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RISKS ELIMINATION WHILE CONSIGNMENT STOCK CONCEPT IMPLEMENTATION

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In Pardubice 27. 3. 2019

Petra Vrbová

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ANOTACE

Tato práce pojednává o konceptu konsignačního skladu, jeho implementaci a jeho dalším využití. Hlavním cílem disertační práce je navrhnout opatření pro eliminaci rizik v rámci implementace konceptu konsignačního skladu. Disertační práce komplexně posuzuje tento koncept na základě praktického využití, které je zkoumáno na vzorku výrobních společností v České republice. V práci jsou identifikována rizika implementace a dalšího využití konsignačního skladu. Práce také prezentuje názor společností, které konsignační sklad implementovali, na tento koncept, jeho nevýhody a případná rizika, která v implementaci shledávají. Také je blíže analyzován podíl objemu konsignačního materiálu z pohledu mezinárodního obchodu České republiky.

KLÍČOVÁ SLOVA

Dodavatelský řetězec, řízení zásob, konsignační sklad, řízení rizik

ANNOTATION

This thesis deals with the Consignment stock policy, its implementation and further utilization. The main goal of the dissertation is to propose risks´ elimination measures applicable to the CS implementation. Furthermore, the dissertation deals with comprehensively assess and the Consignment stock policy in relation to the Czech Republic (sampled on Czech companies). The dissertation mainly explores and identifies possible risks related to the Consignment stock implementation and deals with the share of consigned inventory in the international trade. In addition, detailed opinion on Consignment stock utilization is provided based on opinions of Czech companies who implemented this concept.

Keywords

Supply Chain Management, Inventory Management, Consignment Stock, Consignment Inventory, Risk management

TITLE

Risks Elimination while Consignment Stock Concept Implementation

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List of Abbreviations

BS	Buffer Stock
CS	Consignment Stock
CI	Consignment Inventory
CR	Czech Republic
CZK	Czech Crown
FIG	Figure
GSC	Global Supply Chain
IM	Inventory Management
JIT	Just in Time
KG	Kilogram
NR	Number
RM	Risk Management
TAB	Table
SC	Supply Chain
SCMR	Supply Chain Management Risks
SCR	Supply Chain Risks
VMI	Vendor Managed Inventory

Introduction

Today´s extremely competitive business environment forces companies to manage their inventories as low as possible, deliver and manufacture with as low costs as possible and also keep their own production running without any major problems within the whole supply chain. Absolutely essential aspect of an effective inventory management, is placing the right amount of safety stock to the right places (to a supplier, consignment stock, safety stock) in the supply chain to secure the lowest possible costs. Therefore, managing inventory is one of the most challenging tasks the supply chain managers are facing.

Decisions related to inventory locations and their corresponding levels throughout the supply chain have a fundamental impact on the service level, response time, delivery lead-time and the total cost of the supply chain. As manufacturers and components suppliers developed a trustful, interdependent, and symbiotic relationship through long-term cooperation, a special commercial purchase model and consignment trade became widely adopted in recent years (Wang, 2017). In general, globalization led to a rapid rise in the latter, as focal firms seek to secure competitive advantage by employing competent, low-cost suppliers located around the world (Gereffi, Lee, 2014; Koberg, Longoni, 2019).

Universally speaking the inventory management has an essential role in this turbulent and highly competitive international environment. Therefore, costs cutting and additional costs avoiding measures reducing capital in inventory brings inventory managers to implement various arrangements in order to avoid high value and amount of stock on one hand. On the other, this makes the availability of material for production the highest priority. In addition, buyers can easily choose from several vendors who can deliver the same product of a same quality for a comparable price. In such case the most important point is the level of logistics service provided. To sum these points – it is important to pay attention to the inventory management, focus on researches related to this subject and also publish any new findings on that.

Problem statement

There is a plethora of research, studies, analyses, and formulas dealing with Consignment stock (CS), although mainly from theoretical point of view. By the way of contrast, there is little that is known about the real usage - in terms of a practical adoption. There is also little known about the process of CS implementation and possible criticalities related to this process. Unfortunately, when these criticalities, are not discussed and prevented in advance, they may have serious consequences for both parties (consignee and consignor).

Consignment stocking means that closer relationship and important mutual dependency among the vendor and buyer, improves the complete relationship towards vendor and the buyer sticks to him/her. As already mentioned above, this is an extremely competitive business environment. On one hand, when deciding about the suitable vendor, a buyer can easily choose from a large number of potentials, usually even international, vendors. On the other hand, supply chain managers are forced to implement an arrangement to avoid high amount and value of the stock. Therefore, a CS is considered useful for short-term assets management requiring established and solid cooperation and partnership between both parties to the transaction. Due to the fact that for successful CS implementation, it is crucial to set up a very strong cooperation and strengthen the relationship between both parties. CS implementation includes several crucial decisions that have to be made and there are many issues, that might appear during its implementation. These issues when not taken care of in advance might lead to dramatic consequences, since there is only little practical knowledge and experience with the implementation of CS.

The motivation for the dissertation comes from the popularity of the Consignment stock policy usage and risks related to the Consignment stock implementation. During author´s observation of its implementation and solving issues related to consequences of it in a particular company, there was found out that (in that particular case of an observed company) there is not enough awareness about possible risks that might appear and crucially influence both sites – buyer and vendor. Therefore, this thesis deals with findings about CS and its popularity in the Czech Republic and presents risks elimination or minimization proposal applicable in companies in general.

1. Supply Chain Management

In the past decade there were plenty of authors dealing with Supply Chain Management (SCM) theories, studies and papers. Several various definitions help to understand SCM further in detail. In this environment, Supply Chain (SC) has become an effective business tool to reduce echelon inventory cost (Srinivas, 2017). SCM manages the flow of goods, materials, and information and the production of goods and services across a supply chain from the first suppliers to customers in a way that increases the profits of the members in the supply chain and subsequently that of the chain (Zahran, Jaber, 2017). In addition, Global Supply Chains (GSC) are supply chains that extend beyond a single country's boundaries (Caniato et al., 2013; Koberg, Longoni, 2019). In a traditional SC, products are sold under wholesale, an upstream entity (supplier) sells a product to a downstream party (retailer) who then satisfies the market demand. The retailer owns and controls the inventory and thus incurs the cost of stocking excess inventory to meet demand that exceeds expected demand and/or incurs stock-out costs when demand exceeds supply (De Matta, 2014).

1.1 Fundamentals of Supply Chain Management

The main characteristic of SCM is according to Singh and Verma (2018) a set of approaches utilize to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantity, to the right locations, and at the right time, in order to minimize system wide costs while satisfying service level requirements. Furthermore, Srinivas (2017) defines the supply chain as the process of planning, implementing, and controlling the activities as efficiently as possible. However, Khan, Jaber, Zanoni, Zavanella (2016) claim, that the pursuit of better coordination schemes is crucial for contemporary supply chains to survive in a highly competitive environment. Sarker (2014) explains that SCM deals with planning, design and control of an integrated system of organizations, people, activities, information, and resources involved in movement and transformation of raw materials through a series/network of suppliers and buyers in order to create products and services for customers.

According to Sarker (2014), the main point of supply chain activities is to transform natural resources, raw materials and components into a finished product that is delivered to the end customer(s). In the same context Srinivas (2017) particularizes from the manufacturing perspective that supply chain spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption. Furthermore, its main mission is to get the right materials to right place at right time under an optimized performance measure (e.g., operating cost, through put rate) satisfying a set of constraints (budget, space, time, technological limitations, etc.) (Sarker, 2014).

Effective supply chain management

An effective SCM requires simultaneous improvements in both customer service levels and the internal operating efficiencies of the companies in the supply chain as mentioned by Hugos (2018). It is also important to pay attention to transportation within effective SCM, since warehouses of the network have a limited capacity. Therefore, when the raw materials are delivered to the factories, they should be delivered to production lines or transferred to the distribution warehouses at the minimum possible time. Thus, any production and distribution company would receive a given product at a right time (Hajghasem, Shojaie, 2016). Customer service at its most basic level means consistently high order-fill rates, high on-time delivery rates, and a very low rate of products by customer for whatever reason. Consequently, internal efficiency of organizations in a SC means that these organizations get an attractive rate of return on their investment in inventory and other assets and they find ways to lower their operating and sales expenses (Hugos, 2018).

As mentioned by Khan, Jaber, Zanoni, Zavanella (2016), a SC may employ revenue sharing, information sharing and quantity discounts etc. in order to gain that viable edge. Hence, in any industrial environment or business organization, there is input and output of a different transformation or service activities, so the supply chain and logistics systems play an important role in running these integrated systems (Sarker, 2014). According to Hugos (2018), companies in any SC must make decision individually and collectively regarding their actions in five areas:

- Production (creation of master production schedules, workload balancing, quality control, and equipment maintenance);
- Inventory (how much inventory to store in warehouse paying attention to any possible devaluation of any material for example corrosion etc.);
- Location (in order to be   as cost-efficient in production and in storage of inventory as possible);
- Transportation (distance, frequency of deliveries, kind of transportation);
- Information (in order to make effective decisions about what to produce and how much, about where to locate inventory, and how to best transport it).

DeSmet (2018) considers SCM from a different point of view - he introduced so called the Supply Chain Triangle consisting of 3 points – service,cost and cash (Fig. 1 below). The triangle demonstrates the idea that from an organisation point of view, *we deliver different types of "service" to our customers, which comes at a certain "cost", and requires a certain amount of "inventory", or more generically "cash".*Therefore, according to DeSmet (2018) the SCM is primarily about balacing this triangle.
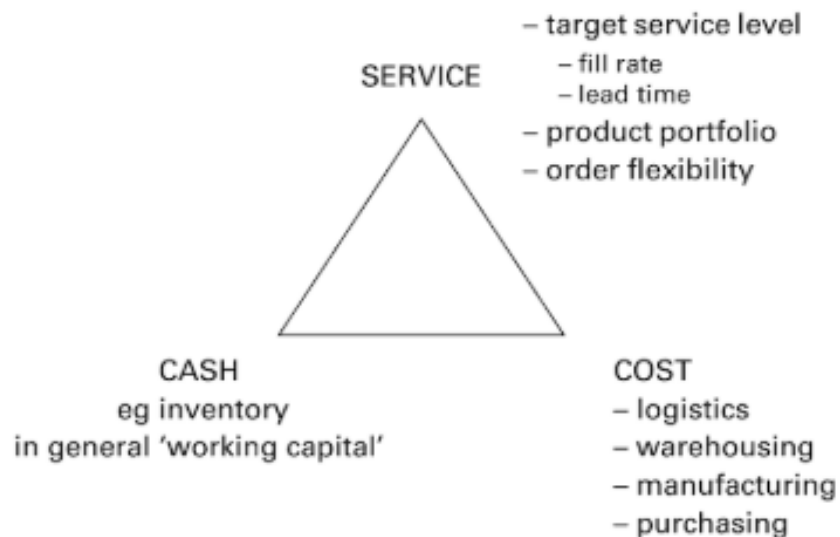
Figure 1: Supply Chain Triangle

Source: DeSmet, 2018

Delving deeper into the issue of an effective SCM, Kamath, Sauray (2016) argues that the key benefits of an efficient SCM for vendor and buyer are:

- facilitating the vendors to reduce inventory carrying cost on one hand, and increasing responsiveness to the orders of the customers on the other;
- helps to reduce the lead time and makes products accessible to the customers;
- it effectively aids in enhancing all business processes like data accuracy, supplier selection, purchasing, warehousing, distribution for the retailers etc.;
- may reduce transportation and operational costs;
- helps a retailer to maintain good relation with its partners by providing real time data removing discrepancies to creep into the SC;
- can enhance customer, if the quality is maintained throughout and could create a competitive advantage as well.

1.2 Inventory management

First of all, it is crucial to highlight, that inventories account for almost 50% of the total logistics costs of a SC according to (Zahran, Jaber, Zanoni, Zavanella, 2015). Equally, it is also important to highlight the role of inventory in SC. Basically it carries inventory in order to meet possible mismatch and uncertainties related to supply and demand. Therefore, IM techniques help to minimize (maximize) the total cost (profit) of a supply chain and enhance its performance (Zahran, Jaber, Zanoni, 2016).

Several authors definitions related to IM are based on their own knowledge and findings. Singh and Verma (2017) defines IM as part of the SCM that plans, implements and controls the efficient, effective, forward, and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer's requirements. In particular, inventory represents a significant portion of the costs of a SC, and managing it well primary depends on the success of a SCM program.

Many researchers have investigated different inventory situations, and developed policies and models or suggested methods to lower inventory costs, one of such is consignment stock. It reduces supply chain costs and eliminates out-of-stock situations by allowing the vendor to store its products at a buyer´s facility (Zahran, Jaber, 2017). Therefore, a very close attention has to be paid particularly to this crucial topic. A lot of research has been conducted in order to identify the factors that determine optimal level of inventory and inventory costs. Basically, an effective SCM can be obtained with an effective inventory management. Wild (2017) claims that there exist three main strategic reasons for IM:

1. to cover up the mismatch between supply and demand processes;
2. to minimize the risk of failure to supply;
3. to minimize the overall costs in the supply chain.

Wild (2017) explains that many activities depend upon having the correct level of stock, but the definition of the term "correct level" varies depending on who defines it. Stock control is definitely a balancing act between the conflicting requirements of the company, and the prime reason for the development of inventory management is to resolve this conflict in the best interest of the business. Therefore, managing inventories helps organizations to reduce costs, increase profits, and satisfy customers' demand. (Zahran, Jaber, Zanoni, Zavanella, 2015). The success of venture depends on its ability to provide services to customers or users and remain financially viable. For organization that supplies goods to its customers, the major activity is to have suitable products available at an acceptable price within a reasonable timescale (Wild, 2017). According to Felice, Falcone, Forcina, Petrillo, Silvestri (2014) an efficient and effective IM helps firm to maintain a competitive advantage, especially in a time of accelerating globalization. From this point of view several organizations employ the ABC analysis to have an efficient control over a large number of inventory items.

With regard to the IM in manufacturing companies, in general, manufacturing management tend to aim more for plant and labour efficiency. In addition, they allow high stocks in order to avoid the disruptions caused by shortages, breakdowns and changing customer demand. Nevertheless, lean supply has led the way to providing low inventory with low operating costs (Wild, 2017).

Inventory classification

There are various kinds and classifications of inventory. Felice, Falcone, Forcina, Petrillo, Silvestri (2014) still consider the ABC analysis, as the most widely adopted technique in industrial inventory classification applications. It divides items into 3 classes - A (very important), B (moderately) and C (least important), according to Pareto's principle or the 80/20 rule. According to ABC Analysis inventory items can be classified in A, B, or C categories based on so-called annual usage. Inventory items are arranged according to the descending order of their annual usage. Class A items are relatively small in number, but account for the greatest amount of annual dollar usage. In contrast, class C items are relatively large in number, but make up a rather small amount of annual dollar usage. Items between classes A and C are categorized as class B. Vrat (2014), determines the following types of inventories – raw materials (input to manufacturing system); bought-out-parts (used to assembly of products); work-in-progress; finished goods; maintenance, repair and operating supplies. Relph, Milner (2015) categorizes inventory into following groups that are possible to hold within an organization such as finished goods, components, semi-finished products, raw material or feed-stock on the shop floor.

Pillars of inventory management

Relph, Milner (2015) believes that inventory management has 3 key pillars:
- Inventory planning – determining the optimum level, which involves understanding demands patterns, which value needs to be added for each product and deciding which inventory categories should each product be in. It also includes setting parameters in order to balance future stock levels as for example order frequencies, safety stock policies, minimum order quantities and lead times;
- Inventory control – managing the integrity of the stock and physical inventory;
- Inventory balancing – balancing the ongoing supply/demand relationship requiring good inventory planning, good inventory control and also good performance measurements.

1.2.1 Consignment Stock policy fundamentals

With regard to the topic of the dissertation, it is important to specify, what a CS is, how the process of the CS implementation works and what are the risks and weaknesses related to its implementation. Probably one the first findings related to the benefits of the CS were presented by Corbett (2001). They suggested that the CS policy can reduce the cycle stock, batch sizes on one side and increase the safety stock on the other. Furthermore, Braglia and Zavanella (2003) studied two-variable analytics CS model considering equal shipment with and without delays in deliveries. CS is a small part of the SC system, where two or more parties at different stages of an inventory flow line can establish a viable economic planning for smoother running of independent and / or centralized operations (Sarker, 2014). Consignment is a unique contract form in which a retailer, over a given period, takes possession of the goods owned by the supplier, promotes the sale of these goods to buyers, and receives a share of the sales revenue (Hu, Li, Wang, 2015).

In addition, Richards and Grindsted (2016) state, that the term comes from the old phrase "on consignment", where something is supplied to a customer before the payment on the basis of that the customer will only pay for what has been sold or used and can return unsold stock. Under a consignment contract, the supplier maintains ownership and control of the inventory, determining the stocking level and product pricing. The retailer is paid a fee marketing the product and handling sales transactions (De Matta, 2014). Obviously, precise bookkeeping and inventory management are required to secure correct billing and proper payment (Sarker, 2014). Consignment stock therefore refers to the inventory that has been delivered to your warehouse, but for which you have not paid or even issued a purchase order. When that material is taken out of stock for use, a purchase order is sent to the supplier and a payment is made. Ownership of the, yet, unused material still in warehouse rests with the supplier and is transferred to the customer at the moment of withdrawal for use (Richards, Grindsted, 2016).

As mentioned by (Zahran, Jaber, Zanoni, 2016), CS is useful for short-term assets management as s specific form of VMI – vendor management inventory. It is very important to highlight, that the main aim of the consignment stock policy is a win-win situation for both vendor and customer. The buyer pays the vendor once the items are withdrawn from the consigned inventory. Thus, purely from the standpoint of inventory risk, the supplier will generally prefer a wholesale contract while the retailer will prefer consignment (DeMatta, 2014).

Parties in consignment transaction. There are typically two parties, the consignor and the consignee. The consignor (e.g., individual, distributor, vendor or manufacturer) is the party providing the goods to be sold or used, and the consignee (retailer) is the party receiving and selling or using the goods. The consignor retains ownership of the inventory and the consignee maintains physical possession of the goods until sold or returned to the consignor. If the goods are sold, the consignee retains an agreed upon portion of the profits (Sarker, 2014).

Consignment stock MIN and MAX concept. This dissertation focuses on the consignment stock MIN and MAX concept. In this particular concept of CS policy supplier is responsible for keeping the buyer's inventory between a **maximum (S) and a minimum level (s)**. The supplier also supports any additional cost due to stock-outs if his stock management strategy is not suitable to assure the required service level (Braglia, Gabbrielli, Zammori, 2013). Setting these MIN and MAX levels is an essential part of the CS policy implementation. Due to this fact, it might be very risky for the vendor to set the min level too low or to set the spread between MIN and MAX level too small. This might either lead into too many frequent deliveries or the risk of not delivering such small amount of goods in a short period of time and so forth.

i.   Responsibilities of Vendor and Buyer

For full understanding of the CS, there were already clarified both parties participating this particular concept. Moreover, both consignor and consignee have their own roles and responsibilities in relation to the CS implementation and further utility. Therefore, in order for the CS to prove its full potential, it is essential to set up a very strong cooperation and even strengthen the relation between both parties. As the result of this cooperation, it will help minimizing the costs as well as maximizing profits. There are several individual responsibilities which both parties have to agree upon in order to achieve the full potential and benefits of the entire concept of the CS.

Due to the complex process of CS implementation, all the details of this cooperation between supplier and buyer need to be clarified to assure the process is safely implemented and both parties know what to expect, what responsibilities suppliers and buyers have, and what consequences this concept might have. Zahran, Jabel, Zanini, Zavanella (2015) determine the whole process and vendors and buyers' responsibilities, there are following specifications related to their responsibilities separately:

- Product ownership;
- Physical loss, damage, theft, or defect;
- Unused, unsold, or expired products;
- Inspection of delivered items;
- Periodic inventory review or audit;
- Inventory management;
- Reporting, and order initiation;
- Product pricing;
- Stock level management, and usage invoice;
- Payment by the due date;
- Storage space requirement.

Since the dissertation deals with the risks related to the CS, responsibilities are closely related to potential risks resulting from responsibilities not being clarified properly, or all the needs being met. Due to the fact that the inventory shortage shrinks responsibility and cost are borne by buyers, level of risk aversion is higher, as compared to the supplier. Hence, due to the shrink responsibility, the buyer improves its degree of risk aversion and therefore is encouraged to reduce upstream orders to cut down the holding cost of excessive inventory. Nevertheless, as the result of this - entire supply chain bears the loss in good will and penalties, due to a lack of inventory as a whole (Guria, Das, Mondal, Maiti, 2013; Gurtu, Jaber, Searcy, 2015; Wang, 2017).

There have been some continuous debates among practitioners as to who should be responsible for the level of consigned inventory in the supply chain. Ru and Wang (2010) presented a study in which he argues who should control the inventory under a consignment contract without considering possible product returns (Hu, Li, Gvindan, 2014). According to Zahran, Jaber, Zanoni, Zavanella (2015), it is the buyers´ responsibility to maintain and manage the products that are stored in its warehouse facility. The consignment stock has to be stored separately from the buyer's stock so it can be tracked easily and accurately. In addition, it is the responsibility of the buyer to insure the products against theft, damage, and loss. The customer is not obliged to pay for the merchandise until it removes the product from the consignment stock.

The customer can usually return the unused consignment stock to the supplier at any point in time (Sarker, 2014). Moreover, the buyer has to inspect the items once it received them and report any damages directly to the vendor so as to avoid any additional charges. Furthermore, it is the responsibility of the buyer to send a regular usage report to the vendor showing the quantities that have been used from inventory and to place orders to replenish its stock.

In addition, with regard to Supply Chain optimization and consignment stock policy responsibilities, it is crucial to specify particular Incoterms type responsibilities of vendor and buyer – demonstrated in the table below.

Table 1: Incoterms suppliers´ and vendors´ responsibilities

Incoterms	Loads truck	Pays export duty	Transport to port of destination	Unloads from truck at port of origin	Pay landing charges at port of origin	Transport to port of destination	Pay landing charges at port of destination	Unloads onto trucks from port of destination	Transport to the final destination	Pay insurance	Handles the entry and customs clearance	Pays from the entry duties and taxes
EXW	B	B	B	B	B	B	B	B	B	B	B	B
FCA	S	S	S	B	B	B	B	B	B	B	B	B
FAS	S	S	S	S	B	B	B	B	B	B	B	B
FOB	S	S	S	S	S	B	B	B	B	B	B	B
CFR	S	S	S	S	S	S	B	B	B	B	B	B
CFR	S	S	S	S	S	S	B	B	B	B	B	B
CIF	S	S	S	S	S	S	B	B	B	S	B	B
CPT	S	S	S	S	S	S	B	B	B	B	B	B
CIP	S	S	S	S	S	S	B	B	B	S	B	B
DAF	S	S	S	S	S	S	B	B	B	B	B	B
DES	S	S	S	S	S	S	B	B	B	S	B	B
DEQ	S	S	S	S	S	S	S	B	B	S	B	B
DDU	S	S	S	S	S	S	S	S	S	S	B	B
DDP	S	S	S	S	S	S	S	S	S	S	S	S

Source: Brijs, 2013

Additionally, to avoid any potential difficulties (Sarker, 2014) mentioned, that both parties, have to perform a periodic review or audit that could be weekly, monthly, quarterly or annually in order to count the items in stock and to compare what is there with the usage reports that have been sent by the buyer. Any discrepancy between the amount stocked and that reported is charged to the buyer.

ii. Advantages and disadvantages of CS Policy

The whole concept of CS policy has its advantages and disadvantages. Since the dissertation aims to examine the risks related to the CS implementation, disadvantages of CS contribute to possible risks related to its implementation as well. The disadvantages which can potentially increase the chance of risk occurrence are highlighted in this chapter.

