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Types of Supply Chains and Tools for Management – Empirical Analysis

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Ph.D. dissertation

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ABC	Activity Based Costing
CAO	Computer-Aided Ordering
CD	Cross-docking
CPFR	Collaborative Planning, Forecasting and Replenishment
CRP	Continuous Replenishment Program
DRP	Distribution Requirements Planning
ECR	Efficient Customer Response
EDI	Electronic Data Interchange
ERP	Enterprise Resources Planning
FMCG	Fast Moving Consumer Goods
IT	Information Technology
PC	Personal Computer
POS	Point-of-Sale Data
QR	Quick Response
RFID	Radio Frequency Identification
SCM	Supply Chain Management
SKU	Stock Keeping Unit
FTL	Full Truck Load
VMI	Vendor Managed Inventory

“Discovery consists of seeing what everybody has seen and thinking what nobody has thought”

Albert Szent-Györgyi

FOREWORD

In my doctoral dissertation, I am dealing with the management issues of supply chains. One of the most cited concepts of the supply chain management literature will be tested empirically, and I am going to make an attempt to add to it.

The *first* research question is if the functional and innovative product types indicated by Fisher (1997) really appear in business practice and are they separable in reality, on the other hand, can they be associated with supply chain types based on their features, such as the physically efficient or market-responsive types – also according to the Fisher-model. The *second* research question concerns the case if there is a mismatch between the product and the supply chain type. My aim is to discover the reasons of this phenomenon.

The *third* research question is if there are functional and innovative products and matching physically effective and market-responsive supply chains, and do these supply chains differ from each other in the management tools applied for managing the distribution side of the supply chain? Are there any specific management tools used within, either physically efficient or market-responsive supply chains, and is there a common basis of management tools adapted in both supply chain types?

During the research, I approach supply chain management from a logistics management perspective. However, the problem is influenced by point of view of several other fields of management science as well (Figure 1).

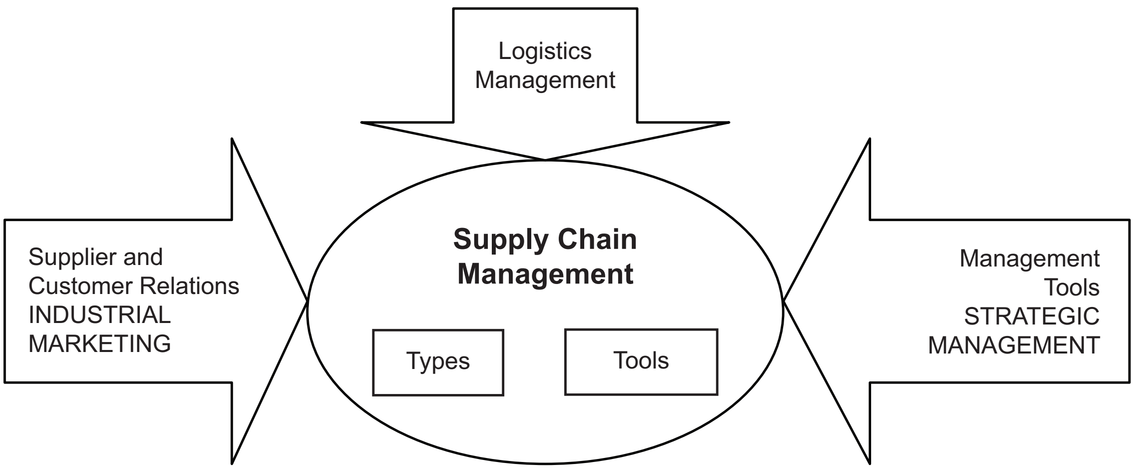

Figure 1: Fields of science concerned in the dissertation

The research primarily approaches supply chain management issues from a logistics management aspect. When talking about supply chains, the value creating processes – production, logistics and services – are realised not only within a company but spanning over firm boundaries. Consequently, relationship management with suppliers and customers are also taken into consideration. The science of industrial marketing deals with the relationship issues between a firm and its suppliers and customers. For my research, mainly the B2B relationships and processes are important.

An additional possibility derives from the research conducted which touches the field of strategic management as well. Supply chain management is a management philosophy which requires a strategic approach on one hand, and on the other hand, I want to describe the current practice of firms operating in Hungary (not only Hungarian-owned!). I analyse the characteristics of industries, which provide the largest part of the research sample (machine, food and other processing industries) and in which supply chain management is traditionally present, according to the literature. I discover how they manage their supply chains, how developed they are and what tools they adapt to smooth the value stream on the distribution side.

The structure of the literature review is shown in Figure 2. The beginning chapters are devoted to reviewing related literature. First, I deal with the notion of supply chain and supply chain management. Definitions and approaches are grouped and cleared and the focal interpretation applied in the dissertation is also selected. If researchers do not agree with the definition of a supply chain, even less unity exists regarding the concept of supply chain management. Many interpretations and approaches of supply chain management are introduced.

Secondly, I display the model of supply chain management techniques and tools applied to managing the distribution side of supply chains. After introducing the techniques and tools presented in the literature, I organise them into a model. Different management tools are characterised individually in the dissertation, as well, to show their essence and benefits for the supply chains.

