptive system, where every agent, grapples with the tension between control and emergence;
3. The supply chain is relative to a particular product and agent;
4. The supply chain consists of both a physical supply chain and a support supply chain;
5. The supply chain is bounded by the visible horizon of the focal agent;
6. The visible horizon of the focal agent is subject to attenuation, where distance is based on factors including physical distance, cultural distance, and closeness centrality.\(^{12}\)

These premises suggest a direction for developing both a theory and a definition of supply chain. However, they do not offer a specific definition.

Furthermore, Chen and Paulraj (2004) point out that the concept of SCM has arisen from many disciplines including not only the core fields of purchasing, logistics, and operations, but also industry specific studies, management information systems, organizational theory, and strategic management, among others.

They relied on the Supply Chain Council’s definition of the supply chain: “a supply chain encompasses every effort involved in producing and delivering a final product from the supplier’s supplier to the customer’s customer.”\(^{13}\)

Ellram and Cooper point out that SCM has been identified as a process, a discipline, a philosophy, a governance structure, and a function. It should be noted that

---


\(^{13}\) Chen and Paulraj, 2004, p. 122
definitions based on these identifications are not mutually exclusive. A discipline, for example, can be based on a process and a governance structure can certainly oversee a process. But this and other articles on SCM theory seem to support the idea that SCM is multidisciplinary in its origins. That does not mean that it cannot become a discipline in its own right; but so far it appears that it has not done so.

Ellram and Cooper found that SCM still seems to be treated as a subcategory by each of its primary founding disciplines. This seems to be in keeping with earlier findings on the same point (Charvet, Cooper, and Gardner, 2008; Chicksand et al., 2012).

A manufacturer may receive material from several suppliers and then supply several distributors as shown in Figure 2.2. As shown in previous figure, to describe the structure of the supply chain it may be more appropriate to use the term supply network or supply web.
Overall value generated should be the objective of every supply chain. The meaning of the word “overall” is that it covers all part of something. Overall value of the supply chain generates the difference between the worth to the customer of the final product and all the costs in supply chain that are product of all activities included in achieving the customer’s request.

Supply chain value is strongly correlated with supply chain profitability, also known as supply chain surplus. The surplus of the supply chain represents the difference between the revenue generated from the customer and the overall cost across the supply chain. Surplus of the SC is total profit to be shared across all supply chain stages and intermediaries. Since the success of the supply chain should be measured in terms of supply chain profitability and not in terms of the profits at an individual stage, the higher supply chain profitability is, the more successful is the supply chain.

The revenue for the supply chain is generated from the customer.

In automotive supply chain the customer buying the vehicle is the only providing the cash flow. All other flows of money are simply the exchange of the funds between the actors in supply chain from customer to the supplier. These flows of information, products and funds generate costs within supply chain that needs appropriate management in order to have successful supply chain.

“Effective supply chain management involves the management of supply chain assets and product, information, and fund flows to maximize total supply chain profitability”.14

All decisions considering the supply chain can influence supply chain surplus. These decisions and their impact can vary for a wide variety of reasons. Design and

---

management of supply chain flows (product, information, and funds) plays key role for success of a company.

“Supply chain decision phase may be categorized as design, planning, or operational, depending on the time frame during which the decisions made apply.”

The first is to determine plans for the product and the structure of a supply chain over the next several years. After the decision about the structure of SC is made, the company must ensure that the chain configuration supports its strategic objectives in order to increase SC surplus. Next is the allocation of resources and determination of processes. During this phase, given the marketing and pricing plans for a product, a company decides how to structure the supply chain over the next several years. It decides what the chain’s configuration will be, how resources will be allocated, and what processes each stage will perform. Strategic decisions made by companies include whether to outsource or perform a supply chain function in-house, the location and capacities of production and warehousing facilities, the products to be manufactured or stored at various locations, the modes of transportation to be made available along different shipping legs, and the type of information system to be utilized.

A firm must ensure that the supply chain configuration supports its strategic objectives and increases the supply chain surplus during this phase. Supply chain design decisions are typically made for the long term (a matter of years) and are very expensive to alter on short notice. Consequently, when companies make these decisions, they must take into account uncertainty in anticipated market conditions over the next few years.

2.2 7 principles of SCM

One of the distinctive things about supply chain management is that there are so many different views about definitions, scope, approaches and so on. One perspective that comprises all in one is the seven principles of supply chain management.

**Principle 1:**
*Segment customers based on the service needs of distinct groups and adapt the supply chain to serve these segments profitably*

Segmentation has traditionally grouped customers by industry, product, or trade channel, and then taken a “one size fits all” approach, to serving it averaging costs and profitability within and across segments. Surveys, interviews, and industry research have been the traditional tools for defining key segmentation criteria.

To strike and sustain the appropriate balance between service and profitability, most companies will need to set priorities - sequencing the rollout of tailored programs to capitalize on existing capabilities and maximize customer impact.

**Principle 2:**
*Customize the logistics network to the service requirements and profitability of customer segments*

Companies have traditionally taken a monolithic approach to logistics network design in organizing their inventory, warehouse, and transportation activities to meet a single standard. For some, the logistics network has been designed to meet the average service requirements of all customers; for others, to satisfy the toughest requirements of a single customer segment.

Neither approach can achieve superior asset utilization or accommodate the segment-specific logistics necessary for excellent supply chain management. In many industries, especially such commodity industries as fine paper, tailoring distribution assets to meet individual logistics requirements is a greater source of differentiation for a manufacturer than the actual products, which are largely undifferentiated.
Principle 3:
Listen to market signals and align demand planning accordingly across the supply chain, ensuring consistent forecasts and optimal resource allocation

Forecasting has historically proceeded silo by silo, with multiple departments independently creating forecasts for the same products—all using their own assumptions, measures, and level of detail.

Many consult the marketplace only informally, and few involve their major suppliers in the process. The functional orientation of many companies has just made things worse, allowing sales forecasts to envision growing demand while manufacturing second-guesses how much product the market actually wants. Excellent supply chain management, in fact, calls for sales and operations planning, that transcends company boundaries to involve every link of the supply chain (from the supplier’s supplier to the customer’s customer) in developing forecasts collaboratively and then maintaining the required capacity across the operations.

Principle 4:
Differentiate product closer to the customer and speed conversion across the supply chain.

Manufacturers have traditionally based production goals on projections of the demand for finished goods and have stockpiled inventory to offset forecasting errors. These manufacturers tend to view lead times in the system as fixed, with only a finite window of time in which to convert materials into products that meet customer requirements.

While even such traditionalists can make progress in cutting costs through set-up reduction, cellular manufacturing, and just-in-time techniques, great potential remains in less traditional strategies such as mass customization. For example, manufacturers striving to meet individual customer needs efficiently through strategies such as mass customization are discovering the value of postponement.
Realizing that time really is money, many manufacturers are questioning the conventional wisdom that lead times in the supply chain are fixed. They are strengthening their ability to react to market signals by compressing lead times along the supply chain, speeding the conversion from raw materials to finished products tailored to customer requirements.

This approach enhances their flexibility to make product configuration decisions much closer to the moment demand occurs.

The key to just-in-time product differentiation is to locate the leverage point in the manufacturing process where the product is unalterably configured to meet a single requirement and to assess options, such as postponement, modularized design, or modification of manufacturing processes that can increase flexibility. In addition, manufacturers must challenge cycle times: Can the leverage point be pushed closer to actual demand to maximize the manufacturer’s flexibility in responding to emerging customer demand?

**Principle 5:**

*Manage sources of supply strategically to reduce the total cost of owning materials and services*

Determined to pay as low a price as possible for materials, manufacturers have not traditionally cultivated warm relationships with suppliers. In the words of one general manager: “The best approach to supply is to have as many players as possible fighting for their piece of the pie - that’s when you get the best pricing.”

Excellent supply chain management requires a more enlightened mindset - recognizing, as a more progressive manufacturer did: “Our supplier’s costs are in effect our costs. If we force our supplier to provide 90 days of consigned material when 30 days are sufficient, the cost of that inventory will find its way back into the supplier’s price to us since it increases his cost structure.”

While manufacturers should place high demands on suppliers, they should also realize that partners must share the goal of reducing costs across the supply chain in order to lower prices in the marketplace and enhance margins. The logical
extension of this thinking is gain-sharing arrangements to reward everyone who contributes to the greater profitability.

Some companies are not yet ready for such progressive thinking because they lack the fundamental prerequisite. That is a sound knowledge of all their commodity costs, not only for direct materials but also for maintenance, repair, and operating supplies, plus the dollars spent on utilities, travel, temps, and virtually everything else.

This fact-based knowledge is the essential foundation for determining the best way of acquiring every kind of material and service the company buys.

With their marketplace position and industry structure in mind, manufacturers can then consider how to approach suppliers - soliciting short-term competitive bids, entering into long-term contracts and strategic supplier relationships, outsourcing, or integrating vertically. Excellent supply chain management calls for creativity and flexibility.

**Principle 6:**

*Develop a supply chain-wide technology strategy that supports multiple levels of decision making and gives a clear view of the flow of products, services, and information.*

To sustain re-engineered business processes (that, at last, abandon the functional orientation of the past), many progressive companies have been replacing inflexible, poorly integrated systems with enterprise-wide systems. Yet too many of these companies will find themselves victims of the powerful new transactional systems they put in place.

Unfortunately, many leading-edge information systems can capture reams of data but cannot easily translate it into actionable intelligence that can enhance real-world operations. From a mid-term perspective, the system must facilitate planning and decision making, supporting the demand and shipment planning and master production scheduling needed to allocate resources efficiently.
To add long-term value, the system must enable strategic analysis by providing tools, such as an integrated network model, that synthesize data for use in high-level “what-if” scenario planning to help managers evaluate plants, distribution centers, suppliers, and third-party service alternatives. Despite making huge investments in technology, few companies are acquiring this full complement of capabilities. Today’s enterprise-wide systems remain enterprise-bound, unable to share across the supply chain the information that channel partners must have to achieve mutual success. Ironically, the information that most companies require most urgently to enhance supply chain management resides outside of their own systems, and few companies are adequately connected to obtain the necessary information. Electronic connectivity creates opportunities to change the supply chain fundamentally—from slashing transaction costs through electronic handling of orders, invoices, and payments to shrinking inventories through vendor-managed inventory programs.