In detail, the primary benefit of the CS operational arrangement is that the consignee saves money on inventory costs and invests no money for purchasing the goods that he/she sells. The vendors suppliers are paid only after the merchandise is sold which may lead to an improved cash flow on the side of the buyer. Next, the buyer can actually save ordering and shipment time by not waiting for new inventory every time—the consignor arranges to replenish the inventory right after some or all of the consigned goods are sold (Sarker, 2014). Also, according to Wild (2017), customers appreciate the CS implementation because then they can avoid capital cost of inventory; ensure supply, avoid transport or production delays; transfer the supply responsibility to the supplier; enable plans to be changed without panic buying; avoid worry by the customer. On the other hand, suppliers agreed because on-site inventory effectively captured the market; the customer should not have shortages; delivery was arranged when convenient, not on short lead times and it also ensures continuing business Wild (2017).

Regarding other CS benefits – the advantages for a vendor are clear – he/she reaches a significant decrease of inventory level and also decrease of finances invested into the inventory. However, the vendors advantages reflect disadvantages for buyer. A CS implementation does not actually change any inventory flows. For instance, Cook (2015) indicates that exporters can become more competitive due to better availability and a faster delivery of goods. Consignment stock policy can also significantly help exporters reduce direct costs of managing and storing inventory.

On the contrary, from the main disadvantages site, there is an **increase of inventory level** and also **finances invested into the inventory** for the vendor. Also, Wild (2017) contributes to this, claiming that consignment stock **increases supply chain costs** and reduces competitiveness. He determines following risks possibly resulting from CS implementation.

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These should be the objects of the following researchers on how to eliminate the possible inconveniences. Therefore, the dissertation also includes possible measures for these risks' minimization or avoidance. In practice, consignment stock will:

- Not reduce the cost, but just transfer it and the customer pays eventually;
- Usually **lead to high stock levels** in the consignment;
- Require **improved recording** accuracy and **stores discipline**;
- Lead to **disputes over unrecorded usages**;
- Make it **difficult to operate the phasing in and out of products**;
- Cause **duplicate back-up stock in suppliers´ stores**;
- Take the pressure off efficient supply.

In addition, Richards, Grinsted (2016) summarized the advantages and disadvantages for each party in the table below. Since disadvantages may be considered as potential risks, to sum the disadvantages in the table below up, from the suppliers´ perspective, when implementing CS, they face risks of **inventory produced which is not available** for other customers, **delayed payments** from buyer, **risk damages** in the buyer´s warehouse that the supplier cannot actually influence and possible inventory increase. In addition, Richards, Grinsted (2016) argues that - from the buyers´ perspective, the **stockholding costs** may increase as well as the **space requirements** and the **amount of inventory** in the SC in total. All these factors are demonstrated in the Tab. 2 below.

Table 2: Advantages and disadvantages of CS policy

	Advantages	Disadvantages
Supplier	- Customer will choose your material over a competitor´s material because it is available - Can plan your deliveries so that you anticipate future requirements and may be able to reduce the number of deliveries - Shared financial risk for products that might not have been ordered otherwise	- This material is no longer available to be send to another customer who have an unplanned urgent requirement - There may be a long wait before payment - Risk damage in the customer´s warehouse - Increased inventory in the supply chain
Customer	- Can obtain favorable financial terms on a buyer´s market - Payment terms can be advantageous for the customer since payment is due at some time after use, rather than some period after delivery - Material is available if there is a sudden increase in demand - Ability to offer/use products that might not have been stocked otherwise	- Stockholding cost of items supplied which do not have immediate use - Increased space requirement for stock and associated stockholding cost - Increased inventory in the supply chain

Source: Richards, Grinsted (2016)

Consequently, based on the findings and opinions mentioned above, majority of disadvantages are actually advantageous for the consignor since working on consignment is based on trust and the accuracy of the process is entirely under the initiative of the consignor. As the consignor considers the case as an advantage, it is an attractive incentive for the importer to work on consignment method since it enables the importer to gain competitive advantage over its competitors in the supply chain (Yilmaz, Semra, Apak, 2016).

iii.   Risks associated with Consignment Stock Concept

As a follow up to the previous chapter, where we examined disadvantages of CS policy – which could be considered as potential risks of its implementation, this chapter will present the most important part of the whole theoretical backgrounds. Since the main focus of the dissertation is the CS implementation risks, we will make a literature review on this particular topic, in this chapter.

First of all, it is essential to take into consideration several critical facts influencing the consignor and the consignee under the CS policy. In general, according to vendor faces the riskier part of the whole consignment policy, especially due to the fact, that vendor does not get any money until all or at least part of the consigned stock has been sold. Therefore, vendors´ cash flow may suffer as **more money is spent on manufacturing the inventory**, while cash coming in may be too slow to cover subsequent production runs. Equally, if the buyer (or warehouse provider as a third party) allows the **inventory to rot or become damaged in warehouses**, the consignor may be exposed to **higher product returns**. That results in the buyer having no money invested in the consigned inventory. Furthermore, because resupplying or restocking the consignment inventory is done regularly, there is a risk of **overstocking** or **duplicate inventories**. Also, the record keeping systems of both the vendor and the buyer might not always be the same. If the CS policy brings **discrepancies in the records** of both consignor and consignee, the whole concept can actually become significantly disadvantageous.

Zahran, Jabel, Zanini, Zavanella (2015) recognise the following risks:

- **Physical loss, damage, theft, or defect**: buyer is responsible for any physical loss, damage, or defect to the items while in inventory;
- **Unused, unsold, or expired products**: The vendor owning the consigned items, is responsible for removing and replacing unused, unsold or expired items at no cost to the buyer.

As mentioned by Yılmaz, Birgün, Apak (2016) consignment process is quite risky for the seller. Risk can be minimized only to a certain extent through a contract drawn up in conformity with the law and in a way that define the whole relationship between the seller and the buyer. With regard to an international trade of consigned inventory, the exporter takes full responsibility of the goods during storage process. If the importer does not **protect the goods as the contract imposes him to and fails to make audits** at given times, problems that would occur during the process might lead to serious **financial losses** according to Yilmaz, Semra, Apak, (2016). Malhotra, Mackelprang, Jayaram (2017) stresses that the implementation of CS can be risky if suppliers become "locked into" a relationship, which may be hard to leave due to a potential increase of their customer´s business. This might lead to an increase of their supplier's business and after that, buyers may become increasingly opportunistic throughout the CS agreement.

As Cook (2015) suggest, an appropriate insurance should be in place to **cover consigned goods in transit or in possession** of a foreign distributor or a third-party logistics provider. Moreover, with regard to a competitive payment method, exporters should find a balance between being competitive and keeping the risk in balance. Additionally**, delay-in-payments** as one of the most crucial risks, has been practiced by firms adopting CS. However, no study has yet investigated the effect of the delay-in-payments on a SCH system with CS agreement Milli Eğitim Bakanlığı, (2011) in Yilmaz, Semra, Apak, (2016). Zahran (2015) examined the joint effect of a permissible delay-in-payments and making frequent equal-sized payments on the total profit of a vendor–buyer SCH system operating under a CS policy (Zahran, Jaber, Zanoni, 2016). Zahran, Jaber, Zanoni, Zavanella (2015) were the first to study the effect of different payment schemes on the total profit of a SCH system with CS. They found out that a scheme where equal payments are made at equal intervals is the most profitable and practical for the system.

The exporter takes full responsibility of the goods during storage process. Ross (2018) confirms, that companies in CS taking ownership of goods incur risk. Mainly, due to possible financial loss caused by **shifts in demand, customer tastes, obsolesce, carrying costs** and spoilage from proportionally including possible product **failures, warranties and price fluctuation**.

Černá, Buková (2016) in their studies focused on risk avoidance; mainly when choosing the suitable supplier, in other words - they find the **choice of supplier** as a crucial step, which has a long-term impact on the company's ability to respond effectively to customer needs. In addition, the wider the possibility of the choice of consumers from foreign markets or the intention of foreign distribution, the more difficult the choice of suppliers is. In particular the proposed methodology for evaluation of a supplier quality, considers the following as the crucial factors – price, quality, reliability, flexibility, responsibility applicable to CS implementation (and also risk and development of supplier).

Laurens van der Laan (2013) specifies following 3 risks that importers face the most often. First of all, the exporters might be **dishonest and not ship the consignment** they had sold. They might not be punctual **and ship their products later** than was agreed. Lastly, they might be incompetent and **ship goods inferior quality** – lower quality than specified in the contract. Malhotra, Mackelprang, Jayaram (2017) presented, that generally a potential problem with ongoing inventory consignment is the risk of **increasing asset specificity** by the supplier to either few or a single customer in form of capital investments into processes or technology for customized IT systems in order to synchronize both IT systems of buyer and vendor.

In addition, Battini (2010) specifies following constrains related to the CS implementation from both vendor´s and buyer´s perspective:

Table 3: CS implementation constrains

Vendor	Buyer
Production capacity	Annual demand
Machines setup costs	Demand variability (dev-std)
Delivery costs	Stock-out costs
Re-filling costs	Items obsolesce risk
Annual interest rate	Annual interest rate
Holding costs	Holding costs
Production lead time	Available space for stocks

Source: Battini, 2010

Furthermore, apart from constrains, Battini (2010) also determines critical factors of CS implementation:

- Item annual consumption rate (in pieces and monetary value);
- Item consumption variability during the year (market demand variability);
- Item Life cycle (obsolescence risk);
- Item standardization level;
- Supply criticalities (variable lead times, high geographic distance vendor-buyer, etc.);
- Item dimension and physical characteristics;
- Item stock-out costs.

The main aim of this sub-chapter was to demonstrate various approaches to consignment policy implementation downsides, critical factors and potential risks presented in available literature. However, there were risks specified in relation to a specific area of the CS. A frame set or risks related to its implementation was not presented in recent papers and literature yet. Therefore, there is a potential to collect and enlarge the current risks identified and described in this chapter. Moreover, the dissertation deals with risks clarification, further risks identification and also their analysis and evaluation.

iv. Consignment contract importance

One of the most important part during the CS implementation is a consignment contract creation and agreement between both parties – vendor and buyer. It is highly important to specify all possible terms and conditions of the Consignment stock policy. In general Contracts are drafted after long-term work and the mutual agreement period is the most important and demanding process for business partnerships (Yilmaz, Semra, Apak, 2016). A consignment contract under distribution-free approach may be a fruitful combination to achieve a profitable business (Sarkar, Zhang, Majumder, Sarkar, Seo, 2018). Moreover, smooth progress of the process is in a proportional relationship with the successful performance of the first function as both parties want maximum protection of their own interests due to the high risk in such working methods, especially consignment (Yilmaz, Semra, Apak, 2016). In order to establish a consignment contract, the negotiation between manufacturer and retailer must be initiated properly. In consignment policy, manufacturer retains the ownership of products. Nevertheless, under certain condition, retailer has to pay a specific amount of fund (royalty) to the manufacturer which can be a barrier to achieve the contract between two parties as mentioned by Sarkar, Zhang, Majumder, Sarkar, Seo (2018). According to Yilmaz, Semra, Apak (2016) during the customization of the contracts for customers, the guidelines of the contract are often not changed and the parties are concerned more about agreeing on price offer. The attitude and competence of employees during the interviews are very important. Employees should be constantly supported by trainings during this period. The contracts based on laws and designed to protect the mutual interests, should be signed after a thorough evaluation and stored during the business partnership.

According to Richards, Grinsted (2016), it is crucial to create a detailed Consignment stock agreement specifying mainly the following:

- Responsibility for any damage before use;
- The grounds under which either the customer can return the product or the supplier can reclaim the product;
- Who pays for the return transport;
- Whose insurance covers its presence in the warehouse.

It is common to specify the period of time, after which the goods are returned to the supplier according to (Richards, Grinsted, 2016). Companies should seriously protect their rights within the countries where they operate in order to survive. To protect their rights, companies sign written contracts with their business partners and base all their rights on laws (Yilmaz, Semra, Apak, 2016). Consignment agreement should also include responsibilities for goods damages, consigned inventory and its price per piece (specifying who pays the transportation), storage requirements and also protections in the event of a consignee´s bankruptcy (De Giovanni, Karray, Martín-Herrán, 2018). According to Avinadav, Chernonog, Perlman (2015), it is essential to include in the contract, when and how should any unsold and unused products be returned. In other words, it is recommended to enter the period of time in which the consignee has to return the inventory before the agreement terminates or expires. De Matta, Lowe, Zhang, Wang (2014) pointed the following points as crucial for a consignment contract:

- The product is delivered immediately at the very beginning of a single selling season, and the retailer offers it to customer at the market price;
- The retailer offers a take-it-or-leave-it consignment contract to the supplier that stipulates the revenue share he will capture for each unit sold;
- The supplier conveys her/his interest in selling a product through a retailer;
- The supplier reviews the contract, accepts it as long as it yields a positive expected profit, and makes the production quantity and retail price decisions;
- Demand is realized and the at the end of the selling season, the retailer remits the supplier´s share of the sales revenues.

1.2.2 Consignment Stock implementation process

Logistics and manufacturing constraints typical of actual industrial systems constitute the base for the model, followed by the ten phases as Battini (2010) describes in more detail below the following concept.

```
        Daily consumption data exchange
  ┌──────────┐  ←───────────────────→  ┌──────────┐
  │  Vendor  │       q: delivery quantity│  Buyer   │
  └──────────┘                           └──────────┘
```

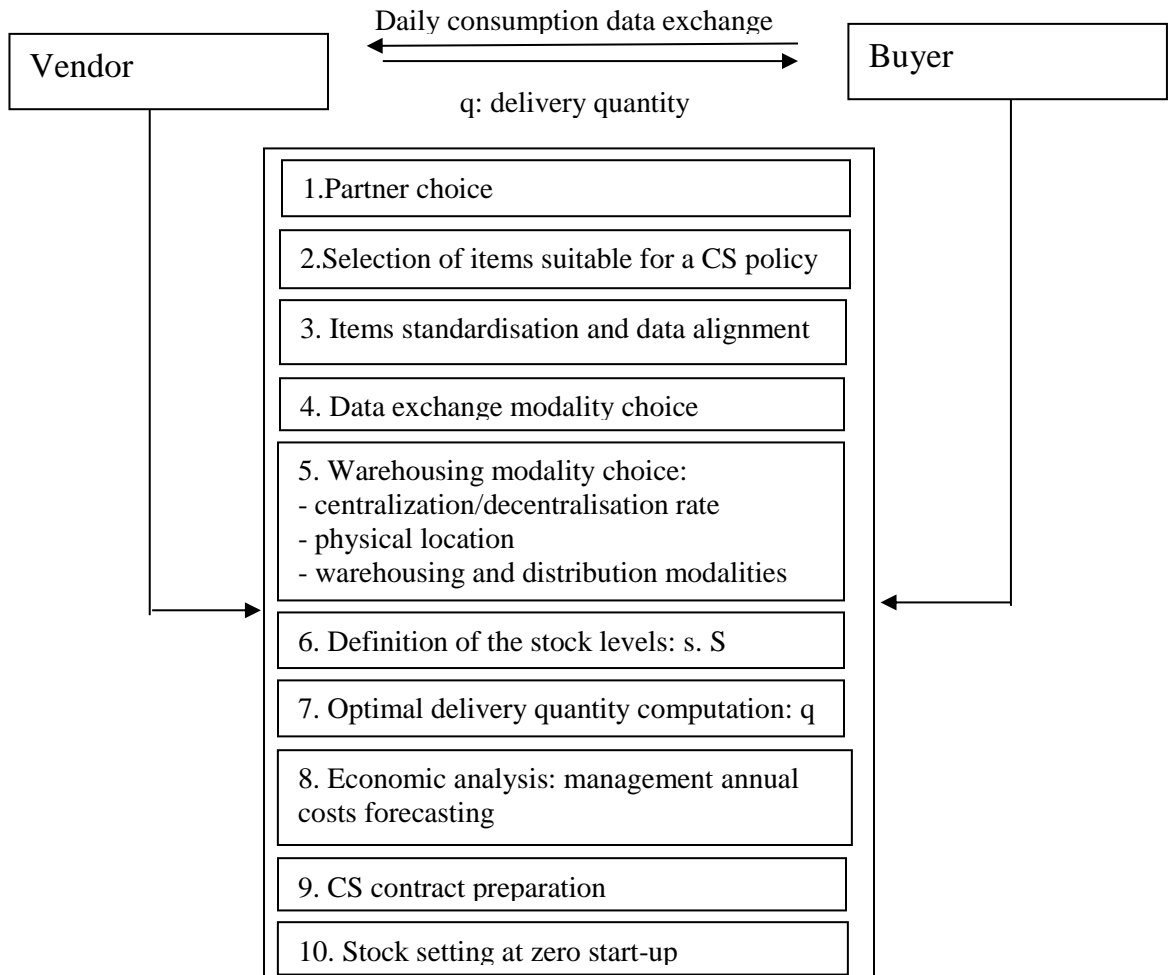| |
|---|
| 1.Partner choice |
| 2.Selection of items suitable for a CS policy |
| 3. Items standardisation and data alignment |
| 4. Data exchange modality choice |
| 5. Warehousing modality choice:
- centralization/decentralisation rate
- physical location
- warehousing and distribution modalities |
| 6. Definition of the stock levels: s. S |
| 7. Optimal delivery quantity computation: q |
| 8. Economic analysis: management annual costs forecasting |
| 9. CS contract preparation |
| 10. Stock setting at zero start-up |

Figure 2: CS concept implementation

Source: Battini, 2010

According to Fig. 2 above, it is essential to consider all factors separately for both vendor (holding costs, refilling costs, more flexible production capacity, ability to take the responsibility for the whole order – delivery on time process etc.) and the buyer (obsolesce risk, demand variability, unexpectedly changing annual demand etc.). Furthermore, based on the CS agreement there are several phases that have to be specified in advance - such as setting the MIN and MAX level, setting the optimal delivery quantity, data exchange tool, CS contract preparation and the whole process of CS starting at zero point in order not to negatively influence the current delivery and manufacturing process.

In addition, during the implementation of the project, it is necessary to accomplish each task independently from the partners' constraints, which should be individually addressed by both partners. Effective communication from the beginning of the partnership is of the utmost importance to reduce start-up times and inception delays Battini (2010).

1.3   Supply Chain Risk Management

Since there is not much information about CS implementation risks in the literature, we will be focusing on a broader range of risks related to the supply chain risks in this chapter. Supply chain risk management has attracted considerable attention from both academics and practitioners in recent years. This attention is warranted due to the potentially serious consequences of supply chain risk.

In general, organization face a wide range of risks that can impact the outcome of their operations (Hopkin, 2017). Recently, managing risk has become a crucial challenge for SC manager due to rising cost pressures, customer expectations, ever-increasing complexity and growing global competition (Daultani, 2015; Khojasteh, 2018). An increase observed SC disruptions has raised awareness toward the SCRM in recent years (Heckmann, 2015). Companies that perform SCRM gain competitive advantage. In the past, SC managers mainly focused on reducing costs. However recently, they have begun to put the emphasis to SC continuity and resiliency which have a significant impact on costs as well. Hence, conventional reactive planning has given way to proactive planning in SCRM (Kırılmaz, Erol, 2017). In order to remain competitive on the market, firms are forced to expand their product offerings and offer high levels of customization, bringing about high uncertainty in their supply chain. Firms that face high environmental uncertainty are increasingly facing higher risks in terms of supply disruptions, production and delivery delays that ultimately result in poor operational performance according to Sreedevi, Saranga (2017). Besides several frameworks, a number of models and tools have been developed focusing on different stages of the SCRM process (Fahimnia, Tang, Davarzani, Sarkis, 2015; Qazi, Akhtar, 2018).

With regard to approaches to SCRM, Qazi, Akhtar (2018) developed an iterative process, more precisely a risk matrix driven by the supply chain risk management, to bridge the gap of developing a SCR process integrating the risk appetite of a decision maker and all stages of the risk management process within an interdependent network of systemic risks. Garvey et al. (2015) introduced risk measures for prioritizing interdependent SCR assuming a risk-neutral decision maker whereas Qazi et al. (2017) introduced probabilistic SC risk measures to prioritize interdependent risks and strategies Qazi, Akhtar (2018).

The desired overall aim to reduce and prevent risks may be stated as a mission or a set of corporate objectives. The events that can impact an organization may inhibit what it is seeking to achieve (hazard risks), enhance the aim (opportunity risks), or create uncertainty about the outcomes (control risks). Therefore, RM needs to offer an integrated approach to the evaluation, control and monitoring of these three types of risks (Hopkin, 2017). Additionaly, Hopkin (2017) defines the SCRM process as follows - the board of an organization will require assurance that significant risks have been identified and appropriate controls put in place. Furthermore, an organization should undertake risks management activities that provide additional structured information to assist with business decision making. The key benefit of the risk management is to enhance the effectiveness and efficiency of operations within the organization. Equally, it should help to ensure that business processes are also effective and efficient (Hopkin, 2017). In SC, the decision-making process contains risks which can be influential on the company's progress in introducing a new product, expanding in various markets, and outsourcing manufacturing operations (Abdel-Basset, Gunasekaran, Mohamed, Chilamkurti, 2019). The SC disruptions are the unexpected and unplanned events which may occurs in SC and impact the predictable flow of components and materials. These disruptions may be either internal or external to the organization, but internal to the SC network and external to the environment are observed as supply chain risks (Abdel-Basset, Gunasekaran, Mohamed, Chilamkurti, 2019). Moreover, according to (Zeng, Yen, 2017) the potential consequences of SCR have been exacerbated by:

1. industry trends, such as globalization, the increasing use of outsourcing, increased demand for on-time deliveries;
2. the adoption of certain practices, such as lean manufacturing and the reduction of the supplier base and buffers;
3. the network or rippling effects of SCR (Huan Fana, Gang Lia, Hongyi Sun, T. C. E. Cheng, 2017). However, several risks such as inventory risks, delay and quality risks have been carefully investigated, researchers maybe in order to retain the focus on the major problem prefer to treat them isolated. Therefore, their internal correlations are seldom studied in the literature (Zeng, Yen, 2017).