In Chapter 3 I deal with the core model of the dissertation. Fisher's model and its critics are introduced in detail. Several experiments to test Fisher's model are also examined, particularly one written by Swedish authors that applied a similar methodology as I but achieved only partial results and another made by Australian researchers using quantitative techniques, but failed to confirm the concept. In the literature, there are some other famous tests to explain the differences between supply chains – such as agile and lean supply chains – so these theories will also be presented and compared to Fisher's model.

Based on the conclusions drawn from the related literature, I derived and formulated hypotheses from research questions in Chapter 4. The first hypothesis concerns the match of product and supply chain types indicated by Fisher. Secondly, those hypotheses are formulated in which I try to explain their mismatch. To do so, I built on the explanations other authors have done in previous tests, however, nobody has tested them systematically before. The third group of hypotheses concern the management tools applied on the distribution side of one or the other of supply chain types. Fisher himself mentions several management tools as well, but does not describe them. My additional aim is to depict the Hungarian practice and which tools companies use to manage the distribution side of their supply chain.

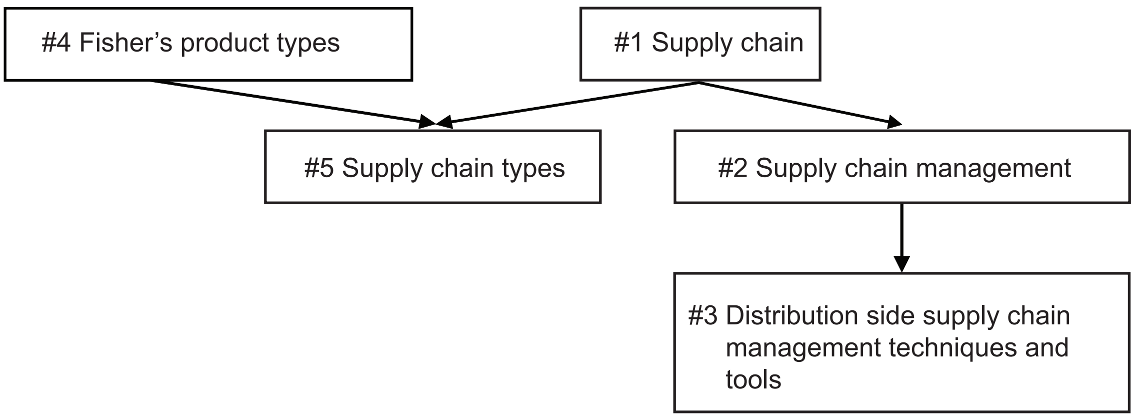

Figure 2: Order and logic of literature review

After summing up the literature and formulating the hypotheses in Chapter 5 the research plan is presented. Both a quantitative (survey) and qualitative (interview) methods were used in the research, which was carried out individually. A questionnaire was published on-line for given addressees, and I gathered 92 responses, of which 79 could be analysed.

A large part of the dissertation is dedicated to present the results. In Chapter 6, I first review the findings of testing Fisher's model, and then those of differentiating the supply chain types along with the tools applied to manage the distribution side of supply chains. I discovered the reasons why Fisher's product and supply chain types do not match each other, first, by quantitative than by qualitative means. I present a description about the supply chain management practice of companies analysed in the sample.

In the closing chapter I sum up the aims, the process of research, findings and experiences, then I present conclusions and refer to the managerial applications and further research opportunities.

I. DEFINING SUPPLY CHAIN AND SUPPLY CHAIN MANAGEMENT

The aim of this chapter is to give an overview about the terms applied throughout the doctoral dissertation because they are widely used in international academic literature and many different concepts exist simultaneously. Definitions created by Hungarian logistics management researchers are also important to mention and compare them to those in international literature.

In the case of interpretation of both supply chain and supply chain management, many concepts and approaches exist in academic literature, and no unified definition is available for either terms.

I.1 Defining the term of supply chain

The next pages present an overview about the definitions of supply chain which are based on academic or business approaches and represent a wider or narrower, theoretical or practical interpretation.

The reviewed supply chain definitions show two basic interpretations: supply chain can be seen as a group of organisations, or a complex process carried out by the cooperating companies (Gelei, 2010). Sometimes these two interpretations are blended within one definition, and while grouping, I focused on the more emphasised reading.

The first group of supply chain definitions is interpreted as a **group of organisations** which are built up from the joint value creating activities of different organisations.

Supply chain is a set of companies among which the product and service flows during the production process. "Normally several independent firms are involved in manufacturing a product and placing it in the hands of the end user in a supply chain" – raw material and component producers, product assemblers, wholesalers, retailers and transportation companies, are all members of a supply chain (LaLonde and Masters, 1994).

The term 'organisation' in this case reflects to a huge international company which has a lot of subsidiaries all over the world, and together they make one large organisation.

Those players can be regarded as part of a supply chain that cooperates in the processes of purchasing, product and service production and delivery to the end user (Harland, 1996).

Supply chain can be defined as a group of companies, which cooperate in delivering products or services to the market (Lambert et al., 1998).

The supply chain can be interpreted as a parent company surrounded by its subsidiaries sharing different tasks of materials flow. This kind of supply chain will be regarded as an *internal supply chain* in the following (Gelei, 2009). The majority of the academics capture supply chain as cooperation of a set of individual firms, while a harmonised logistics flow within a company is called an integrated logistics system

Mentzer et al. (2001, p.4) defines a supply chain as:

"Set of three or more entities (organisations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer."

