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Identification and elimination of risks in Supply Chain management automobile industry

Case *PSA Peugeot Citroen Automobiles*

Focus on identification and elimination of risks

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Abstract

PSA is one of the most popular car producers in the world. While being popular in Russian Federation, head of the company made a decision to build a production plant in Kaluga. However, after economic crisis in Russia in 2016, situation on the market has changed and amount of sales has been severely decreased. This decreased profit of the company and also cause many problems in operations. Therefore, the main objective of thesis was to identify all possible risks in transportation and provide solutions to eliminate these risks.

To answer these research questions, first of all the analysis of possible risk causes was made. Secondly the problems were identified and divided on internal and external problems, depending on their nature. Moreover, main risks concerning transportation were divided in four main groups and were studied separately. All data was collected from different sources, such as: interviews, observation, workshops, literature, etc.

The results demonstrated that there are several main risks, which cause main and the most critical problems for company. According to it, several solutions, which company can which would not solve the problem, but would reduce amount of risks were developed and proposed. Finally, the analysis of the thesis was done and suggestions for improvement were proposed.

In conclusion, author wants to notice that thesis is done from theoretical point of view. All suggestions were made to improve current situation and increase quality of transportation.

Keywords/tags PSA; Risks; Supply Chain Management; Transportpation; Logistics.

Miscellaneous (Confidential information)

1. Introduction 5

1.1 Company and problem description 6

1.2 Research aim and focus 7

1.3 Research methods 7

1.4 Restriction of research 8

1.5 Motivation. 8

2. Theory review 8

2.1 Defining the supply chain. 8

2.1.1 The aim of supply chain. 10

2.1.2 The importance of the supply chain 11

2.1.3 Main Processes of the supply chain 12

2.1.4 Main drivers of the supply chain 14

2.1.5 Aggregate planning in supply chain 17

2.2 Transportation in supply chain 17

2.2.1 Transportation role in the supply chain 19

2.2.2 Transportation modes 19

2.3 Risk Management in Supply Chain 21

2.3.1 Defining Risks 24

2.3.2 Decision with risk 24

2.3.3 Types of risk 25

2.3.4 Identification of risk 26

2.4 Managing Risk 26

2.4.1 Implementation of risk management 28

3. The implementation of study 34

3.1 Research methods. 34

3.2 Risk management plan used in research 35

3.3 Analysis of risks with Ishikawa diagram 37

3.4 Ideas for improvement.....40

4. Results of study.....43

5. Discussion.....44

6. Conclusion 44

Figure 1. Connections between Supply Chain members (Chopra & Meindl 2013, 13) 10

Figure 2. OEM definition (Chopra & Meindl 2013, 15) 11

Figure 3. Main stages in SCM (Chopra & Meindl 2013, 19).....13

Figure 4. Drivers in Supply Chain (Chopra & Meindl 2013, 53).....16

Figure 5. SCRM steps (Donald Waters, 2011, 1-9,75-95) 23

Figure 6 Decision tree (Donald Waters, 2011, 173) 30

Figure 7. Fishbone diagram 1 (Ilie G. and. Ciocoiu C.N., 2010, 4) 31

Figure 8. Changing causes table (Ilie G. and. Ciocoiu C.N., 2010, 4).....32

Figure 9. Fishbone Diagram 2 (Ilie G. and. Ciocoiu C.N., 2010, 6) 33

Figure 10. Framework (Bose 2012, 20).....35

Figure 11. Ishakawa diagram for PSA.....37

1. Introduction

Nowadays, it is becoming more and more complicated to stay in a market and being popular with the customers, without paying attention on development of competitors and without increasing level of your own position in a market. This means that for producer important to control: quality of what is produced and how it is maintained, make price more attractive to the consumers, implement new technologies, which show how modern and financially stable producer is.
Number of brands and models has been increased and this trend is going to continue in the future. It is common nowadays for people look for something, what will make them different from others. That's why individuality, which companies share with their customers is important.
That position can face company with other problems. For example, concentrating on the usability and individuality can easily destruct attention from the most important factors nowadays, quality and cost. Moreover, this can be a reason of companies to fail.
Sales and maintenance are defectively depending on Supply Chain Management. High quality SCM reduces time of delivery, risks of damage, saves a lot of money to the producer, etc. Due to the fact that customers nowadays have a wide option to choose products on a market, it is a way more complicated to gain interest of the customer without hard working.
The most efficient way to achieve this is to reduce price and implement modern technologies. Only implementing new technologies and creating new ways of supply chain can help to achieve this. (Lu 2011, 8)

1.1 Company and problem description

This research work was done for one of the biggest suppliers of cars in the world, PSA Peugeot Citroen Group. PSA Peugeot Citroen Group. Nowadays, This corporation consists of five popular brand of cars: Peugeot, Citroen, DS (which was part of Citroen brand), Opel and Vauxhall. However, not all of them are present on the Russian market nowadays. For example, Opel brand has left left country, during crisis in March 2015, while it was part of General Motors Corporation. Brand Vauxhall, which is similar one to the Opel, was not a Russian market at all. Car manufacturers like Peugeot and Citroen produce both passenger and commercial cars. They are very popular with hospital cars, buses, delivery companies, etc. Brand DS has different policy. It appears as futuristic cars with unique design and ideas in car industry. For example, they invest a lot in Formula 1 racing and act very well in this field. In general, idea of this free brands is to share individualism and bright design for modest amount of money. That's why, according to their research, target audience of cars are young people under 35 years old, who wants to be unique and don't want to pay too much. However, in Russian Federation these brands do not appear as available to such type of customers. Due to the crisis in 2014 currency of Euro was changed twice and that occurred problems with sales. Amount of producing cars in Russia and import cars from Europe decreased; Number of employers was reduced; Economy crisis was spread also on logistics department and it made some problems in Supply Chain management.

The production line is located in Kaluga (200 km from Moscow). It also includes one out of four warehouses in Russia, where company stores cars before transporting them to official dealers. Venture, where Peugeot and Citroen are produced is joint. Besides PSA, company Mitsubishi Motors Corporation produces their cars at the same premises. Plant is divided on two Parts between French and Japanese companies as 70% and 30% and has a name PCMA RUS. **(Shtanov, 2017,1-2)**

1.2 Research aim and focus

As It is already explained, now company has some difficulties with sales and distribution on a Russian market. The requirement of the company is urgently to have changes in their management system, which will at least return them on the previous position. Goal of the research is to find a solution how to decrease the amount of costs the company spends on the transportation of cars, improve supply chain visibility and eliminate risks, which occur along the supply chain. During this project I would have to go through each process step by step and evaluate all the important members involved in the Supply Chain of PSA. In order to understand, what can be the cause of the problem, it is important to answer the three most important questions:

- What are the main supply chain members in PSA?
- What are the most risky members in SCM?
- How to develop the Supply Chain Members in order to eliminate and decrease the risks?

Answers to these questions and whole research would provide an opportunity to implement a better department control of the company and suggest a solution for increasing of visibility and elimination of risks in the supply chain of the company.

1.3 Research methods

The goal of research is to give knowledge or solution for problem. The goal of this research is to solve problem that exists in the supply chain of the company. So, this research is a scientific solution that will include two main scientific research methods: Qualitative and Quantitative. These methods would be used in this research in different scope and beginning assumption of the author is that qualitative method would be used more. In addition, the research itself is a case study, which aimed on reveal problems of particular case. The research process

could be described as: 1) Data collection; 2) Data analysis; 3) Development of the solution; 4) Analysis of the results; 5) Final discussion.

1.4 Restriction of research

This research is focused only on the Supply Chain risks of PSA, which could seriously influence the Russian market. More specifically, taking into account the main manufacturing facility, which is located in Kaluga. Any other risks, which could be related to other members in supply chain that does not influence production of cars in Russia would be not included in research.
In addition, the current research is made especially for one company, but in theory it could be applied to other companies as well. But for successful implementation it would need an additional research.

1.5 Motivation.

The idea to write this thesis came to me because I have started to work for the given company and notice that they have this problem, which could be studied and developed in my thesis work. Knowledge and experience that I have received during my logistics studies is enough for theoretical development of this problem. At the end of the thesis I am aiming to present theoretical solution that could be used to resolve the problem and bring the solution.