According to Hopkin (2017) by taking a proactive approach to risk and risk management, organization will be able to achieve the following four areas of improvement:

- Strategy, due to the fact that the risks associated with different strategic options will be fully analyzed and better strategic decisions will be reached;
- Tactics, because consideration will have been given to selection of the tactics and the risks involved in the alternatives that may be available;
- Operations - events causing disruption will be identified in advance and actions will be taken in order to reduce the probability of occurrence of these events, limit the damage caused by these events and contain the cost of the events;
- Compliance will be enhanced because the risks associated with failure to achieve compliance will be statutory and customer obligations will be recognized.

1.3.1 Types of Supply Chain Risks

Risks may have positive or negative outcomes; therefore, risks may be considered to be related to an opportunity, a loss or the presence of uncertainty for an organization. Every risk has its own characteristics that require particular management or analysis as Abdel-Basset (2019) suggests. In general terms, organizations will seek to minimize compliance risks, mitigate hazard risks, manage control risks and embrace opportunity risks. Additionally, there are following types of SCR according to Abdel-Basset (2019) – classified to internal risks (managed risks) and external risks (uncontrolled risks) summarised as follows:

- Manufacturing risks;
- Business risks;
- Planning and control risks;
- Mitigation and contingency risks;
- Cultural risks - business cultural tends to stow or retard negative information.

Fig. 3 below demonstrates that the supply chain risk system (SCRS) can be engendered by a specific application of RCN in supply chains according to Zeng, Yen, (2017). Essentially SCRS is a network constructed by a number of individual risks in supply chains following their casual relationships.
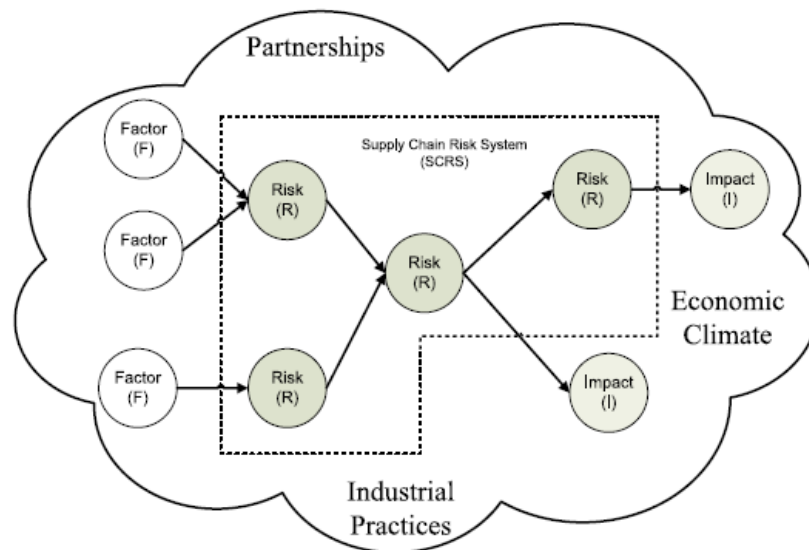

Figure 3: Supply Chain Risk System

Source: Zeng, Yen, 2017

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Furthermore, Zeng, Yen (2017) refined the notion of risk in SC and proposes a model of SCRS which is able to convey a risk-based view of partnerships in global SC. Through analytical inference it was proved that the level of collaboration among partners contributes to the resilience of supply chains. In addition, Abdel-Basset, Gunasekaran, Mohamed, Chilamkurti, (2019) defined five types of external risks:

- Demand risks - unexpected customer demand;
- Supply risks - obstruction of product flow, whether by materials or parts of the supply chain;
- Environmental risks – for example governmental, economic, social and climate factors;
- Business risks - due to the stability of a supplier´s finance or management, or purchase and sale of supplier companies;
- Physical plant risks.

Sodhi, Thang (2012) states that there were firstly generalized potential risks facing the supply side (for example purchasing risks), internal processes risks (manufacturing, storage and internal distribution) and demand side risks (distribution and sales). They sort these risks in groups presented in the Tab. 4 below:

Table 4: Supply Chain risks categorization

Supply risks	Process risks	Demand risks	Corporate-level risks
• Supplier failure • Supply commitment • Supply costs	• Design • Yield • Inventory • Capacity	• Forecasting • Change in technology or in consumer preference • Receivable	• Financial • Supply chain visibility • Political/Social • IT systems • Intellectual • Exchange rate

Source: Sodhi, Thang (2012)

However, Dionne (2013) presents risks from another point of view – defining the following types of risks:

- Pure risk - insurable or not;
- Market risk - variation in prices of commodities, exchange rates, asset returns;
- Default risk - probability of default, recovery rate, exposure to default;
- Operational risk - employee errors, fraud, IT system breakdown;
- Liquidity risk - risk of not possessing sufficient funds to meet short.

In addition to that, Hudnurkar, Deshpande, Rathod, Jakar (2017) presented summarized SCR specified in available journal articles published between 2003 and 2015 identified by various researches. There were following SCR identified, based on risk source:

- Product characteristics – including product quality, obsolescence, development delay, packaging, labelling, sustainability for end;
- Information Systems – for example IT structure, system integration, information delays, information distortion etc.;
- Transportation – including transport delay, network complexity, transhipment etc.
- Financial factors– funding liquidity, currency, interest rate, insolvency, asst impairment, market liquidity etc.;
- Manufacturing facilities – worker strikes, inventory, cos, flexibility, yield, maintenance, plant obsolescence, process stability, capacity, facility breakdown etc.;
- Source process – outsourcing, quality, yield, delivery, sourcing flexibility, single sourcing, sourcing flexibility, material cost, capacity, market shortages etc.;
- Make process – capacity, operational disruptions, design changes;
- Deliver process – product delivery, customer demand volatility;
- Return process – legal, recycling/reprocessing inventory;
- Plan process – strategic, forecasting, integration, capacity;
- Human resources – lack of skills, employee dissatisfaction, employee accident, employee turnover etc.;
- External environment – natural disasters, social instability, security, disasters, government regulations etc.

It is crucial to have a deeper look into 2 types of risks – internal and external risks as demonstrated in the figure below:
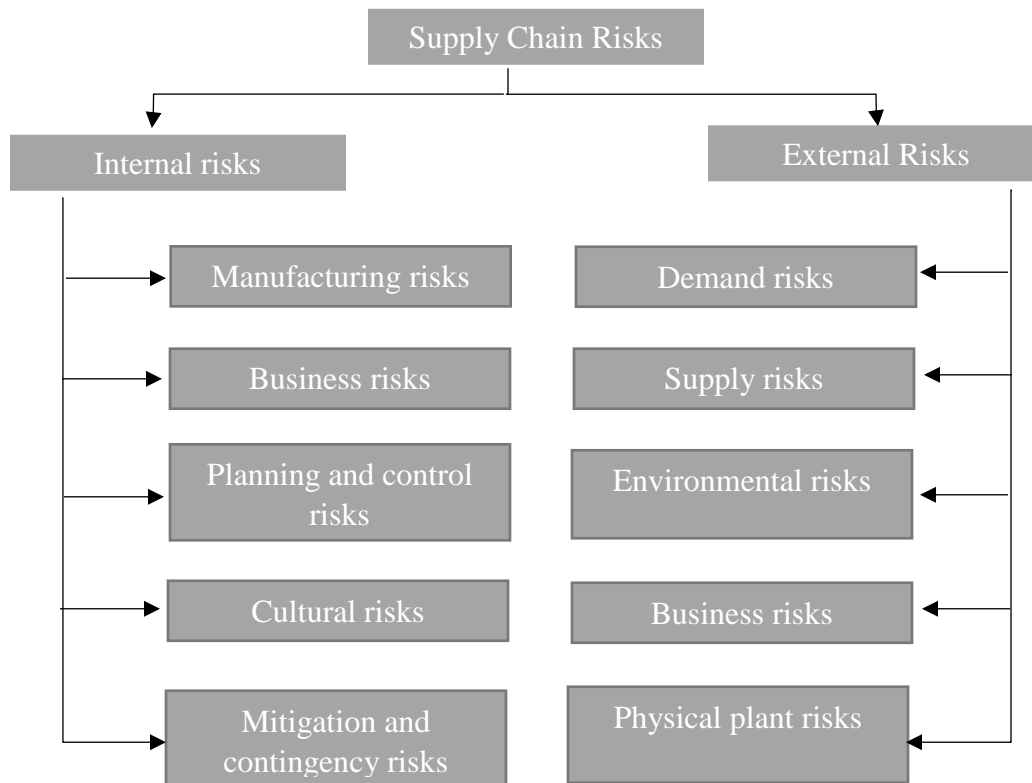

Figure 4: Supply Chain Risk System

Source: Abdel-Basset, Gunasekaran, Mohamed, Chilamkurti (2019)

Additionally, the image below presents an overview of SCR in general. Potential SCR are concerning with the objectives to be achieved by their organisations in the supply chain. Furthermore, the importance of non-accomplished or probable objectives should be estimated by quantifying the risk attitude of the particular decision makers (Heckmann, Comes, Nickel, 2015).
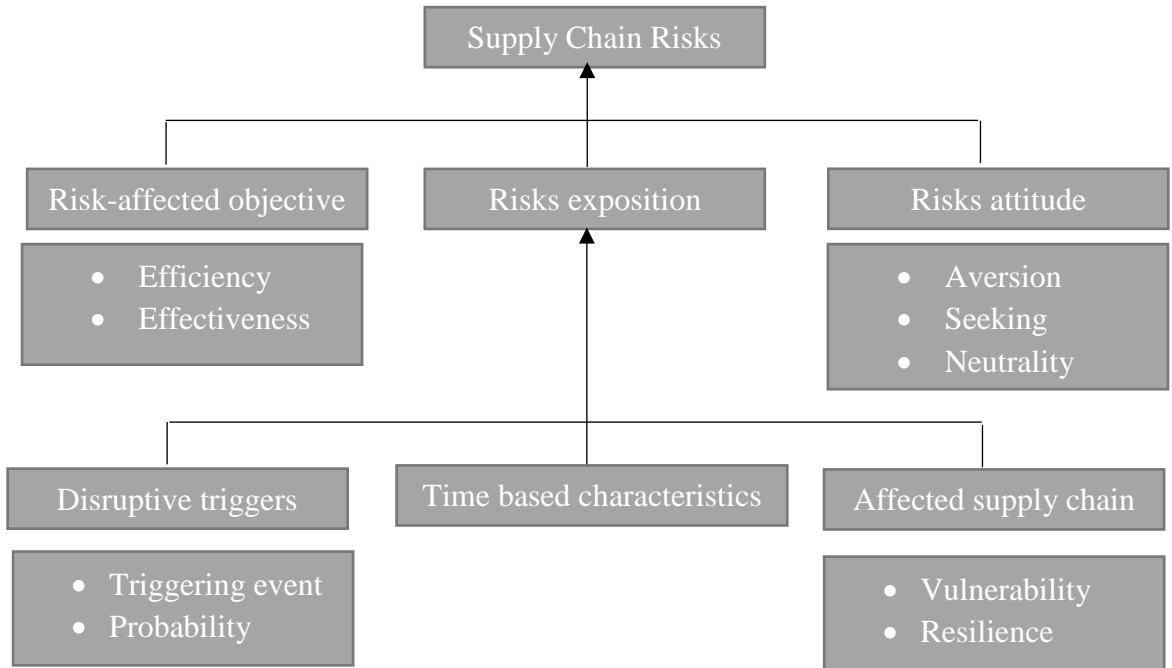
Figure 5: The main characteristics of Supply Chain Risks

Source: Heckmann, Comes, Nickel (2015); Abdel-basset, Gunasekaran, Mohamed, Chilamkurti, (2019)

1.3.2 Attitudes to Risks

In general, companies will prefer to take the risks in to account in their decisions and employ the proper mitigation strategy to respond to the unexpected events. The subjectivity, uncertainty and vagueness which exist in reality are the key factors to make risks difficult to handle. Hence, risk analysis, mitigation and control provide recommendations for making suitable decisions (Abdel-Basset, Gunasekaran, Mohamed, Chilamkurti, 2019). The pursuit of sustainability is increasingly recognized as an effective strategy when dealing with some of the contemporary challenges facing global SC. It leads to enhanced competitiveness and improved financial performance (Wang and Sarkis, 2013; Giannakis, Papadopoulos, 2016). Therefore, sustainability strategies should consider the level of future uncertainty and the risks that decisions may impose on the natural and social environments, in addition to the investment costs that are required to make supply chains more sustainable. All risks can be minimized to a manageable level by employing the proper mitigation strategy (Abdel-Basset, Gunasekaran, Mohamed, Chilamkurti, 2019). According to Popov, Lyon, Hollcroft (2016) risk treatment is the process of modifying risk. As mentioned earlier, risks that are judged to be unacceptable to the organization must be "treated" to reduce risk through the use of risk controls. Risk treatment generally involves the selection and implementation of one or more risk control measures or enhancements to existing controls. The risk treatment process involves the following Popov, Lyon, Hollcroft, (2016):

- the assessment of a risk treatment;
- determining if residual risk levels are acceptable;
- selecting new risk treatments for those residual risks that are not acceptable;
- assessing the effectiveness of any new control measure.

Abdel-Basset, Mohamed, Chang, Nmcda (2018) categorize various decisions of risk management process as follows - avoidance; acceptance (efficient decision for very trivial risks); compensation (taking on risk to substitute another); transferring (transferring risk to another party via insurances or by contracting with non-insurance party); and reduction (reducing the probability of an unwanted event or shorten sits impact). Jie Cao, Li Zhu, He Han, Xiaodong Zhu (2017) specify methods of risk avoidance: First, it is possible to **completely refuse to bear risks**. This way of risk avoidance is characterized by the ability of the risks managers to foresee the likelihood of occurrence of a risk events and forestall it. Second, there is a possibility of **abandoning the originally borne risks**. In reality, this means that risks factors have been existing, but the risk management personnel promptly discovered and dealt with.

Furthermore, Giannakis, Papadopoulos (2016) present following ways of risks treatment:

- Avoid - for example drop, or not select suppliers that use unsustainable technologies or processes;
- Control - reduction of the probability of a risk event occurring – e.g., establish a supplier development program to reduce the probability of environmental accidents;
- Share - cooperation with suppliers to achieve risk diversification;
- Retain - acceptance of the potential damage that will be incurred by a sustainability-related risk event.

Obicci (2017) explains that while the complete elimination of all risks is rarely possible, a risk avoidance strategy is designed to deflect as many threats as possible in order to avoid the costly and disruptive consequences of damaging events. However, risk avoidance and mitigation can be achieved through **policy** and **procedure**, **training** and **education** and **technology implementation**. According to Jie Cao, Li Zhu, He Han, Xiaodong Zhu (2017) risk avoidance refers to behaviour of risk managers that involves taking active measures to abandon the originally borne risks or completely refuse to bear risks.

1.3.3   Risk management process

The managing process of risk according to Abdel-Basset, Gunasekaran, Mohamed, Chilamkurti (2019) is demonstrated in the Fig. 6 below. First of all, it is necessary to identify internal and external environment of the company. Then, the company have to focus on prioritising and addressing its risks by determining criteria for identifying what may cause a risk to its operations.   After that, the company should perform a risk assessment containing risk identification, analysis and evaluation. The whole process is concluded by treatment process of risks.
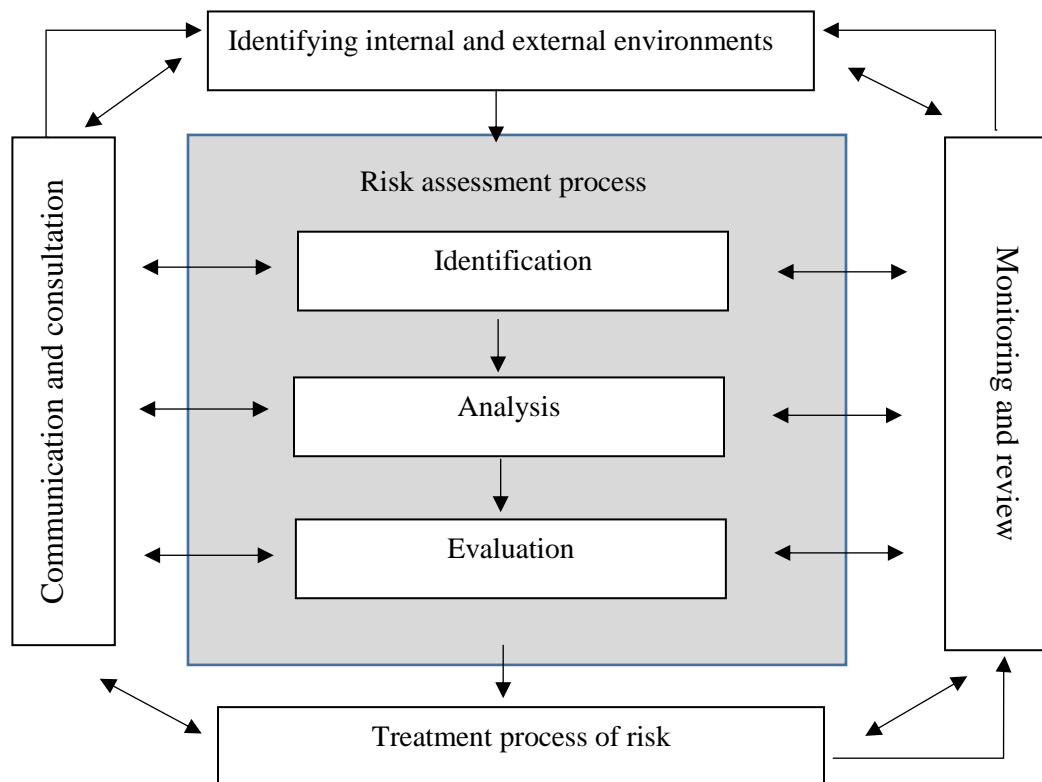

Figure 6: The Management Process of Risk

Source: S.C.R.L. Council (2013)

The same concept is presented in the ISO 31000 applied to SCM introduced by Oliveira, Marins, Rocha, Salomon, (2017). Study by Giannakis, Papadopoulos (2016) explains that a consensus exists, however the main stages of SCRM involve five sequential stages risk - **identification; assessment; analysis; treatment and monitoring**. Overall the risk management process is repetitive and cyclical. As the project evolves, some risks will be resolved or diminished, while others may surface and thus be added (Molenaar, 2010) as demonstrated in the Fig. 7 below.
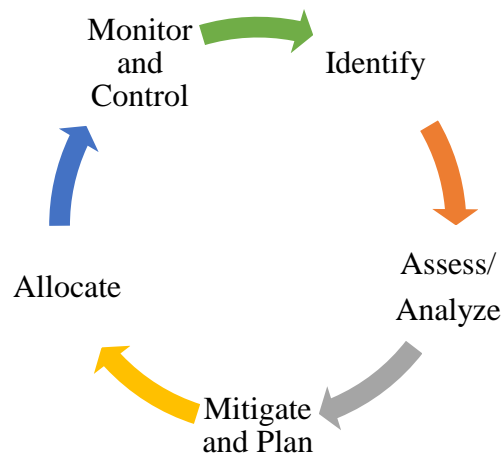

Figure 7: Risk Management Process

Source: Molenaar (2010)

1. **Risk identification –** risk identification and categorisation are not easy as each company run their processes under different environment and circumstances. In addition, researches dealing with risks also come from different backgrounds. However, risk identification is a process of determining which risks might affect the project - documenting their characteristics using tools like brainstorming and checklist (Molenaar, 2010). Additionally, Kirilmaz, Erol (2017) claims, that risk identification is the first and the most important stage of the risk management. For an efficient risk management, SC must be divided into elements such as suppliers, manufacturers, warehouses, distribution channels etc. and the risks associated with each element should be examined and identified specifically and elaborately. This is called SC mapping and risk registering.

Klöber-Kocha, Braunreuthera, Reinhart (2018) stresses that the approach for risk identification consists of the following sub-processes:

- System Definition;
- Provision of information;
- Examination of known risks;
- Identification of new risks;
- Detailed Analysis.

2. **Risk assessment/analysis** involves the quantitative or qualitative analysis that assesses the impact and probability of a risk. Risk assessment assists in deriving contingency estimates. Quantitative and qualitative risk analysis procedures are applied to determine the probability and impact of risks (Molenaar, 2010). According to Klöber-Kocha, Braunreuthera, Reinhart (2018) phase of risk assessment consists of the following sub-processes: Criteria selection; Information gathering; Criteria assessment; Multidimensional assessment; Graphical representation and comparison with acceptance limits and Risk Prioritization.

Pasman, Rogers, Mannan (2017) found out that it is difficult to conduct quantitative risk assessment well, as it is expensive, and because it is usually applied with inaccuracies. Therefore, its use is often disappointing especially because the uncertainties are not generally modelled, and the predicted risk is imposed as a point value instead of a distribution. Kirilmaz, Erol (2017) labeled this stage as risk measurement. They also explain two criteria used for the risk measurement - the probability and the impact of a risky event. Expected impact, which is the product of probability and impact, is referred to as the risk measurement.

When considering risks, it is important to unsure if a given event is likely to happen or not. Also, there may be a certain level of uncertainty as to what the consequences would be like, if it did eventually occur. Likelihood – the probability of an event occurring, and consequence – the impact or outcome of an event, are the two components that characterize the magnitude of the risk (Hopkin, 2017). In addition, Kirilmaz, Erol (2017) also present the probability-impact matrix, which is a useful tool to visualize and define the expected impacts.

			Impact				
			Very low	Low	Medium	High	Very high
			1	2	3	4	5
Likelihood	Very unlikely	1	1	2	3	4	5
	Unlikely	2	2	4	6	8	10
	Medium	3	3	6	9	12	15
	Likely	4	4	8	12	16	20
	Very likely	5	5	10	15	20	25

Figure 8: Probability impact matrix

Source: Kirilmaz, Erol (2017)

3. **Risk migration and planning -** Molenaar (2010) claims, that it involves analysing risk response options (acceptance, avoidance, mitigation, or transference) and deciding how to approach and plan risk management activities for a project.

4. **Risk allocation** involves placing responsibility for a risk on a party – typically through contract. The fundamental tenants of risks allocation include allocating risks to the party that is best able to manage them, allocating risks in alignment with project goals, and allocating risks to promote team alignment with customer-oriented performance goals (Molenaar, 2010). In addition, Kirilmaz, and Erol (2017) classify the risk mitigation strategies into two groups: reactive and proactive. In a reactive approach, no action is taken before the occurrence of a risky event but it is implemented to mitigate the impact and/or probability after it occurs.