**Principle 7:**

*Adopt channel-spanning performance measures to gauge collective success in reaching the end-user effectively and efficiently*

To answer the question, “How are we doing?” most companies look inward and apply any number of functionally oriented measures. But excellent supply chain managers take a broader view, adopting measures that apply to every link in the supply chain and include both service and financial metrics.

First, they measure service in terms of the perfect order - the order that arrives when promised, complete, priced and billed correctly, and undamaged. The perfect order not only spans the supply chain, as a progressive performance measurement should but also view the performance from the proper perspective, that of the customer.

Second, excellent supply chain managers determine their true profitability of service by identifying the actual costs and revenues of the activities required to serve an account, especially a key account. For many, this amounts to a revelation, since traditional cost measures rely on corporate accounting systems that allocate overhead evenly across accounts. Such measures do not differentiate, for example,
an account that requires a multi-functional account team, small daily shipments, or special packaging. Traditional accounting tends to mask the real costs of the supply chain - focusing on cost-type rather than the cost of activities and ignoring the degree of control anyone has (or lacks) over the cost drivers.

Deriving maximum benefit from activity-based costing requires sophisticated information technology, specifically a data warehouse. Because the general ledger organizes data according to a chart of accounts, it obscures the information needed for activity-based costing. By maintaining data in discrete units, the warehouse provides ready access to this information.

To facilitate channel-spanning performance measurement, many companies are developing common report cards. These report cards help keep partners working toward the same goals by building the deep understanding of what each company brings to the partnership and showing how to leverage their complementary assets and skills to the alliance’s greatest advantage. The willingness to ignore traditional company boundaries in pursuit of such synergies often marks the first step toward a “pay-for-performance” environment.16

### 2.3 Difference between Logistics and Supply Chain Management

All the activities, associated with the sourcing, procurement, conversion and logistics management, comes under the supply chain management. Above all, it encompasses the coordination and collaboration with the parties like suppliers, intermediaries, distributors and customers. Logistics Management is a small portion of Supply Chain Management that deals with the management of goods in an efficient way.

---

Supply Chain Management, it is a broader term which refers to the connection, right from the suppliers to the ultimate consumer.

It has been noticed that there is a drastic change in the manner in which business was conducted many years ago and now, due to the improvement in the technology which leads to the development of all key areas of business. Supply Chain Management also evolved as an improvement over Logistics Management, from past years.

Comparision of Logistics Management and SCM is shown in the following table (Table 2.1.)

<table>
<thead>
<tr>
<th>BASIS FOR COMPARISON</th>
<th>LOGISTICS MANAGEMENT</th>
<th>SUPPLY CHAIN MANAGEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meaning</td>
<td>The process of integrating the movement and maintenance of goods in and out the organization is Logistics.</td>
<td>The coordination and management of the supply chain activities are known as Supply Chain Management.</td>
</tr>
<tr>
<td>Objective</td>
<td>Customer Satisfaction</td>
<td>Competitive Advantage</td>
</tr>
<tr>
<td>Evolution</td>
<td>The concept of Logistics has been evolved earlier.</td>
<td>Supply Chain Management is a modern concept.</td>
</tr>
<tr>
<td>How many organizations are involved?</td>
<td>Single</td>
<td>Multiple</td>
</tr>
<tr>
<td>One in another</td>
<td>Logistics Management is a fraction of Supply Chain Management.</td>
<td>Supply Chain Management is the new version of Logistics Management.</td>
</tr>
</tbody>
</table>

As the SCM is already defined above in order to understand the differences between SCM and Logistics, the term Logistics Management must be defined.

The management process which integrates the movement of goods, services, information, and capital, right from the sourcing of raw material, till it reaches its end consumer is known as Logistics Management. The objective behind this process is to provide the right product with the right quality at the right time in the right
place at the right price to the ultimate customer. The logistic activities are divided into two broad categories they are:

1. Inbound Logistics: The activities which are concerned with procurement of material, handling, storage and transportation
2. Outbound Logistics: The activities which are concerned with the collection, maintenance, and distribution or delivery to the final consumer.

Apart from these, other activities are: warehousing, protective packing, order fulfillment, stock control, maintaining equilibrium between demand and supply, stock management. This will result in savings in cost and time, high-quality products, etc.

The following are the major differences between logistics and supply chain management:

1. The flow and storage of goods inside and outside the firm are known as Logistics. The movement and integration of supply chain activities are known as Supply Chain Management.
2. The main aim of Logistics is full customer satisfaction. Conversely, the main aim behind Supply Chain Management is to gain a substantial competitive advantage.
3. There is only one organization involved in Logistics while some organizations are involved in Supply Chain Management.
4. Supply Chain Management is a new concept as compared to Logistics.
5. Logistics is only an activity of Supply Chain Management.

### 2.4 Defining the Supply Chain Control Tower

Supply Chain Visibility is the key enabler for managing a business both within the organizational boundaries as well as across the boundaries. This visibility provides speed, reliability and flexibility in order to gain a competitive advantage in the form of well controlled and managed supply chain functions. In response to the need for
Supply Chain Visibility, the leading Supply Chain Visibility principles are increasingly being embodied in Supply Chain Control Towers.

“A supply chain control tower is a central hub with the required technology, organization and processes to capture and use supply chain data to provide enhanced visibility for short and long term decision making that is aligned with strategic objectives.”

Successful Supply Chain Visibility solutions are deployed around five leading practices which enable an organization to achieve an end-to-end view of inbound and outbound operations:

1. Create an ‘Information Hub’ – integrate and aggregate key information from inside and outside the enterprise such as key order, shipment, and inventory information from all internal ERP, TMS, WMS and other inventory planning systems
2. Track landed costs along the chain – reduce total landed costs by tracking product, freight and insurance costs as well as integrating trade compliance information such as duties, tax, VAT and other governmental charges.
3. Manage trading partners with scorecards – use a repository of supply chain data and develop scorecards to manage supplier compliance, or transportation booking performance etc. to continuously improve global operations
4. Achieve organizational buy-in – gain the CFO and finance organization’s support by extending the visibility solution to include financial settlement and financing triggers
5. Devise a risk management framework – configure visibility tools and solutions for Sarbanes- Oxley (SOX) risk mitigation and disaster recovery in order to recover effectively from risk related events

These leading Supply Chain Visibility practices are the key in gaining an efficient end-to-end supply chain view. These can most effectively be achieved with an

---

17 “Global Supply Chain Control Towers: Achieving end-to-end Supply Chain visibility”, Capgemini Consulting, UK, 2011
integrated Control Tower solution that includes having the right people chosen and trained to act upon the data provided. A large number of leading organizations have adopted this approach and have been able to successfully reap the benefits, giving them more control over their market reach.

Control Towers are cross-divisional organizations with system integrated “information hubs” that provide Supply Chain Visibility. These hubs are used for gathering and distributing information, and allow people trained to use these visibility capabilities to detect and act on risks or opportunities more quickly.

Control Towers are typically set-up to monitor measure and manage transport and inventory movements across the supply chain.

Control towers combine organizations (people), systems and processes in order to provide supply chain partners with a high level of product visibility along the entire supply chain. This enables three levels of management control:

- **Strategic** – provides control over the design of the overall supply chain network
- **Tactical** – enables proactive planning of procurement, operations and distribution according to market demand
- **Operational** – encompasses various real time functionality including transportation management, inventory tracking and exception management

The three pillars of CT are shown in figure 2.3.
Function of SCM CT is shown in following figure.
2. CONCEPTUAL MODEL OF THE SCM

3.1 Supply Chain Process Reengineering

Business process reengineering (BPR) was first mentioned by Michael Hammer and Jame Champy in 1994. This BPR management theory pointed out that companies should:

- treat business process as the object to innovate,
- care about the demand and satisfaction of customers,
- rethink and redesign the recent business processes to achieve the maximal integration of technology and management functions
- and establish the process-oriented organization structure.

The main purpose of BPR is to make great progresses on cost, quality, service and efficiency. Individual optimization can’t guarantee the optimal benefit of the whole supply chain, that BPR as traditional process redesign method can provide. The BPR can only accomplish the internal firm process reengineering and can’t redesign the processes among firms on supply chain.


Figure 3.1: Processes in BPR model
It is very hard for companies to transform BPR, which focuses on the optimization of internal processes, to supply chain process reengineering (SCPR) whose emphasis is on optimizing the processes of the whole external supply chain.

Supply chain operations reference (SCOR) model is the first model to evaluate the performance of supply chain and to improve supply chain management.

SCOR integrates the management ideas such as business process reengineering, benchmarking and best practices analysis into a cross-functions frame and becomes the ideal model of supply chain process reengineering (Archie 2004).

### 3.2 Development of the SCOR model

Earlier study on the SCOR model was done by Gordon Stewart (1997) who did his research from the corporate strategy perspective. He suggested that SCOR was the first cross-industrial framework model for integrating supply chain management, and it can be used to evaluate enterprise-wide supply chain performance and to improve supply chain management performance.  

Peter Bostorff of Pragmatek Consulting Company did most of the work for developing SCOR theory. He used a virtual company as the main implementation body of SCOR, which is rooted in his supply chain management experience from many industries in the past thirty years, instead of putting in real - life environment.

SCOR model is a growing model. Joint planning team is very necessary for today’s application of SCOR, to achieve the maximum overall value of the supply chain.

For some researchers the SCOR model was a strategic planning tool, and they also analyzed the strengths and weaknesses of the model based on the previous studies.