2. Theory review

2.1 Defining the supply chain.

The supply chain is the system of processes required to satisfy customer requests. In general, supply chain includes all the activities needed to convert initial resources

(raw materials for example) into final product and deliver it to customer. Accordingly, supply chain includes not only manufacturer and supplier of materials, but also inventory, warehouses, distributors, retailers, transportation and customer, because their also included in the supply chain activities. If we imagine that we have customer who is coming to the famous retail grocery shop like Wal-Mart to purchase detergent. In this situation, supply chain activities of detergent begins from the customer, because he creates demand for detergent. The next process of the supply chain in this case would be inventory and warehouse of Wal-Mart shop where this detergent is stored. If the detergent is present in the warehouse of Wal-mart, the customer could buy it directly, but if not, the Wal-Mart has to create a request for supply of this detergent from local distributor. Distributor in its turn supplies the detergent to Wal-mart and in order to do that is has to purchase the detergent from the manufacturer. Manufacturer in its turn produces the detergent from raw materials, which he purchases from the certain supplier, who supplies these raw materials and so on. All in all, in order to sell a single product, the Wal-Mart has to establish dynamic network of activities, which would work together in order to produce, transport, store and sell the required product to customer at certain time. This involves a significant amount of coordination between supply chain members, which is quite difficult to achieve. In case if the coordination is low, the supply chain member could have serious huge costs that will influence their performance and performance of all supply chain. The following picture represents connections between Supply Chain members:

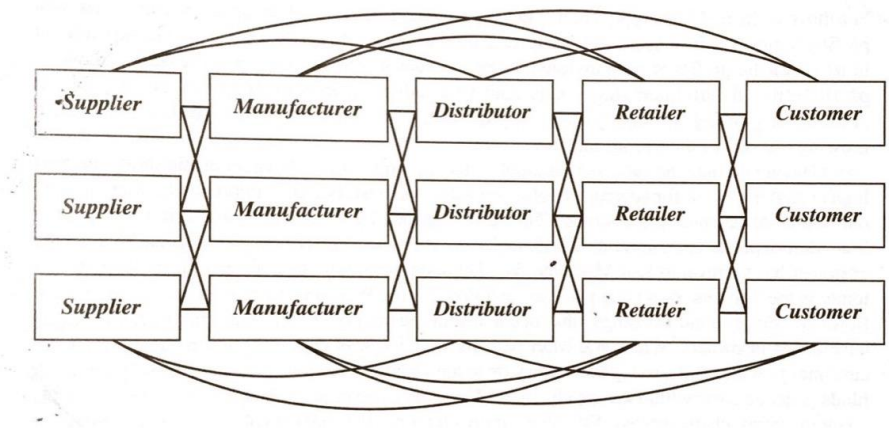

Figure 1. Connections between Supply Chain members (Chopra & Meindl 2013, 13)

(Chopra & Meindl 2013, 13-14)

2.1.1 The aim of supply chain.

Purpose of supply chain is to achieve the biggest possible overall value. The difference between Customer value and Supply chain cost is the value of Supply chain. Estimation of the maximum possible price of the item for consumers

influences the value of the final product. The overall profit of the upper organization shows the success of supply chain. However, it can't be counted on stages of SC cause it results to risk of decreasing the profit in whole. Value, revenue and cost are three main metrics of Supply chain profitability. Another definition of Supply Chain is totality of stages and companies, which make connection between the first step of creating the product and end product. Supply chain can't exist if it consists only from one stage. Moreover, these stages should be independent from each other. The majority of professionals consider that Supply Chain serves as connection of chains between the customer and supplier, where OEM exists in the middle of this chain. The following picture makes this definition more clear:

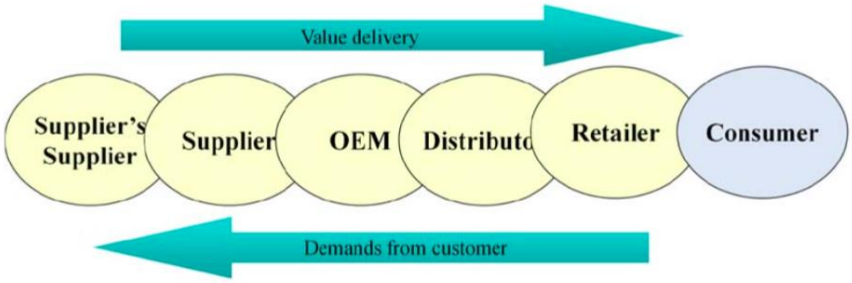

Figure 2. OEM definition (Chopra & Meindl 2013, 15)

Chopra & Meindl 2013, 15-16) (Lu 2011, 8-11)

2.1.2 The importance of the supply chain

Successful Supply chain also depends on the design and management of Supply Chain Flows. Good example of this strategy is implemented by Wal-Mart. This company invested a huge amount of money in distribution, transportation and other important constituents of logistics world. Such contribution in improving availability deduced company on the first position in the market and allowed to achieve high profit. This example shows how role of Supply chain is important for any company. It can both help to achieve success and aggravate position of the business. That's why it is important nowadays to follow new technologies, which appear on the market and implement them. Wal-Mart is good example of successful

company with high-developed Supply Chain design. Since the time company was founded, a lot of money was invested in developing and improving Supply Chain. These investments, in transportation, co-operation with suppliers and other important aspects for the company helped to increase income to more than $14 billion per year, while before improvements the amount of annual sales was only $1 billion. One more example of successful Supply Chain design is operating of company Dell. By implementing politics of passing distribution and retails, Dell started to sell product to the end customer. The second idea was to centralize manufacturing with inventory, while postponing final assembly. It gave a huge variety of product and attracted customers. (Chopra & Meindl 2013, 16-18)

2.1.3 Main Processes of the supply chain

In general, Supply chain consists of processes and flows within and between stages, which are intended to satisfy customer. It can be divided on two existing models. First one is Cycle View. It consists of four process cycles, which located between Supply chain stages:

1. Customer order cycle (between customer and Retailer)
   Customer order cycle occurs between customer and member of supply chain who offers the final product. Customer order cycle is very importance because it creates the demand for the whole supply and other members make their forecasts according to this final demand.
2. Replenishment cycle (Between Retailer and distributor)
   Replenishment process happens every time when the final seller runs out of the final product and has stock outs. Replenishment cycle is very important because if it is not done properly, the final seller and the whole supply chain loses money significantly due to occurrence of stock outs.
3. Manufacturing cycle (Between distributor and Manufacturer)
   Manufacturing cycle in its turn happen according to the certain that was predicted by supply chain members, the manufacturer launches his production according to this demand and purchases materials and does also other planning tasks.

4. Procurement cycle (Between Manufacturer and Supplier)

   Procurement cycle is the bottom core process of supply chain. During this cycle the manufacturer purchases certain amount of particular materials from the supplier which would be then re-manufactured to final product. Procurement cycle is important because it can affect the profitability of the firm.

   The following picture represents stages:

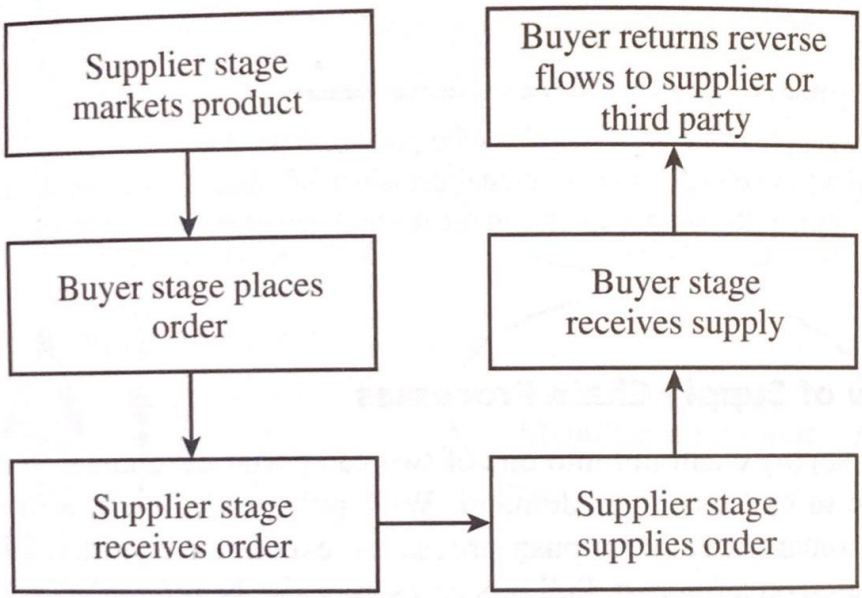

Figure 3. Main stages in SCM (Chopra & Meindl 2013, 19)

It represents sequence of six sub-processes in each Supply chain process cycle. First stage belongs to supplier. On this step he is trading off the product to the consumer. Second step shifts responsibility from supplier to buyer. Buyer places an order. Then supplier receives it and supply. After it, the buyer receives the product. Then, buyer has an option to return to the supplier or to the 3rd party some of the material to recycle or some of the product. After this cycle repeats.

Priority of the buyer during these stages is to maximize level of availability and increase benefit from receiving the order. Meanwhile, priority of the supplier is to reduce the cost of receiving orders and try to forecast what buyer would order next time. In General, Cycle View determines processes and responsibilities between supplier and buyer during supply chain cycle.