5. **Risk monitoring and control** is the capture, analysis, and reporting of project performance, usually as compared to the risk management plan. Risk monitoring and control assists in contingency tracking and resolution (Molenaar, 2010). According to Kirilmaz, Erol (2017), this phase includes both observations of previous assessments and observations of changing situations and environment. New risks may be identified and/or new judgments about previously identified risks maybe revised by means of this phase.

Heckmann (2015), specifies a formation of SCR analysis in the Fig. below, which addresses distinct steps of the supply chain risk management cycle.

Figure 9: Formation of Supply Chain Risk Analysis

Source: Heckman, 2015

Furthermore, with regard to attitude towards risks, Heckmann (2015), divided the subjective perception of the importance of risks into following groups: risk-averse, risk-seeking and risk-neutral.

2. Objectives and Methods of the Dissertation

Main goal of this thesis is based on the literature review presented in the previous part of the thesis. Apart from the mail goal, there are another 3 partial goals, that will help the author to achieve the main goal of the thesis. Based on the literature review, there will be 3 research questions and 3 hypotheses presented. To elaborate this work, several methods were used and they are listed and explained below.

2.1 Goals, hypotheses and research questions

The **main goal** of the dissertation is to **propose the possible ways to eliminate risks in the CS implementation** (on the sample of Czech companies).

In order to fulfil the main goal, there were following secondary/partial goals set up to:

> A. Identify consignment stock implementation risks
> B. classify and evaluate the identified risks,
> C. identify the most critical risks.

Research Questions Determination

For the purpose of the dissertation, the following research questions were determined in order to follow up with the hypothesis's determination:

Q1: What source of information does adopters of consignment stock concept in the Czech Republic use?

Q2: What is the attitude of companies in the Czech Republic towards the implementation of the consignment stock?

Hypotheses Determination

H1: CS is mainly adopted by large size companies.

H2: Small and medium size companies adopted CS, because to the business partner demanded it.

H3: Opinions on CS disadvantages of both buyers and vendors are not statistically significant.

H4: In recent years, storage of the vendor's inventory at the buyers' warehouse as consignment stock (CS) has increased in popularity (Gharei, Karimi, Shekarabi, 2019).

2.2 Methods used

For the purpose of achieving the mail goal, the following methods were considered as the main data collection and proceeding.

- **Analysis**

In general, the analysis is used as a method of studying and separating of any material or data into its constituent elements and determining its essential features and their relations (Molnár, Miledová, Řezanková, Brixí, Kalina, 2012). In the dissertation, after collecting all the data, analysis will then help us the author distil the most relevant extracts of it. Subsequently, the data were synthesized through synthesis of links to logical units that will define the results of the dissertation. Using the analysis, information discovered and collected in the quantitative research will be analysed in order to generalize information about CS utilisation on the sample of companies in the Czech Republic. Also, the identified risks will be analysed for further evaluation of particular specialists in order to identify the most critical risks of all that have been identified.

- **Synthesis**

This method is used for merging or combining 2 or more constituent into a single or unified entity according to Sedláková (2014). Additionally, she also clarifies that synthesis concludes based on a summary of partial knowledge and their generalization.

Therefore, mainly for risks elimination proposal, this method is used together with literature review, internal companies' materials etc. to create a set of recommendations related to the most critical risks identified. Analyses and synthesis are closely related and are being typically used after one another due to the fact, that first when investigating a phenomenon, there are a smaller piece of analysed information that have to be merged into a single entity according to Sedláková (2014). These methods complement each other, and their usage is a very compact tool for investigation when used together.

- **Quantitative research**

According to Komárková a kol., 1998; Kozel (2006) a quantitative research obtains data on the frequency of occurrence of something that has already happened or is happening. To be able to collect measurable figures and answer the question "*How much?*", it is necessary to work with large sets of respondents to meet the conditions for obtaining statistically significant data. Alternatively, data can be obtained by observing the frequency of certain events or by analysing secondary data. In the dissertation a survey will be used as the main data collection source, gathering numerical data. First, a pilot survey will be compiled and tested by selected number of companies as a testing sample. Then, a final quantitative research – questionnaire will be distributed then study to determine a relationship between industry and company size of CS adopters and find out missing information related to the CS policy implementation. A very important part is, of course, the true and reliable outcome of the research. This will be obtained by selecting the right sample of surveyed subjects as well as the standardization typical of quantitative research. From the detailed analyses of quantitative statistics, there will be derived the assertions from which will be drawn conclusions. Based on this, the hypotheses will be either confirmed or denied.

- **Qualitative research**

In contrast to the quantitative research, qualitative research is used to find out the reasons and attitudes that lead to some action. Individual depth and group discussions of a smaller sample of respondents may be used (Disman, 2000). In the dissertation a qualitative research in form of interviews organised with several specialists from the practical and theoretical areas will be another source of information in order to identify all possible risks related to the CS implementation.

The quantitative research contains 7 both closed-ended and open-ended questions. Furthermore, in case of 2 questions an evaluation is included, therefore a Likert scale was used for evaluation from 1-5 points based on level of agreement with the presented statements (Veselá, Kanioková Veselá, 2011). For the questionnaire evaluation a Leven and Friedman tests were used – once the Leven test proves the p-value at the value of 0,05, the zero hypothesis is generally denied. To confirm the zero hypothesis, an ANOVA method is used.

- **Induction and Deduction**

Induction and deduction are basic methods for data processing and drawing conclusions mainly for an empirical research. Generally, according to Molnár, Miledová, Řezanková, Brixí, Kalina (2012), an induction is a method of forming judgments about observed elements. These are being generalized into new generic hypothetical statements. On the contrary, deduction is based on process of investigating the generic statements and focusing on the particular elements in detail. These 2 methods are used in the dissertation for any relations when investigating collected data and therefore from a general conclusion creating new and less generic conclusions according to relations (Molnár, Miledová, Řezanková, Brixí, Kalina, 2012).

- **Correlation analysis**

Correlation analysis as a method of statistical evaluation will help to identify a relationship between two, numerically measured variables including a Pearson´s product-moment coefficient in order to indicate an association between the two variables (Molnár, Miledová, Řezanková, Brixí, Kalina, 2012). In the dissertation, correlation analysis will be used in order to find out any relation between the consigned inventory imported and all inventory imported into the Czech Republic. It will also be used between the exported consigned inventory and all the exported inventory from the Czech Republic. This method usage will draw a probable development of further trends of amount of consigned inventory imported and exported in relation to the Czech Republic.

- **Monte Carlo**

In general Monte Carlo significance test is according to Hope (1968) a method of comparison of the observed data with random samples generated in accordance with tested hypotheses. The main outcome of this test is further determined by the rank of the rest criterion of observed data in order to test the criteria of previously mentioned random samples forming the reference set (Hope, 1968). In the dissertation, Monte Carlo significance test is used for investigating any significance between the size of a company and responds collected in the quantitative research organised with companies in the Czech Republic.

- **Saaty method of metacriterion analysis**

This method is generally used to define the importance of the particular criteria (Bouška, Černý, Glückaufová, 1984). In addition, repeating the method can be used to rank criteria (risks in case of the dissertation). For the purpose of this thesis, identified risks will be applied instead of criteria – using Saaty matrix for risks importance specification. This method encompasses according to Yang, Wang, Yang (2012) the following steps applicable to the thesis:

1. Structuring the criteria / risks identified;
2. Judgments matrix obtained based on pairwise comparison between criteria and alternative;
3. Consistency test must proceed until satisfactory;
4. Synthesizing comparisons across various levels to obtain the final weights of alternatives.

Additionally, evaluation of the questionnaire includes, apart from the characteristics of position and variability, the Leven test and the non-parametric Friedman test. The Leven test is performed according to Budíková, Králová, Maroš (2010) for testing the variance homogeneity (whether each group has an independent variable of the same variance) that will determine the most appropriate variance analysis method. If Leven's statistic is significant at p 0.05, the null hypothesis of variance matching is rejected. When confirming the null hypothesis, common parametric ANOVA methods are used, otherwise it is preferable to use a nonparametric Friedman test.

One-way analysis of variance ANOVA examines the dependence of the interval or ratio variable X on the nominal variable A, which has at least two variants. A is called a factor and its factor level variants. The dependence of X on A is manifested by the fact that there is a statistically significant difference in the averages of X and random selections that were made by sorting the variant A. According to Hinton (2004), the non-parametric Friedman test answers the question of whether there is a difference between the medians in each dependent group. The null hypothesis assumes that distributions in multiple dependent selections are the same, and the alternative hypothesis suggests that distributions in at least two dependent selections vary. If the null hypothesis is rejected, then another test must be followed to determine the groups (or pairs) that differ from each other. The Freedman test results will be displayed and demonstrated using the IBM SPSS statistical analysis software.

In order to fulfil the MAING GOAL - to propose the risks´ elimination in the CS implementation in relation to the Czech market **-** literature review of Czech and foreign literature, interviews and brainstorming with specialists were used as the main source of information. In the dissertation, a single-vendor single-buyer supply chain is considered, where the vendor ships every production batch in a number of lots to the buyer's warehouse. Manufacturer buyer as a consignee cooperating with a supplier manufacturing specific parts for completing buyer's product.

Furthermore, to fulfil the SECONDARY GOALS, following methods are considered to be the most important for the data collection. These are detailed and specified in the overview below:

- Goal A. – RISKS IDENTIFICATION - literature review of Czech and foreign literature, interviews and brainstorming with specialists, information from various companies' documents, guidelines (how to avoid possible risks) and internal materials (including ISO standards for example ISO 31000:2018).
- Goal B. - RISKS CLASIFICATION and EVALUATUON – the identified risks will be classified according to Hudnurkar, Deshpande, Rathod, Jakar (2017) classification.based on specialists' opinions, using the Saaty´s pairwise method will be used from both vendor's and buyer's perspectives in order to evaluate consequences and likehood of identified risks occurrence.

- Goal C. - MOST CRITICAL RISKS IDENTIFICATION – combination of results of separate Saaty pairwise comparisons from both vendors´ and buyers´ perspective, will help to specify the most critical risks. Based on these findings, the measures and recommendations for risks prevention and elimination will be proposed.

To demonstrate how the methods, mentioned above, were used in the dissertation, a scheme of methods has been designed. See the Fig. 10 below:
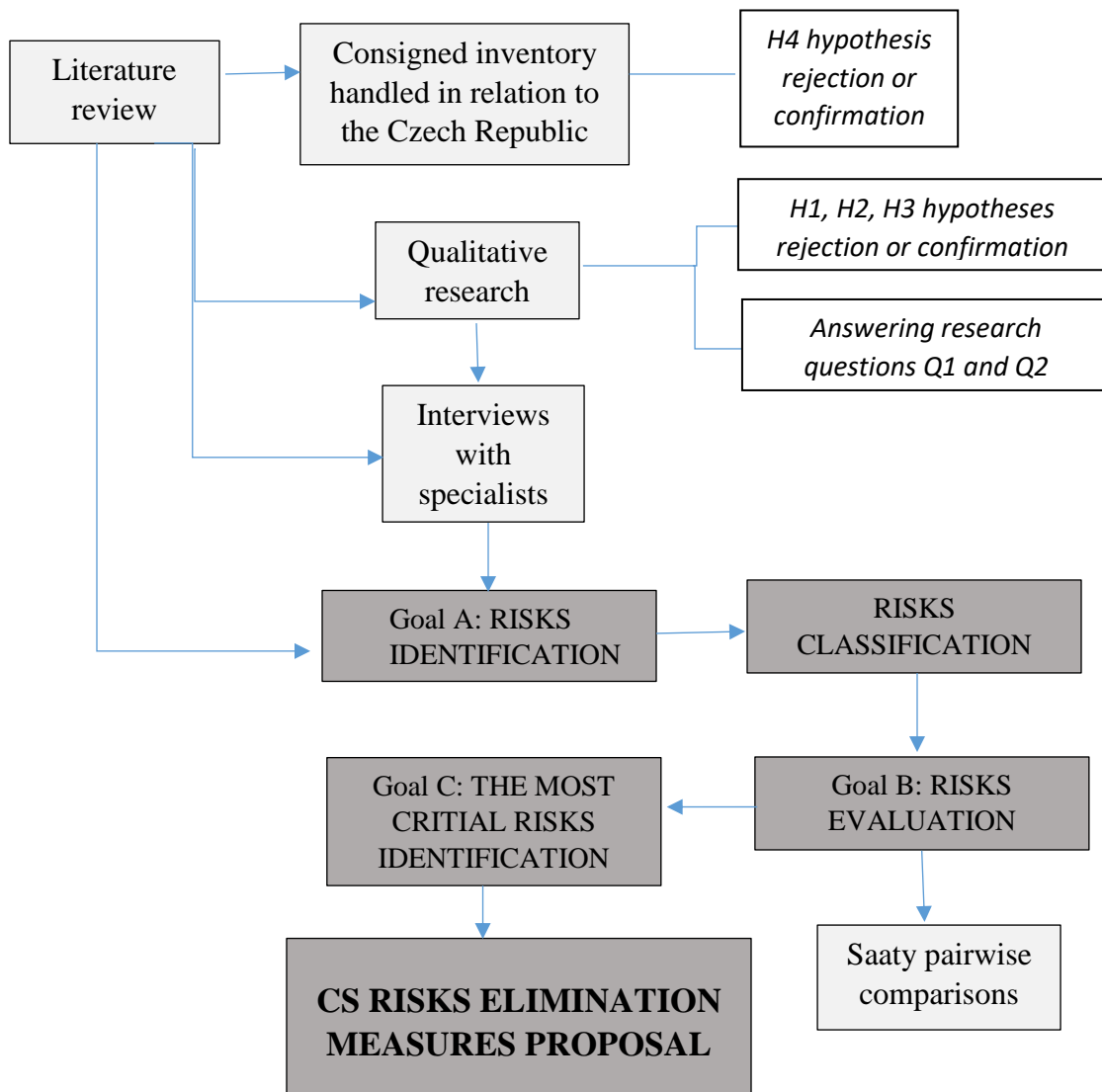

Figure 10: Methods of dissertation

Source: Author

Phases of the dissertation

Phase P1 - Literature review and theoretical background summary

This phase includes research of Czech and foreign literature much related to the area of supply chain management and consignment stock concept. In particular, the fundamentals of supply chain management are specified with a great focus on inventory management. There are several approaches to inventory management, however the dissertation deals just with the VMI and Consignment Stock concept. In addition, this phase also summarizes and compares approaches to basics of the Consignment stock concept considering the single buyer and single vendor model: responsibility of consignor and consignee; advantages, disadvantages, risk and benefits of CS; specification of the CS implementation process.

Phase P2 – Consignment stock adoption in the Czech Republic

This phase consists of 2 main data collections methods:

a. **Quantitative research**

A qualitative research was conducted as another data collection method in order to find out what companies typically implement and to find out a relation between the company size or industry on CS implementation. Moreover, the research also reveals, size of the companies that adopts the CS and whether they provide the CS for their buyers, or whether they are provided with the CS by their vendors or both ways CS utilisation. Monte Carlo method will be used.

b. **Data provided by Czech statistical office**

There is information about exported and imported consigned inventory in relation to the Czech Republic provided by the Czech Statistical Office.

P3 - Risks identification

Information found out in the P3, qualitative research, literature review, interviews and brainstorming with specialists will be used as the main source of data. All the pieces of information will be summarized – combining risks presented in literature, risks based on responds in the quantitative research and qualitative research and from interviews and a

brainstorming with specialists and representatives of respondents' companies plus research of company materials and guidelines in case of any risks, ISO 31000:2018 standards will summarize all identified risks related to the CS implementation and further utilization.

All these methods and previous phases lead to **FULLFILMENT OF THE GOAL A**

P4 - Identified risks classification

Continuing in interviews and brainstorming with specialists with regard to inventory and supply chain management mentioned in the previous phase, there will be focus on classification of these risks into a few groups according to their factual levels based on Hudnurkar, Deshpande, Rathod, Jakar (2017) classification of Supply Chain risks groups in general.

FULLFILMENT OF GOAL B

P5 – Risks evaluation

For this step, Saaty pairwise comparison method was used to identify the most critical risks having the most damaging consequences and may appear the most frequently.

FULLFILMENT OF PARTIAL GOAL C

P6 - Risks elimination measures proposal

Setting all the identified risks to larger groups simplifies the generalization of measure minimizing the as many risks in the that particular group as possible. Proposed measures are based on the literature review, interviews and brainstorming with specialists and representatives of respondent's companies; research of company materials, internal guidelines and ISO 31000:2018 standards. This phase led to the completion of the main goal of the dissertation – proposal of the risks´ elimination in the CS implementation in relation to the Czech market.

FULLFILMENT OF THE MAIN GOAL

3.   Consignment stock concept usage

There is a plethora of researches and new costs reductions formulas related to the Consignment Stock utilization in Supply Chain Management. Yet, there is not very much known about the real data of consignment inventory quantification etc. Therefore, main aim of this chapter is to find out more information about the CS policy usage and the consigned inventory possible quantification in practical usage.

First, when finding more information about the CS adopters in the Czech Republic, several institutions were contacted. From all the contacted institutions, only Czech Statistical Office was able to provide us with information related to imported and exported consigned inventory – amount and value of this consigned inventory. These pieces of information are described and analyzed in the Chapter 4.4.

Second, due to the fact, that these pieces of information were not sufficient for company size identification, industry and any further information related to risks of CS implementation – we had to acquire **a quantitative research from the Czech Republic between May and June 2018.** This provided with more information - not just about the risks that adopters find in the CS implementation and utilization but also, what a typical CS adopter in the Czech Republic looks like (company size, industry etc.). These findings helped us to understand, what types of companies adopted the CS policy, what is their attitude towards the whole concept and what information sources they used for finding more information about the concept. These findings have not been quantified in available up-to-date scientific literature yet.

Procedure of the quantitative research

There were very few specified respondents, in other words – small number of companies adopting or having any experience with the CS policy implementation. In order to identify the minimum sample (n), we implied the mathematical formula presenting *n* as function of required reliability and accuracy with a particular variability of the examining sample using the formula below according to (Scheer, 2007):

$$n = (Z^z{}_{\alpha/z} * \delta^2{}_x)/\Delta\frac{z}{x} \qquad (1)$$

n – range of examining sample

$Z_{\alpha/2}$ – value of the random variable z (1,96 for $\alpha = 0,05$)

$\delta^2{}_x$ – estimated standard deviation

When considering 95% reliability there is the table value $z_{0,025} = 1,96$ and required accuracy $\Delta^{\bar{x}} = 0,2$ also considering variance of $\delta^2{}_x = 0,6$. Setting all these values the result is

$$n = (1,96^2 * 0,6)/0,2^2$$
$$n = 58 \text{ respondents}$$

According to this computation, the sufficient sample of respondents is 58.

In May 2018 a pilot survey was used to pre-test the questionnaire using a small sample of companies (that author was aware of their CS implementation) – 5 companies in order to find our weaknesses and test the validity, reliability and correctness of the instructions to be measured and whether the respondents can follow them. After the pilot survey, a few questions were rewritten in order to clarify some of the suggested replies.

In June 2018, the survey (Attachment C) was distributed to 168 companies addressed in various industries, locations and company sizes. Respondents/companies were both selected randomly. In the first phase, just a few percent of the questionnaires were filled in and returned to us. Therefore, it was necessary to contact the companies again and remind them to fill the questionnaire. Finally, 51 companies did not reply or refused to participate. Therefore, 117 replies were compiled. Eventually, 69,6% of all the questionnaires were completely filled in. The questionnaire consisted of 7 questions related to CS usage and its risks implementation. In order to analyse and evaluate the questionnaires, MS Excel was used.

Tab. 5 below demonstrates the respondents – industry distribution. Mainly manufacturing companies (43%) which agreed to participate and sent us back a filled questionnaire.

Table 5: Industry distribution

Industry	Count	Percentage
Services	24	21%
Retail	40	34%
Manufacture	50	42%
Unknown	3	3%
Sum	117	100%

Source: Author

The Tab. 6 below demonstrates company size distribution of the respondents participating in the quantitative survey. Mainly small companies (44%) provided us with some feedback in a filled questionnaire.

Table 6: Company size distribution

Company size	Count	Percentage
Large	34	29%
Medium	31	27%
Small	52	44%
Sum	**117**	**100%**

Source: Author

3.1 Consignment stock adoption according to company size

Tab. 7 below demonstrates company size distribution of CS adopters as well as nonadopters. Out of the research sample, the CS policy is mostly adopted by large companies (82% of total number of large size companies) and medium size companies (55% of total medium size companies). **Confirmation of H1:** *CS is mainly adopted by large size companies* - **as demonstrated on the research sample, there are mainly large size company's adoption the CS policy.**

Table 7: CS adopters according to company size

Company size	CS implemented	% of company size
Large	**34**	**29%**
No	6	18%
Yes	**28**	82%
Medium	**31**	**26%**
No	14	45%
Yes	**17**	55%
Small	**52**	**44%**
No	37	71%
Yes	**15**	29%
SUM	**117**	

Source: Author

Tab. 8 below demonstrates "direction" of CS policy according to company size.

Table 8: Way of CS implementation

CS type	Count	Percentage
Both ways	13	100%
Large	5	38%
Medium	6	47%
Small	2	15%
Provided by supplier/s	19	100%
Large	11	58%
Medium	4	21%
Small	4	21%
Provided for buyer	26	100%
Large	12	46%
Medium	7	27%
Small	7	27%
Unknown	2	-
SUM	**60**	

Source: Author

55

According to information provided in the Tab. 8 above, there are mainly large size companies providing the CS both ways and also single way – for their buyers and for their vendors.

3.2   Data information sources regarding the CS implementation

The additional part of the survey was dealing with whether the companies have enough and sufficient pieces of information related to the Consignment stock policy and its risks and benefits – in other word, whether they have any chance to consider, whether this type of deliveries is optimal between both parties etc.
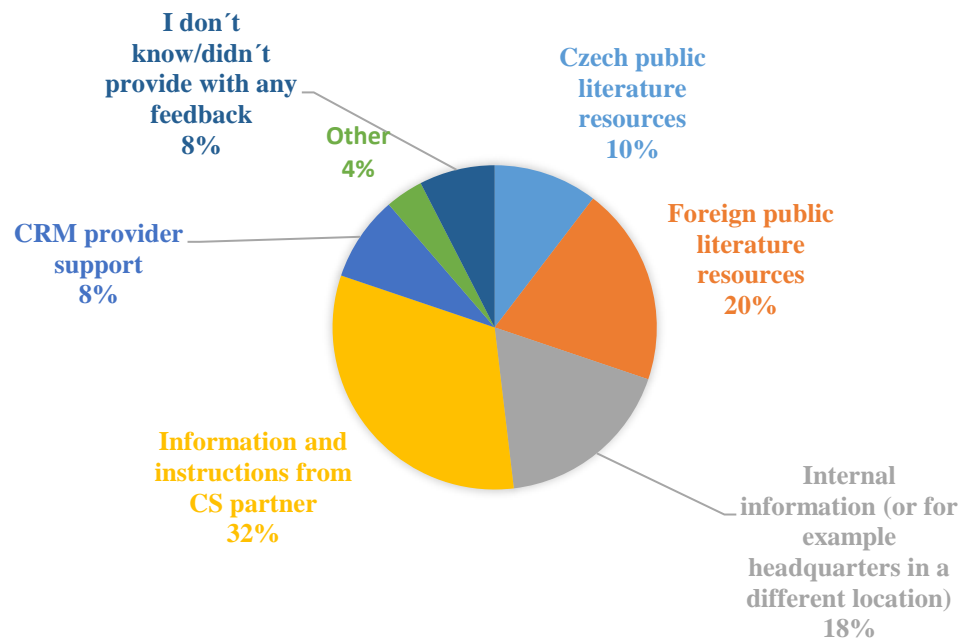
Figure 11: CS information resources

Source: Author

The Fig. 12 above demonstrates the main source of information (multiple choice), which respondents used to find out more about CS concept, its risks, advantages, usage etc.