The commonality of the definitions presented above are that supply chains consist of two or more members, so it is usually more than a dyadic partnership. Secondly, members of a supply chain make a common effort to create value to the targeted customers. LaLonde and Masters, Lambert and co-authors, and Harland call *supply chain* those firms which cooperate but do not suppose close partnership between them. However, the interpretation of Mentzer et al. expects such close partnerships between supply chain members because of the complex set of common flows.

The second interpretation of a supply chain is the process-based view (Gelei, 2009). In this approach, it is still correct that supply chains consist of more members, but the focus of the interpretation is on the process and its optimisation. This concept emphasises the role of the value creating process along which companies join to serve the end user as much as possible.

Consequently, a supply chain may involve all players who add value, such as suppliers of raw materials or components, manufacturers, final product assemblers, packaging, transportation, warehousing and logistics service providers (Dawande et al., 2006). Supply chain cooperation may cover, not only the primary processes indicated by Porter, but several supportive processes as well.

When defining supply chain, Hungarian literatures, as well as the dissertation, lean on the process-based definition of Chikán:

"A vertically integrated set of business activities which spans over company boundaries and aims to satisfy consumer needs" (Chikan, 2008. p. 163).

According to other definitions, a supply chain is a network of companies, which covers inbound and outbound relationships, different processes and activities, which add value to the end consumer through products and services delivered (Christopher, 1992). Consequently, supply chain integrates many companies both upstream (suppliers) and downstream (distribution) in the value creating process, as well as the end consumer.

Approaches above focus on processes spanning over firm boundaries and difference between the opinions of authors can be found in the activities emphasised.

Lambert and Cooper (2000, in Gelei, 2008) have identified the following key processes within the supply chain operation:

- customer relationship management
- customer service management
- demand management
- complex ordering process
- management of production processes
- management of sourcing processes
- product development process
- management of reverse processes.

In the following section of the dissertation, I use the latter, process-based interpretation of a supply chain. The reason for this is that to the third research question – that supply chains differ from each other in the tools applied for managing distribution processes – a process-based view fits.

I.2 Definition of supply chain management

Literature is unified in accepting the positive effect of supply chain partnerships on company competitiveness. Cooperation makes it possible for companies not to fight for a larger share of a given cake at each others' expense, but they can make a joint effort to consequently enlarge the piece of their own shares (Cigolini et al., 2004).

Definitions of supply chain management – just like those of supply chain's – can be classified. Definitions can be separated along the interpretation of their authors if it is a management philosophy, or it is a set of activities implementing the management philosophy itself.

It is a question of which companies can be included in supply chain management, and it depends on which firms are really concerned in the coordinated behaviour of value creation. Supply chains are usually organised around a *focal company* which is the initiator of supply chain thinking and coordinated operation (Gelei, 2003a).

SCM can be regarded as a management philosophy which helps to coordinate supply channels from suppliers to end consumers (Cooper et al., 1997).

The goal of supply chain management is to harmonise customer expectations, and suppliers' materials flow to help find equilibrium between those substantially controversial aims like high level of customer service and low level of inventory and unit cost (Stevens, 1989).

When defining supply chain management, I first use the terminology of a Hungarian author which I base the dissertation on as well:

"Supply chain management is a conscious management of a supply chain in order to enhance the competitiveness of cooperating partners" (Gelei, 2003a. p. 5).

According to Zheng and co-authors (2000), supply chain management is a process of optimising a company's internal practices and improving the interaction with its suppliers and buyers. Zheng's interpretation represents a minority within the literature while focusing on the integration of company's internal processes.

The definitions above interpret supply chain management on a strategic partnership level, and emphasise the integration of cooperating parties and the joint coordination of their activities. Each author highlights the elementary purpose of managing a supply chain: increasing competitiveness and improving partners' cooperation.

Authors – like Mentzer et al. (2001) – who interpret supply chain management as *management philosophy* regards it as an integrated whole not as a set of different activities.

Management philosophy approach looks for the opportunity for harmonising operational and strategic intra-firm and inter-firm capabilities to achieve a unified, sustainable and strong market share. SCM as an integrative management philosophy that calls the attention of cooperating parties to developing innovative solutions in order to provide excellent customer value. According to the SCM philosophy, it is advisable for supply chain members not to focus only on harmonising materials flow, but to integrate many other activities, too, both within the company and partnership to achieve a higher customer satisfaction. By admitting this to get to know and service customer expectations and value, become a common and elementary goal (Gelei and Nagy, 2005). SCM philosophy shepherds supply chain members to a customer-oriented way of thinking.

Summing up the characteristics of management philosophy interpretation of SCM, three points are to be emphasised:

- A system approach to view supply chain as a whole, and aims to coordinate the flow of goods from suppliers to end customers.
- A strategic orientation towards harmonising intra-firm and inter-firm operational and strategic capabilities into a unified whole.
- A customer oriented way of thinking to provide unique products and/or services, which create customer value, and consequently, customer satisfaction.

In the opinion of Mentzer et al., (2001) there are researchers that rather emphasise that the *set of activities* constitute supply chain management, which aim to successfully implement the management philosophy.