Another model is Push/Pull View. This view has two categories. During Pull Process the operations are made concerning customer order. During Push Process Company makes a forecast of customer order. This strategy helps to satisfy consumer with timely delivery. This type of view is important and helps to make decision about Supply chain strategy in different situations. (Chopra & Meindl 2013, 16-24)

2.1.4 Main drivers of the supply chain

It is essential to study main drivers to understand better what can be done in order to improve the situation in the company and understand the factors which have the biggest effect on the company's success and effectiveness. There are six logistical and cross-functional drivers:

1. Facilities. The most important in list of facilities is location of manufacturing site and location of storage (warehouses) site. Such factors as flexibility, capacity or location has a big and important effect on success of the company.
2. Inventory. Any changes in the manufacturing operations will require to make changes in inventory as well and this can both improve or destroy Supply chain operations within a company. Supplier should be very accurate in all decisions he makes concerning inventory and stock.

3. Transportation. It composed of many combinations of operations. For example, transportation within harbor or transportation inside of the warehouse, transportation between facilities by road, air, sea or even pipeline transportation. That's why this driver is one of the most important.
4. Information. The biggest driver. It supports other five drivers. Availability of required information makes supply chain more coordinated, agile and responsive. For example, the proper use of information helps to match supply and demand and as a result eliminate extra expenses and costs.
5. Sourcing. Main purpose is distribution of duties within a supply chain. Helps to make a decision where company should perform by itself and where to involve outsourcing firms. Decisions about Sourcing have an impact both on efficiency and responsiveness.
6. Pricing. This aspect is specified by costs of the company, which it spends on Supply chain management activities. Pricing policies of the companies has significant effect on many other things in the supply chain. For example, it affects the behavior of the buyer inside the supply chain and final buyer. Proper pricing policies may attract more customers and improve cash flow in the whole supply chain.

To achieve the balance between responsiveness and efficiency, company needs to make correct combination of three cross-functional and three logistical drivers. It leads the company to become more effective and achieve higher profit. The following picture illustrates relation between drivers within Supply Chain:

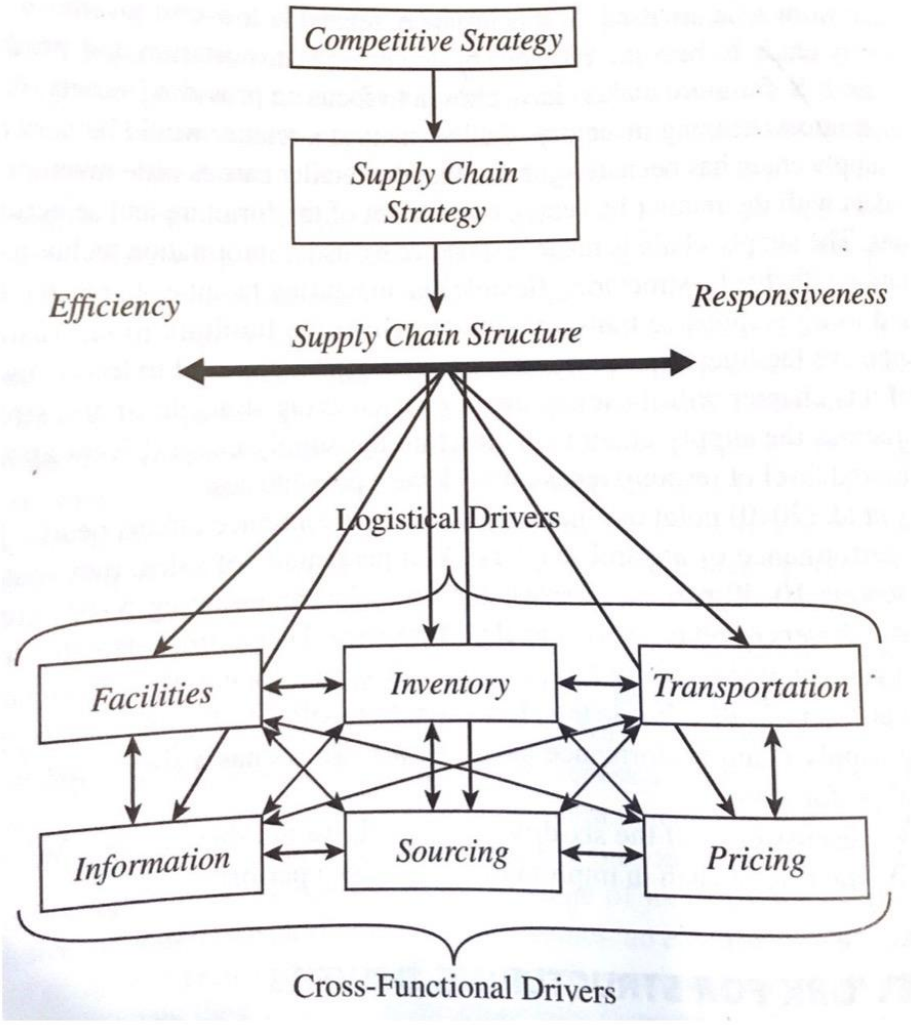

Figure 4. Drivers in Supply Chain (Chopra & Meindl 2013, 53)

Usually companies begin their performance with competitive strategy. After they become to feel themselves more stable on the market, they make a decision which combination to choose in order to be a market leader. (Chopra & Meindl 2013, 53-55)

2.1.5 Aggregate planning in supply chain

Every activity in Supply chain requires resources for successful completion. Procurement, production, warehousing, transportation, everything needs certain capacity which lead to costs, but the most important resource is time because lead-time cannot be zero, but on the other side it often takes a long period. This is the reason why companies must make a forecast a demand, determine the capacity levels of their production, outsource services they cannot do themselves and promote their product. Aggregate planning activity is related to making decision about production, planned level of capacity, inventory, stockouts and costs together with all members of supply chain. The aim of this planning is to maximize profit via creation of a plan which controls all the activities and finally satisfies demand. Aggregate planning includes seven mail indicators:

1. Production Rate. Number of units to be done per certain amount of time.
2. Workforce. Amount of employers or units of capacity needed for production.
3. Overtime. Amount of production, planning to be done during overtime period.
4. Machine Capacity Level. Number of machines used for production.
5. Subcontracting. Number of subcontractors needed for production, transportation, warehousing or other services.
6. Backlog. Demand that is not supposed to be utilized for the certain period of time but transferred to the future.
7. Inventory on Hand. Planned inventory distributed over different periods of production. (Chopra & Meindl 2013, 223-224)

2.2 Transportation in supply chain

Transportation is a connector between different stages of Supply Chain. It moves the product and has direct influence on efficiency and responsiveness. Faster transportation gives more responsiveness to Supply Chain and make it less efficient and more expensive. Type of transportation also has a huge impact on the on the Supply chain. Location of the components of Supply chain depends on which type of transportation use. Good example is company Dell. They transport some

components from Asia by plane. It reduces efficiency, since it is way more expensive, than transportation by ship. However, responsiveness is higher. Since there are different situations and locations within all companies in the world, transportation gives opportunity to make a balance between efficiency and responsiveness. Value of the product and lead-time is different and therefore decision-making procedure, in terms of what option is better for each company individually, should be made differently. Decision-making is very important factor. Moreover, for choosing the most suitable way, company should pay attention to following components:

1. Design of transportation network. It is a complex of everything what belongs to the transportation within the company (transportation modes, locations, routes, etc.)
2. Choice of transportation mode. Depends on the size, weight, importance, and other circumstances that has an effect on which way of transportation to choose. It can be air, rail, road or even sea.
3. Overall trade-off. The balance is in the middle of efficiency (cost) and responsiveness (speed of transportation goods).
4. Transportation related metrics. List of subsidiary facts, which play important role in making a decision:

- Average inbound transportation cost
- Average incoming shipment size
- Average inbound transportation cost per shipment
- Average outbound transportation cost
- Average outbound shipment size
- Average outbound transportation cost per shipment
- Fraction transported by mode

(Chopra & Meindl 2013, 61-62)

2.2.1 Transportation role in the supply chain

Transportation has an important role in performance of the company. It is impossible for most of the companies to produce and utilize goods in the same place. That's why shipments compose of significant amount of money from the total cost. Companies spend more and more money every year on transportation. For example, company BTS (Bureau of Transportation Statistics) claims that amount of money spends on transportation in United States of America increased from $822 billion in 1990 to $2.2 trillion in 2004. In Supply Chain duties related to transportation are distributed. A decision about transportation equipment and infrastructure is responsibility of Carrier. He chooses type of transportation (train, truck, plane, etc.). It should be done in a way to achieve the biggest profit. The idea is to decrease costs, shipper spend on information, inventory, transportation, facility and sourcing and provide worthy quality of service. Transportation infrastructure substantially is the duty of the government. They are responsible for constructing and design of the roads, ports, airports, waterways, etc. These constructions also need maintenance and service in a future. That's why while building transportation infrastructure it is important to consider that in future it will require additional cost for maintenance. (Chopra & Meindl 2013, 409-410)

2.2.2 Transportation modes

Choosing of transportation mode depends on many aspects such as operating decisions, investments in equipment, available infrastructure and transportation policies.
Supply chain consists of several transportation modes:

1. Air. Air transportation requires specific conditions to the cargo such as weight, size, volume, etc. In these dimensions aircrafts are limited. Moreover price to transport goods by air is the highest. The most appropriate cargo tor the plane is usually small, high-value and lightweight item for a long-distance delivery. Important to consider following aspects: location; number of items needed to be

transported; maintenance schedule of the plane; crew schedule; cost-management, etc.