Answering of research question Q1: *What source of information does adopters of consignment stock concept in the Czech Republic use?* The most frequent sources were - **Information and instructions from CS partner** (32%). In this case, respondents relied on information provided by the future consignment partner, who might have more experience with CS set up, instructions and information. Second most frequent information source was - **Foreign public literature** (or internet information sources - 20%). Third most frequent response was - **Internal information** (18%), provided for example by headquarters, since the respondents´ companies were most likely divisions of large international companies. Or alternatively the respondents´ company representatives already knew, the basic backgrounds of Consignment Stock Concept.

Based on these responses, it is alarming, that just 10% of respondents used Czech literature resources. With regard to all the available Czech literature in the past 10 years, there are publications that discuss the consignment stock; at least broadly. More importantly, there are titles which refer to the VAT and accounting solutions of CS policy in general – for example Benda (2013), Louša (2012), Galočík, Louša (2016). In addition, more detailed overview about CS policy presents Lošťáková (2009). Knoblochová (2008) discuss the process of CS utilization focusing on Consignment contracts. Šiman (2010) briefly explains the fundamentals of CS concept and presents the main 4 advantages of the concept itself regardless whether these are advantages for buyer or vendor, and Sixta, Mačát (2005) present logistics from various perspectives. All of these titles could be useful for the potential CS adopters to learn more about transportation, warehousing etc. However, there is a huge potential for new publications to describe the subject of Consignment stock concept, its detailed fundamentals, possible scenarios during implementation and further usage in more detail.

3.3   Reasons for the CS implementation

Another part of this research was designed to find out, the main reasons for the CS policy adoption. Majority of respondents implemented the CS due to their own initiative – mainly in case of large companies. The second most frequent reason was that there was an initiative from the business partner – mainly in case of medium and large companies.

The third most frequent reason was any other or a third-party interest - again mainly in case of medium and large companies.

Table 9: Reason for CS implementation

Reasons for CS implementation	Count	Percentage
a. Business partner insisted	**23**	100%
Large	7	30%
Medium	9	**39%**
Small	7	**31%**
b. Our own initiative	**19**	100%
Large	13	**68%**
Medium	3	16%
Small	3	16%
c. Other (third party interest etc.)	**14**	100%
Large	7	**50%**
Medium	5	36%
Small	2	14%
d. I don't know	**4**	100%
Large	2	50%
Medium	1	25%
Small	1	25%
SUM	**60**	100%

Source: Author

Confirmation of the Hypothesis H2: *Medium and small size companies adopted CS as a request of the business partner*. Based on this quantitative research sample, indeed, in case of medium and small size companies, they adopted the CS due to the fact, that their business partner insisted to.

3.4 Further CS implementation

Very important task was also to find out CS adopter's attitude to CS implementation, in other words to have a better overview, how they find a further implementation of Consignment stock.

In the Fig. 13 below there is an overview of further respondent's willingness to adopt the CS concept again (applied to more vendors/buyer or other inventory items).

Answering of research question Q2: *What is the attitude of companies in the Czech Republic towards the implementation of the consignment stock?* Only 28% of the respondents would potentially adopt the CS with no doubts. There may have not been any difficulties, or even if there were, the adopters find no problems with solving these issues either in advance or during the process of implementation.

There is an essential information, that 34 % of the respondents would prefer a better preparation in case of any further CS implementation. 7% had even a negative experience with the implementation of this concept and they would not probably implement it. Furthermore, 13% would not implement CS at all.
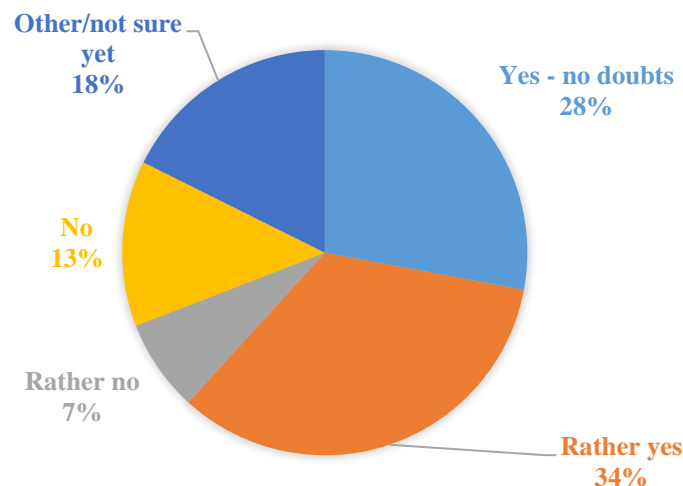
Figure 12: Further CS implementation

Source: Author

3.5 Consignment Stock disadvantages

The available literature has shown a number of major disadvantages of Consignment stock concept adoption in the Czech Republic. There are all the results below divided according to the buyers' and suppliers' perspective. Based on the findings presented by Richards, Grinsted (2016), Wild (2017) and Yilmaz, Semra, Apak (2016), there were several CS policy disadvantages indicated by the vendors and buyers.

3.5.1 Consignment Stock disadvantages from vendors´ perspective

Table below shows the most significant disadvantages of CS from the suppliers' perspective, which were evaluated according to Likert scale from 1 to 5 points (1 – strongly disagree, 5 – strongly agree).

Table 10: CS disadvantages from vendors´ perspective

CS disadvantages vendors´ perspective	Mean		Standard deviation	Variance	95% Confidence interval for mean		Min.	Max.
	Statistics	Std. Error			Upper end point	Lower end point		
Material is no longer available to send to another customer having an unplanned urgent requirement	2,81	0,21	1,20	1,45	3,24	2,37	1	5
Long wait before payment	1,56	0,14	0,80	0,64	1,85	1,27	1	4
Risk damage in the customer´s warehouse	1,97	0,18	0,99	0,99	2,32	1,6	1	4
Increased inventory in the supply chain	2,4	0,20	1,18	1,4	2,83	1,98	1	5
Increased stockholding costs	1,90	0,20	1,15	1,31	2,31	1,78	1	5
Increase of space requirements	3,06	0,23	1,32	1,74	3,53	2,59	1	5
Increase of finances invested into the inventory	2,25	0,19	1,11	1,23	2,65	1,85	1	5
Duplicate back-up stock in suppliers´ stores	2,16	1,11	1,11	1,23	1,76	2,56	1	5

Source: Author

60

The Tab. 11 below demonstrates Leven test of homogeneity of variances in order to find out the best method for analysis of variance.

Table 11: Test of Homogeneity of Variances

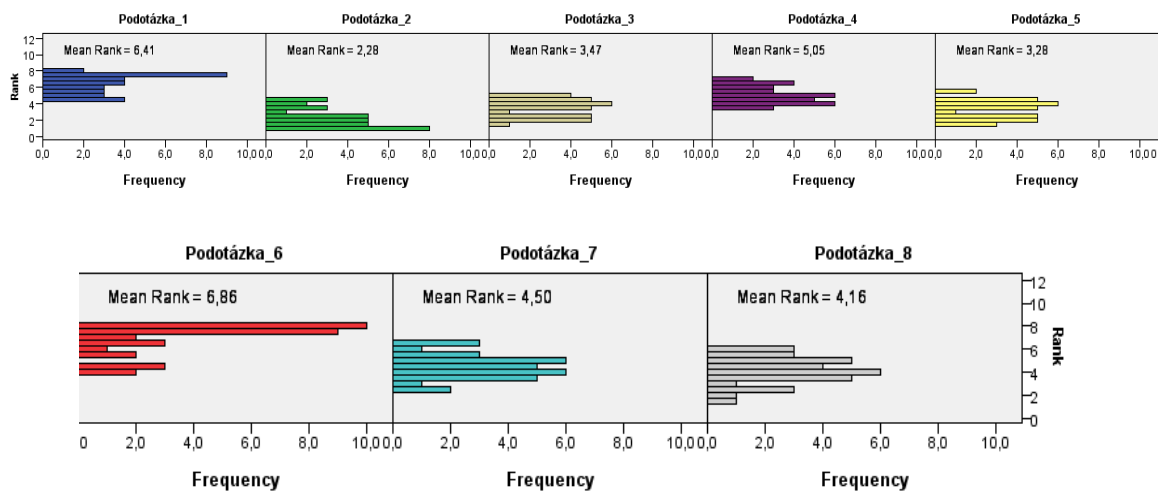|		Levene Statistic	df1	df2	Sig.
Sub-questions	Based on Mean	,681	4	251	,606
	Based on Median	,549	4	251	,700
	Based on Median and with adjusted df	,549	4	238,603	,700
	Based on trimmed mean	,657	4	251	,623

Source: Author

Due to the fact, that its p-value – sig. > 0,05 we cannot conclude, that a significant difference exists. Furthermore, the Friedman two-way analysis of variance by ranks was used. Since the result of Friedman test is 0, the importance of all the questions is the same.

Source: IBM SPSS

Total N	32
Test Statistic	139,916
Degrees of Freedom	7
Asymptotic Sig. (2-sided test)	,000

Figure 13: Friedman test (vendors´ perspective)

Source: IBM SPSS

Due to the results of the analyses presented above, the most obvious median values can be easily interpreted according to the Fig. 15 below. The most significant disadvantages are sub-question 2 (Long wait before payment), 3 (Risk damage in the customer´s warehouse) and 5 (Increased stockholding costs).
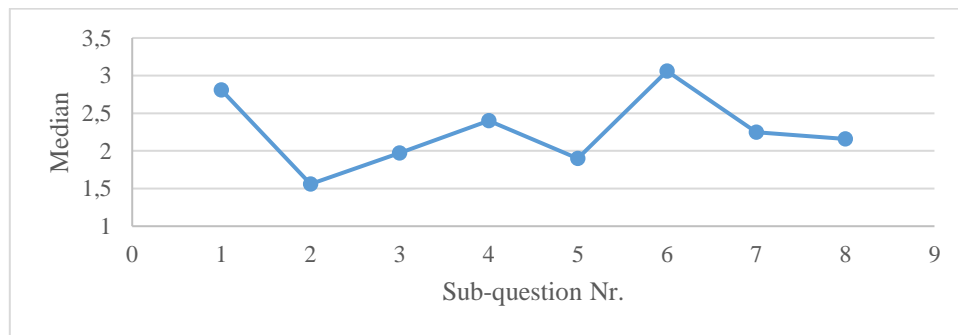
Figure 14: Sub-questions median values

Source: Author

3.5.2 Consignment Stock disadvantages from buyers' perspective

Tab. 12 below shows the most significant disadvantages of CS from the buyers' perspective. Respondents (buyers in this case) were also asked to evaluate the significance of all the mentioned disadvantages again according to Likert scale from 1 to 5 points (1 – strongly disagree, 5 – strongly agree).

Table 12: Disadvantages of CS concept from the buyers´ perspective

CS disadvantages buyers' point of view	Mean		Standard deviation	Variance	95% Confidence interval		Min.	Max.
	Statistics	Std. Error			Upper end point	Lower end point		
Stockholding cost of items supplied which do not have immediate use	3,30	0,17	1,06	1,11	3,65	2,97	1	5
Increased space requirement for stock and associated stockholding cost	3,05	0,21	1,31	1,73	2,62	3,48	1	5
Increased inventory in the supply chain	2,54	0,17	1,07	1,15	2,89	2,19	1	5
Claims, returned goods	1,92	0,16	0,98	0,97	2,24	1,60	1	4
Disputes over unrecorded usages	2,48	0,19	1,21	1,47	2,88	2,109	1	5

Source: Author

For the purpose of testing the homogeneity of variances, the Levene test was used.

Table 13: Test of Homogeneity of Variances – buyers´ perspective

		Levene Statistic	df1	df2	Sig.
Sub-questions	Based on Mean	1,382	4	190	,242
	Based on Median	,884	4	190	,475
	Based on Median and with adjusted df	,884	4	177,319	,475
	Based on trimmed mean	1,298	4	190	,272

Source: Autho)

Due to the fact, that its p-value – sig. > 0,05 we cannot conclude, that a significant difference exists. Furthermore, the Friedman two-way analysis of variance by ranks was used. Since the result of Friedman test is 0, the importance of all the questions is the same.
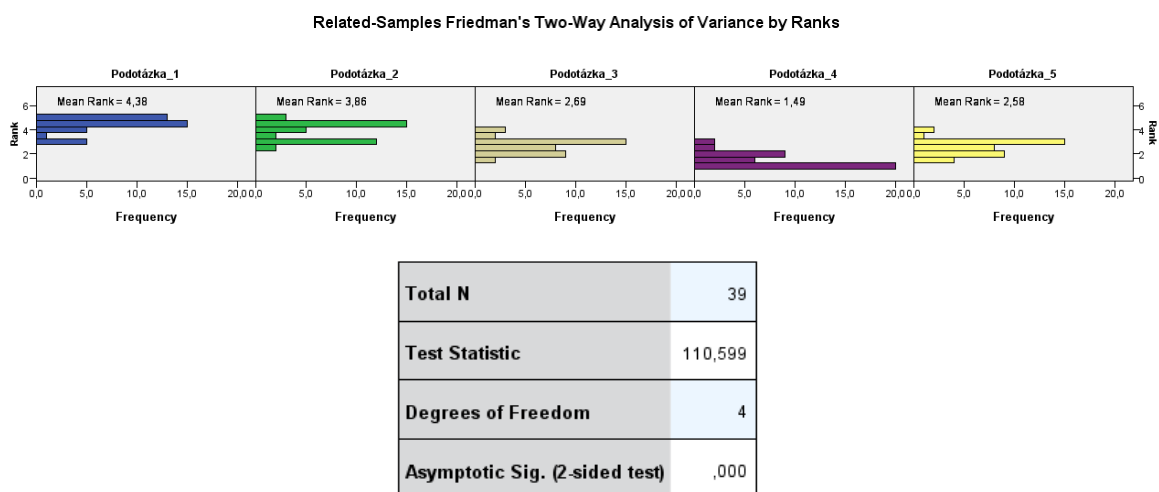

Figure 15: Hypothesis test summary

Figure 16:Friedman test (buyers´ perspective)

Furthermore, to be able to interpret the result as clearly as possible, the chart below demonstrates the median values of importance of all sub-questions. As a result, the most significant sub question is sub-question Nr. 4 (Claims, returned goods).
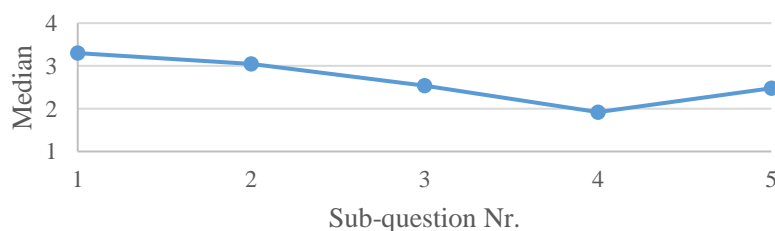
Figure 17: Sub-questions median values

3.6   Statistical evaluation of research

Chi-squared test of a pivot table summarizing all the information of all previous quantitative questions and responds according to company size – **determining an influence of the company size on the responds.**

A test was utilized - where p-value was determined by Monte Carlo method. 2000 thousand simulations were used when utilising this method. The test was provided by secondary function chi-square test of a sample "stats" in the "R" statistical software (R Development Core Team, 2017) (Hope, 1968).

In the table below, there are a statically significant values determining any relation between the company size and the responds.

Table 14: Analysis of relation between the company size and the research responds

Research questions	Chi-squared test	p-value
X1_Consignment stock policy implemented yes/no	*23,772*	*0,0005*
X2_Consignment stock policy provided for customer, by supplier or both ways	2,776	0,6062
X3_reasons for Consignment stock policy implementation	6,8553	0,1424
X4_further potential Consignment stock policy implementation yes/no/maybe	*18,637*	*0,0025*
X5_disadvantages from vendors perspective	*21,357*	*0,0005*
X6_disadvantages from buyers' perspective	*21,357*	*0,001*

Source: Author

As stated in the overview above – implementation of CS policy significantly depends on the company size as well as the potential of further CS policy implementation.

Rejection of the hypothesis H3: *Opinions on CS disadvantages of both buyers and vendors are not statistically significant*. Based on the research sample, opinions on CS disadvantages considered and evaluated from vendors and buyers point of views are statistically significant.

3.7 Consigned Inventory quantification and further prognosis

With regard to quantification of consigned inventory and its further prognosis, several organisations and institutions were contacted in order to find out, whether there is any tracking or any evidence of this concept specifically in the Czech Republic. Finally, Czech Statistical Office have been keeping and collecting data – Attachment A (Consigned inventory imported to the Czech Republic in 2009 – 2018) and Attachment B (Consigned inventory exported from the Czech Republic in 2009 – 2018). The thesis collected pieces of information which helped the author to analyse and evaluate CS inventory exported and imported from the Czech Republic and foreign countries (excluding CS inventory in the Czech Republic itself (relationship between consignor and consignee in the Czech Republic without any border crossing)). It is important to mention, that these values are exclusively related to the consigned inventory tracked within the international trade only. There was also a significant amount of consigned inventory produced and delivered within the Czech Republic, about which we were not able to find any information.

Main purpose of this subchapter is to either prove or deny a variable demand with regard to the international trade.

3.7.1 Consigned Inventory exported from the Czech Republic

At the beginning, the author focused on yearly differences between the amount and value of consigned inventory exported. The Tab. 15 below presents an overview of the amount and value of consigned inventory, which was exported from the Czech Republic between the years of 2009 and 2018. In the columns "difference" there are yearly differences between values. Column "Value KG/CZK" represents the value of 1 kg of exported Consignment inventory.

As we can see, the value of 1 KG rapidly increased in 2011 (66,4 CZK/KG). There is also a significant increase in 2017, followed by estimated exported value of Consignment inventory in 2018. Furthermore, the amount of exported Consigned Inventory drastically increased in 2012 in comparison to 2011 - the amount is almost triple than in 2011.

Table 15: CS items exported from the CR 2009-2018

Year	Amount of exported Consignment inventory (KG)	Difference Netto (kg)	Value of exported Consignment inventory (CZK)	Difference value CZK	Value KG/ CZK	All inventory exported (CZK)	Share of CS invent ory
2009	491 268 278	-	15 079 068 562	-	30,7	2 033 354	0,74 %
2010	685 980 845	0,40	22 385 231 594	0,48	32,6	2 334 842	0,96 %
2011	520 991 448	-0,24	34 599 972 179	0,55	**66,4**	2 570 941	1,35 %
2012	1 531 055 486	**1,94**	80 653 746 734	**1,33**	**52,7**	2 725 844	**2,96 %**
2013	1 037 023 151	-0,32	42 492 728 591	-0,47	41,0	2 786 229	1,53 %
2014	1 305 300 346	0,26	43 254 085 820	0,02	33,1	3 149 196	1,37 %
2015	1 443 588 688	0,11	47 069 642 634	**0,09**	32,6	3 262 971	1,44 %
2016	1 462 154 683	0,01	48 202 100 042	0,02	33,0	3 299 106	1,46 %
2017	1 034 118 515	-0,29	53 834 637 233	0,12	**52,1**	3 512 897	1,53 %
2018	1 118 555 139	0,08	57 516 900 677	0,68	51,4	unknown	-

Source: Author

In addition, share of exported consigned inventory and the total exported inventory, it is constantly between 0,7% and 1,53% apart from a significant raise (peak) in 2012 – where the consignment inventory reached almost 3% of the total inventory exported.

Another theme worth analyzing, is whether there is any relation between the exported consigned inventory value and the value of total inventory exported from the Czech Republic. **Using the correlation analysis, there was found the Pearson coefficient in the value of 0,56 proving a moderate positive correlation between these two trades´ values.** This means, that this trend in the total imported inventory may indicate the trend in probable consigned inventory amount.

Table 16: Correlation analysis result

Value of Inventory exported (CZK)	Consigned inventory exported	Inventory exported in total
Consigned Inventory exported	1	-
Inventory exported in total	**0,56**	1

In addition, forecasting potential further trend in consigned inventory, a scatter chart was used in order to find out a trend - the exponential regression providing the highest value of the confidence interval - in the value of 0,48 as demonstrated in the Fig. 19 below.

Figure 18: Scatter Chart - exported consigned inventory correlation analysis

$$y = 8E\text{-}93e^{0,1106x}$$
$$R^2 = 0,4829$$

.
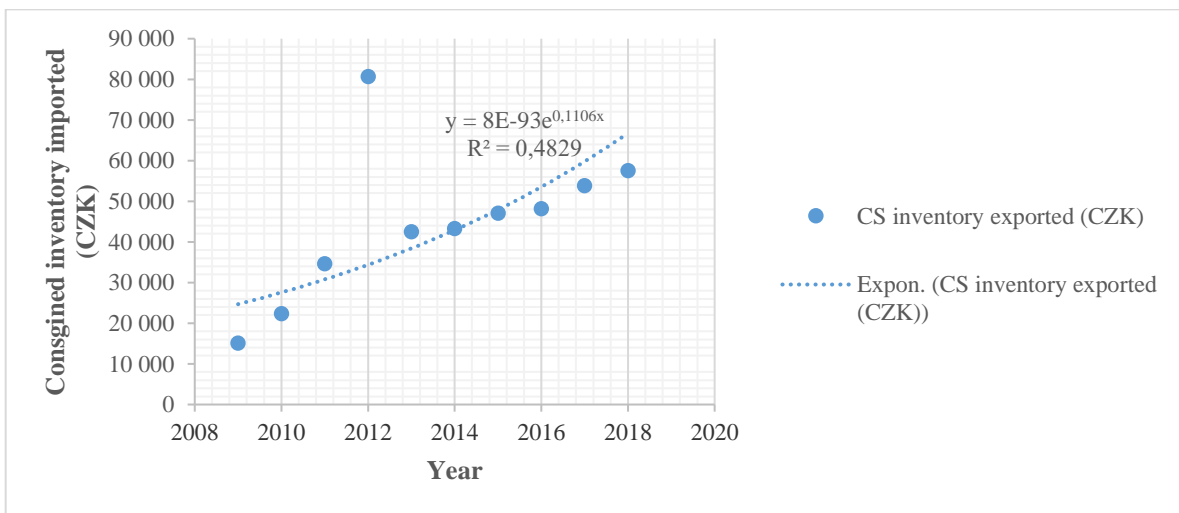
3.7.2   Consigned Inventory imported to the Czech Republic

On the contrary, the Tab. 17 below demonstrates values of IMPORTED Consigned inventory – in KG and its value in CZK. between the years 2009 and 2018. The main purpose of this subchapter is not to analyse and explain peaks and drops of the values in the table below. The main purpose is to find whether there is any relationship between the imported consigned inventory and the total imported inventory into the Czech Republic.