Extension of integrated behaviours to customers and suppliers – namely the external integration – is the first level of supply chain management (Stevens, 1989). To realise SCM it is necessary to integrate processes, too, from procurement through manufacturing to distribution along the entire chain. Integration can be generated by cross-functional teams, employing internal suppliers or external service providers. The operation of a supply chain can only be successful if, besides the integrated processes, supply chain members capture the same goals and focus on servicing the customer. Establishing the same goals and focus, members are integrated not only on a process level but on a strategic level as well (Nagy, 2006). Strategic integration is necessary in supply chain management to avoid redundancy and overlap of activities, and to allow members to become more effective at a lower cost.

The mutual sharing of risk and rewards results in a competitive advantage. It reflects the participants' engagement, which can be achieved only through long term cooperation.

A common information system between supply chain partners is also necessary to realise supply chain management as a management philosophy, particularly important in operating joint planning and control processes. Operational level partners grant access to information about each other's inventory level, demand forecast data, sales promotion and marketing strategies, which support to decrease uncertainty of members and result in a higher performance. Harmonising processes via sharing relevant information between supply chain participants allow the joint planning of all activities as well as the performance assessment of the entire process.

Successful supply chain management is not only the process for passing by products between the members, but requires members to build and maintain long term relationships.

According to Monczka et al. (1998) SCM requires traditionally separate materials functions to report to an executive responsible for coordinating the entire materials process, and also requires joint relationships with suppliers across multiple tiers. SCM is also a concept whose primary goal is to integrate and manage procurement, materials flow and control using a system which integrates multiple functions and multiple tiers of suppliers.

Supply chain management can be interpreted as a long term agreement between two or more firms, as the development of trust and commitment, as integration of logistics processes, including the share of demand forecast and sales data, and as a potential shift of focus towards the control of logistics activities (LaLonde and Masters, 1994). According to the cited authors – and contrary to Mentzer et al. (2001) – a dyadic partnership may also construct a supply chain.

Supply chain management is a new business paradigm which derives from the need of integrating procurement, manufacturing and distribution, on the basis of a common and developed IT system (Shapiro, 2004).

Supply chain management integrates materials flow from suppliers to end users (Jones and Riley, 1985).

Definitions summarise the activities of which their integration is basic to realise and carry out supply chain management, so integration of logistics processes, sharing of different information and the joint IT system. Definitions also call attention that besides strategic decisions, supply chain management requires a high level of a process based view at operational level. In the following, the dissertation lays emphasis on the supply chain processes, and when interpreting supply chain management I use the activity-based approach.

The dissertation focuses on the analysis of the distribution side of the supply chains. Consequently, I use the terms *demand chain* and *distribution chain* as synonyms to refer to that set of companies, which deliver end products to the market.

The next chapter deals with solutions which aim to support information and materials flows on the distribution side of supply chains, as well as to help to assess the performance of participants and the entire supply chain. I regard these solutions as demand chain management tools which are in the focus of my research.

II. SUPPLY CHAIN MANAGEMENT TECHNIQUES AND TOOLS

The aim of this chapter is to review the distribution side supply chain management tools that help manage the operational work in a demand chain by harmonising the materials and information flow, and providing feedback about the performance of supply chain partners.

Demand chain management tools were categorised and separated based on the focus they are having: information sharing, which is an elementary requirement of successful supply chain operation; smoothing materials flow, which is a primary purpose of supply chain management in a narrow interpretation; or assessing the costs and performance of supply chain members in order to discover the risks and advantages taken by partners. These categories are highly interconnected, both for balancing materials flow and getting data for cost and performance assessment information sharing is essential.

When collecting supply chain management tools I was focusing on the distribution side. In the last decades several famous supply chain management techniques have evolved for managing distribution processes such as Efficient Customer Response in FMCG sector (BHUTTA et al., 2002; HARRIS and SWATMAN, 1997), Quick Response in fashion industry (AL-ZUBAIDI and TYLER, 2003; BIRTWISTLE et al., 2003; FERNIE and AZUMA, 2004) and CPFR in various industries (SKJØTT-LARSEN et al., 2003; FLIEDNER, 2003). The effect of these on managing sales channels can be compared to the lean philosophy in managing supply processes in the automotive industry. The commonality of these demand chain management techniques is that they all aim to harmonise the distribution related processes.

The internal structure of demand chain management techniques can be broken down into elements, as it is shown in Table 1. It can be seen that techniques are built up from different, but sometimes overlapping tools. Consequently, during the dissertation I am not dealing with demand chain management techniques as a whole but only with the **tools** building up the techniques.

In the following, I am focusing on *demand chain management tools* as exact solutions, which help *demand chain partners to share information, to harmonise materials flow or to assess costs and performances* realised during the operation. *Techniques* can be interpreted as – e.g. industry-specific – *combinations of different demand chain management tools.*

Table 1: Classical structure of demand chain management techniques

Appearance of technique	Tools constructing techniques	Industry
QR Mid-80s: USA	Electronic Data Interchange Common planning and forecasting Vendor-Managed Inventory	Fashion industry
ECR End of 80s: USA	Category management Electronic Data Interchange Continuous Replenishment Cross-docking Computer-Aided Ordering Activity-Based Costing	FMCG
CPFR 90s: USA	Common planning and forecasting Continuous Replenishment	Fashion industry General merchandise industry

II.1 Construct of supply chain management techniques

According to the process-based view of supply chain and activity-based approach of supply chain management task of distribution-side supply chain management techniques is to harmonise value creating processes and activities through the application. Distribution side supply chain management techniques cover three areas in which they aim to harmonise operations. Integration of processes and activities is primarily defined by the realised level of harmonisation of information and materials flows. In order to be able to assess the effectiveness of flows a cost and performance evaluation system is also necessary (Nagy, 2008).