---

18 Y. Jianyuan; L. Kai; Q. Dongliang, "A SCOR-Based Method for Supply Chain Process Reengineering with Applications in Chinese Automotive Industry" , 2007
In other studies, the SCOR was used for research of benchmarking system of supply chain collaboration. Researchers found that SCOR model could provide a new perspective for enterprises, make them better understand supply chain collaboration through benchmarking providing them ability to improve supply chain performance.

On the other hand, researchers considered SCOR model as an effective strategy tool for managers to solve complex supply chain management problems. However, recent implementation of SCOR is deeply depended on project leader, many analysis processes are also manual. Therefore, some researchers included computer technology.

SCC sets up a special interest group (SIG) to study the integration of SCOR, Six Sigma and Lean methodology. HP Company who studies from the perspective of the value chain, figured out that besides the areas of supply chain, an enterprise should also extend its sight to the field of design and customers. And the company firstly brought forward design chain operations reference model (DCOR) and customer chain operations reference model (CCOR).¹⁹

Value-Chain Group (VCG) brought forward a complete value chain operations reference model (VCOR).

Some software tools based on the SCOR already are developed, such as SCOR Database (StreamlineSCM), ProcessWizard (Xelocit), EasySCOR (IDS Scheer), mySAP Tools (SAP) and so on.

### 3.3 The SCOR model

Supply Chain Operations Reference model (SCOR), represents the cross-industry standard for supply chain management. SCOR is developed and endorsed by the Supply Chain Council.

The SCOR model represents cross-functional framework which is the integration of well know concepts of business processing, benchmarking and process measurement.

The following figure shows the integration of those concepts and processes.

![SCOR framework diagram]


Figure 3.2.: SCOR framework

A Process Reference Model Contains:

- Standard descriptions of management processes
- A framework of relationships among the standard processes
- Standard metrics to measure process performance
- Management practices that produce best-in-class performance
- Standard alignment to features and functionality

The Process Reference Model can be measured, managed and controlled, adapted to specific purpose and can be used and implemented to achieve competitive advantage.

The SCOR model can be defined: “From your supplier’s supplier to your customer’s customer”

---

SCOR model falls under the classification of normative models, where it provides standard definitions of measures and procedure for calculating the metrics.

SCOR spans:
- All customer interactions, from order entry through paid invoice
- All product (physical material and service) transactions, from your supplier’s supplier to your customer’s customer, including equipment, supplies, spare parts, bulk product, software, etc.
- All market interactions, from the understanding of aggregate demand to the fulfillment of each order

Not all business process or activities are covered by SCOR. Sales and marketing (demand generation); research, product and technology development and some elements of post-delivery customer support are example of those.

Training, quality, information Technology (IT) and administration (non SCM), are assumed by SCOR but are not specified clearly.

SCOR is based on five distinct management processes:
1. plan
2. source
3. make
4. deliver
5. return

Those processes are shown in following figure.

---

21 ibid
3.4 Processes of SCOR

A Process Reference Model differs from classic process decomposition models. SCOR is based on hierarchical modeling.

3.4.1. Demand/Supply Planning and Management
Planning is a process that identifies demand for products as well as products availability, in order to make an action plan for the production, procurement and delivery to customers.

The balance of resources according to the requirements for these resources is carried out. The plan is also broken down and implemented with all members of the chain, including procurement, production and distribution.

In stage of demand/supply planning the business rules are established and supply chain performance measures are determined. During this stage collection of data, inventory, capacity and transportation are executed, supply chain is configured, regulatory requirements analysis and risk analysis is carried out. Within this stage, the supply chain unit plan is aligned with the financial plan.
3.4.2. Sourcing Stocked, Make-to-Order, and Engineer-to-Order Product

Sourcing (procurement) at this stage is based on product demand forecasts. The delivery and receipt schedules are made, verification, transfer and payment authorization are performed. Suppliers are identified and selected if they are not predetermined.

Managing business rules, evaluating vendors, and keeping records on suppliers is part of this phase. Inventory management, capital asset management, input products, import / export requirements, contract deals with suppliers and identification of the risks arising from the procurement process are done in this phase.

3.4.3. Make-to-Stock, Make-to-Order, and Engineer-to-Order

Production is a process that transforms the input raw materials and components into the final product.

In this stage production is distributed, orders are issued, and production, testing, packaging, temporary warehousing and preparation of products delivery are done. Engineering is completed for products that are tailored to order. Production rules are managed, performance indicators are monitored, data is collected, inventories, plants and intermodal transportation, production networks are developed, and risks identified.

3.4.4. Order, Warehouse, Transportation, and Installation Management for Stocked, Make-to-Order, and, Engineer-to-Order Product

Delivery is a process in which a finished product is delivered to meet the planned demand. Orders and transportation are managed, and distribution is carried out. The warehouse from receipt of goods to the loading of goods into the means of transport is managed.

The accuracy of the customer's delivery is verified, as well as the customer's installation of the product. Invoices are sent to buyers.
Distribution rules are managed, performance indicators are monitored, data is collected, inventories of finished goods and capital assets are managed, transport is carried out, product life-span is taken into account, import and export documentation is implemented, and distribution risks are identified.

3.4.5. Return of Raw Materials (to Supplier) and Receipt of Returns of Finished Goods (from Customer), including Defective Products, MRO Products, and Excess Products

The return is process in which includes all return defective product steps from authorizing return; scheduling product return; receiving, verifying, and disposition of defective product; and return replacement or credit. The same is applied for MRO (Maintenance, Repair and Operations) products steps from authorizing and scheduling return, determining product condition, transferring product, verifying product condition, disposition, and request return authorization.

This stage also includes return excess product steps including identifying excess inventory, scheduling shipment, receiving returns, approving request authorization, receiving excess product return in source, verifying excess, and recover and disposition of excess product.

Manage Return business rules, performance, data collection, return inventory, capital assets, transportation, network configuration, and regulatory requirements and compliance are the core scope of this stage of SCOR.

3.5 SCOR levels

A Process Reference Model differs from classic process decomposition models. SCOR is a process reference model that provides a language for communicating among supply-chain partners.

The first level of SCOR is top level which defines the scope and contents of SCOR.
Level 1 provides wide definitions of plan, source, make, deliver, and return processes. Here basis of competition performance targets are set.

The second level is configuration level. A company’s supply chain can be “configured-to-order” at Level 2 from 30 core “process categories.” Companies implement their operations strategy through the configuration they choose for their supply chain.

The third level is process element level, which defines a company’s ability to compete successfully in its chosen markets. Companies define their operations strategy at Level 3.

There are 3 levels under Level 3, where companies implement specific supply-chain management practices.

A metric is a standard for measurement of the performance of a supply chain or process.

SCOR metrics are diagnostic metrics (compare to how diagnosis is used in a medical office).

SCOR recognizes three levels of pre-defined metrics:

- Level-1 metrics are diagnostics for the overall health of the supply chain. These metrics are also known as strategic metrics and key performance indicators (KPI). Benchmarking level 1 metrics helps establishing realistic targets to support strategic directions.
- Level-2 metrics serve as diagnostics for the level-1 metrics. The diagnostic relationship helps to identify the root cause or causes of a performance gap for a level-1 metric.
- Level-3 metrics serve as diagnostics for level-2 metrics\(^{23}\).

\(^{23}\) SCOR quick reference guide: version 12, APICS, 2017
The analysis of performance of metrics from level-1 through 3 is referred to as metrics decomposition, performance diagnosis or metrics root cause analysis. Metrics decomposition is a first step in identifying the processes that need further investigation. (Processes are linked to level-1, level-2 and level-3 metrics).

![Figure 3.4.: SCOR process levels](https://www.researchgate.net/profile/Samuel_Huang9/publication/223768747/figure/fig7/AS:668839176060959@1536475094820/The-SCOR-process-levels-Stephens-1999.png)

The hierarchy of SCOR metrics is shown in following figure (Figure 3.5.)
Figure 3.5.: SCOR metrics

Figure 3.6 shows process categories defined by the relationship between a SCOR Process and a process type. Practitioners select appropriate process categories from SCOR configuration toolkit to represent their SC configuration(s).

Figure 3.6.: SCOR configuration toolkit
Performance metrics of SCOR’s level 1 process is shown in following figure.

**Level 1 Performance Metrics**

<table>
<thead>
<tr>
<th>Performance Attribute</th>
<th>Customer-Facing</th>
<th>Internal-Facing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivery performance</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Fill Rate</td>
<td>✅</td>
<td></td>
</tr>
<tr>
<td>Perfect order fulfillment</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Order fulfillment lead time</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Supply-chain response time</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Production flexibility</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Supply chain management cost</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Value-added productivity</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Warranty cost or returns</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Cash-to-cash cycle time</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Inventory days of supply</td>
<td></td>
<td>✅</td>
</tr>
<tr>
<td>Asset turns</td>
<td></td>
<td>✅</td>
</tr>
</tbody>
</table>

Source: APICS

*Figure 3.7.: Level 1 Performance Metrics*

At level 2, each SCOR process can be further described by process type: planning, execution and enable (Figure 3.8.).

**SCOR Process Type**

<table>
<thead>
<tr>
<th>SCOR Process Type</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Planning          | A process that aligns expected resources to meet expected demand requirements. Planning processes:  
• Balance aggregated demand and supply  
• Consider consistent planning horizon  
• (Generally) occur at regular, periodic intervals  
• Can contribute to supply-chain response time |
| Execution         | A process triggered by planned or actual demand that changes the state of material goods. Execution processes:  
• Generally involve -  
  1. Scheduling/sequencing  
  2. Transforming product, and/or  
  3. Moving product to the next process  
• Can contribute to the order fulfillment cycle time |
| Enable            | A process that prepares, maintains, or manages information or relationships on which planning and execution processes rely |

Source: APICS

*Figure 3.8.: Level 2 SCOR process type*
SCOR Version 5.0 level 2 toolkit has 30 process categories, shown in following figure (Figure 3.8.).