Table 17: CS items imported into the CR 2009-2018

Year	Amount of imported Consignment inventory (KG)	Difference Netto (kg)	Value of imported Consignment inventory (CZK)	Difference value CZK	Value KG/CZK	All inventory imported (CZK)	Difference	Share of CS inventory
2009	227 277 962	-	22 444 483 067	-	98,75	1 938 006	-	1,16%
2010	276 443 102	0,22	25 978 373 613	0,16	93,97	2 273 929	0,17	1,14%
2011	558 062 309	1,02	46 100 531 202	0,77	82,61	2 473 042	0,09	1,86%
2012	1 751 113 204	**2,14**	153 864 706 240	**2,34**	87,87	2 575 371	0,04	**5,97%**
2013	906 333 975	**-0,48**	58 079 970 612	**-0,62**	64,08	2 588 423	0,01	2,24%
2014	1 028 254 332	0,13	61 105 656 358	0,05	59,43	2 899 972	0,12	2,11%
2015	1 434 193 660	0,39	72 457 745 663	0,19	50,52	3 017 011	0,04	2,40%
2016	1 956 443 574	0,36	74 309 035 806	0,03	37,98	3 022 500	0,00	2,46%
2017	1 280 162 438	**-0,35**	83 162 715 612	0,12	64,96	3 349 431	0,11	2,48%
2018	1 417 376 763	0,11	77 144 980 936	-0,07	54,43	unknown	-	-

Source: Czech Statistical Office

Apart from information in columns amount and value of consigned inventory imported to the Czech Republic, there is also information about the value of 1 KG. Furthermore, the column "Share of CS inventory" represents the share of CS inventory of the total imported inventory value – which is between 1 up to 6% between the years 2009 and 2018. In 2012 there was the highest share of consignment inventory imported – 6% of the total value of imported inventory.

Moreover, when analysing the relationship between the value of imported consigned inventory and value of total imported inventory, using correlation analysis helped to determine **a positive moderate correlation**.

Table 18: Correlation analysis result

	CS inventory imported	*All inventory imported*
CS inventory imported	1	
All inventory imported	**0,44**	1

Correlation analysis was used as another method of imported inventory analysis. The Scatter chart below provides a **polynomial regression** providing the highest value of the confidence interval - in the value of **0,39**.
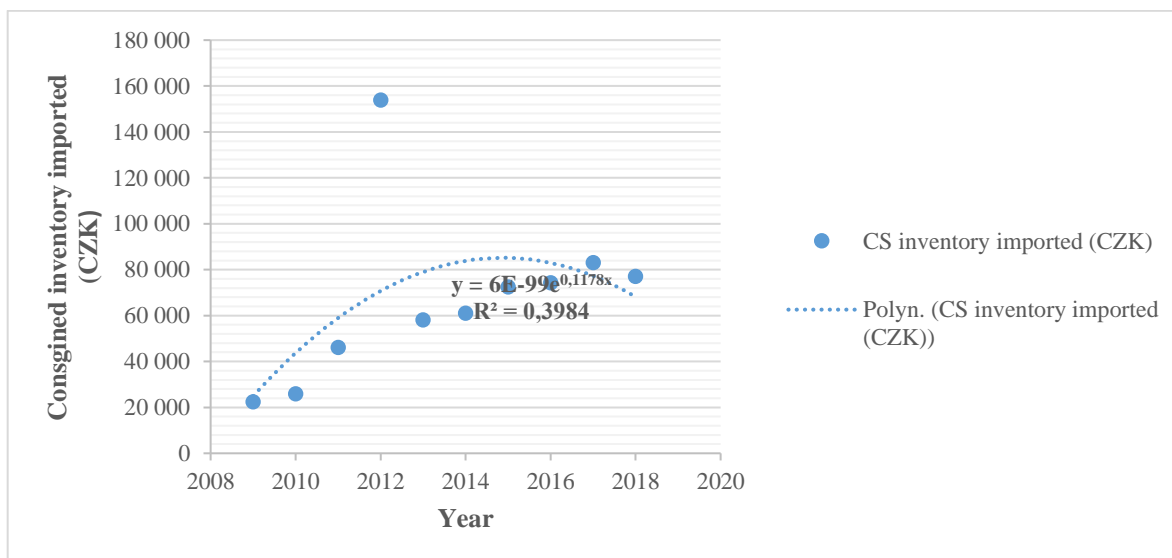
Figure 19: Scatter Chart - imported consigned inventory correlation analysis

Summary of the quantitative research

In this subchapter, there was consigned inventory related to international trade quantified. The collected information was analysed in order to identify the current trend in imported and exported amount of consigned inventory and forecast further possible trends in consigned inventory.

Partial **confirmation of hypothesis H4:** *In recent years, storage of the vendor's inventory at the buyers' warehouse as consignment stock (CS) has increased in popularity (Gharei, Karimi, Shekarabi, 2019).*

Exported consigned inventory – there was a medium positive correlation between the value of consigned exported inventory and the total exported inventory. Therefore, based on potential exported inventory values, this may indicate further potential trend of consigned exported inventory. Furthermore, based on amount consigned inventory analysis, **exponential regression** was identified. This means that there is possibly an increasing trend in possible value exported consigned inventory. Hence, with regard to value of exported consigned inventory there is mainly an increasing trend of amount exported. Therefore, **in the case of export, the hypothesis H4 is partially confirmed.** The value of expected consigned inventory may be increasing.

Imported consigned inventory – even with regard to value of imported consigned inventory and value of total imported inventory, a positive moderate correlation was found out. This means that the total inventory forecast can also indicate forecasting of consignment inventory import for following periods. The consigned inventory imported was analysed separately and a **polynomial regression** was found out, indicating significantly possible various trend in following periods of time. **In the case of imported consigned inventory**, due to polynomial regression found out, the trend varies and therefore it is **not possible to confirm the hypothesis H4 in relation to imported consigned inventory**, as well as in relation to any other supplies of consigned inventory within the Czech Republic, which information are not being collected about. To sum this overview up, the hypothesis H4 in relation to value to the international trade the hypothesis cannot be fully confirmed.

4. Identification and evaluation of risks related to the Consignment stock implementation

In this part of the research, it was necessary to identify all possible risks related to the consignment stock policy implementation. At first, there were all risks found out at literature review summarized (first part of subchapters - Risks identification). Then all these summarized risks were presented to the specialists in order to discuss, whether there are any other potential risks missing from both vendors´ and buyers´ perspective. For this purpose, there were following interviewed - 6 respondents of the quantitative survey in Chapter 2 agreed to participate a qualitative research – 3 representatives of the CS implementation from the vendor´s perspectives and 3 people representing the buyer´s perspective. Each interview took approx. 15-20 minutes.

These representatives had to meet several conditions set by the author, such as having a practical experience with the whole CS implementation and further utilisation; managing title at that logistic department of the company in order to have a more strategic perspective about the whole process. Furthermore, other 2 specialists from a university environment having a wide knowledge about supply chain and consignment stock in particular agreed to participate on these interviews. These representatives had to meet several conditions set by the author, like University degree in the area of logistics, having a large knowledge about supply chain specifications and CS policy as a part of a subject taught by this representative.

In the following phase dealing with risks identification, all the risks will be classified into few larger groups of risks based on classification presented by Hudnurkar, Deshpande, Rathod, Jakhar (2017).

4.1 Overall risks from buyers' perspective

First of all, we will focus on risks identification from buyer´s perspective. These risks were collected and therefore identified using 3 main methods – Czech and foreign literature review, quantitative research and interviews with specialists from both academic and business environment of potential CS policy implementation.

4.1.1 Risks identification

Below, there are consignment stock implementation risks which were already mentioned in the theoretical part of the dissertation by the following authors Battini (2010), Richards, Grinsted (2016), Ross (2018), Sarker (2014), Sodhi, Thang (2012), Zahran, Jabel, Zanini, Zavanella (2015), Wild (2017):

- Physical loss, damage, theft, or defect;
- Unused, unsold, or expired products;
- Overstocking or duplicate inventories;
- Damage in the customer´s warehouse;
- Shifts in demand/obsolescence;
- Price fluctuation;
- Increasing carrying costs;
- Partner Choice and selection of items suitable for a CS policy;
- Items standardisation, data alignment, recognizable inventory, record of the inventory phasing in and out, discrepancies in records;
- Data Warehousing modality choice: centralization/decentralisation rate, physical location, warehousing and distribution modalities;
- Optimal delivery quantity computation: q;
- Setting of the stock levels: s, S possibly leading to too high stock levels;
- Process of stock setting at zero start-up;
- Supply criticalities (variable lead times, delayed supplies, high geographic distance vendor-buyer, etc.);
- Disputes over unrecorded usages and claims.

Secondly, according to the quantitative research, all respondents agreed with real or possible appearance of above-mentioned risks identified at available literature resources. Moreover, there were additional following risks identified by above mentioned specialists from both practical and academic environment enlarging the range of identified risks by above mentioned authors:

- Potential of stock outs;
- Not sufficient adaptability and knowledge about the CS system;
- Not clarified competences between the vendor and the buyer;
- Costs of express transport in case of any delay in deliveries (depending on Incoterms agreed);
- Underestimated financial backing of vendor;
- Laziness or negligence on the part of the supplier, staff detests the CS policy to get used to it;
- Technical setting of the consignment inventory evidence – new system of evidence of incoming and consumed inventory;
- Problems with data exchange (current level or inventory, providing forecast of the CS items);
- Difficulties in accounting, handling and tracking of CS inventory -> danger of increased labor costs and double handling;
- Stock and accounting errors due to side step the normal inventory processes;
- EDI implementation and its coordination with existing buyers/vendors CRM system;
- Vendors and buyers CRM systems connections;
- Political, economic, social, legislative, climate situation/changes;
- Incoterms – cost for express deliveries;
- Personnel not willing to cooperate under the CS policy;
- Dependency on key supplier/consignor;
- Financial instability of financial failure.

4.1.2 Risks classification

All identified risks from above were divided into 2 major groups – according to the applicable influence – which risks are influenceable and non-influenceable (which will not be subjected to any further examination in this thesis) risks.

Moreover, the influenceable risks were then based on Hudnurkar, Deshpande, Rathod, Jakhar (2017) classification (clarified and explained in Chapter **1.3.1   Types of Supply Chain Risks)** classified into 8 major groups of risks – demonstrated in the Tab. 19 below:

Table 19:Risks classification from buyers´ perspective

Influenceable risks	Non-influenceable risks
1. Transportation and logistics risks This group of risks include any discrepancies caused during or due to transportation and any other actions taken in relation to the flow of goods from suppliers to buyers' consignment stock. Examples: Damage during transportation, insufficient packaging, Transport delay or Demand volatility. **2. Product Characteristics** This group of risks is related to product characteristics such as risks with delivered Product Quality, defects, obsolescence etc. **3. Manufacturing risks** Manufacturing facilities risks include any risks related to the manufacturing process such as capacity, Flexibility, Forecasting. **4. Financial risks** This is a large group of risks related to any potential financial risks such as suppliers Insolvency, Financial instability of financial failure, Exchange rate, Increasing carrying costs or customer default/credit risks in general.	- Shifts in demand - Price fluctuation - Underestimated financial backing of vendor - Laziness or negligence on the part of the supplier, staff detests the CS policy to get used to it - Political, economic, social, legislative, climate situation/changes - Natural disasters - Regulatory changes - Tax, quotas, duties - Strikes

5. Human Resources Risks

These risks are very closely related to the human factor in the whole consignment stock policy and its implementation process. There are examples of following possible risks - difficulties in accounting, handling and tracking of CS inventory e.g. danger of increased labor costs and double handling or personnel not willing to cooperate under the CS policy

6. Warehousing risks

Warehousing risks are related to any of the environment of consignment stock, where following risks may appear - physical loss, damage, not sufficient warehouse conditions, discrepancies in records.

7. Information system risks

Information systems are an essential part not just of the implementation process. Following risks may relate to the Consignment stock policy – problems with Vendors and buyers CRM systems connections and data exchange (current level or inventory, providing forecast of the CS items), Technical setting of the consignment inventory evidence.

8. Implementation process risks

Furthermore, there is a separate group or risks related primarily to the process of CS implementation itself considering MIN and MAX version of CS – setting all the process and getting used to the new concept of deliveries. There are many risks included in this group – following risks may appear - Setting of the stock levels: s, S possibly leading to too high stock levels, Optimal delivery quantity computation, starting delivering into the CS at zero point and many more.

Source: Author

4.1.3   Risks evaluation

For the purpose of examining the importance of each of the identified risks separately from the vendors´ and buyers´ perspective, the Saaty method of metacriterion analysis was used. Calculation of criterion importance is obtained with the aid of Saaty matrix associated with several practitioners. Therefore, each matrix below is amended by i-th practitioner.

Respondents were asked to evaluate the above mentioned risks from 2 different point of views – the likehood (the probability of an event occurring) and the impact (or outcome of an event) of those risks clarified and demonstrated in **Figure 8: Probability impact matrix** presented by Kirilmaz, Erol (2017) in the sub chapter 1.3.3 Risk management process . There were 4 respondents asked to provide us with filled form on pairwise comparison – 3 representatives of all company sizes (small, medium, large) and 1 representative from the academic area.

Table 20: Saaty Matrix – identified risks evaluation

Risks evaluation by specialist	Transp. risks	Product Charact. Risks	Finan cial risks	Manufa ct. facilitie s risks	Human Resource s Risks	Wareh ousing risks	Inf. syste m risks	Imple ment. process risks
Transport. risks	1							
Product Charact. Risks		1						
Financial risks			1					
Manufact. facilities risks				1				
Human Resources Risks					1			
Warehousin g risks						1		
Inf. system risks							1	
Implement. process risks								1

Source: Author

In the Tab. 21, there is a risk importance calculation template which will be used for both point of views – the likehood and the impact of this groups of risks.

Table 21: Risks importance calculation by i-th practitioner

Risks evaluation by specialist	R_1	R_2	...	R_{k-1}	R_k	$Si = \prod_{j=1}^{k} Sij$	$Rij = \sqrt[k]{Si}$	$vi = Ri / \sum_{i=1}^{k} Ri$
R_1	1							
R_2		1						
...			1					
R_{k-1}				1				
R_k					1			
						$\sum_{i=0}^{k} Ri$		1

Source: Author

A. Risks consequences evaluation

For the purpose of this research, an online calculator was used for easies evaluation of pairwise comparison. All interviewers were given a URL address with the prepared FORM to fill. This online Saaty pairwise comparison example can be found in the Appendix E.

Table 22: Risks consequences evaluation by 1st practitioner

Risks evaluation by specialist 1	R_1	R_2	R3	R4	R5	R6	R7	R8	$Si = \prod_{j=1}^{k} Sij$	$Rij = \sqrt[k]{Si}$	$vi = Ri / \sum_{i=1}^{k} Ri$
R_1	1,00	1,00	0,17	1,00	0,33	2,00	4,00	3,00	1,33	1,04	0,0979
R_2	1,00	1,00	0,25	3,00	0,17	4,00	3,00	1,00	1,50	1,05	0,0994
R3	6,00	4,00	1,00	4,00	1,00	3,00	6,00	4,00	6912,00	3,02	0,2852
R4	1,00	0,33	0,25	1,00	0,20	3,00	2,00	2,00	0,20	0,82	0,0772
R5	3,00	6,00	1,00	5,00	1,00	5,00	6,00	3,00	8100,00	3,08	0,2909
R6	0,50	0,25	0,33	0,33	0,20	1,00	2,00	0,25	0,00	0,44	0,0415
R7	0,25	0,33	0,17	0,50	0,17	0,50	1,00	0,33	0,00	0,34	0,0324
R8	0,33	1,00	0,25	0,50	0,33	4,00	3,00	1,00	0,17	0,80	0,0755
									$\sum_{i=0}^{k} Ri$	10,59	1

Source: Author

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The specialists were asked to send back the results (csv. file) counted and generated by this online software – example in Appendix F.

The Tab. 23 below demonstrates the results of all separate Saaty matrixes of all the specialists pairwise comparing all the groups risks identified, including the results from the Tab. 22 above – marked in the table below as Specialist´s 1 opinion. results, in the column Rank, are the results of ranking according the consequences resulting from the risks.

Table 23: Risks consequences - buyers´ perspective

Risks consequences From buyers´ perspective		Specialist 1	Specialist 2	Specialist 3	Specialist 4	Average	RANK
R1	Transport. risks	0,0979	0,1913	0,0531	0,0558	0,0995	6
R2	Product Charact. Risks	0,0994	0,0979	0,1021	0,1207	0,1050	4
R3	**Financial risks**	0,2852	0,1316	0,2263	0,0980	0,1853	3
R4	**Manufact. facilities risks**	0,0772	0,2294	0,1836	0,3023	0,1981	2
R5	**Human Resources Risks**	**0,2909**	0,2022	0,1836	0,1919	0,2172	1
R6	Warehousing risks	0,0415	0,0511	0,0828	0,0878	0,0658	7
R7	Inf. system risks	0,0324	0,0233	0,0408	0,0297	0,0316	8
R8	**Source and Implement. process risks**	0,0755	0,0733	0,1279	0,1138	0,0976	5

Source: Author

According to ranking demonstrated in the Tab. 23, the most critical risks of all are associated with the Human resources risks, Manufacturing facilities risks and Financial risks.

B. Risks likehood evaluation

In the table below, the same procedure as in the Tab. 21 is demonstrated – risks are evaluated from the likehood point of view.

Table 24: Likehood risks evaluation from buyers´ perspective

Likehood Risks evaluation by specialist 1	R$_1$	R$_2$	R$_3$	R$_4$	R$_5$	R$_6$	R$_7$	R$_8$	$Si = \prod_{j=1}^{k} Sij$	$Rij = \sqrt[k]{Si}$	$vi = Ri/\sum_{i=1}^{k} Ri$
R$_1$	3,00	0,50	2,00	0,33	1,00	4,00	2,00	3,00	8,00	1,30	0,1305
R$_2$	1,00	0,33	0,50	0,50	3,00	4,00	3,00	1,00	1,00	1,00	0,1006
R$_3$	3,00	1,00	3,00	2,00	5,00	7,00	2,00	3,00	2520,00	2,66	0,2678
R$_4$	2,00	0,33	1,00	0,33	2,00	5,00	2,00	2,00	2,22	1,10	0,1112
R$_5$	2,00	0,50	3,00	1,00	4,00	6,00	3,00	2,00	648,00	2,25	0,2260
R$_6$	0,33	0,20	0,50	0,25	1,00	5,00	1,00	0,33	0,04	0,67	0,0676
R$_7$	0,25	0,14	0,20	0,17	0,20	1,00	0,20	0,25	0,00	0,24	0,0244
R$_8$	0,33	0,50	0,50	0,33	1,00	5,00	1,00	0,33	0,07	0,72	0,0721
									$\sum_{i=0}^{k} Ri$	9,94	1

Source: Author

All the separate pairwise evaluations are collected into the Table 25 below. As demonstrated in the previous procedure with consequences of ranking - also in the table below, there are all the risks ranked according to the likehood evaluation – specialists consider as the most frequent following risks: Human resources risks, Manufacturing facilities risks and Product characteristics risks.

Table 25: Likehood risks evaluation from buyer´s perspective overview

Risks evaluation by specialists LIKEHOOD		Specialist 1	Specialist 2	Specialist 3	Specialist 4	Average	Rank
R_1	Transport. risks	0,1305	0,1701	0,1211	0,1251	0,1367	4
R_2	Product Charact. Risks	0,1006	0,2187	0,1141	0,1346	0,1420	3
R_3	Financial risks	0,2678	0,0683	0,0886	0,0663	0,1228	5
R_4	Manufact. facilities risks	0,1112	0,1725	0,2298	0,1601	0,1684	2
R_5	Human Resources Risks	0,2260	0,2237	0,2003	0,1499	0,2000	1
R_6	Warehousing risks	0,0676	0,0911	0,1685	0,1236	0,1127	6
R_7	Inf. system risks	0,0244	0,0186	0,0214	0,0253	0,0224	8
R_8	Implement. process risks	0,0721	0,0370	0,0561	0,2151	0,0951	7

Source: Author

Consistency ratio was in all cases between the values of 6-9%. Based on above mentioned rankings, the results were imported into the resulting in placing particular risks into extreme (red coloured), high, moderate or low (green coloured) importance of the risks. Based on the analysis above, the results of all found out rakings are presented in the Tab. 26 below.

Table 26: Risk matrix from buyers´ perspective

		CONSEQUENCES				
	Ranking	5	4	3	2	1
LIKEHOOD	1					R5
	2				R4	
	3		R2			
	4					
	5			R3		

Extreme High Moderate Low

Source: Author according to Kersten (2014)

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As demonstrated in the Tab 26 above, there were 2 most critical or rather extreme risks identified – R4 Manufacturing facilities risks and R5 Human Resources Risks. This means that it is crucial for buyers to have always enough stock in the consignment stock in order to avoid any manufacturing interruptions etc. Furthermore, they also provided us with feedback, that the risks caused by human element are also very frequent and may cause serious difficulties.

There were also high risks identified when comparing their consequences and likehood – R2 Product Characteristics Risks and R3 Financial risks.

R1, R6, R7 and R8 were not considered as much important as the risks R4, R5 and R2 and R3:

- R1 – Transportation risks – consequences rank 6 and frequency rank 4;
- R6 - Warehousing risks - consequences rank 7 and frequency rank 6;
- R7 – Inf. system risks - consequences rank 8 and frequency rank 8;
- R8 - Implement. process risks - consequences rank 5 and frequency rank 7.

Based on this analysis, there will be recommendations and proposal for risks elimination focusing on these 2 risks identified as extremely important.