Demand chain management techniques are combinations of several management tools. When constructing management techniques, the emphasis is laid not only on optimising logistics processes, but on considering the product characteristics as well. It happens many times that tools are adopted in the form of a relation-specific investment (Bensaou, 1999) (e.g. IT system between a supplier and customer) (Nagy, 2010).

Three areas of supply chain integration have a key role in a successful operation: information sharing, coordination and inter-firm relationships. Lee (2000) means by information sharing the common planning and forecasting. Coordination is mainly focused on the integration of materials flow (e.g. via VMI). Inter-firm relationship includes EDI and a communication tool, and Lee also emphasises the importance of performance assessment.

Similarly to mine and Lee's interpretation, Warma et al. (2006) built up their own supply chain strategy in their article. According to them, pillars of a well operating supply chain are harmonisation of materials flow, harmonisation of logistics flow (e.g. greening logistics processes, too), and IT support and supply chain performance assessment.

II.2 Demand chain management tools

According to Cigolini et al. (2004), the toolbox of *information sharing* affects the application of all other demand chain management tools. An elementary part of the information system is the corporate or inter-firm ERP system, which may appear in the form of an on-line connection between partners (based on EDI or the Internet). Its role is to ease the information and document flow between companies; e.g. in standardised form making the data transfer more effective and decreases the time requirement of (order) processing. Standardised information sharing supports punctuality and better control.

Automatic order transfer solutions (CAO), check the decreasing inventory level at the customers' point of sales and send notices to the central warehouse for replenishment. Product identification systems (barcodes, RFID) help the flow of product information and support tracking and tracing throughout the supply chain. Common operated or shared databases make the information accessible to all members who are necessary to forecast, planning and operating the chain. The more accurate and up-to-date the information is, the more the chain is capable of adapting to demand changes. Distributing the exact demand data of end customers helps to decrease the inventory level in the supply chain and makes a positive impact on the bullwhip-effect (Disney and Towill, 2003). However, it has to be noticed that the information exchange between supply chain partners has to be mutual, selective and valid, but not necessarily symmetric (Lamming et al., 2001).

In smoothing *materials flow,* many activities of the operations have to be involved. The basis of optimising materials flow on the distribution side is a clear assortment of goods. Composition of the right assortment allows providing the goods that meet most of the customers' needs, and they buy the most frequently, which results in a higher turnover and increased profit maximisation. One of the most important areas of materials management is inventory handling in the supply chain, because this is a typical source of redundancies and waste. Many solutions have evolved to handle inventories within the supply chain from vendor-managed inventory *(VMI)* to those systems where suppliers individually and automatically decide about replenishment of their customers' warehouse according to the POS-data shared *(CRP)*. Forwarding materials within the supply chain is important as well. This not only covers the planning and optimisation of costs of transportation, but application of specialised facilities in which the bulk of products can be broken down, a quick order-picking is carried out to match customer orders, and goods can be transmitted quickly in smaller packages *(cross-docking)* (Gelei, 2008).

Cost and performance assessment is interpreted by Cigolini et al. (2004) not only for counting costs and estimating overall performance, but supplier assessment as well, which can also be extended to customer assessment. Assessment systems can be applied both on the supply chain level and on the level of dyadic partnerships within a supply chain. Cost management systems spanning over the supply chain partners make it possible for managers to examine the total supply chain costs as well as the economic performance of individual firms. Before applying such a system it is very important to discover most of the costs related to the supply chain operations and their trade-offs. The most frequently adopted tool for this is Activity-based costing. Supplier and customer assessment tools are necessary to map the logistical and financial performance of supply chain partners.

In his article, Van Goor (2001) measures supply chain evolution by the level of integration of supply chain participants. He also refers to different supply chain management tools in different stages of evolution, which somehow build on each other. In the *physical integration phase,* cooperating companies aim to improve the performance of the primary processes. This can be carried out by standardising consumer and transportation packaging: pallets, containers. In the *information integration phase,* primary materials processes are supported by information sharing between partners through standardised tools such as EDI and barcode systems. In the c*ontrol* *integration* phase, physical flow is simultaneously managed at more than one level in a supply chain. Time phased information facilitates the introduction of DRP. As the cooperation is getting stronger, partners start to make an effort to make the supply chain more responsive, to enhance the level of customer service and to decrease the level of inventory. To achieve these latter, partners adapt VMI or QR. *Structure integration* phase is the highest level of supply chain integration, which concerns the structure of partners' logistics processes. In this phase, cooperation and mutual trust are high, and one of the cooperating parties takes over the logistics responsibilities within the territory of the other party. Although this can be the case by including a logistics service provider it is not necessary to do so (VAN GOOR, 2001).