2. Package carrier. This type of transportation mode represents services of delivery such as FedEx, UPS, etc. Such companies deliver mostly lightweight items, such as letters and small parcels. They use aircrafts, trucks, cars, and trains for delivery. This service is intended to transport goods for the short period of time. One more advantage is that most package carriers provide tracking system with their deliveries. Customer can check online location of his item. More deliveries carrier receives in the same geographical position, which results in higher efficiency and less cost.

3. Truck. Delivery by truck is more expensive than by train. However, it has its own advantages. First of all, it does not require transportation between pickup and delivery. That's why it takes less time and provides door-to-door warehouse shipments.

4. Rail. Suitable for heavy and massive items. The main disadvantage is the time of delivery. However, in other cases it is the best solution to carry high-density items over long distances. The main reason, why it always takes a long time to transport goods does not consist of long travel time only. Usually, the problems of train delays arise because of not so qualified staff and vehicle scheduling, delays of tracks and terminals, long time of transitions. Better scheduling can improve situation.

5. Water. The most suitable for large items with low cost. However, since there are queues in ports and terminals, there are a lot of delays. The slowest way of transportation. Despite this fact, water transportation is popular with all varieties of goods.

6. Pipeline. Used mostly for transportation natural gas, petroleum and refined petroleum products. Using pipeline is profitably only when it concerns huge

amount deliveries. In other cases, it does not bring any value. For example, petroleum for gasoline station cheaper to transport with normal truck.

7. Intermodal. Intermodal transportation defines as several types of transportation combined together. For example the most popular type is a combination of truck and rail. It is becoming more and more popular. The reason of this growth is enlargement of using containers in transportation. It does not take a long time to transfer container from one mode of transport to another. It is one of the most popular ways of transportation in a worldwide logistics. Since it is not popular for example to have plants and points of sales in shipyards, port companies usually make a combination with trucks, rails and sea transportation. One of the most important part in intermodal transportation is to dock different modes in order to avoid delays and problems.
   (Chopra & Meindl 2013, 411-414)

2.3 Risk Management in Supply Chain

Since it is impossible to predict future and even the best forecast would not give exact view about what will happen, majority of supply chain people concerns risk as something very unpleasant. In supply chain risk can appear on any stage. Natural disaster is a good example. However, in practice this type of risks is not so often. Mostly all of the risks are minor and do not bring destructive effect. Such as traffic jams on the road, which delay arrival time of the truck for one hour. However, there are risks, which can destroy all the supply chain flow from the initial supplier to final customer. Risks in SC divided on two groups:

1. Internal. Those, which appear in usual circumstances inside the company. For example, late delivery, humans mistake, problems with information flow, financial risks, etc.
2. External. Weather cataclysms, wars, terrorist attacks, rise of costs or inflation, unexpected problems with customers or suppliers, etc.

It is possible for a company to survive without risk management. In this case company has to wait until it faces with a problem and than just solve it. Negative

side of this working mode, is that it takes a lot of time and problem is already existing when company starts to solve it, which results in high costs and lost opportunities.

Supply Chain Risk Management (SCRM) is includes all possible risks within Supply chain. When company acquires experience in logistics field it can create a strategic plan for themselves. This is the list of the general risks:

- Responsibility of internal, external companies and individuals in SCRM
- The objectives, which company wants to achieve
- Companies attitude concerning risks
- Relevance of the occurred risk situation to the corporate policy
- Resources, available to eliminate SCRM problem
- Methods, to eliminate SCRM problem
- Enough education to solve problem

Objectives of SCRM are to ensure that supply chain is stable from the initial supplier to the final customer. It also admits some risks, but able to prevent them immediately in order not to disturb Supply Chain processes. SCRM helps to eliminate a lot of problems and has a lot of benefits:

- Forecast of standard risks, which help to prevent them beforehand
- Possibility of balanced decisions
- Prevention of financial risk operations
- The most skilled people are responsible for eliminating risks
- Elimination goes smoothly
- Registration of problems which have already happened in case to avoid them in future

Altogether, SCRM consists of three main steps:

1. Identification of risks. Finding a problem in processes takes time and it can lead to a negative outcome for the company. Risk management helps to determine and prevent risk in time. Using forecasts to predict risks and background experience to struggle with risks helps to the manager to find correct solution.

2. Analyze the risks. Understanding why situation happened and how to manage it. Impact, which problem can entail after it occurs or probability of risk. Than manager is able to understand and forecast figures and decide which resources he will use to reduce risk.
3. Finding solution for risks. Exist three most popular way of risk reduction. First one is prevention. It reduces probability of risk. Second one is mitigation, which is based on consequences reduction. The third one is response. Waiting until problem happens and than solve the problem itself.

These steps could be seen on the following picture:

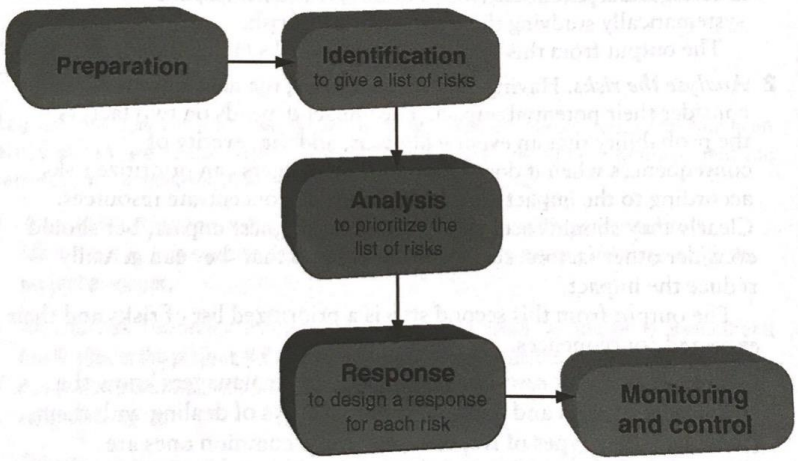

Figure 5. SCRM steps (Donald Waters, 2011, 1-9,75-95)

(Donald Waters, 2011, 1-9,75-95)

2.3.1 Defining Risks

Since we cannot predict the future, we are being persecuted by unexpected circumstances, which can cause problems. There are a huge variety of risks, which can happen to the company. To explain it better it is good to go through some examples of risks, which have already occurred in different companies. Since there was a strike of less than 100 workers on the west coast in the USA, some serious problems with incoming goods from Asia occured. Due to the queue formed around there, it took approximately 6 months to stabilize situation back to the normal operating conditions. One more example is related to 2010, when after the accident between containership MSC China and Bulk carrier Khalijia 3 approximately 200 containers have disappeared. The more often company faces with problems, more experience it acquires. Similar problems are becoming more obvious for them. This experience is useful to make decisions about ways of preventing risks. It also reduces time of thinking when something emergently occurs. However, it is important to remember, that risk management is always continuous process. (Donald Waters, 2011, 14-34)

2.3.2 Decision with risk

It is not always possible to forecast decision's outcome. Thus it is one of the most important points manager's work. Even the poorest solution can lead to the best result and conversely the best-structured and deliberate decision can cause huge problems for the company. That's why risk management does not always have to concentrate on eliminating the risk but should look through the problem and make decision about how not to aggravate the situation. Decisions consist of essential elements:

- A decision maker
- Objectives, decision maker wants to achieve
- Amount of alternative ways of solving problems
- The best alternative and outcome
- Effects of decision
- Negative effects

While making decision, manager (decision maker) should consider, that each way would bring different outcome. That's why manager should work through each process and try to forecast outcome of all decisions he could make. (Donald Waters, 2011, 18-30)

2.3.3 Types of risk

Supply chain risks include all types of risks, which can destroy or interrupt materials flow. Moreover it can happen during each stage of Supply Chain. As we know risks can be divided on two types: internal and external risks. However, there are different classifications, which can be applied for identification type of risks. For example, this classification is based on the organizational flows:

1. Physical risks. Good example is risk during transportation (late delivery), inventory (shortage of stock), material movements (damage of goods), etc.
2. Financial risks. All risky payments and other money/cash related risk. Problems with transactions, poor investments, etc.
3. Informational risks. Risks, which related to the information flow. Missing information, problems with communication within departments of the company or supplier and customers. Also includes situations when database is out-of-date, erroneous, not licensed, etc.
4. Organizational risks. Risks, which consists of human factor. It describes the relationships between suppliers and customers, colleagues from one company, different departments, alliances, etc. The reason could be problems in communication, misunderstanding, loss of customers, etc.