4.2 Overall risks from vendors' perspective

As well as in the Chapter 4.1 where we discussed risks from the buyers´ perspective, there will be identified, classified and evaluated the risks from the vendors´ perspective

4.2.1   Risks identification

Below, there are the risks which we identified from the vendor's perspective. These risks have already been summarized in the theoretical part of this thesis by following authors: Battini (2010), Richards, Grinsted (2016), Ross (2018), Sarker (2014), Sodhi, Thang (2012), Zahran, Jabel, Zanini, Zavanella (2015), Wild (2017):

- Physical loss, damage, theft, or defect
- Unused, unsold, or expired products
- Delay in payments
- The consignor's cash flow may suffer as more money is spent on manufacturing the goods
- Shifts in trade demand technology or in consumer preference
- Risk of overstocking or duplicate inventories
- Risk of damage in the customer´s warehouse
- Stockholding cost of items supplied which do not have immediate use
- Partner Choice
- Selection of items not suitable for a CS policy
- Items standardisation and data alignment, disputes over unrecorded usages
- Data Warehousing modality choice: centralization/decentralisation rate, physical location, warehousing and distribution modalities
- Optimal delivery quantity computation: q
- Setting of the stock levels: s, S – min level could be too low, MAX level (S) too high, space between s and S could be too wide
- Increased inventory in the supply chain
- Make it difficult to operate the phasing in and out of products
- Duplicate back-up stock in suppliers´ stores

- Forecasting of probable inventory demand
- Change in technology or in consumer preference

Also, in the vendor´s perspective, according to the quantitative research, all respondents agreed with a real or possible appearance of above-mentioned risks identified in the available literature resources. Moreover, there were additional following risks enlarging the range of identified risks by above mentioned authors:

- Costs to physically store, warehouse and move parts;
- Claims of supplied items;
- Potential of stock outs;
- Not sufficient adaptability and knowledge about the CS system;
- Financial losses vs finances lost in case of low moving goods;
- Not clarified competences between the vendor and the buyer;
- Costs of express transport in case of any delay in deliveries (depending on Incoterms);
- Extended periods for payments of merchandise sold;
- Technical setting of the consignment inventory evidence – new system of evidence of incoming and consumed inventory;
- Setting of the manufacturing process according to the consignment policy rules (intermediate products, interim storage, raw materials orders if necessary);
- Additional costs associated with risk mitigation measures;
- Problems with understanding of a platform where the current situation and a forecast of the CS items is;
- Staff detests the CS policy to get used to it;
- Risk of losing capital investment associated with the CS;
- Chance of discrepancies could lead to lost profit of distrust in the relationship between consignor and consignee;
- Increased finance costs and holding costs due to slow movement;
- Difficulties in accounting, handling and tracking of CS inventory -> danger of increased labor costs and double handling;

- Chances of stock and accounting errors due to side step the normal inventory processes;
- EDI implementation and its coordination with existing buyers/vendors CRM system, vendors and buyers CRM systems connections;
- The whole system and cooperation setting;
- Decrease in the trade demand of the final items which influencers both – the supplier and the buyer;
- Political, economic, social, legislative, climate situation/changes;
- Innovative competitors;
- Financial instability of financial failure.

4.2.2   Risks classification

The risks identified by vendors are listed in the Tab. 27 below and they are classified into following groups, mostly based on the source form which the potential risks are likely to occur. The above identified risks were also divided into 2 primary groups – influenceable and non-influenceable risks.

Table 27: Risks classification from the vendors´ perspective

Influenceable risks	Non-influenceable risks
1. Transportation risks This group of risks may be identical from vendors' and buyers' perspectives. However, the responsibilities for logistics and transportation discrepancies depends on Incoterms agreed between the consignor and the consignee. However, the most critical risks identified are the following: Damage during transportation, Transport delay and Transportation disruptions with inbound supply channels in general. **2. Product Characteristics Risks** Product Characteristics Risks are typically risks related to the quality of delivered items, defects or obsolescence. **3. Financial risks** This group of risks is very closely related to essential risks such as delayed payments from buyer, currency rate and material price fluctuations, Increasing carrying costs or financial instability of financial failure in general. **4. Manufacturing facilities risks** These risks include any potential inconvenience related to Capacity, Potential of stock outs and with regard to CS implementation also setting of the manufacturing process according to the consignment policy rules (intermediate products, interim storage, raw materials orders - if necessary).	- Physical loss, damage, theft, or defect at consignment stock - Delay in payments - Shifts in trade demand technology or in consumer preference - Risk of damage in the customer´s warehouse - Forecasts quality of probable inventory demand - Change in technology or in consumer preference - Decrease in the trade demand of the final items which influencers both – the supplier and the buyer - Political, economic, social, legislative, climate situation/changes - Natural disasters - Regulatory changes - Tax, quotas, duties - Strikes

5. Human Resources Risks

Human Resources Risks play a significant role and can have a crucial impact not just on the CS implementation and further utilization. There are the following examples of potential risks - personnel not willing to cooperate under the CS policy, not sufficient adaptability and knowledge about the CS system, problems with understanding of a platform where the current situation and a forecast of the CS items is or staff detests the CS policy to get used to it.

6. Warehousing risks

These risks are related to any discrepancies when storing the consigned inventory. There are the following examples of potential risks such as physical loss, damage, theft, or defect, not sufficient recognition of consigned inventory, record of the inventory phasing in and out.

7. Information system risks:

Information system of both parties in the CS policy are very important to consider their cooperation and connection in general. There are the following risks to mention as examples such as stock and accounting errors due to side step the normal inventory processes, EDI implementation possibly required, problems with data exchange, technical setting of the consignment inventory evidence – new system of evidence of incoming and consumed inventory and many more.

8. Source and Implementation process risks

This group includes risks related to the implementation process of CS policy and also any risks related to supplier´s risks.
CS implementation has several phases and most of them may appear in a difficult position facing several risks from the preparatory phase (choosing the right partner, inventory item for CS implementation) and also form the utilization phase. There are the following risks as examples of potential risks- process of stock setting at zero start-up, setting of the stock levels: s, S possibly leading to too high stock levels, not clarified competences between the vendor and the buyer.

Source: Author

4.3.3 Risks evaluation

For the purpose of examining the importance of each of identified risks separately from the vendor´s and buyer´s perspective, the Saaty method of metacriterion analysis was used. Calculation of criterion importance is obtained with the aid of Saaty matrix - associated with several practitioners. Therefore, each matrix below is amended by i-th practitioner.

Furthermore, there will be the same process as from the buyer's perspective – to find evaluate the risks in relation to potential consequences and likehood of occurring these risks.

A. Risks consequences evaluation

The Tab. 21 below demonstrates the example of pairwise evaluation of Specialist 1 – evaluating risk's consequences from the vendor´s perspective.

Table 28: Risks consequences evaluation by 1st practitioner from vendors´ perspective

Risks evaluation by specialist 1	R_1	R_2	R3	R4	R5	R6	R7	R8	$Si = \prod_{j=1}^{k} Sij$	$Rij = \sqrt[k]{Si}$	$vi = Ri/ \sum_{i=1}^{k} Ri$
R_1	1,00	0,50	0,20	0,33	1,00	3,00	5	2	1,00	1,00	0,0959
R_2	2,00	1,00	0,25	1,00	2,00	4,00	8	3	96,00	1,77	0,1697
R3	5,00	4,00	1,00	5,00	3,00	2,00	8	3	14400,00	3,31	0,3175
R4	3,00	1,00	0,20	1,00	2,00	2,00	6	3	43,20	1,60	0,1536
R5	1,00	0,50	0,33	0,50	1,00	1,00	8	3	2,00	1,09	0,1046
R6	0,33	0,25	0,50	0,50	1,00	1,00	8	2	0,33	0,87	0,0836
R7	0,20	0,13	0,13	0,17	0,13	0,13	1	0,2	0,00	0,19	0,0181
R8	0,50	0,33	0,33	0,33	0,33	0,50	5	1	0,02	0,59	0,0569
									$\sum_{i=0}^{k} Ri$	10,43	1

The Tab. 29 below demonstrates results and indicates ranking based on average values resulted from specialist's pairwise evaluations.

Table 29: Risks consequences evaluation - vendors´ perspective

Risks evaluation by specialists		Specialist 1	Specialist 2	Specialist 3	Specialist 4	Average	Rank
R1	Transport. risks	0,0959	0,1094	0,1051	0,2000	0,13	5
R2	Product Charact. Risks	0,1697	0,2155	0,1188	0,1914	0,17	2
R3	Financial risks	0,3175	0,2514	0,2628	0,2306	0,27	1
R4	Manufact. facilities risks	0,1536	0,1525	0,1566	0,0867	0,14	3
R5	Human Resources Risks	0,1046	0,1239	0,1610	0,1382	0,13	4
R6	Warehousing risks	0,0836	0,0630	0,0823	0,0635	0,07	6
R7	Inf. system risks	0,0181	0,0201	0,0250	0,0403	0,03	8
R8	Source and Implement. process risks	0,0569	0,0642	0,0884	0,0492	0,06	7

Source: Author

As demonstrated in the table above, the most critical consequences were based on ranking identified in case of R1 Financial risks, R2 Product Characteristic Risks and R4 Manufacturing facilities risks.

B. Risks likehood evaluation

Tab. 30 below demonstrates example of Specialist´s 1 pairwise comparison of risks likehood occurrence from vendors´ perspective.

Table 30: Likehood risks evaluation from vendors´ perspective

Risks evaluation by specialist 1	R_1	R_2	R3	R4	R5	R6	R7	R8	$Si = \prod_{j=1}^{k} Sij$	$Rij = \sqrt[k]{Si}$	$vi = Ri / \sum_{i=1}^{k} Ri$
R_1	1,00	3,00	2,00	1,00	1,00	2,00	6,00	2,00	144,00	1,86	0,1966
R_2	0,33	1,00	4,00	0,33	0,25	3,00	6,00	2,00	4,00	1,19	0,1256
R3	0,50	0,25	1,00	0,50	0,33	0,50	5,00	0,33	0,02	0,60	0,0636
R4	1,00	3,00	2,00	1,00	1,00	3,00	5,00	3,00	270,00	2,01	0,2126
R5	1,00	4,00	3,00	1,00	1,00	2,00	3,00	2,00	144,00	1,86	0,1966
R6	0,50	0,33	2,00	0,33	0,50	1,00	3,00	2,00	0,33	0,87	0,0921
R7	0,17	0,17	0,20	0,20	0,33	0,33	1,00	0,50	0,00	0,30	0,0314
R8	0,50	0,50	3,00	0,33	0,50	0,50	2,00	1,00	0,12	0,77	0,0814
									$\sum_{i=0}^{k} Ri$	9,47	1

Source: Author

Tab. 31 below demonstrates results of all 4 specialists pairwise comparisons of likehood.

Table 31: Likehood risks evaluation from vendors´ perspective overview

Risks evaluation by specialists		Specialist 1	Specialist 2	Specialist 3	Specialist 4	Average	Rank
R1	Transport. risks	0,1966	0,2088	0,1822	0,0878	0,17	3
R2	Product Charact. Risks	0,1256	0,2196	0,0920	0,2823	0,18	2
R3	Financial risks	0,0636	0,1984	0,0537	0,0610	0,07	5
R4	Manufact. facilities risks	0,2126	0,1411	0,2216	0,1473	0,18	1
R5	Human Resources Risks	0,1966	0,0965	0,1253	0,2012	0,18	4
R6	Warehousing risks	0,0921	0,0652	0,0798	0,0822	0,08	6
R7	Inf. system risks	0,0314	0,0343	0,0522	0,0375	0,04	7
R8	Source and Implement. process risks	0,0814	0,0361	0,1932	0,1006	0,10	5

Source: Author

As a conclusion of these pairwise comparisons, the Tab. 32 below demonstrates the level of criticalities of identified and evaluated risks.

Table 32: Risks matrix from vendor´s perspective

	Rank	CONSEQUENCES				
		5	4	3	2	1
LIKEHOOD	1			R4		
	2				R2	
	3					
	4	R1				
	5		R5			

Source: Author according to Kersten (2014)

There were 2 the most critical risks identified – R2 Product Characteristics Risks and R4 Manufacturing facilities risks comparing the likehood and consequences of all the groups of risks presented.

All the other risks of the groups were not considered as critical as the 2 above mentioned when comparing their likehood and consequences resulting from these risk's possible appearance:

- R1 - Transport. Risks - consequences rank 5 and frequency rank 4;
- R3 - Financial risks - consequences rank 1 and frequency rank 6;
- R5 - Human Resources Risks - consequences rank 4 and frequency rank 5;
- R6 - Warehousing risks - consequences rank 6 and frequency rank 7;
- R7 - Inf. system risks - consequences rank 8 and frequency rank 8;
- R8 - Source and Implement. process risks - consequences rank 7 and frequency rank 3;

Based on this analysis, we will propose some recommendations for the risks elimination targeted on these 2 risks identified as extremely dangerous.

4.3 Summary of the most critical risks

In this chapter we identified the following risks as the most critical from the suppliers and customers perspective, based on consideration of evaluation frequency, its occurrence and also the significance of the consequences of these risks.

Below in the Tab. 33, there is an overview of risks, indicated as the most critical ones.

Table 33: Risks evaluation summary

Risks evaluation by specialists		Buyers	Vendors
R1	Transport. risks		✓
R2	Product Characteristic Risks	✓	✓
R3	Financial risks	✓	
R4	Manufact. facilities risks	✓	✓
R5	Human Resources Risks	✓	✓
R6	Warehousing risks		
R7	Inf. system risks		
R8	Source and Implement. process risks		

Extreme   Iigh   Moderate   Low

Source: Author

All specialists agreed on the R4 – Manufacturing facilities risks – to be the most critical for both vendors and buyers. Furthermore, there were Human Resources risks additionally considered as the most critical from the buyer's point of view and Product Characteristics risks considered as the most critical from the vendor's perspective.

In the following chapter, all these findings summarized in the Tab. 33 will be proposed as a set of recommendations, which may help to reduce or even eliminate the most critical risks discovered.

5 Elimination of risks related to the Consignment stock concept implementation

According to the identified risks, there are the following measures recommended in order to eliminate or completely avoid risks mentioned above. In the previous chapter, risks related to the consignment stock implementation were identified. Furthermore, this chapter presents a deeper understanding of those separate risks and finds solutions for these risk's elimination.

5.1 From the buyer's perspective

Based on methods used for CS risks identification, followed by Saaty method used for pair comparison, there were 2 the most harming risks found out. Proposal for these risk's prevention, minimization and elimination are presented in following 2 subchapters.

5.1.1 Human Resources Risks

Universally speaking, risks related to Human Resources risks may have a significant impact not just on the CS implementation but also on further utilization. As mentioned in the previous chapter, the following risks may appear - personnel not willing to cooperate under the CS policy, not sufficient adaptability and knowledge about the CS system, problems with understanding of the platform where the current situation and forecast of the CS items is or staff detests the CS policy to get used to it.

The recommended measures are as follows – shift thinking, effective communication before and during the CS implementation process. In detail, there are the following recommendations to be adopted for the CS implementation risks elimination and prevention:

- **Personnel choice** – choosing the right employee for participating in the whole process of CS implementation is considered as an important separate project. Hence, placing the right people in charge is the first step to success in risk management. These people should be motivated, trained and rewarded.

- o **Personnel substitution** – there are several reasons for a responsible personnel absence which may harm the CS process and may lead to inappropriate risk management decisions. Primarily the responsible staff should always have a substitution and the HR consistent planning should also be an integral part of RM.

- **Training** – it is crucial to make sure that both sides are aware of all processes related to the implementation and further sustaining the CS concept. Equally, it is extremely important to inform all employees about who are in charge or work closely with the CS inventory on both sides – buyer and vendor (and alternatively external warehouse provider).

- **Motivation** – it is also extremely important for employees on both sides to explain the main reason for CS implementation, highlight the benefits of CS system of deliveries and motivate staff for keeping the Consignment partnership between buyer and vendor reliable and stable. Another approach to the change management in general is to empower certain employees to motivate them to contribute to the smooth process of CS implementation and utilisation.

- **Performance evaluation** – measured explicit duties specified by manager's descriptions of the project. Personnel requiring feedback to their performance. There is also a monitoring of newly set up procedures in order to avoid potential risks and disruptions.

- **Responsibilities setting** – as already explained in details in the Chapter 2.1. Responsibility of Vendor and Buyer – it is crucial for employees on both sides to be aware of each other's responsibilities especially in critical situations (damage, theft, defects and many more). Moreover, even internal responsibilities are crucial – all roles related to CS system of deliveries have to be specified; who is in charge of which phase of production or delivery.

- **Communication** – to ensure a smooth CS implementation and further adoption, it is crucial to communicate – listen, provide with feedback, send clear message not just about the CS policy implementation but also about the appearance of any measures identified for more effective processes usage etc. Even in case of any conflicts, difficulties are necessary to be reported and solved as soon as possible in order to solve this particular problem and avoid any possible further appearance of this problem.

- **Broaden cooperation with other areas** - in medium and large size companies mainly, there are separate departments of procurement, technology, quality and logistics. In case of any inconvenience and unwanted production interruptions costing huge amount of money, these issues require a greater degree of collaboration within these departments. All these segments may solve these problems operationally such as any supplier substitution and many more.

- **Continuous implementation** – it may be a very efficient way to eliminate and avoid potential resistance to change continuous implementation. In other words, not to do the whole implementation at once. Employees should be aware of new way of order and deliveries tracking in their CRM system, new system of manufacturing planning etc. Separating the implementation process into several separate continuous phases may significantly help people to understand the whole process, main purpose and advantages of CS implementation and further utilization.

5.1.2　Manufacturing facilities risks

As previously stated, manufacturing facilities risks include any risks related to the manufacturing process such as capacity, flexibility, forecasting, facility breakdowns, inventory, capacity and flexibility difficulties, potential of stock outs and with regard to CS implementation, also setting of the manufacturing process according to the consignment policy rules (intermediate products, interim storage, raw materials orders if necessary). There are the following recommended measures to be taken to prevent, minimize or eliminate the CS implementation and utilization risks:

- **Inspection of delivered items –** due to the fact, that buyer is responsible for inspecting the items before entering its warehouse, it is crucial to confirm that the received items are of the quality previously agreed upon with the vendor.

- **Periodic inventory review or audit**- it is essential for both parties to conduct periodic reviews or audits of the inventory to check the quantity in stock and the storing conditions- weekly, monthly, quarterly, annually, or as pre-agreed according to both parties. It is essential for a buyer to properly monitor and audit the consigned inventory. Identification, segregation and further monitoring of the particular consigned inventory is highly recommended to avoid risks related to duplicate items, obsoletion, etc. Furthermore, buyer should allow the vendor to have an access to the CS to be able to inspect the consigned inventory.

- **Account Sales report** – with regard to the cooperation between consignor and consignee, the amount used for invoicing has to exchange on regular bases. The sales report shows the inventory received into the Consignment stock, inventory used, any possible expenses chargeable to the consignment and the inventory remaining in the consignment stock. In addition, the revenue can be then recognized by the consignor.

- **Reporting, and order initiation**: The buyer is responsible for sending frequent reports to the vendor listing the quantities used or sold from the consignment inventory, and asking for new shipments to replace the withdrawn items. In some cases, using a modern innovative technology, there are software updating the forecast frequently so that both parties can check the up-to-date buyers probable requested needs. It is also crucial that the importer is accurately informed about the consignor's sales. When not informed properly and timely, the importer is negatively affected. If that was to happen, the bill is not prepared timely for the consignor, even though the product is sold and the sold products becomes physically lost products for the exporter.

- **System of consigned inventory levels and status sharing** – in order to keep a sufficient amount of consignment inventory in the consignment stock, it is necessary to agree on a system of information sharing. This system should provide enough information about the current level of inventory (when running low on supplies and when it is not necessary to deliver any more items in the following days etc.). In the best scenario, this system should also provide the forecast of the inventory for the following 12 months based on the target values of produced products and also based on historical data. Well prepared system of the information sharing guarantees more effective supply chain/delivery system partnership.

- **Distance between supplier and buyer (buyer`s stock)** – it might significantly influence the prices. On the other hand, the distance can be easily balanced by a particular setting of MIN and MAX level, creating buffer stock etc.

- **Identification of consigned items** - should be clearly recognizable - for example labeled by any tags once it was received. It is also very useful to record the different parts of the consignment inventory with a different number. Equally, it can be beneficial to physically segregate the consignment items form the rest of the items to avoid any duplicities, overstocking and in a place protect from various hazards. In addition, consignment inventory should be monitored in order to distinguish and avoid obsolescence.

- **Theft or vandalism** – in order to minimize the consequences of theft and vandalism an insurance or security precautions are highly recommended to be applied.

- **Obsolescence of the inventory -** there should also be a set amount of time that the consigned inventory may be retained until it becomes obsolete, between the vendor and the buyer.

- **Sourcing from multiple suppliers** - it is also very risky to rely just on 1 supplier. Another option to cover risks is to have multiple suppliers or at least another alternative "backup" supplier ready to cover any missing parts from the primary supplier.

5.2 From the vendors' perspective

Based on Saaty´s method resulting in ranking – there were 2 most critical risks identified - Product Characteristics Risks and Manufacturing facilities risks. Below there are presented measures that may contribute to prevention, minimization and elimination of the risks.

5.2.1 Product Characteristics Risks

Product Characteristics Risks are typically risks related to the quality of delivered items, raw materials, product composition, suitability for end, use, packaging, labeling, design changes, development delay, defects, product quality, product, obsolescence, substitution, alternatives.

- **Fixed frame order** – due to the consignment policy, there is no order-delivery model applied any more. There is a MIN and MAX level of inventory in the consignment stock and the vendor agreed to be able to keep the level of inventory in between these 2 borders. Therefore, it is highly recommended to set a frame order (for example a half-year of yearly past consumption pieces) to have the guaranty including agreement, that up to the end of the amount of the agreed frame order, there will not be any technical or design amendments required and that the agreed amount will be fully consumed or simply purchased by the buyer. In case of any amendments of the consigned inventory, vendor should insist on a number of weeks announcement before the amendments will take the effect.

- **Raw materials alternative resources** – based of forecasting information from buyer as precise as possible; multiple raw materials possibilities are recommended.

- **Any possible alternatives –** it is also recommended to have any other alternatives in case of any difficulties of quality issues with the consigned inventory – either an extra stock available or any other supplier able to substitute these not meeting needs of the buyer;

- **Regular quality checks** – a crucial part of the whole manufacturing and supply process is to keep the products on a good quality. Hence it is highly recommended, to stick to regular quality checks in order to avoid any claims, obsolescence etc.

- **Extra stock –** as already mentioned above, if there is any space available at supplier's premises, during a possible critical period of the year (for example summer peaks of required consignment inventory from the buyer), it may be effective to keep an extra stock of the consigned inventory in case of any peaks in buyer's production.

- **Identification of consigned items** - should be clearly recognizable - for example labeled by any tags once it was received. It is also very useful to record the different parts of the consignment inventory with a different number. Equally, it could be beneficial to physically segregate the consignment items form the rest of the items to avoid any duplicities, overstocking and in a place protect from various hazards. In addition, consignment inventory should be monitored in order to distinguish and avoid obsolescence. In case of any claims, it is crucial to be able to identify, what the number of batches the insufficient quality the consigned inventory was.