Figure 3.9: SCOR Version 5.0. level 2 toolkit process categories

SCOR level 3 presents detailed process element information for each level 2 process.
3.6 A SCOR-Based Method for SCPR

The implementation plan of the SCOR-based method for SCPR could be divided into 3 steps:

- First, describe the supply chain “as-is” situation using the standardize supply chain process definition and reference tools in SCOR model
- second, measure the performance of supply chain according to the metrics of SCOR model, benchmark the result with the best practices and do gap analysis,
- last, design “To Be” supply chain process that can achieve objective performance by using the tools and methods of SCOR model.24

2.6.1. Description and Analysis of “As Is” Supply Chain Process

The beginning of the SC modeling process is description and analysis of the current state of the SC, i.e. capturing “As Is” situation.

The beginning is to define the boundary of SC process, where enterprises can diagram an existing process and decide whether it is an “atom” process or can be divided into some sub-processes. SCOR in general assumes that all SC processes can be subdivided into one of five general process types: Plan, Source, Make, Deliver and Return. These general processes create the first level of SCOR model.

When the SC processes are decomposed, the enterprises are mapping the “As Is” situation by creating Geography Map, positioning the sources, manufacturing sites and distribution centers in a map.

The Geography Map (Figure 3.9.) usually challenges the SCOR analysts to rethink the scope issues. How much of your supplier’s supply chain do you want to include in your analysis? Do you distribute through wholesalers and do you want to include them in your analysis? Are you really talking about one product line and one set of target customers, or are their significant variations for multiple groups of customers?

---

After the mapping locations, using the SCOR’s Level 2 symbols, execution processes of each point from manufacturing sites to sources, and then to distribution centers can be drawn.

As these issues are refined the SCOR analysis moves to the creation of a SCOR Thread Diagram which is made up of a series of Level 2 processes. In effect, sequences of Level 2 processes, usually simply represented by a letter and number, are placed inside arrows and linked together. Bold vertical lines separate companies. Dashed vertical lines represent divisions within the same organization. The thread diagram often becomes the basis for a subsequent analysis to the time it takes to move items through the supply chain.

“Thread Diagram (Figure 3.10.) is the foundation of analyzing supply chain processes. Geography Map focuses on extra processes. But Thread Diagram includes more, such as intermediary organizations, planning and return processes”.

---

Thus, in some cases the analysts will want to represent intermediary organizations, like customs, that can cause predictable delays in the flow of materials. In SCOR terms, an intermediary operation, like customs, or an outside shipper, would be represented by a Source process and a Deliver process. Obviously, in these cases there is no Make process, since the materials being moved are not changed in the process.

Level 3 processes are a group of standard activities which are decomposed from the processes of Level 2. Refining the Thread Diagram till satisfied, enterprises can acquire the nature and scope of their “As Is” supply chain process.

As with the Geography Map, one initially focuses only on the outbound processes. Later, however, the Thread Diagram is refined to include intermediary organizations, planning processes and various types of return processes, when appropriate. Figure 3.11 provides a more detailed description of the SCOR Thread Diagram showed in Figure 3.10.
3.7 Performance of Supply Chain Process and Benchmarking

When the existing SC process is described, the next is to measure its performance to know how the existing supply chain operates. SCOR Model defines five generic performance attributes and three levels of metrics. “Based on metrics and formulas of SCOR Model and historical data, enterprises can determine which metrics they can use to define their specific supply chain”\(^{26}\) If an enterprise wants specific benchmark data, it needs to consult the SCC or some other professional benchmarking database suppliers such as Performance Measure Group LLC, to form the Supply Chain SCORcard (Figure 3.12.)

\(^{26}\) Yan, Jianyuan; Li, Kai; and Qiu, Dongliang, "A SCOR-Based Method for Supply Chain Process Reengineering with Applications in Chinese Automotive Industry" (2007). AMCIS 2007 Proceedings. 226.
SCORcard shows the performance attributes a set of metrics and the benchmark data for a hypothetical company described in more detail in the SCOR workshop. The right-hand column represents some “guesstimates” about what kind of value the hypothetical companies might achieve, assuming it could move its supply chain process closer to the average for the industry.

SCOR terms the comparison of the company’s actual, historical performance, with the benchmarks for the company’s industry as a gap analysis and uses it to determine if redesign or improvements in the As-Is supply chain will really justify an investment.

Once the SCOR team has examine the Level 1, and in some cases the Level 2 As Is historical data it is, in a position to decide, if the supply chain should be changed.

In effect, it is now ready to review the organization’s existing approach to its supply chain and, in necessary, define a new supply chain strategy and to set some targets, priorities and a budget for any redesign effort.
Also, the corporate strategy can be determined by the SWOT (Strength, Weakness, Opportunity, Threat) analysis. With SWOT analysis, enterprises can understand where their strengths and weaknesses are, and discover opportunities and threats which they confront at present. In the performance improvement implementation, enterprises may refer to the specific processes and sub-processes of SCOR reference handbook, and compare with corresponding best practices, then make their implementation plans.

### 3.8 “To Be” supply chain process reengineering and application software

SCOR suggests after capturing the “As Is” state and performance attributes of a SC that it is already encountered, and decision can be made where the company’s SC is superior, has an advantage, has parity, or is below average.

Specifically, the SCOR team should fill out the chart illustrated in Figure 3.13. The SCOR card already developed during Phase 2 provides a good picture of how the observed supply chain ranks, compared with others in the same industry.

The goal now is to decide how the SC under the study should be in the future.

![Figure 3.14: Performance attributes chart for comparison of SC with competition](image)
According to the Figure 3.13 one black ball should be assigned to the box beside the performance attribute that is expected to dominate. After that assigning one or two bold circles for performance areas in which is expected SC to be above average, and narrow circles for the remainder, where is expected to be at least on par with the competition.

The constraints on the assignment of balls simply reflects reality. It can’t be expected to be superior in every category, and it should expect to be very good in at least one or two.

The tools and methods of “To Be” supply chain process reengineering are similar with those of “As Is” supply chain process reengineering. First, drawing a “To Be” Geography Map and SCOR Thread diagram; then, according to the supply chain measurement goal, enterprises should constantly adjust the Geography Map and Thread Diagram.

After that, we start to describe the processes on the Level 3 by drawing Swimlane Diagram, which is a commonly used tool to describe the specific activities and related consequences on the Level 3.

In the complex supply chain system, it is hard to foresee the “To Be” supply chain’s operation. Along with the simulation technology development, enterprises take the advantage of specialized supply chain modeling software to assist the SCPR activities, observe “To Be” supply chain process’s performance and effectively avoid the possibly risk which may appear during the project’s implementation. Some available supply chain modeling software are: Proforma Company’s ProVision, IDS Scheer’s EasySCOR, Xelocity’s ProcessWizard.
3.9 Special Applications - SustainableSCOR

SustainableSCOR is based upon The GRI Sustainability Reporting Standards (GRI Standards) that are within scope of the SCOR model. GRI Standards are free to use and are available at www.globalreporting.org/standards. The following strategic environmental metrics allow the SCOR model to be used as a framework for environmental accounting:

- Materials Used (Weight or Volume)
- Energy Consumed (Joules, Watt-hours or Multiples)
- Water Volume Withdrawn (Gallons, Liters or Multiples)
- Air Emissions (Metric Tons or Equivalents)
- Liquid and Solid Wastes (Gallons, Liters or Multiples, Weight or Volume)
The SCOR framework ties emissions to the originating processes, providing a structure for measuring environmental performance and identifying where performance can be improved. The hierarchical nature of the model allows strategic environmental footprint goals to be translated to specific targets and activities.

In the context of the GRI Standards, the environmental dimension of sustainability concerns an organization’s impacts on living and non-living natural systems, including land, air, water and ecosystems.

GRI 308 addresses the topic of supplier environmental assessment. An organization might be involved with impacts either through its own activities or as a result of its business relationships with other parties. Due diligence is expected of an organization in order to prevent and mitigate negative environmental impacts in the supply chain. These include impacts the organization either causes or contributes to, or that are directly linked to its activities, products, or services by its relationship with a supplier.

### 3.10 Setting the hypothesis

**H1:** Real time information and end-to-end visibility through “SCM Control Tower” can streamline logistics costs and improve supply chain efficiency

The VW Group developed the ONE.KBP platform, to be able to connect all their suppliers, transportation companies and buyers at one place.

**H2:** In order to optimize the SC, simultaneous optimization of all the SC components is a must, which can be achieved by establishing an adequate CT

ONE.KBP represents a CT for SCM of VW Group, and since the introduction of the Konzern Business Plattform in 2003 all parties could improve their high-efficient
communication and interaction competence, their transparency and optimized processes, and their competitiveness.

The ONE.KBP is a dynamic platform that is constantly being assimilated for an optimal cooperation between the supplier and the Volkswagen Group.

The ONE.KBP has brought the already excellent supplier relationship to a new quality level.

**H3: SSCM can drive growth and reduce costs by creating, protection and growth of long-term environmental, social and economic value for all stakeholders involved**

For Volkswagen, sustainability means pursuing economic, social and ecological objectives simultaneously and with equal energy. Aim is to create lasting values, offer good working conditions, and conserve resources and the environment.

VW AG sustainability concept, want to ensure that opportunities and risks associated with environmental, social and governance activities are identified as early as possible at every stage of the value creation process.

Together with its many thousands of suppliers, Volkswagen does its best to make this long and complex process chain as environmentally compatible as possible.
3. EMPIRICAL MODEL OF THE SCM: THE CASE OF VW SARAJEVO

4.1 Volkswagen Group

Volkswagen Group is one of the world’s leading and the Europe largest automobile manufacturers. It is based in Wolfsburg, Germany and holds 12 brands. “The Group has a 12.1% share of the global passenger car market and reported after-tax earnings of €11,638 million on sales revenue of €230,682 million in 2017” 27. The VW Group employs more than 640,000 people which produce or are involved in production of about 44,170 vehicles/working day.