In 1999 Merna and Smith suggested their categorization, which divides risks types in more details. List of their classification consists of 21 categories: Strategic, Natural, Political, Economic, Physical, Supply, Market, Transport, Products, Operations, Financial, Information, Organization, Management, Planning, Human, Technical, Criminal, Safety, Environment, Local permits. List shows how huge variety of risks can be. Moreover, even the most experienced manager cannot predict all of them. (Donald Waters, 2011, 99-103)

2.3.4 Identification of risk

Since it is complicated to identify all risks, identification of risks means to spot the most significant and popular option and try to eliminate it. List of these risks plays important role and can help to prevent obvious and direct problems. That's why it is important for the company to have people, who has an experience and know all processes from inside. To identify risks, there exists general procedure:

1. Defining Supply Chain process. Understanding the whole Supply chain process and examine it.
2. Divide them on several parts. Each part should include related operations.
3. Clarify details of each operation.
4. Identify risks within each operation.
5. Characterize the most important risks and register.
   (Donald Waters, 2011, 108-110)

2.4 Managing Risk

Since all risks are different there is a huge variety of possible solutions how to manage it. Risks divided on three categories of difficulty, where category A stands with the high probability and high consequences level, category B stands with the middle probability and middle consequences level and category C stands with low

probability and low consequences level. Task of risk managing is to find the most suitable solution to avoid risks in Supply Chain.
Second step in risk management would be an implementation of this solution. In order to minimize the effect of the risk the whole supply chain has continuously and efficiently work towards implementation of this solution, otherwise, some parts of the risk may still be valid for supply chain. At the same time, the solution of risk elimination should be legal and do not cause any harm to environment. However, sometimes manager can make a decision not to respond about the problem either because it is costly for the company or because managing would not help. Instead of managing risk manager can do the following:

- Ignore or admit the risk. From one point of view it is the easiest way. It literally means just to seat and do nothing. However, for using this strategy manager must be sure, that outcome of this risk would be scanty. That means if the company is ready to accept this risk, than this way of defining risk is appropriate. One more good reason to ignore risk is high expense for solution. For example, there is a small shop in the city center. It has a stable profit and work in a normal way. Than in a certain period of time a new mall out of the city is built. Profit of shop in the city center decreases because most of city citizens prefer to go to the new mall. Moreover, in this case it would be very expensive to move shop in this mall, that's why owner of the shop adopt to stay in city center and continue work with less profit than it used to be.
- Adapt to the risk. This solution is popular with risks, which appear according circumstances. For example, fall of demand changes the situation on the market and decrease the profit of the company. In this situation, where it is impossible to change environment, there is a way to change politics to respond to new changes. Since environment is sensitive to these changes, that plans must be activated immediately.
- Reduce the probability of risk. Could be implemented in situations, where exists a huge possibility of risk, which can be avoided. For example, while transporting cargo within sea transportation, ship could be attacked by pirates. Such situation can lead to lose of goods or even robbery on the ship. To avoid such situation

manager should check before which part of the sea or the ocean is the most risky and plan the route of the ship in a way to reduce possibility meet danger.

- Limit or reduce the consequences. This way does not reduce probability of risk. However, it reduces consequences, what is also important for the company situation. For example seat belts in a truck. They cannot reduce probability of risk. However, if accident happens, they will reduce consequences. Of cause manager would try to eliminate both probability and consequences. However, sometimes situations do not allow solving both.
- Move to another environment. The most extreme way of reducing risk. When it seems to be that there are no chances to reduce risk in the field company operates and works, there is a possibility to change the environment and start to operate using new different strategy. For example, manager of ICI in 1990s calculated that producing chemicals is not profitable anymore for their company and made a decision to become a provider of specialized goods. Sometimes it happens that manager identifies that staying in environment is risky, however he does not change anything because simply does not know where to move.
- Oppose a change. It happens when government or politics decide to change the law of make something, what destroys economic situation in a company. In this case, manager does not have any other options. He has to oppose the change in case to keep company in a profitable condition.
- Make contingency plans. When manager not 100% sure that something can happen, he prepares plan how to fix the problem if it happens.
- Transfer, share or deflect risk. When manager understand that company is not able to manage problem he is willing to share solving this problem with suppliers or other intermediaries of Supply Chain.
  (Donald Waters, 2011, 150-159)

2.4.1 Implementation of risk management

Implementation of risk management consists of three stages.
During first stage managers define all possible ideas. They look through the background of the company and check if something similar happened with the company, share ideas and make a list of all possibilities how to solve problem with

the minimum expenses and maximum profit. Next step is examination of all these varieties and supporting them with theories and facts. Last step is choosing the most suitable solution and implementing it. For this decision manager should have formal procedure. It should include quantitative analyzes. However, in real life it is enough to put emphasis on opinion and management judgment. In this case there are a lot of tools, which help to indicate which solution is the best.

2.4.1.1 Solution Decision tree

One and good example of solution could be systematic analysis or decision trees. One and the most common method of choosing the best way of reducing risk would

be “Decisions Tree”. On the picture there is an example of such tree:

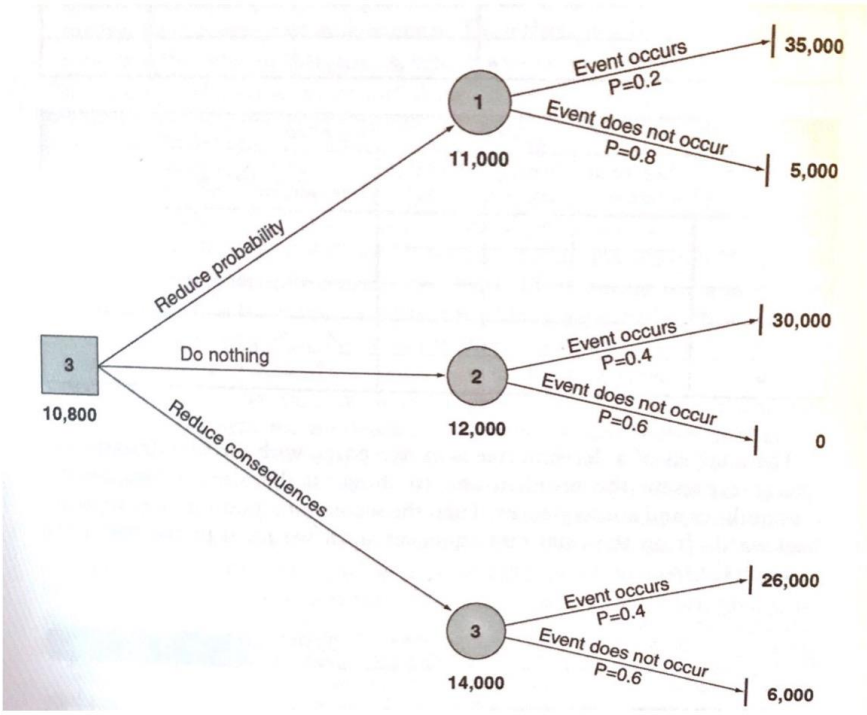

Figure 6 Decision tree (Donald Waters, 2011, 173)

The picture represents the tree, where head of it is the risk and branches are possible solutions in details (cost, priority, value, etc.).

Implementation consists of two stages. First stage is implementation within all measures, policies, everything to prepare the company to struggle with risk. For this managers use theory, draw decision tree, calculate profits and losses, etc. Second stage is activation.

It indicates during which stage the biggest risk exists and if there are such risks, evaluate it and look for possible ways to eliminate it.

One more tool, which helps to find solution, is the systematic analysis. It helps to understand what goes wrong; how significant risk is; the best deal for solving risk. Systematic analyze represents the table. It includes main data about company during certain period of time.