Based on Lee (2000), Varma et al. (2006) and Van Goor (2001), it can be stated that – in general – demand chain management techniques consist of tools for managing information and materials flow and supporting cost and performance assessment. However, information sharing tools are inevitable and elementary for making both tool-categories operational.

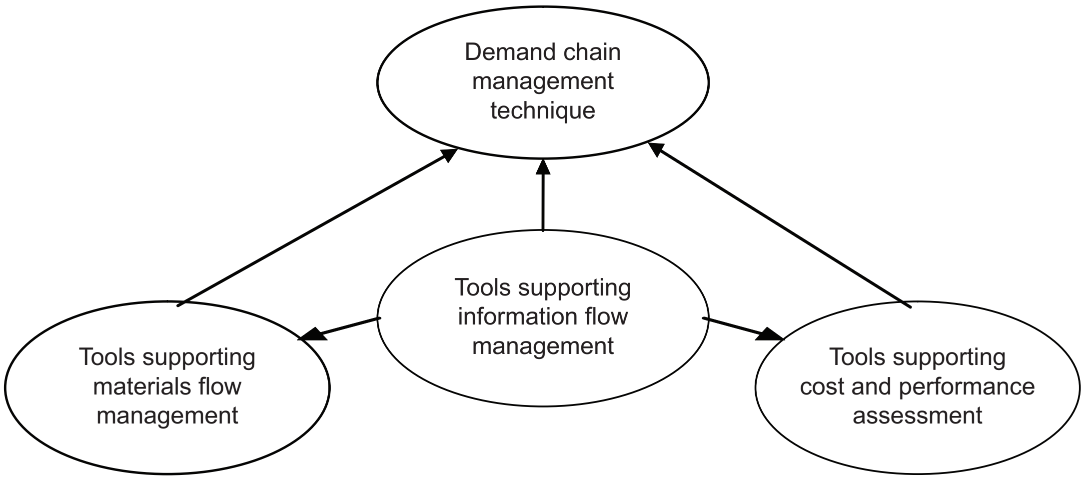

Figure 3: General structure of demand chain management techniques

Table 2 below summarises the examined demand chain management tools which were collected from the literature and which all aim to manage the distribution side of the supply chains irrespectively of any industry specification. They are all generally applicable and can support the distribution-related processes.

Table 2: Demand chain management toolset categories

Structure of demand chain management techniques	General demand chain management tools
Tools supporting information flow management	EDI (ERP, and other web-applications), CAO, common planning and forecasting, barcode, RFID
Tools supporting materials flow management	VMI, CRP, Cross-docking, postponement
Tools supporting cost and performance assessment	ABC, supplier assessment, customer assessment

II.2.1 Tools supporting information integration

Tools supporting information integration are elementary to balance materials flow as well as to discover cost and performances within the supply chain. In this chapter I call attention to not only that of sharing sales and planning data that can substantially improve demand forecast and consequently, smooth materials flow, but there are many other tools, which are important to track the goods within the distribution chain.

II.2.1.1 Product identification

The application of both barcode systems and RFID aims to obviously identify goods flowing between partners within the demand chain. It also aims to track and trace materials and provide the most possible information for all participants concerned.

Barcodes can be defined as a graphic representation of codes containing different information. By using proper hardware and software, barcodes can be read at each stage of the supply chain. Information can be gained and stored and this way allowing tracking and tracing of goods (Gelei and Kétszeri, 2007). An additional advantage is that it allows a global, unique and automatic identification, and the use of barcodes results in a high level of accuracy. Barcodes can be applied on consumer and transportation packaging, on unit loads and on other transportation units as well (Halászné, 1998).

RFID is used in automatic identification systems, which allow unique tracking and tracing of goods or other units by adopting radio frequency technology. RFID works without the need of visual contact to the product, only by radio connection.

RFID technology consists of two parts: a tag and a reader. The tag contains a memory and an aerial and serves to capture and provide information when reading. When a tag is stuck on a product all information about it can be loaded up to the memory which allows for a unique identification and a product code is generated. EPC-Global system includes all the product codes generated by companies joint to the system globally. Consequently, products can be tracked and traced uniquely in anywhere in the world (White at al., 2008; Gelei and Kétszeri, 2007).

Most of the companies use the widespread and costly implemented barcode-based systems (Gelei and Kétszeri, 2007). For this reason, they may feel that adopting a new, RFID technology does not provide a huge advantage, which could counterweight the high level of costs related to the implementation. This is one explanation why RFID spreads so slowly and that RFID will not replace the barcode system in the short term. Barcodes will be applied extensively for a reasonable time, and RFID will exist in line with it.

II.2.1.2 Electronic data interchange

A substantial criterion of managing a supply chain is the sharing of relevant and accurate information.

Many researchers support the fact that information sharing systems have an extremely important role in supply chain management (White et al., 2008; Schubert, 2007; Holweg and Pil, 2008). Chopra and Van Mieghem (2000) say that if demand chain participants are linked by the Internet – and not necessarily by expensive inter-firm systems – contact with each other and sharing information helps greatly to increase efficiency. Besides the effect that information sharing enhances efficiency and embeddedness in corporate strategy, it can also support company growth and profitability (Byrd and Davidson, 2003). On an operational level, data share increases the information supply of the market and customer service level as well. Kent and Mentzer (2003) also state that extending information systems to commercial partners has a positive effect on the relationship of demand chain participants.