5.2.2 Manufacturing facilities risks

This group of risks is mainly related to any potential inconvenience related to capacity, potential of stock outs, facility breakdown, capacity difficulties, flexibility and process stability difficulties, yield and also setting of the manufacturing process according to the consignment policy rules (intermediate products, interim storage, raw materials orders if necessary). The setting of the new manufacturing process includes 3 most crucial factors: knowing **how much inventory** to produce and deliver at each particular time, having enough of (raw) **material for production** and further delivery and having the **capacity** to manufacture enough consigned inventory.

- **Account Sales report** – with regard to the cooperation between consignor and consignee, the amount used for invoicing has to exchange on regular bases. The sales report shows the inventory received into the Consignment stock, inventory used, any possible expenses chargeable to the consignment and the inventory remaining in the consignment stock. In addition, the revenue can be then recognized by the consignor.

- **Reporting, and order initiation**: The buyer is responsible for sending frequent reports to the vendor listing the quantities used or sold from the consignment inventory and asking for new shipments to replace the withdrawn items. Usually, the reports are sent based on the agreement between the parties; e.g. weekly or monthly.

- **MIN and MAX borders setting** – it is crucial to set a maximum amount of time consigned inventory can be retained before it becomes outdated. In the MIN and MAX CS concept, generally, it is buyer's responsibility to guarantee the sufficient amount of consigned inventory in the consignment stock. It means, not to let the inventory under certain level of supplies as well as not exceed the maximum capacity agreed upon. It is in both highest interests to agree on a reasonable and manageable MIN and MAX level from both financial and manufacturing and delivery process point of view.

- **System of consigned inventory levels and status sharing** – in order to keep a sufficient amount of consigned inventory, it is necessary to agree on a system of information sharing. This system should provide enough information about the current level of inventory (when running low on supplies and when it is not necessary to deliver anymore items in the following days etc.). In the best scenario, this system should also provide the forecast of the inventory for the following at least 6 - 12 months based on the target values of produced products and also based on historical data. Well prepared system of the information sharing guarantees more effective supply chain/delivery system partnership.

- **Extra stock available** – in order for vendor to ensure he always has enough inventory, it is good to keep semi-finished products, raw material available extra stock just to ensure always deliveries on time.

- **Distance between supplier and buyer (consignment stock)** – it may significantly influence the prices. On the other hand, the distance can be easily balanced by a particular setting of MIN and MAX level, creating buffer stock etc.

5.3 Insurance, Crisis management and Consignment contract

In general, it is applicable to most of the above-mentioned risks. There are 3 basic rules, that may lower the risks and their consequences to the minimum possible.

- **Insurance** – the firs success step is to arrange appropriate insurance to cover consigned goods in transit or in possession of a foreign distributor as well as to mitigate the risk of nonpayment. This solution will not actually prevent any risks but may cover potential penalties caused by any difficulties in the supply process.

- **Consignment stock policy contract** –also an important element of the whole Consignment stock policy concept for the buyer and vendor is to agree on reasonable conditions in the Consignment stock contract. Due to the fact, that this cooperation is usually a long term, it may be very problematic to interrupt the cooperation and substitute the buyer or the supplier by any other. Hence, the conditions should be accepted by both parties without any pressure made by any of these parties.

- **Crisis management** – it was found by the AON (2017) Business Risks Research held in the Czech Republic in 2017, that only a third of all respondents have a standardized risk management process set. Furthermore, only one fifth of the respondents evaluate likehood and consequences of possible risks that may appear in their businesses in general. In addition, just one tenth of respondents have their own risks management department dealing with risks prevention and solution. In case of no risk management department, there are mainly presidents and Chief Executive Officers dealing with risks management themselves. Considering completely different research sample, these are still essential pieces of information, like that there might be a lack of standards, rules and guidelines how to prevent risks, and how to eliminate consequences of the risks appearing. Another essential recommendation for both vendors and buyers is to set a Risk Management structured system solving problems how to avoid and solve risks.

Conclusion

This dissertation thesis discussed the risk's elimination during consignment stock implementation. One of the most challenging and crucial objectives of the supply chain inventory management is the costs and inventory reduction in such amount so that it still assures the required high service level. As the current trend is focusing on innovative ways and/or methods for an accurate managing of stock inventory, therefore, the dissertation examined the risk and proposes recommendations in order to prevent, eliminate or minimize potential consequences.

Main goal of this thesis was to present a proposal of the risk's elimination in the CS implementation. There were several steps set in order to achieve the main goal. The dissertation is based on both the theoretical fundamentals and on practical part consisting of analysis of the current situation on a sample of companies located in the Czech Republic.

In order to identify the risks related to the CS implementation, a quantitative research was used as the main data collection. Using this method, an overview of CS adopters (company size, industry, way of CS) was specified – based on sample of companies in the Czech Republic. Furthermore, it was found, that only 28% respondents would implement the CS again. There was a strong motivation to get a deeper understanding of the process of CS implementation and its further utilisation. In addition, we collected information about imported and exported consigned inventory from the Czech Republic. We discovered that there was an exponential regression with regard to exported consigned inventory - indicating probable increasing trend of export of consigned inventory.

Based on these 2 findings, using data collected from the quantitative research, literature review and interviews with specialists, several possible risks related to the CS implementation and further utilisation, were identified and then classified into 8 main groups. Additionally, using a Saaty pairwise comparison method (made by 4 inventory management specialists), the most critical risks groups were identified from both supplier and the vendor perspective separately.

From the buyer's perspective - 2 most critical or rather harmful risks identified were - Manufacturing facilities risks and Human Resources Risks. This means that it is crucial for buyers to have enough stock in the consignment stock at all time, in order to avoid any manufacturing interruptions etc. Furthermore, they also provided us with feedback, that risks caused by human element are frequent and may cause serious difficulties. The following recommendations were presented to help avoiding or eliminating these potential risks – Human Resources risks – personnel choice, staff training, motivation, performance evaluation, communication and responsibilities setting; Manufacturing facilities risks – inspection of delivered items, periodic inventory review or audit, reporting and order initiation, account sales report, system of consigned inventory levels and status sharing and identification or consigned items.

From vendor's perspective, there were 2 most critical risks identified - Product Characteristics Risks and Manufacturing facilities; risks comparing the likehood and consequences of all the groups of risks were also presented. With regard to risks prevention and elimination, following recommendations were proposed: Product characteristics risks – Frame order fixing an agreed amount of consigned inventory, raw materials alternative resources, regular quality checks, extra stock of consigned inventory available, identification of consigned items; Manufacturing facilities risks – reporting and order initiation, account sales report, Min and Max border setting, system of current CS inventory status, extra stock available.

It is not without interest, that in both cases - from the vendor's and the buyer's perspective, none of these risks were considered as critical. Mainly the risks related to the further CS utilization were considered as the major harm to the business. In general, the crucial parts of the whole CS policy implementation are – the trust between the two parties and also appropriate insurance covering as many potential risks could be covered - for example the penalties, establishment of a CS contract - to clarify and agree on all the responsibilities, potential penalties etc. and Crisis management system setting. This set of recommendations may contribute to avoidance, elimination and potential minimization of risks related to the CS implementation.

Dissertation thesis contribution

The benefits of the work can be divided into 3 areas that are interrelated - theoretical, practical and pedagogical.

Theoretical Contributions

- Detailed analysis available literature resources in the area of research
- Identification of risks related to CS implementation
- Critical evaluation of risks while the CS implementation
- Identification and specification of factors influencing the implementation decision

Practical Contributions

- Proposal of identified risks minimization or elimination measures that may contribute to prevention or minimization of probable consequences of the risks
- Results of the dissertation might be used as basis for further researches
- The whole concept might be useful for both vendors and buyer as a valuable source of recommendations to avoid or completely eliminate the most dangerous risks related to the CS implementation

Pedagogical Contribution

- A deeper understanding of the Consignment stock implementation can be used as a possible basis for further papers, publications, other materials
- Particular parts of the dissertation might be used as further materials for studying of this area
- This dissertation might be used as basis for further research as for deeper/updated look into this area or might be expanded for other possible risks elimination

The topic of the dissertation is to be further developed in the future. As part of another research activity, it might be more beneficial to focus the attention on more detailed examination of other identified risks groups elimination and prevention.

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Appendix

Appendix A: Consignment stock deliveries imported 2009 – 2018

Appendix B: Consignment stock deliveries exported 2009 – 2018

Appendix C: International trade overview of the Czech Republic

Appendix D: Quantitative Research

Appendix E: Pairwise comparison online – Saaty method example

Appendix F: Pairwise comparison online – Saaty method results example

Appendix A: Consignment stock deliveries imported 2009 – 2018

Import/Export	Year	Transaction Type	Netto (kg)	Stat.value CZK
Import	2009	12	227 277 962	22 444 483 067
Import	2010	12	276 443 102	25 978 373 613
Import	2011	12	558 062 309	46 100 531 202
Import	2012	12	1 751 113 204	153 864 706 240
Import	2013	12	906 333 975	58 079 970 612
Import	2014	12	1 028 254 332	61 105 656 358
Import	2015	12	1 434 193 660	72 457 745 663
Import	2016	12	1 956 443 574	74 309 035 806
Import	2017	12	1 280 162 438	83 162 715 612
Import	2018	12	1 417 376 763	77 144 980 936

Appendix B: Consignment stock deliveries exported 2009 – 2018

Import/Export	Year	Transaction Type	Netto (kg)	Stat.value CZK
Export	2009	12	491 268 278	15 079 068 562
Export	2010	12	685 980 845	22 385 231 594
Export	2011	12	520 991 448	34 599 972 179
Export	2012	12	1 531 055 486	80 653 746 734
Export	2013	12	1 037 023 151	42 492 728 591
Export	2014	12	1 305 300 346	43 254 085 820
Export	2015	12	1 443 588 688	47 069 642 634
Export	2016	12	1 462 154 683	48 202 100 042
Export	2017	12	1 034 118 515	53 834 637 233
Export	2018	12	1 118 555 139	57 516 900 677

Appendix C: International trade overview of the Czech Republic

Source: ČSÚ, MPO

	Obrat	Vývoz	Dovoz	Bilance	Změna proti předchozímu roku v %		Krytí dovozu vývozem v %
	v mld. Kč				vývoz	dovoz	
1989	427,5	216,5	211,0	5,5	.	.	102,6
1990	448,0	214,1	233,9	-19,8	-1,1	10,9	91,5
1991	442,4	233,6	208,8	24,8	9,1	-10,8	111,9
1992	541,5	248,1	293,4	-45,3	6,2	40,5	84,6
1993	847,7	421,6	426,1	-4,5	69,9	45,2	98,9
1994	957,2	458,8	498,4	-39,5	8,8	17,0	92,1
1995	1 231,9	566,2	665,7	-99,6	23,4	33,6	85,0
1996	1 356,4	601,7	754,7	-153,0	6,3	13,4	79,7
1997	1 569,0	709,3	859,7	-150,5	17,9	13,9	82,5
1998	1 748,7	834,2	914,5	-80,2	17,6	6,4	91,2
1999	1 881,9	908,8	973,2	-64,4	8,9	6,4	93,4
2000	2 363,0	1 121,1	1 241,9	-120,8	23,4	27,6	90,3
2001	2 653,7	1 268,1	1 385,6	-117,4	13,1	11,6	91,5
2002	2 580,5	1 254,9	1 325,7	-70,8	-1,0	-4,3	94,7
2003	2 811,7	1 370,9	1 440,7	-69,8	9,2	8,7	95,2
2004	3 471,8	1 722,7	1 749,1	-26,4	25,7	21,4	98,5
2005	3 698,5	1 868,6	1 830,0	38,6	8,5	4,6	102,1
2006	4 249,4	2 144,6	2 104,8	39,8	14,8	15,0	101,9
2007	4 870,6	2 479,2	2 391,3	87,9	15,6	13,6	103,7
2008	4 880,2	2 473,7	2 406,5	67,2	-0,2	0,6	102,8
2009	4 127,7	2 138,6	1 989,0	149,6	-13,5	-17,3	107,5
2010	4 944,4	2 532,8	2 411,6	121,2	18,4	21,2	105,0
2011	5 566,3	2 878,7	2 687,6	191,1	13,7	11,4	107,1
2012	5 839,5	3 072,6	2 766,9	305,7	6,7	3,0	111,0
2013	5 998,2	3 174,7	2 823,5	351,2	3,3	2,0	112,4
2014	6 828,5	3 628,8	3 199,6	429,2	14,3	13,3	113,4
2015	7 360,2	3 883,2	3 477,0	406,2	7,0	8,7	111,7
2016[1]	7 468,7	3 974,0	3 494,7	479,4	2,3	0,5	113,7
2017	8 046,0	4 244,6	3 801,4	443,2	6,8	8,8	111,7

Appendix D: Quantitative Research

„Vážená paní, vážený pane,

ráda bych Vás poprosila o spolupráci na dotazníkovém šetření zkoumajícím implementaci konceptu konsignačního skladu v České republice s důrazem na identifikaci rizik spojených s implementací konsignace. Výsledky tohoto šetření budou využity pro vědecko-výzkumné účely.

Vyplnění dotazníku Vám nezabere více než 10 minut. V případě dotazů mě kontaktujte na emailu petra.vrbova@student.upce.cz.

Předem děkuji za ochotu a Váš čas strávený vyplňováním dotazníku.

Ing. Petra Vrbová
Ústav podnikové ekonomiky a managementu
Fakulta ekonomicko-správní
Univerzita Pardubice

_____

EN: *Dear Madam or Sir,*

I would like to kindly ask you to participate a quantitative research examining the implementation of the consignment stock concept in the Czech Republic focusing on identifying the risks associated with its implementation. The results of this survey will be used for scientific and research purposes.

Completing the questionnaire will not take more than 10 minutes. In case of any questions, please contact me via email - petra.vrbova@student.upce.cz.

Thank you in advance for your help and your time spent filling out the questionnaire.

Best regards

Petra Vrbová

DOTAZNÍKOVÉ ŠETŘENÍ: KONSIGNAČNÍ SKLADY V ČESKÉ REPUBLICE A RIZIKA SPOJENÁ S IMPLEMENTACÍ

QUANTITATIVE RESEARCH: CONSGINMENT STOCK USAGE IN THE CZECH REPUBLIC AND RISKS RELATED TO ITS IMPLEMENTATION

- Odvětví průmyslu / *Industry:*

☐ Služby / Services
☐ Obchod / Retail
☐ Výroba / Manufacturing

- Velikost firmy / *Company size:*
☐ Malá /*Small size*
☐ Střední / *Medium size*
☐ Velká / *Large size*

1. Setkal/a jste se v současné společnosti s praktickým zapojením do konceptu konsignačního skladu? / *Have you ever personally been involved in the concept of Consignment Stock in your current company?*

☐ Ano / *Yes*
☐ Ne / *No*

Jestliže jste na otázku 1 odpověděl/a Ano, pak prosím pokračujte k dalším otázkám. Pokud ne, dotazník již dále nevyplňujte a pošlete ho takto vyplněný zpět na emailovou adresu, ze které jste dotazník získal/a / *If your answer to the question 1 was YES, please continue in filling this questionnaire. If not, please send this filled form back to the email address from which you have received this form.*

2. Jestliže máte zkušenost s konsignací v současné firmě, jakým směrem konsignaci společnosti konsignaci vyžíváte? / *What are your experiences with utilising the CS policy in your company:*

☐ Dodáváme materiál do konsignačního skladu dodavatele / *Our company delivers the consigned inventory into the buyer´s consignment stock*
☐ Náš dodavatel dodává materiál do našeho konsignačního skladu / *Our supplier supplies the consigned inventory into our Consignment stock*
☐ Konsignaci zprostředkováváme jak pro naše zákazníky/a, tak naši dodavatelé pro nás / *Both above mentioned options are applicable to our company*

3. Jaké byly vaše zdroje informací v souvislosti s implementací konsignace / *Once implementing the Consignment stock concept, what was your main source of information?*

☐ Česká literatura / *Czech literature*

v

☐ Zahraniční literatura / *Foreign literature*

☐ Interní informace (např. interní materiály součástí směrnic zavedení konsignačního skladu, které jsou součástí celého koncernu, do kterého vaše společnost patří aj.) / *Internal materials (internal guidelines provided by headquarters)*

☐ Informace a instrukce od dodavatele / *Information and instructions from our consignor*

☐ Informace a instrukce od odběratele / *Information and instructions from our consignee*

☐ Poskytovatel vašeho CRM / *CRM provider*

☐ Jiné / *Other*

☐ Nevím / *I do not know*

4. Jaký byl hlavní motiv pro implementaci konsignace ve vaší společnosti / What was your main motive for CS implementation in your company?

☐ Náš obchodní partner (dodavatel/zákazník) na tom trval / *Our business partner insisted on it*

☐ My sami jsme chtěli konsignaci s obchodním partnerem (dodavatelem/zákazníkem) zavézt / *It was our own initiative*

☐ Jiné (zájem třetí strany,..) / *Third party interest*

☐ Nevím / *I do not know*

5. Jestliže byste nyní měl/a možnost znovu se o implementaci rozhodnout na základě vašich předchozích zkušeností s implementací, konsignaci byste znovu implementovali? / *Having the knowledge and experience with the implementation, if you had the chance to decide whether you want to implement it again, would you do it? And if so, what would your approach to it be like?*

☐ ANO – opět bychom konsignaci bez problémů implementovali / *Definitely yes, with no doubts*

☐ SPÍŠE ANO – ale zajistili bychom lepší připravenost na implementaci / *Rather yes, but we would have to secure a better implementation process*

☐ SPÍŠE NE – raději bychom se další implementaci vyhnuli / *rather not (avoidance towards any further implementation)*

☐ NE – rozhodně bychom odmítli / *No – we would definitely refuse any further implementation*

☐ NEVÍM/ JINÉ................. / *I do not know / Other*

6. OTÁZKA PRO DODAVATELE DO KONSIGNANČÍHO SKLADU: Jaká rizika shledáváte v rámci využívání konsignačního skladu **z pohledu dodavatele** / *What main risks related to the CS implementation do you personally find as a vendor?*

Označte na škále 1-5 podle důležitosti motivu (1 - nejdůležitější, 3 - středně důležitý, 5 - nedůležitý) / *Please evaluate on the scale from 1 (the most important) to 5 (not important at all)*

Question in Czech language	Question in English language	Evaluation				
Vyrobený materiál není k dispozici pro vaše jiné zákazníky, kteří by měli neplánované urgentní požadavky na dodávku	*Material is no longer available to send to another customer having an unplanned urgent requirement*	1	2	3	4	5
Dlouhá doba zaplacení faktur za dodaný materiál	*Takes them a long time to pay the invoice for the supplied material*	1	2	3	4	5
Znehodnocení nebo dokonce zničení materiálu ve skladu kupujícího	*Risk of damage in the customer´s warehouse*	1	2	3	4	5
Zvýšené množství zboží v dodavatelském řetězci	*Increased inventory within the supply chain*	1	2	3	4	5
Nárůst skladovacích nákladů	*Increased* stockholding *costs*	1	2	3	4	5
Nárůst skladovací prostory	*Increase of space requirements*	1	2	3	4	5
Nárůst financí vázaných v zásobách	*Increase of finances invested into the inventory*	1	2	3	4	5
Jiné, prosím, uveďte jaké	*Other, please specify any other*	1	2	3	4	5

7. OTÁZKA PRO ODBĚRATELE Z KONSIGNANČÍHO SKLADU: Jaká rizika shledáváte v rámci využívání konsignačního skladu **z pohledu kupujícího** / *As a buyer, what are the main risks that you identify in relation to the CS implementation:*

Označte na škále 1-5 podle důležitosti motivu (1 - nejdůležitější, 3 - středně důležitý, 5 - nedůležitý) / *Please evaluate the scale from 1 (the most important) to 5 (not important at all)*

Question in Czech language	Question in English language	Evaluation				
Náklady na držení materiálu, které nemají okamžitou spotřebu	*Stockholding costs of supplied items which do not have immediate use*	1	2	3	4	5
Zvýšené požadavky na skladování materiálu spojené se zvýšením nákladů za skladování	*Increased space requirement for stock and associated stockholding costs*	1	2	3	4	5
Zvýšení množství materiálu dodavatelském řetězci	*Increased inventory in the supply chain*	1	2	3	4	5
Reklamace a vracení zboží obecně	*Claims, returned goods*	1	2	3	4	5
Spory o neevidovanou spotřebu materiálu	*Disputes over unrecorded usages*	1	2	3	4	5
Jiné, prosím, uveďte jaké	*Other, please specify any other*	1	2	3	4	5

Appendix E: Pairwise comparison online – Saaty method example

Link (https://bpmsg.com) sent to specialists for Satty pairwise comparison:

Appendix F: Pairwise comparison online – Saaty method results example

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons

	Category	Priority	Rank
1	Transport. and logistics risks	9.8%	4
2	Product Charact. Risks	10.2%	3
3	Financial risks	28.5%	1
4	Manufact. facilities risks	7.8%	5
5	Human Resources Risks	28.5%	2
6	Warehousing risks	4.3%	7
7	Information system risks	3.1%	8
8	Implement. process risks	7.8%	6

Number of comparisons = 28
Consistency Ratio CR = 7.9%

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix

	1	2	3	4	5	6	7	8
1	1	1.00	0.17	1.00	0.33	2.00	4.00	3.00
2	1.00	1	0.25	3.00	0.17	4.00	3.00	1.00
3	6.00	4.00	1	4.00	1.00	3.00	6.00	4.00
4	1.00	0.33	0.25	1	0.20	3.00	2.00	2.00
5	3.00	6.00	1.00	5.00	1	5.00	6.00	3.00
6	0.50	0.25	0.33	0.33	0.20	1	2.00	0.25
7	0.25	0.33	0.17	0.50	0.17	0.50	1	0.33
8	0.33	1.00	0.25	0.50	0.33	4.00	3.00	1

Principal eigen value = 8.777
Eigenvector solution: 6 iterations, delta = 2.2E-9

Example of results of a single pairwise comparison downloaded from the online software above.

AHP priorities - specialist Nr.1									
8									
Transport.	Product Charact	Financial r	Manufact.	Human Re	Warehous	Informatic	Implement. process risks		
1.000000	1.000000	0.166667	1.000000	0.333333	2.000000	4.000000	3.000000		
1.000000	1.000000	0.250000	3.000000	0.166667	4.000000	3.000000	1.000000		
6.000000	4.000000	1.000000	4.000000	1.000000	3.000000	6.000000	4.000000		
1.000000	0.333333	0.250000	1.000000	0.200000	3.000000	2.000000	2.000000		
3.000000	6.000000	1.000000	5.000000	1.000000	5.000000	6.000000	3.000000		
0.500000	0.250000	0.333333	0.333333	0.200000	1.000000	2.000000	0.250000		
0.250000	0.333333	0.166667	0.500000	0.166667	0.500000	1.000000	0.333333		
0.333333	1.000000	0.250000	0.500000	0.333333	4.000000	3.000000	1.000000		
0.098343	0.101977	0.285383	0.077988	0.284820	0.042931	0.030856	0.077701		
8.777296	0.079252								