However, the most common ways to solve the problems within the managers is to ignore it; adapt to the problem; concentrate on reduction of not risk, but consequences; transfer the problem to different environment and avoid responsibility of taking the consequences. (Donald Waters, 2011, 169-177)

2.4.1.2 Solution Ishikawa diagram

One more example of solving problem is implementing of "Fishbone diagram". On the following picture the structure of that diagram:

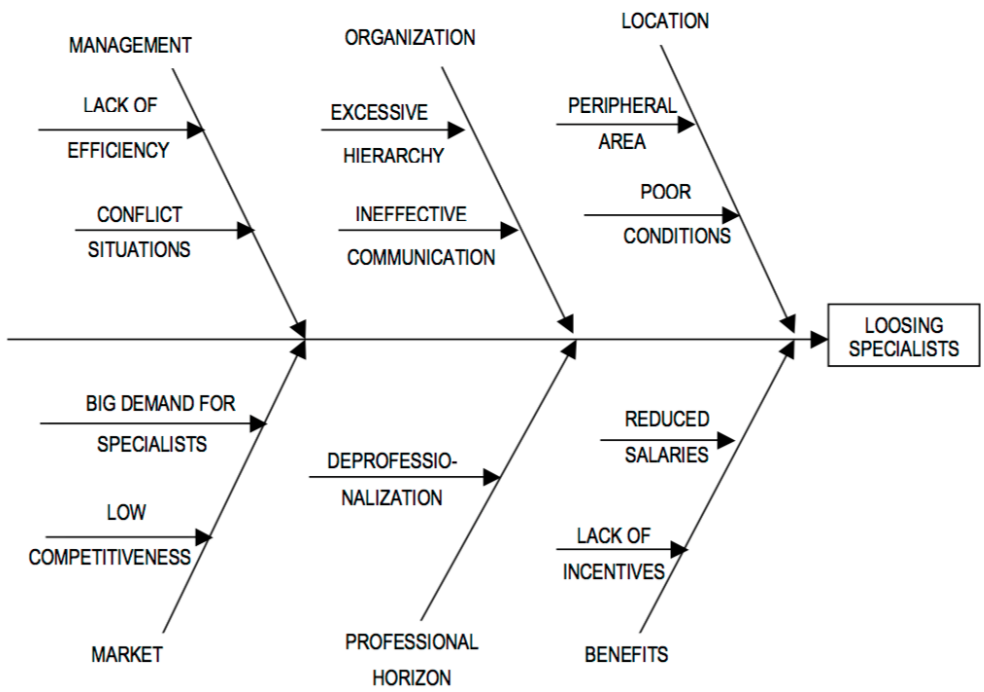

Figure 7. Fishbone diagram 1 (Ilie G. and. Ciocoiu C.N., 2010, 4)

This Fishbone (Ishikawa) diagram consists of six main components and eleven secondary components, which are characterized as potential causes of risks. Main causes (could be seen at the edges of the diagram) are: location, organization, management, market, professional horizon and benefit. Sub causes (which are in the middle of the picture) exist as indicators of risk. Diagram is made the way that the most important problems are in the beginning (management and market). The same idea with the sub causes. The causes on the left side are more important and more probable to happen, while on the right side of the picture less popular. While choosing the name and place for both main and sub causes, everything has to be made according relevance to the main problem. Causes codification is created to simplify Fishbone diagram system for better understanding. It is based on the following principles:

- The side, to which risk belongs (left or right)
- The cause. It could be external or internal.
- Chronology of causes.
- Group composition. To male diagram more understandable and interlinked.
- Possibility of changing causes. Sometimes, opinion before and during analyzes can be different. In this case, codification can be changed. It is possible to do only once and for this operation, should be used a table. Its main option to remind manager that codification has been changed. Example of the table on the following picture:

Current Issue	CAUSE	SUB-CAUSE	INITIAL CODE	FINAL CODE	Initial current issue
3 3.1	Professional horizont	Deprofessionalization	S_3 S_{31}	D_2 D_{21}	5 5.1

Figure 8. Changing causes table (Ilie G. and. Ciocoiu C.N., 2010, 4)

It illustrates changes causes and assigns new code.

Ishikawa diagram is the most suitable for situations, where multiple causes of the problem exist. In this case, fishbone diagram allows making a prioritizing of the risks to prepare the rating from the most important problems to insignificant.

However, Fishbone diagram does not imply that there are instruments how to solve risk with this diagram. This method is recommended for initial or comparative analyses. Exists lot of varieties of Fishbone diagram. The following diagram is the most common in logistics:

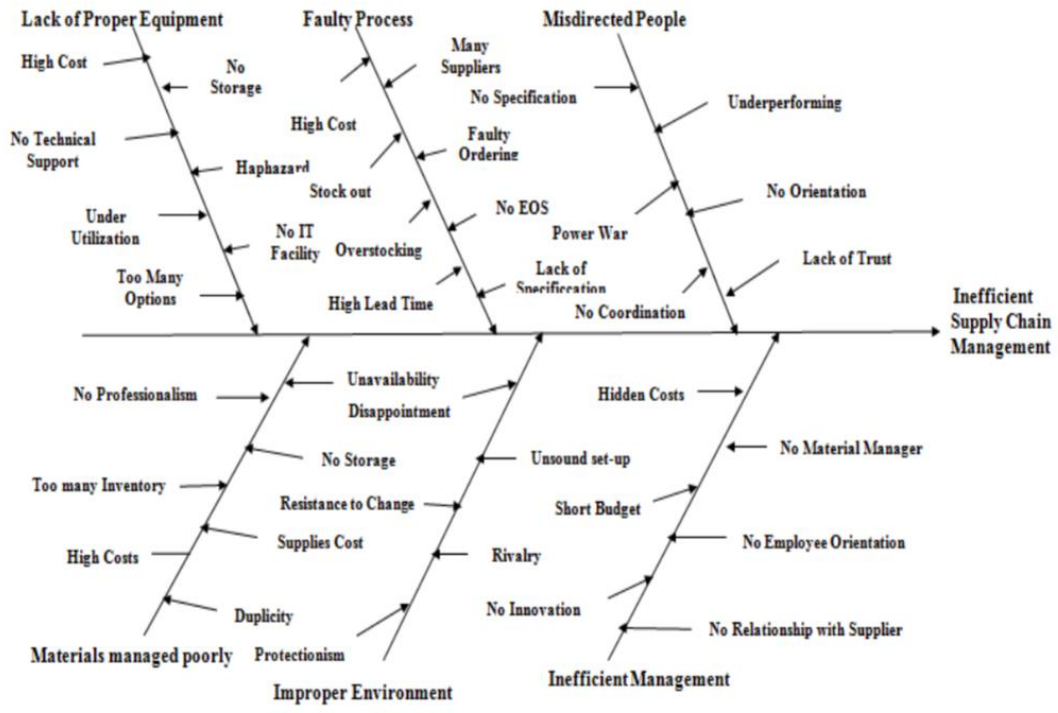

Figure 9. Fishbone Diagram 2 (Ilie G. and. Ciocoiu C.N., 2010, 6)

This diagram is divided on six main components, as the previous one. First is Lack of proper equipment. Everything, what shows low quality of equipment and its maintenance belongs to this component description. Faulty process. All problems that can be met during transportation process. Misdirected people describe problems with employees. Materials managed poorly describe problems with material flow. For example, raw material cost, problems with stock, lack of enough space in warehouse for materials, etc. Improper environment describes circumstances around transportation, which can cause problems to the supply chain. The last problem in this list is inefficient management. It demonstrates risks, which occurs because of incorrect, low quality or sometimes lack of management.

(Ilie G. and. Ciocoiu C.N., 2010, 4-6)

3. The implementation of study

3.1 Research methods.

Research is a process, which consists of collecting data, and making analyses. Idea of this is to answer the research questions. As I mentioned in 1.3 (Research method) there are two main research methods qualitative and quantitative. However, good research should include both of them. Since these methods are different, it is important to include them both in the research. (Denscombe, 2003, 232-235)
The quantitative method allows transforming information in numbers and making statistical outputs out of it. While qualitative method tends to study one topic but deeper. Scientists are constantly arguing which method is more suitable and effective. Some of them consider that since quantitative method implies accurate analysis, it gives more adequate and reliable outcome. However, main idea of this method is to analyze several patterns - figures. From this point of view, qualitative analysis better describes problem and explains how it has happened because it studies the topic more thoroughly. This is also the reason why qualitative analysis brings less volume of information than quantitative. However, because qualitative analyzes are more individual, quantitative might be more informative and show problem from the different point of view, demonstrating connection to other topics and issues. One more difference of these methods is that qualitative method is normally done before the research begins. While qualitative method is usually done during the research. (Denscombe, 2003, 232-235)

There are several ways of how to collect research data:

- Observations
- Individual interviews
- Action research
- Literature

- Focus groups

In this research both methods are used. However, accent is done on the qualitative method. The methods to collect data are: interviews, literature. (Dahlberg & McCaig, 2010, 14-15)

3.2 Risk management plan used in research

To carry out research concerning existing risks in supply chain transportation sector successfully Risk Management plan should be implemented. It would step by step describe process of founding and preventing risk. In order to develop the basement of Risk management plan, special framework would be used:

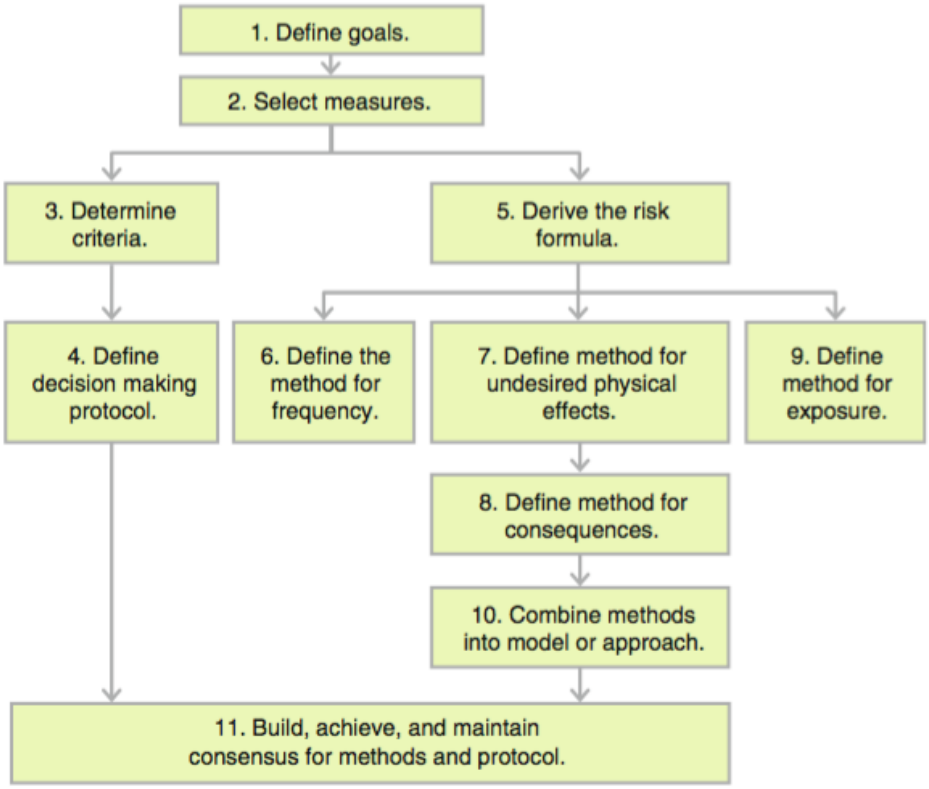

Figure 10. Framework (Bose 2012, 20)

1. Define goals. This step allows to understand the purpose of risk management. It gives clear understanding why company should implement risk management. It

is important, because, without knowing concrete aim, it would be complicated to implement risk management. To do this, research should be done.

2. Select measures. This step explains how to measure the risk. Depending on the answer, Risk manager choose either determine criteria or derive the risk formula. It needs to choose the right way of solving current problem and create clear instructions on how to measure the risk.
3. Determine criteria. This step tells about what I measure. For example, on time delivery performed by the transportation. The percent of damaged cargo or cost of transportation.
4. Define decision making protocol. Understand, how the decisions about risk would be done. What rules it should follow and etc.
5. Derive the risk formula. If it is possible, do the computational method, which could be used to assess the risk.
6. Define the method for frequency. It determines how often risks occurs. If risk happens more than once, it means that problem is not solved, and it needs more global research and attempt to avoid it. Reducing frequency reduces costs and time. For example, driving truck through the bad quality road spoils wheels. If Risk manager, would not make a decision to change the route, problem would repeat several times. In this situation Risk manager should take into account all facts, concerning driving this road: When government plans to repair the road; is it critical risk for the transportation; If this is going to happen with the car again and again, would it be less expensive than driving through the different road, etc.
7. Define method for undesired physical effects. This frame describes how important for risk manager must be involved in all processes. It helps to learn everything from inside. For example, if there is a risk, of late delivery, without any obvious reason, there exists an option to ask about the reason a truck driver or to learn from statistics.
8. Define method for consequences. Which way of managing risk to choose, if it occurs. There are several ways of managing risk. However, not all of them are usually suitable. That's why manager needs to find the most appropriate way to solve the problem with the most pleasurable consequences.
9. Define method for exposure. This frame describes how to deal with unexpected risks or with risks that already happened. Of course, there are risks, which are

impossible to predict. For example, traffic jam. It can happen because of the accident on the road or police control. Moreover, something can happen with environment, which can lead to the difficulties on the road. In this case manager should make a decision how to manage this problem and react to urgent case with the lowest expenses. Changing routes, using more available transportation options, do some insurances etc. Sometimes it can be even better to change the transportation mode from the truck to something else.

10. Combine methods into model or approach. That means combination of all previous steps in one approach, which will deal with any risk the company is facing.
11. Build, achieve, and maintain consequences for methods and protocol. This means to implement the risk model in practice and eliminate risks. (Bose 2012, 20)

3.3 Analysis of risks with Ishikawa diagram

The following diagram is a risk model of PSA. It has not typical structure and consists of the most vulnerable components in a research company environment:

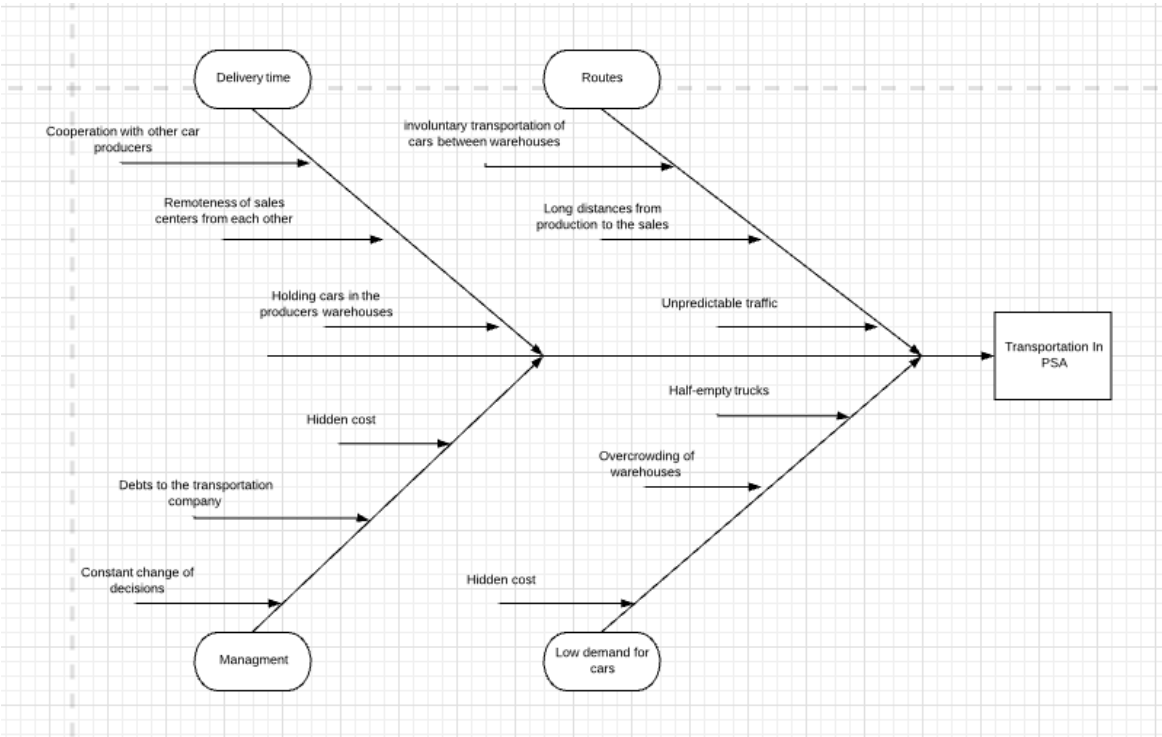

Figure 11. Ishakawa diagram for PSA

This diagram consists of the most important transportation risks in PSA. First one is Delivery time. Cars are often late. It takes time while customer receives his purchase from sales manager. It happens because of three main reasons:

- Cooperation with other car producers. PSA has sales centers all around the Russia. However, demand is not so high, to fill full truck only with cars of the PSA. That's why Transportation Company shares the transportation truck with other car producers. However, sales points almost always located in different regions or different cities. Such transportation takes more time, than direct one.
- Remoteness of sales centers from each other. Even if the truck is full of PSA cars, distance form cities and regions in Russia is huge. It means, that delivery can take a lot of time. For example, one plant is located in Kaluga, which is 200 km far from Moscow. It is not a problem, to transport cars to the capital of the country, where located the biggest amount of sales centers. However, it is way more complicated to transport car to Vladivostok, which is more than 8000 km from Kaluga or to Kaliningrad, the region, which is located in the middle of Europe.
- Holding cars in the warehouse of manufacturer. PSA has 4 main warehouses. Two of them are in the central part of Russia (one in Moscow and one in Kaluga) and two in ports (on the north and on the south of Russia). A transportation of cars from these places to the east part of Russia takes a long time.