Source: VW supply

Figure 4.1.: Parts of a single vehicle, decomposed to the smallest screw

4.2 Structure of VW AG

Volkswagen AG is the parent company of the Volkswagen Group. Volkswagen AG holds direct or indirect interests in AUDI AG, SEAT S.A., ŠKODA AUTO a.s., Dr. Ing. h.c. F. Porsche AG, Scania AB, MAN SE, Volkswagen Financial Services AG, Volkswagen Bank GmbH and a large number of other companies in Germany and abroad.

Twelve brands operate as an independent entity on the market to provide products from motorcycles to low-consumption small cars and luxury vehicles. In the commercial vehicle sector, the products include ranges from pick-ups, buses and heavy trucks.

The Volkswagen is Group’s core brand, with presence in more than 150 markets around the world. Volkswagen produces vehicles at over 50 manufacturing and assembly sites in 14 countries. “In 2017, Volkswagen delivered around 6,23 million new cars to customers. The brand employs some 200,000 people, with another 10,000 people working in dealerships around the globe”28.

4.2.1. Locations of production

The Volkswagen Group’s production network is comprised of 123 locations (Figure 4.2.) of which 71 (Figure 4.3) is in Europe (28 sites in Germany), keeping it the most important production region for vehicles and components.

Figure 4.2.: Locations of VW Group plants worldwide

Figure 4.3.: Locations of VW Group plants in Europe
The location of VW Sarajevo plant, which is the focus of this paper, is shown in following figure (Figure 4.4.).

Source: VW AG

Figure 4.4.: VW Sarajevo plant
4.3 Volkswagen Sarajevo plant

TAS (abbr. bos. - tvornica automobila Sarajevo, eng. Car factory of Sarajevo) is founded in 1970 with share 49% of VW AG and 51% share of UNIS\(^\text{29}\).

The assembly of the Volkswagen Golf in TAS began in 1976. In the beginning, the Golf was made up of parts that Volkswagen delivered to the TAS, and as the time passed, and production grew in the production of the "Yugoslav" Golf, companies from the former Yugoslavia also joined. All parts for the Golf produced in Yugoslavia meet most stringent quality standards, so Golf from Sarajevo did not differ in quality from Germany.

Production of the Golf in the following year, in 1977, reached the number of 5,000 cars, and each year the production grew. Golf I in TAS was produced until 1985,

\(^{29}\) UNIS was founded in 1968. By 1992, the company founded or integrated into its composition more than 100 companies in the areas of: automobiles and parts, raw materials, chemical industry, mechanical engineering, dedicated industries, bearings, tools, bicycles and parts.
two years longer than in Germany, so the second generation entered the production with two years of delay.

In the period since 1986, production has grown to 25,000 cars, with the prospect of increasing it to 40,000. This is evidenced by the fact that in 1988, 3109 workers were employed, which produced 28,341 cars, of which 15,184 were directly delivered to Volkswagen. Volkswagen and TAS in 1989 marked the small jubilee with the production of a 300,000-piece Golf, Alpine white. In the next year, Volkswagen will continue to grow TAS Golf’s production, reaching the number of 37,411 cars at the end of the year. It was a record year in the production of the Volkswagen Golf in TAS, when its production included 3,500 workers.

In addition to the Golf in TAS, Jetta and the Golf Caddy were produced. It is interesting to mention that TAS was the only European factory in which the Golf I with the Caddy design was produced. The first Golf I Caddy from the TAS production line went down in 1982 and until the war in 1992 about 200,000 copies were produced. Golf Caddy, except in Sarajevo, was also produced at the US plant.
in Pennsylvania. Half of the total production of Golf went to the Slovenian market, 20% in Bosnia and Croatia, and 10% of the manufactured Golfs were sold in Serbia, Montenegro and Macedonia.

The Golf II in TAS was produced until 1992 when warfare in Bosnia and Herzegovina began, when the factory was first robbed and then, completely destroyed. Before the outbreak of war, in TAS several trial copies of the Golf III were made which never entered the serial production at the Sarajevo factory precisely because of the beginning of the war.

After the end of the war in BiH, at the end of the 1990s, attempts were made to restore the old production facility. In 1998 the Volkswagen Sarajevo d.o.o. was founded with share 58% of VW and 42% of UNIS. On the foundations of the old factory SKD assembly of the Golf and some other models from the Volkswagen group started. Due to a small number of cars and unprofitable purchases from further renewal of production, it was abandoned.
In 1998, there was the introduction of components as the second business area (ring gear, sleeve, wheel hub, flange point).

From 2003 to 2009 the VW Sarajevo plant apart from components, produce standard pallets.

In 2009 production of Ecco Carrier in collaboration with the company Eco Craft started and last until 2011.

In 2010 the VW Sarajevo focused on the development of the specialized pallets (product portfolio development) and components (volume increase, further relocation of projects).
4.4 Production in VW Sarajevo

Current production in VW Sarajevo is divided in two sectors:

1. Components
2. Specialized pallets

4.4.1. Production of Components

After reopening of the VW Sarajevo plant, components were the core of the production.

There are four main products of components:

On Figure 4.9. are shown products of components production and their buyers.

Source: VW Sarajevo

Figure 4.9.: Product catalogue of components in VW Sarajevo (a)
4.4.2. Production of pallets

In 2003 the VW Sarajevo decided to start the production of universal pallets as an additional business area. From 2003 to 2009 six types of universal pallets were produced.

With business expansion in 2008 the company decided to make reconstruction and investments into the production and in 2009 the company focused mostly on the production of specialized transportation pallets.
With reconstruction of production units, including new laser technologies and production of prototypes, the production of pallets experienced development. The production is based on VW AG concepts and norms.
Figure 4.13: Production and assembling specialized pallet in VW Sarajevo (b)

On the following figures are shown types of the specialized pallets and their buyers.

### 3.3 Proizvodni portfolio proizvodnje paleta

<table>
<thead>
<tr>
<th>Specijalne transportne palete - Palette za motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kupac: VW Chemnitz, Škoda, VW Motor Polaka, VW Salzgitter, VW Russland, AUDI Győr</td>
</tr>
<tr>
<td>Motore EA211, EA288, EA888: UNIMAG 70A 514 763</td>
</tr>
<tr>
<td>UNIMAG 70A 523 630G</td>
</tr>
<tr>
<td>UNIMAG 70A 528 777</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specijalne transportne palete - automatske</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kupac: AUDI Neckarsulm, Lamborghini, VW WOB</td>
</tr>
<tr>
<td>Struktume i limene komponente: Schweller innen 70A 516 111</td>
</tr>
<tr>
<td>Klimabezgerat 70A 510 767</td>
</tr>
<tr>
<td>Fersenti TIGUAN 70A 511 997</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specijalne transportne palete - manueine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kupac: VW Braunschweig</td>
</tr>
<tr>
<td>Montažne komponente: Schwenklager 17° 70A 525 872</td>
</tr>
<tr>
<td>Raddnbe Spur 2° 70A 511 206</td>
</tr>
<tr>
<td>Hinterachse JIS 70A 512 290</td>
</tr>
</tbody>
</table>

Source: VW Sarajevo

Figure 4.14: Types of specialized pallets and their buyers (a)
Except of components and standard and specialised pallets, the VW Sarajevo developed a special kipptrolley for internal use. On the following figures are shown characteristics of those kipptrolley and their function.

**Figure 4.15: Types of specialized pallets and their buyers (b)**

**Figure 4.16: Product: Kipptrolley for internal use, characteristics and design (a)**
4.5 Main Suppliers and Buyers of VW Sarajevo

In order to simplify the analysis, into the discussion in this paper were taken into account all clients of VW Sarajevo, but because of the large number of suppliers both for components and for pallets, 38 most important suppliers are taken into account.
Figure 4.19: List of VW Sarajevo buyers worldwide

Source: VW Sarajevo

Figure 4.20: VW Sarajevo buyers in Germany

Source: VW Sarajevo
4.6 Relationship between SCM, CT and SSCM based on the VW strategies and tools

4.6.1. ONE KBP, Discovery and Sustainability as part of SCM of VW Sarajevo

For its own needs, VW Group has developed a platform where all customers and suppliers are connected in one place. This platform represents the CT supply chain where visibility from the first to the last point in the supply chain is enabled.

![ONE.KBP Interface](image1)

*Figure 4.21.: ONE.KBP Interface*

All managers as well as procurement planning and logistics personnel have access to this platform. Also, buyers and suppliers have access to the platform, but each has access to certain parts, according to their responsibilities and needs.
The figures show how ONE.KBP platform looks for a sales manager in VW Sarajevo. The sales manager is able to track all customer inquiries and orders, to submit the offer to the customer providing the delivery deadlines, on the basis of the supplier's estimated delivery time for the parts and raw materials delivery as well as the production department on the deadlines for making the order.

After the sales manager, receive the confirmation of the order, it automatically update the system and provide information to the customer with approximate delivery time. All changes e.g. the supplier update information that there is no xy spare parts on stock and provide the manager with the new time needed for production for delivery, are recorded and manager is able to update the new status of the order based on new predictions.

Also, in the case of some extraordinary situations such as machine failure and lack of production or reduced production volume, the sales manager receives information from the production department about possible delays in the production.
Figure 4.23.: Task center for sales manager - quotations

Figure 4.24.: Task center for sales manager - tenders
Sales manager upload delivery predictions into system and according to the changes that might occur track the progress of current projects.

**Figure 4.25.: Delivery status**

**Figure 4.26.: Payment status**
The ONE.KBP give information also about the payments needed to be done, payments received, deadlines for payments, and etc. (Figure 4.25.)

As already mentioned, ONE.KBP has many of application integrated. Access to specific applications, are assigned according to the roles of managers. Thus, the sales manager has access to the Discovery application.

DISCOVERY works as a platform for data interchange. It supports the communication between the process partner supplier, forwarder and Volkswagen in Europe. Creating a standardized pick up notification process, the adherence to quantity stipulations and schedules will be guaranteed within the supply chain.