The most standardised ways of information flow in supply chains are the Internet and EDI connection, which are based on standardised messages. Information shared may concern POS sales data, inventory or order data and inputs for common planning, etc. EDI is structured information sharing between supply chain members, which allows for decreasing transaction costs (Nagy and Schubert, 2009). EDI not only positively affects the integration of functional areas within a company or supports formulating internal supply chains, but is important in the relationship with external partners, as well. To implement an EDI, or any other information system, costs a lot both financially and timewise, and most of the companies are not ready to invest in such a complex technology, which also requires effort on the human resources side (Bhutta et al., 2002).

The positive effects of EDI application on distribution processes can be summarised as (Gelei and Nagy, 2008):

- decreasing paper work
- increasing accuracy thanks to decreasing manual processes
- increasing speed of order flow
- remarkable reduction of administrative work related to data input, data processing and communication
- number of problems decreases concerning ordering, order processing and order handling
- because of the reduced administrative work and human resource problems, there is more time for creating value
- information supply increases
- increasing accuracy and decreasing order cycle results in an effective operation.

Challenges of EDI application are related on one hand, to hardware and software requirements, and the new way of process approach, but on the other hand, it is also hard to convince demand chain partners to implement a similar system.

II.2.1.3 Common planning and forecasting

Common planning and forecasting require intense information sharing and cooperation from demand chain participants. A primary purpose of tools is a specialised information flow and share activity, which provides a basis for the materials flow and replenishment processes. According to the approach of Voluntary Interindustry Commerce Standards Organisation (VICS, 1998), when common planning and forecasting companies leverage the opportunities of the Internet and EDI which help them to radically reduce inventories and costs, and increasing the customer service level the same time.

ECR Europe (2002) says that common planning and forecasting, and information sharing develop supplier/manufacturer /retailer relationships.

Skjøtt-Larsen et al. (2003) interprets common planning and forecasting as collaboration were two or more parties in the supply chain jointly plan promotional activities and work out synchronised forecasts, on the basis of which the production and replenishment processes are determined.

Definitions agree that the basis of common planning and forecasting is an information sharing and harmonised activity, which improves the production and distribution processes and performance within the supply chain.

There are many tendencies which are involved in the spread of common planning and forecasting, which basically means the sharing of very sensitive information. Maybe the most important tendency is the strength of competition on the market (fashion industry, FMCG) (Gelei et al., 2009). Customers expect a wide assortment, but when competing with many players on the market it is hard to sustain effectivity and economies of scale. As supply chains are becoming more and more complex due to global sourcing and sales spread, there arose a need for a tool for coordinating supply chain participants. Particularly, in the production of fashion and commodity goods, the distribution side of the supply chain is very extended in geographical meaning, which worsen transparency and increase lead time. Geographical extension also affects cost structure, and it is the interest of supply chain members to capture the possibilities to rationalise. The above phenomena all affect companies that are trying to react responsively to the fluctuation in customer demand and other market events, and to do so, they have to share information (Fliedner, 2003).

In Fliedner's (2003) opinion, common planning and forecasting (and any other activity sharing of relevant and accurate information) helps to increase transparency and allows cost optimisation. Along with literature review and pilot projects, his team summarised what advantages the adoption of joint planning and forecasting provides for retailers, manufacturers and the entire demand chain.

At *retailers',* supply accuracy improves and can offer a higher customer service level. Inventory level is reduced, and the ordering process becomes faster. All these serve to achieve a larger sales volume.

Manufacturers are also faced with decreasing the level of stock and capacity utilisation improves. Order filling rates also develop, and lead time decreases, which results in increasing sales.

Demand chain costs decrease and materials flow smoothes, because of the reduced number of stock keeping points, and better forecasting helps to reduce the level of safety stock and over-stock.

An advantage of common planning and forecasting can be measured not only by cost savings, but it allows for gaining competitive advantage as well. Through adoption QR in the fashion industry and CPFR in various industries, have come demand chain management techniques, which substantially improve demand chain efficiency and cost structure. Those who cannot follow the trends and keep the new cost structure suffer a disadvantage in competition (VICS, 2002).

Advantages can be promising for all members in supply chains. However, there are some obstacles, which can hinder the application of that tool. One of the obstacles is when cooperating parties do not trust each other, and consequently, do not share sensitive information which is elementary for the planning and forecasting process. Further hurdles could be if internal forecast collaboration lacks. Many times some supply chain members cannot afford the cost of technology and expertise to implement the joint planning and forecasting system. This could be a problem if cooperating companies are using fragmented information sharing standards and differ in the number of forecasts and frequency of generation. Sometimes companies basically are in fear of collusion (Fliedner, 2003).

II.2.1.4 Computer-aided ordering

Bhutta et al. (2002) interprets computer-aided ordering process between the central warehouse of the customer and the sales points. CAO aims to automate the replenishment process of the customers' sales points by a low level of intervention which is generated on the basis of historical and actual POS data, transportation information and sales forecasts (Garry, 1994).

CAO allows the demand chain labour savings, reduced inventory level and improves warehousing and transportation performance (Garry, 1994; Harris and Swatman, 1997; Bhutta et al., 2002).