Second transportation risk relates to the routes. As in previous risk main problem directly linked to the distances between cities and size of the country. However, let's analyze this problem deeper:

- Involuntary transportation cars between warehouses. It happens, because of different conditions and prices in various warehouses. PSA does not have its own parking for produced cars. Moreover, they rent each parking slot of the warehouse where cars are stored. Obvious, that in different regions of the country parking prices have different price. And to avoid overpayments, PSA forced to moves cars from more expensive parking zones to the cheapest. Since, the most expensive parking zone located in

ports, company can't simply stop using expensive parking areas. That's why they have to always distribute cars between warehouses, while forecasting demand.

- Long distance from production points to the sales. For example, there is a Sales center in Vladivostok, which is at the east of Russia. While production is located in Kaluga, which belongs to the European part of the country. The shortest route from these two points is 9200 km.
- Unpredictable traffic. The most common reason of late deliveries by truck all around the world. Roads oversaturated with cars. Moreover, it is impossible to predict traffic jams, caused by accidents or road works. One more reason of traffic jam can be weather condition. Russia is located on the north of the world and such cataclysms as buzzard, snowfall are popular at least half of the year and in some regions it is even more often. These problems bring difficulties for the truck movements.

Talking about management, heads of different departments always have to make decisions. It is impossible to predict everything and always choose only 100% profitable and right solutions. Sometimes such solutions does not even exist. Three following risks explain this:

- Hidden cost. The most common way to transport cars within the country is by truck. Because on the way of transportation there is a high risk to damage the car, transportation company faces such problem. That's why manager has to make a decision about insurance of the car during transportation. Moreover, if such problem occurs and for example because of stones on the road or something else and the car is destroyed, value of the car decreases and there comes extra costs, such as repainting or repair. These type accidents also take time and this brings negative impact to the sales centers and dissatisfy end customers.
- Debts to the transportation company. This is not often problem in PSA, however it is always necessary to distribute budget in a right way. For transferring money PSA uses PSA Bank.
- Constant change of decisions. Circumstances, which dictate new priorities directly influence on decision-making. Situation in the

world, demand for cars, extra costs, everything is important and has to be considered. It is important to predict everything beforehand and sometimes it is difficult to act according to first plan. That's why strategy always has to be able to adapt to the new environment.

In my opinion, the most important problem inside of the company, which makes influence on the PSA development, is demand for cars. Unfortunately, because of the world situation and changes in currency market, PSA has lost significant part of the customers. This is how low demand of the cars influence the transportation:

- Half-empty trucks. Sometimes, when Transportation Company can't put the mix of cars from different brands in one truck, they are forced to make transportation with limited amount of cars on board. This brings difficulties, increases costs and reduces profitability.
- Overcrowding of warehouses. It is obvious, that low demand influences the sales. Moreover, the cars which are not sold are stored in warehouse for long time. Parking area for cars stocking in PSA is not for free, because the warehouses are not owned by the company. This increases stock costs and decrease the amount of empty parking slots in the parking zone.
- Hidden Cost. In case of low demand, benefits from transportation decreases. To keep being competitive, PSA has to reduce sales price. Moreover, because Transportation Company does not belong to PSA, it is not possible to reduce transportation cost. Especially, taking in account fact that because of low demand PSA not always fulfills trucks completely.

3.4 Ideas for improvement

To improve situation in PSA transportation, risks must be evaluated. Any improvements of risks can directly influence on solving problems. That's why the reason to analyze all risks has to be taken carefully and learned these problems from different points of view.

Cooperation with other car producers. There are several car producers, who also have production lines in Kaluga. If it is impossible to refuse the PSA transportation cars with other brands, company can negotiate to combine shipping with car brands, which production is also located in Kaluga and have approximately the same final destination.

Remoteness of sales centers from each other. In my opinion, the best solution would be to make a research of the most popular cars, prepare a statistical analysis of sales in each region and make a delivery well in advance to keep cars in stock of the sales place.

Holding cars in the producer's warehouse. In my opinion, the best solution for this would be the same as in previous problem. Statistics would help to understand which cars are the most popular in each region and plan distribution well in advance to keep cars in sales points, but not in stock which is far away. This idea would need changes in roles and responsibilities between PSA and official sellers of cars.

Involuntary transportation of cars between warehouses. Since the most expensive warehouses are in the ports of Russia, the best idea would be to keep there only those cars, which are planning to sell in the same region or ready for ship transportation in immediate days.

Long distance from production to the sales. Since, it is impossible for PSA to change the size of the country or the length of the roads, the most appropriate way would be changing mode of transport. In Russia good option could be Trans-Siberian Magistral. This is a railway from Moscow to Vladivostok. It is cheaper, than transporting by truck. Moreover, there is an option to transport cars with a sea. However, the problem in ship transportation is time.

Unpredictable traffic. The same as in previous problem, the best solution is to have an opportunity to choose mode of transport from different alternatives. In

my opinion, for the most of transportation destinations in Russia, where endpoint is more than 1000 km from starting point the best mode of transport is train.

Hidden costs. The best way to avoid overpayments for cars damage during transportation is using protective film. Moreover, it does not mean that insurance has to be declined. Combination of both helps to save money in increase the safety moment of delivery.

Debts to the transportation company. In my opinion, PSA should agree on new terms of partnership with Transportation Company. They should prepare an agreement, which would postpone payment from the transportation date.

Constant change of decisions. This is caused because of unstable position on market. When problems with constant income would be solved and company would be more stable, this problem would disappear.

Half-empty trucks. In my opinion changing mode of transport can solve this problem. With train it would be cheaper to deliver cars. One more obvious solution is increasing sales by changing politics of the company. Moreover, when an economic crisis will come to an end and price of cars would come back to the normal, demand for cars would increase.

Overcrowding of warehouses. Solution for this problem is decreasing the amount of cars, company produce to keep in stock and therefore company has to rearrange the manufacturing strategy.

Hidden costs in low demand of cars. In my opinion, the best way would be changing the type of main product. Company should concentrate on production of commercial cars. They have a highest demand nowadays, because of their popularity in the country.

4. Results of study

In my opinion, all suggested ideas for improvement are valuable.

Changing situation in co-operation with other car producers would decrease costs, company spend on transportation. It would be cheaper to transport cars to sales points from one city, than to collect cars from different locations and then try to organize unloading to different sales dealers.

Idea to keep less car in stock, but to make a research concerning the amount of sales in different regions, would reduce problem with delivery time and increase customer service level. Moreover, it would decrease payments the producer pays for each parking slot in warehouse.

Moving cars from ports' warehouses to central warehouse is valuable and would help to avoid extra costs.

Changing transportation mode is a valuable idea. However, it needs deeper research to check all railway connections between different cities.

Next solution to stabilize income, it makes sense and can bring the maximum risks reduction. Also, it would improve situation between Transportation Company and PSA and would help to get rid of debts and utilize money on solving other problems.

Reducing number of produced cars or concentrate on producing different type of cars is valuable. However, increasing amount of sales would change situation more significant.

5. Discussion

This research consisted of ideas how to improve Supply Chain in PSA Russia by solving risks and implementing new ideas in transportation. In my opinion, even partly elimination of problems would change situation and even will improve current one. Company PSA has huge chances to become a leader among the car producers in Russia. This leadership needs time, however it is possible to achieve by improving key factors of company performance.

The solutions, which were developed and proposed have practical value and could improve the operations of PSA on the Russian market. However, since availability to use all information related to operations in PSA is limited, it is difficult to propose something more accurate and more effective. If take into account future development and improvements, the best suggestion for it would be study the operations of PSA in Russia better, with better availability of information and redesign current proposed solutions based on updated info.

6. Conclusion

Despite the fact, that I am not able to implement this research in real life and try by myself reduce all risks, It was important experience in my studies, which gave me understanding how to face with different problems and look for solutions from each point of view.

References

Dr. Lawei Lu 2011, Fundamentals of Supply Chain Management Ventus Publishing ApS.

S. Chopra, P. Meindl 2013. Supply Chain Management: Strategy, Planning and Operation. Pearson Education.

D. Waters 2011. Supply Chain Risk Management: Vulnerability and Resilience in Logistics. Kogan Page; 2 edition.

G. Ilie C.N. Ciocoiu 2010. Application of Fishbone Diagram to determine the risk of an event with multiple causes. Academy of Economic Studies, Bucharest, Romania.

Denscombe, M 2003. The good research guides. Maidenhead, Open University.

L. Dahlberg, C. McCaig 2010. Practical Research and Evaluation. SAGE Publications.

Bose T.K. 2012. Application of Fishbone Analysis for Evaluating Supply Chain and Business Process. International Journal Of Managing Value and Supply Chains.

Shtanov V. 2017. The PCA Factoty in Kaluga has stopped the production of cars for three weeks. (Завод ПСМА рус в Калуге на три недели приостановил выпуск автомобилей). Newspaper Vedomosti.