Discovery application, as part of ONE.KBP, enables the purchasing manager and sale manager, to see at any time, available vehicles for transport, the quantities of goods that should be transported from and to, and terms for delivery, the scheduled delivery deadlines and etc.

![Discovery Application](source_image)

Source: VW Sarajevo

*Figure 4.27.: Representation of Discovery application*

Discovery is one of the most important applications, that most often, affects changes related to production, procurement and sales. All these managers must know at any
times the ability to transport goods and the time of arrival so that planning can be performed at each level. Discovery not only shows the availability of vehicles, but also incorporates legal procedures, required documents for import or export of the goods, Incoterms 2010 delivery parity, etc.

When a procurement department issues a purchase order for a particular shipment, which is on DAP parity, then in the Discovery program, its supplier provides information about when the shipment can expect to be delivered. Under this parity, the buyer, i.e. VW Sarajevo has no obligations other than import customs duties and procedures. All other costs are invoiced to the supplier.

If a supplier supplies exclusively shipment on the EXW parity, then the purchasing officer of VW Sarajevo fill up the order form. ONE.KBP notifies the supplier of the order. At that time, the supplier's obligation is only to inform the buyer of the possible pick up time for goods. Further, logistics department VW Sarajevo takes over all obligations and costs related to the takeover, transport, export and import clearance of the shipment, and provides information to the procurement department by entering into the system the transit time for the shipment, and the delivery deadline.

![Diagram](image.png)

Source: VW Sarajevo

Figure 4.28.: Brief instruction of notification process in Discovery
The same applies in cases of delivery to customers. VW Sarajevo always offers the customer the option of delivering shipments on DAP, DAT, FCA and EXW Incoterms2010 parity. Depending on how the customer requires the delivery of the ordered product, obligations and costs are defined. If the buyer has paid all shipping costs to the place of delivery, VW Sarajevo shall enter all the necessary data into ONE.KBP and inform the buyer of the possible delivery date. If it is the opposite, then the seller's obligation stops with the information about the possible takeover time.

<table>
<thead>
<tr>
<th>Benefits of using DISCOVERY</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simplified pickup notification</strong></td>
</tr>
<tr>
<td>• Notification proposal is based on pickup date and is taking public holidays into account</td>
</tr>
<tr>
<td>• Suggests entries for pickup notification for every part number (pickup date, container etc.)</td>
</tr>
<tr>
<td><strong>Pickup confirmation issued by forwarder on the same day</strong></td>
</tr>
<tr>
<td>• Pickup time, consignments to be picked up, license plate of the truck, delivery of empties)</td>
</tr>
<tr>
<td><strong>Decrease of communication efforts between suppliers, forwarders, and Volkswagen</strong></td>
</tr>
<tr>
<td>• Same state of knowledge for process partners using DISCOVERY</td>
</tr>
</tbody>
</table>

Source: VW Sarajevo

*Figure 4.29.: Benefits of using Discovery*

The well known “Diesel crisis” that made in public on 18th September in 2015 made a black spot in VW AG history. The VW AG was known as one of the World’s best role models when it comes to the sustainability and “green” technologies in production - the Diesel crisis ruined that reputation.

That is the reason why in 2016, when the Group launched the strategy “Together 2025”, the biggest change process in the history of Volkswagen. The program for the future is making VW AG more focused, efficient, innovative and sustainable. With responsibility for the environment, safety and society as goals, and integrity, reliability, quality as the cornerstones, the Group by pursuing these goals and principles strive for technological leadership in the industry and competitive profitability.
The VW Sarajevo is fully included into Group’s strategy for sustainable management - Together 2025.

Together 2025 strategy pillars are:
1. Excellent employer
2. Role model for environment, safety and integrity
3. Competitive profitability
4. Excited Customer

![TOGETHER – STRATEGY 2025](image)

Source: VW Sarajevo

Figure 4.30.: Pillars of VW Strategy “Together 2025”

Into Together 2025, not only group’s companies are included, but also their supplier.

The sustainability in Supplier Relations concept is based on the “Volkswagen Group requirements regarding sustainability in its relationship with business partners (Code of Conduct for Business Partners). The latter embeds VW AG expectations of business partners’ conduct with respect to key environmental, social
and compliance standards in contractual agreements. The Tier 1 suppliers are expected to pass those requirements down along the supply chain. Before taking into consideration to work with potential supplier, VW AG uses a country risk analysis and other data to obtain a clearer picture of the social, environmental and human-right risks in the areas where they operate.

![Sustainability in Supplier Relations Concept](source: VW Sarajevo)

Figure 4.31.: Sustainability into supplier relations concept

### 4.7 Capturing the “As Is” state of VW Sarajevo SC using SCOR model

The most important suppliers for VW Sarajevo are located in 6 countries, of which 2 are not within the European Union. Bosnia and Herzegovina is also not within the EU, meaning that all goods entering or leaving the country must undergo import and export customs procedures.

The logistic mode of factories in automotive industry is a kind of self-support logistics. The logistic processes of purchase, manufacture and distribution in VW Sarajevo are all implemented by factory. VW Sarajevo factory purchase direct materials from foreign material supplier, and the product market mainly lies in EU.
The recent development trend in automotive industry is that the assembly factories more and more focus on their core business activities, such as design, assemble, marketing, so the range of vertical integration is reduced, and vertical disintegration is present.

The logistics of automobile supply chain should include at least 4 parts:
1. logistic center of factory;
2. foreign carrier chose by foreign suppliers, which lie on upriver supply chain, such as DHL to VW Group. They deliver parts to Bosnia and Herzegovina from the suppliers all over the Europe;
3. the third - party logistics (3PL) providers chose by native suppliers in Bosnia and Herzegovina. They deliver the direct materials to logistic center of assembly factory from native suppliers,
4. logistic providers which deliver the final products to all clients.

The logistic process in VW Sarajevo SC can be generally defined as below:
1. Customer send inquiry through ONE.KBP platform about price for production of specific type of a pallet, tailored for their needs with specified quantities they will need, and set the deadline for quotation
2. Inquiry is automatically sent to the sell department of a factory
3. Sell department pass the inquiry to the engineering and design department which design specific pallet and decides about possible materials and quantities of the materials that will be needed for production.
4. Once design is made, factory makes assumption of the production plan, and purchase department sends the future production plan to its spare parts suppliers which provide the factory with information about availability of the spare parts/raw materials and deadlines for delivery
5. After getting preliminary results, sales department send quotation to the customer
6. If the customer accept the offer and confirm the order, production starts
7. According to the production plan, spare parts suppliers all over the world immediately order from their material suppliers and begin to produce, and calculate the lead time from leaving factory to entering into the store.
8. Suppliers choose the carrier and transport route to deliver the parts from its factories to overseas packaging center, then transport them to Bosnia and Herzegovina (depending how agreement between supplier and factory is made)
9. Before the parts are delivered to factory, supplier should send the store-in list to the logistic center of assembly factory through ONE.KBP platform. The store-in list includes information about tab, quality and arrive time of the parts. The supplier also should keep up to date information about the shipments through Discovery application. When the parts arrive to factory, the logistic center must check them, according to the store-in list, and then input into the inventory information system.

10. The logistic center of factory, sorts the goods in the warehouse and decide the time to deliver. Furthermore, goods might be repackaged if it’s necessary. When the goods are sorted, the information will be sent to the factory. At the same time, the inventory information system will record the store-out information. When the goods are offloaded, they will be sent to the product line of factory directly.

11. After the pallets are assembled, factory will choose native 3PL to deliver the pallets to the client, according to the order.

12. When customers require return, the return should be the same as normal logistics, but it is converse, which can be cast back to raw material suppliers.

The above process is very complex.

Regardless of the good strategic position of the factory itself, logistical costs are extremely high due to poor road infrastructure as well as the cost of import and export. Although VW Sarajevo has certain facilitations for customs procedures, such as non-payment of customs duties on commodities that can be proven to have EU preferential origin, "home clearance" of the shipment and etc., on the supply chain will have a significant impact these procedures.

Largest number of shipments from and to VW Sarajevo, are transported by groupage road transport.

On figure 4.32. the main hubs and the groupage transit lines by which the goods are transported to the factory, as well as to the buyers, are shown.
With the help of the data of the Procurement and Logistics Department of VW Sarajevo, a Geography map is created, showing the suppliers and buyers, as well as the links between those, described by SCOR reference model.

In accordance with SCOR-Based Method for SCPR at the first stage of SCPR i.e. capturing “As is” situation, decisions are made on what should be the focus of the entire redesigning process. The focus is on only the most important suppliers and buyers of VW Sarajevo. Suppliers outside the EU, as well as suppliers whose volumes of goods involved in production processes are negligible, are not taken into consideration. Due to the complexity of the SC on the map are shown only suppliers (black dots) and buyer (blue dots) locations, warehouses (purple dots), production and main executive processes.
The activities of spare parts suppliers are S1, S2, M1, M2, D1 and D2. After spare parts suppliers receive the production plan from factory, they begin to produce the parts (S2). In order to avoid the situation that some materials of the upriver suppliers is out of stock or upriver suppliers can’t ensure delivering the goods in time, spare parts suppliers should keep some safe inventory (S1) if possible. In the producing process, spare parts suppliers often produce more products in order to get scale economy effect. A part of products will meet the demand of instant order (M2), and others will store into inventory (M1). Suppliers send the parts to the warehouse of assembly factory (D1). If production plan of assembly factory changes, assembly factory will add some temporary urgent orders. Spare parts suppliers need to transport the goods from inventory by air (D1) or produce the parts temporarily (M2) and transport them (D2). In reverse logistics, logistic center receives the damaged goods (DR1) and delivers them to upriver suppliers (SR1).

Logistic center of assembly factory The operation of logistic center of assembly factory includes S1, S2, M1 and D1. Before the goods arrive at logistic center of assembly factory, logistic center should receive a Store-in lists notice from spare parts suppliers. When the goods arrive, logistic center will check the goods with the store-in lists and store in the goods. Both the store-in goods (S1) and the urgent order goods (S2) will be sorted and reset in the distribution center (M1). The activities of assembly factories are S1, M2 and D2. After the goods are offloaded, they may be sent to the factory directly (S2).

Pallets are assembled according to the customer’s order on the product line of assembly factory (M2). When the pallets are put down the product line, they will be delivered to the distribution center by the 3PL providers chosen by assembly factory (D2). Distributors The activities of distributors are S2, D2, SR1, DR1 and DR2. After distribution center receive the pallets from assembly factory (S2), the delivery to the customer will be organizes (D2). If it is necessary to return the goods, customer will via ONE.KBP inform the factory, and distribution center will organize the return and get the damaged products from customers (DR1) and transport them back to assembly factory (SR1). If distribution center received the MRO products, they can send them in their repair workshops (DR2).
Figure 4.33.: Geography map – “As is” VW Sarajevo SC
Figure 4.34: SCOR Thread Diagram of a As Is SC process in VW created in ARIS
4.8 Designing “To be” state of VW Sarajevo using SCOR model

To design the desired SC state under observation, an analysis of the current state was first performed.

After “As Is” process of supply chain is clearly described, next is to know the operation performance of supply chain. The more members there are in the supply chain, the more complex the communication becomes, and the more errors will happen, so the effectively and efficiency of the whole supply chain become difficult to enhance.

There are 13 performance indexes in the first level of the supply chain in SCOR model. However, these 13 performance indexes play different roles in specific firms. For the manufacturers (including spare parts suppliers and assembly factory), delivery performance indexes and perfect order fulfillment are the most important.

Delivery performance (DP), which focuses on the evaluation of delivery’s cost and time, is defined as the percentage of orders (O2R) that the delivery is both in right time and right quantity.

\[
DP = \frac{O2R}{O_{total}}
\]

Perfect order fulfillment (POF), which is similar but different with delivery performance, is the percentage of orders that the delivery is both in right time and right quantity minus the orders (OE) with any error or delivery damage.

\[
POF = \frac{O2R - OE}{O_{total}}
\]

Perfect order fulfillment focuses on the assessment of the delivery quality (Figure 4.34). These indexes influence directly whether the whole working procedures of assembly factory will operate regularly or not and whether the production plan can be finished in time or not. The successful implementation of production plan is helpful to guarantee and enhance the levels of other performance indexes, such as decreasing the order cycle time and increasing the assets velocity. According to the
formula, we can compute the perfect order fulfillment rate and treat it as an industry benchmark and the prospective goal to do the gap analysis and SWOT analysis.

After computing the performance indexes, it is necessary to do gap analysis between recent situation and objectives. According to SCORcard method, company should establish the prospective performance of every index, which must be consistent with the strategic mission of the company. The gap of total level between VW Sarajevo, and other companies inside the VW AG is very big. Moreover, the immaturity of Bosnian automotive logistics expands this gap. In order to catches up with the Konzern’s advanced level the VW Sarajevo should completely integrate their production processes and adopt the best practice examples.

Take the supply chain reliability index as an example, the following table (Table 4.2.) indicates that the task of VW Sarajevo logistic is very hard. Especially, the gap in the perfect order fulfillment index is very large.

<table>
<thead>
<tr>
<th>Level</th>
<th>Performance Attributes</th>
<th>Metrics</th>
<th>Actual VW Sarajevo</th>
<th>Parity VW AG</th>
<th>Value from improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Supply Chain Reliability</td>
<td>Delivery Performance</td>
<td>94%</td>
<td>99%</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fill Rate</td>
<td>96%</td>
<td>99%</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perfect Order Fulfilment</td>
<td>92%</td>
<td>100%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Source: VW AG reports and ONE.KBP reports for VW Sarajevo Supply Chain

SWOT analysis showed the main strengths, weaknesses, opportunities as well as treats, for the VW Sarajevo supply chain (figure 4.35.)
Figure 4.35.: SWOT analysis

Once the “As Is” state is analyzed it is possible to re-draw the Geography map and the thread diagram of the desired state. In accordance with goals aimed to be achieve the geography map can be adapted until the desired state is achieved. Supply Chain SCORcard with actual and benchmark data and some guesses about the value that might be achieved by redesigning the SC analyzed, can be made (Table 4.1.)
4.7.1. Judgment of proposed hypothesis

After analyzing the current supply chain in VW Sarajevo using the SCOR reference model, it is possible to make a judgment on the hypotheses previously set.

**H1: Real time information and end-to-end visibility through “SCM Control Tower” can streamline logistics costs and improve supply chain efficiency**

**True**
With introduction of Group’s platform ONE.KBP, the real time information and end-to-end visibility through complete supply chain is achieved. The goal by 2025 is to connect all suppliers and buyer at this specific CT from which all managers and stakeholders involved will be able to track all changes and react on time.

The platform enables to streamline logistics costs by choosing the best available transit routes at any moment, to plan the delivery schedules just in time with minimized costs of warehousing and stocking the supplies and finished goods.

The companies in VW AG that fully uses the ONE.KBP already shown improvements in relation to those companies that have only partially introduced this system.

**H2: In order to optimize the SC, simultaneous optimization of all the SC components is a must, which can be achieved by establishing an adequate CT**

**True**

The ONE.KBP is a dynamic platform that is constantly being assimilated for an optimal cooperation between the supplier and the Volkswagen Group. The ONE.KBP has brought the already excellent supplier relationship to a new quality level. The VW Sarajevo SC performance can be measured through both, financial and nonfinancial, key performance indicators.

The “Integrate strategy and planning process” Group initiative is focused on continuity and even closer dovetailing of the Group and brand strategies with the operational planning process. This enhances transparency when it comes to the financial assessment and evaluation of directional decisions.
H3: SSCM can drive growth and reduce costs by creating, protection and growth of long-term environmental, social and economic value for all stakeholders involved

True

The future of the car is electric, digital and connected. Volkswagen will be a key player in charting and shaping this future as it is one of the leaders in automotive industry worldwide. The Strategy 2025 is viable, but there are still several areas where the improvement is needed to realize its goal to become and remain a world leading provider of sustainable mobility. The VW AG empowers sustainability – now and in the new mobility era. VW AG is efficient and profitable, innovative and customer-oriented, responsible and respected.
4. Conclusion on the results obtained in the research and suggestions for further research

In this research, analysis of the supply chain of the Volkswagen Sarajevo factory was carried out. Since the Supply Chain Management is a very complex topic, analysis is simplified by focusing on the key points of the chain and the current strategies that are being implemented, with the aim of proving or denying, the previously set hypothesis.

The first part of the paper was introduction to the problem of research itself. The second part of the paper encompassed the definitions and beginnings of SCM development as scientific disciplines, CT and the term "sustainability". In the third part, the SCOR model was presented as a tool for analysis and optimization of supply chains, which was later used in the fourth chapter to analyze the supply chain in VW Sarajevo.

The fourth chapter represents the core of the research. A case study was carried out at example of Volkswagen Sarajevo. Research was carried out together with the VW Logistics and Procurement Department, and through the SCOR model, the current supply chain state is defined, its weaknesses, and the key points that should be affected in order to improve the supply chain itself.

The set hypotheses have been proven through financial and nonfinancial reports from the VW Group, whose strategies and goals are being implemented by VW Sarajevo as part of the group. What it should be the future of VW Sarajevo is to constantly coordinate with VW AG, track and develop together with the group, as “the best in class” example.

Analysis of the "as is" situation has provided the basis for improving the current supply chain status and its redesign.

Supply Chain of VW Sarajevo is very diverse and includes a large number of suppliers. The biggest problem is the variety and specificity of the production of special transport pallets such as pallets for the transport of various engines. Each of the pallets is designed and developed according to customer requirements.

Two production areas: pallets and components are completely different so that it can be said that the factory has two separate supply chains. The supply chain of the
components is much simpler than the pallet because the quantities of the required materials for the manufacture of the products can be predicted for months in advance as the component production is planned according to the plans for the production of vehicles at the annual level. There are few deviations from the predefined numbers.

In the production of pallets, as previously mentioned, the supply chain is much more complex precisely because of the unpredictability of customers' demands. Until a request for a bid is made for the production of a particular pallet, the required amount of spare parts and raw materials for production of pallet is unknown.

Focus for VW Sarajevo, regarding the production of special pallets, should be to maximize the standardization of the basic parts of the pallets, such as the basic dimensions of the pallet frame, the materials needed for production and etc.

At the annual level, the production in VW Sarajevo for components amounted to 12 million pieces with a turnover of 12 million euro, what is more or less, the average production in a last couple of years.

In the pallet production, the numbers vary from year to year with a tendency of growth, so in 2016, 10 million pallets with a turnover of 9.5 million euro were produced, and in 2018 those numbers increased to a record number of 10.5 million pallets with turnover something more than 10 million euro.

Transportation and logistics related costs as a percentage of sales range from 9% to 14% depending on industry sector for companies who do not adopt a logistics efficiency management approach. As supply chains are unique networks between businesses that deal with the production, shipment, warehousing and delivery of products, they are very important to businesses as they largely affect sales and profits. However, without effective and well-organized logistics, supply chains can’t help business gain a clear advantage over the competition.

The logistics costs in 2018 for VW Sarajevo were 11%, which is for 2% less in comparing to 2015. The aim is to achieve 9% by 2025.

In order to improve the performance of the supply chain of VW Sarajevo, it is important to cooperate actively with 3PL providers and integrate 3PL into the
Discovery application, decrease the number of carrier and develop the strategic partner relationships with strong and steady 3PL providers.

In the “To Be” logistic process of VW Sarajevo supply chain, factory will support the 3PL partners, who cooperate intimately with them, develop and adapt according to the Konzern strategies and visions.

Cutting logistics costs is a sub-optimization that produces just partition of savings in SC. As VW Sarajevo introduced ONE.KBP in 2016 the total costs of SC decreased providing the company the bigger revenue. It is a must that VW Sarajevo broaden their performance measures to include inventory investment and carrying costs so that total expenses are managed. Then, buying fast, reliable transportation will allow managers to operate supply chains with the lowest possible safety stocks.

Although the ONE.KBP platform has already shown its benefits in supply chain management, optimizing it and achieving end-to-end visibility across the entire chain, it has not yet reached its peak and needs further improvements. The full potential of the platform has not been used since all stakeholders are still not using it. For example, not using all customers platform for ordering already rely on old methods like sending orders via mail, fax, do not follow the status of delivery deadlines through the application etc.

Everyday improvements are certainly needed, for example, an additional option that could be added is to upload a "delivery note" into the system so that the factory should not send it by email or by post. In any case, additional education in the exploitation of the full potential of the ONE.KBP platform for all stakeholders is necessary.

Suggestions for further research would certainly include the possibility of allocating the production within the EU (e.g. to Slovenia or Croatia), given that the supply chain and its key performance factors are mostly affected by the constraints that VW Sarajevo faces, all because of a non-unique market.

Except the bad road infrastructure, the import and export procedures have a significant impact on supply chain unreliability, since it can’t be significantly changed or affected. Waiting at customs, preparing the necessary documentation for clearance procedures can make delays in delivery up to few days or even weeks.
According to the Law on Customs Policy, and the fact that the EU has concluded bilateral trade agreements with Bosnia and Herzegovina, one of the import reliefs is that the importer can be exempted from paying customs duties if the goods they import have an EU preferential origin.

Preferential origin can be proven in the import procedure in three ways:

- manufacturer’s declaration of preferential origin for shipments up to 6000 EUR value
- EUR 1 documents or
- by the statement of an authorized exporter which, as EUR1, is not limited to a particular value of the goods

Of the 38 listed suppliers, even 12 of them can’t prove the origin of the goods, so the total value of the customs duties is paid for the import of goods, which can be from 5-30% on the value of goods plus transport.

In order to reduce the costs of importing raw materials and parts, VW Sarajevo should try to import goods with EU preferential origin, which is not always the case. Although the supplier is located in the EU, this does not mean that they completely produce their products using parts and raw materials from that country, just as with VW Sarajevo.

Waiting time for import and export procedures can be significantly reduced by adequate documentation preparation which is possible to achieve with well planning and organization.

As a long-term goal can be set, finding major suppliers within Bosnia and Herzegovina, as large number of products and raw materials that VW Sarajevo procures for production, can be found in Bosnia and Herzegovina. VW Sarajevo should strive to direct the procurement to the domestic market. Negotiations are under way with a few local suppliers of screws, steel and lacquer manufacturers. This can greatly affect the speed of the supply chain and, therefore, the efficiency of the chain,
One of the goals that VW should never abandon is sustainability as an imperative for future generations. In this VW Sarajevo must fully integrate with Konzern policies.

By the time a raw material has been transformed into a component installed in a VW, it will have passed through some 15,000 stations in the course of its production, treatment, finishing and transportation. Together with its many thousands of suppliers, does its best to make this long and complex process chain as environmentally compatible as possible. VW AG is also involved in resolving social issues. Since 2015, the company has been committed to helping refugees by managing emergency aid, helping with language learning, training and education, and providing comprehensive information on a proprietary platform.

VW AG initiates and supports sustainability projects. In 2017, the company undertook more than 400 projects worldwide which addressed issues including regional structural development, health, education, sport, and environmental conservation.

Proposals for further research would include the allocation of the main part of production within the EU. What would be achieved and whether there is a cost-effectiveness of such a decision? Does the state policy show signs that Bosnia and Herzegovina will sign an agreement on accession to the European Union in the near future?

The impact of the construction of Corridor Vc on the future functioning of the supply chain and the integration into the Trans-European Network is another possible topic for consideration, given that the current road infrastructure is in a very poor state.

The possibilities for further research are varied as the supply chain itself is complex and requires complex management techniques at each moment and at every level.

VW Sarajevo does the “good” supply chain management, but opportunities for development and improvement are always present, and “outstanding” supply chain management, should be the company’s future goal.
BIBLIOGRAPHY

Books and articles


– Yan, Jianyuan; Li, Kai; and Qiu, Dongliang: A SCOR-Based Method for Supply Chain Process Reengineering with Applications in Chinese Automotive Industry”, AMCIS, 2007


– Empowering Transformation: Sustainability Report 2017”, Volkswagen AG, Wolfsburg, 2018

– Business Process Trends, SCOR Methodology Whitepaper – Paul Harmon


– SCOR WORKSHOP Revision 6.0 Bert van Eekhout – Van Eekhout Consulting, Jan Wongergem – Business Process Training Center


– Brnjac, N.: Intermodal Transport Systems. Faculty of Transportation and Traffic Sciences, University of Zagreb, Zagreb, Croatia, 2012
Web sources
- http://www.businessdictionary.com/definition/logistics.html
- https://keydifferences.com/
- http://www.businessdictionary.com/definition/supplier.html
- http://www.businessdictionary.com/definition/management.html
- https://searcherp.techtarget.com/definition/supply-chain-visibility-SCV
  http://www.globalfootprints.org/sustainability/
- http://annanagurney.blogspot.com/2014/10/which-suppliers-really-matter-to-your.html
- https://slideplayer.com/slide/9118729/ž
LIST OF FIGURES AND TABLES

List of Tables

Table 1.1. List of abbreviations used in research ................................................................. 13
Table 2.1. Difference between logistics and SCM ................................................................. 26
Table 4.1. Gap Analysis of VW Sarajevo Supply Chain using SCORcard ................................. 85

List of Figures

Figure 1.1. Scheme of the research ...................................................................................... 12
Figure 2.1. The Archetypical Supply Chain Diagram ............................................................ 15
Figure 2.2. Simplified representation of SC network ............................................................... 17
Figure 2.3. Pillars of the SCM CT ....................................................................................... 30
Figure 2.4. Function of SCM CT ......................................................................................... 30
Figure 3.1. Processes in BPR model ...................................................................................... 31
Figure 3.2. SCOR framework ............................................................................................... 34
Figure 3.3. SCOR processes .................................................................................................. 36
Figure 3.4. SCOR process levels ........................................................................................... 40
Figure 3.5. SCOR metrics ...................................................................................................... 41
Figure 3.6. SCOR configuration toolkit .................................................................................. 41
Figure 3.7. Level1 Performance Metrics .............................................................................. 42
Figure 3.8. Level 2 SCOR process type .................................................................................. 42
Figure 3.9. SCOR Version 5.0. level 2 toolkit process categories ......................................... 42
Figure 3.10. Geography Map of an “As Is”Supply Chain .................................................... 45
Figure 3.11. A SCOR Thread Diagram of a simple SC process ......................................... 46
Figure 3.12. A more detailed SCOR Thread Diagram of a simple SC process ....................... 47
Figure 3.13. SCORcard with actual and benchmark data and some guesses about the value that might be achieved by redesigning the supply chain being analyzed .............. 48
Figure 3.14. Performance attributes chart for comparison of SC with competition ............... 49
Figure 3.15. Process Map created in ARIS EasySCOR software .......................................... 51
Figure 4.1. Parts of a single vehicle, decomposed to the smallest screw .................................. 54
Figure 4.2. Locations of VW Group plants worldwide ........................................................... 56
Figure 4.3. Locations of VW Group plants in Europe ............................................................. 56
Figure 4.4. VW Sarajevo plant .............................................................................................. 57
Figure 4.5. VW Sarajevo plant in the “customs free zone” of industrial zone “Vogošća” ....... 58
Figure 4.6. VW Golf produced in TAS .................................................................................. 59
Figure 4.7. First series of VW golf produced in TAS .......................................................... 60
Figure 4.8. Factory production area and components .................................................. 61
Figure 4.9. Product catalogue of components in VW Sarajevo (a) ......................... 62
Figure 4.10. Product catalogue of components in VW Sarajevo and their (b) .......... 63
Figure 4.11. Universal VW pallets ............................................................................. 64
Figure 4.12. Production and assembling specialized pallet in VW Sarajevo (a) ......... 64
Figure 4.13. Production and assembling specialized pallet in VW Sarajevo (b) .......... 65
Figure 4.14. Types of specialized pallets and their buyers (a) ................................. 65
Figure 4.15. Types of specialized pallets and their buyers (b) ................................. 66
Figure 4.16. Product: Kipptolley for internal use, characteristics and design (a) ..... 66
Figure 4.17. Product: Kipptolley for internal use, characteristics and design (b) .... 67
Figure 4.18. VW Sarajevo buyers worldwide ............................................................ 67
Figure 4.19. List of VW Sarajevo buyers worldwide .................................................. 68
Figure 4.20. VW Sarajevo buyers in Germany ............................................................ 68
Figure 4.21. ONE.KBP Interface .............................................................................. 69
Figure 4.22. Task center for sales manager ............................................................... 70
Figure 4.23. Task center for sales manager – quotations ......................................... 71
Figure 4.24. Task center for sales manager – tenders ............................................. 71
Figure 4.25. Delivery status ....................................................................................... 72
Figure 4.26. Payment status ...................................................................................... 72
Figure 4.27. Representation of Discovery application ............................................... 73
Figure 4.28. Brief instruction of notification process in Discovery ......................... 74
Figure 4.29. Benefits of using Discovery ................................................................... 75
Figure 4.30. Pillars of VW Strategy “Together 2025” ............................................... 76
Figure 4.31. Sustainability into supplier relations concept ...................................... 77
Figure 4.32. Current locations of hubs and groupage transit lines ......................... 80
Figure 4.33. Geography map – “As is” VW Sarajevo SC ......................................... 82
Figure 4.34. SCOR Thread Diagram of a As Is SC process in VW created in ARIS .... 83
Figure 4.35. SWOT analysis ...................................................................................... 86