When operating CAO, some problems may arise which have to be solved. First, CAO needs structured POS data which provide the basis for the scheduling of the replenishment process between the warehouse and the sales points. Second, the information technology system has to be linked between the sales point and the warehouse in order to transfer data. Supportive technology, therefore, requires investment. Third, to replenish sales points so frequently, shipping of products cannot be carried out in standard unit loads, but smaller packages of goods are needed. Therefore, warehousing systems and shipping vehicles have to be able to handle not-standard-size small containers. This affects transportation capacity utilisation and economies of scale, too (THAYER, 1991).

II.2.2 Tools supporting materials flow integration

In my interpretation, an elementary aim of constructing and managing supply chains is to coordinate and harmonise the activities of the participants. The tools presented in this chapter allow for smooth materials flow, reducing inventories, balancing value creating processes, and help to make the demand chain responsive.

II.2.2.1 Continuous replenishment and vendor managed inventory

Bhutta et al. (2002) interprets the continuous replenishment process between the supplier and the central warehouse of the customer. CRP aims to solve the problems of traditional replenishing systems: high safety stock and related cost level, long lead time, hectic ordering and fluctuating customer service level. The key to the solution is the effective information sharing system presented in the previous chapter. The continuous and accurate information is inevitable in the effective replenishment process. When processing, the POS data coming from the customer's supplier becomes aware of inventory movements to customers and is able to replenish the proper amount of product.

Vendor-managed inventory is a similar solution to smooth materials flow in CRP. In the VMI system, the manufacturer is responsible for managing its customer's inventories. In exchange, the customer has to provide actual and accurate inventory data to the supplier who decides individually about the replenishment. The customer, of course, defines the expected minimum level of logistics service or his expectations about the replenishment process, but basically empowers the vendor to make the everyday operational decisions about his inventories (MISHRA and RAGHUNATHAN, 2004).

VMI can be interpreted as collaboration between the customer and supplier to optimise the availability of products at the minimal cost to the two parties. The supplier takes the responsibility for the operational management of inventory within a mutually agreed framework of performance targets, which are constantly monitored and updated to create an environment of continuous improvement (Breite and Koskinen, 2007). Disney and Towill (2003) keep VMI as a very important tool in the overwhelming bullwhip-effect, but emphasise that effective and accurate information sharing has a substantial role in operating such a tool.

According to Waller et al., (1999) the main benefits of VMI are cost savings and customer service level improvement. However, the largest advantage of the application is not the amount of cost saved, but the more effective coordination of demand chain and higher customer satisfaction achieved.

In their research, Claassen and her team (2008) analysed what benefits of VMI can be experienced by stakeholders, what prerequisites are necessary for successful implementation and what are the success factors. For a *vendor*, the most important benefit is that he is better able to align his production processes to customer demand. Since information about actual and forecasted demand is available at an early stage and fluctuations can be smoothed and suppliers can respond proactively. As suppliers become trustees of planning and carrying out replenishment gains more flexibly. Flexibility in replenishment schedules enables the vendor to create full truck loads (FTL), consequently, achieving a reduction in transportation costs. Further advantages for the supplier are the establishment of long trustworthy relationship with the customer, a more loyal customer and thus secured sales.

On the *customer*'s side, benefits come from the reduced administrative costs because material requirement planning is not necessary anymore, purchase orders become easy and there will no longer be backorders or returns. Furthermore, the customer benefits from better logistics service level, and consequently, can offer a higher service level to his own customers.

Regarding the entire *demand chain*, inventory levels can be decreased all along the chain. In traditional supply chains the customer decides the volume and date of replenishments, which was based on his actual inventory and handling costs, and do not take into account the transportation costs and the costs of maintaining flexible capacity by the supplier. VMI provides all the information necessary to the vendor about stock levels and demand, which enables him to optimise the replenishment process, inventories and costs resulting in a higher overall margin. The early and continuous share of information between customer and supplier should also result in a reduction of the bullwhip-effect.

Table 3: Advantages of VMI

Customer	Supplier	Demand chain
Reduction of administrative costs	Better align production processes to customer demand	Reduction of inventory costs
Lead time reduction	Can respond proactively	Optimal decisions for the entire supply chain instead of optimisation of sub-processes, resulting in lower operational costs
No backorders and returns	Flexibility in the replenishment schedules	
Better service level	Reduction in transportation costs	Reduction of the bullwhip effect
	Long trustworthy relationship, secured sales	

Source: Claassen et al., 2008

After summing up the benefits of VMI realised by different stakeholders, Claassen et al. (2008) gathered the success factors of VMI. In their opinion, there are four factors which substantially influence the VMI implementation and everyday operation:

- information sharing
- quality of information
- quality of IT system
- quality of buyer-supplier relationship.

If all of these operate well, VMI provides three overall benefits: better customer service, coordinated demand chain and cost saving opportunities.

II.2.2.2 Postponement

In her working paper, Gelei (2003b) keeps postponement a tool for managing the distribution side of supply chains. The core of postponement is that risk and uncertainty costs are linked to the differentiation of goods that occur during manufacturing and logistics processes. If manufacturing and logistics operations – at least partly – can be postponed until final customer needs have been obtained, the risk and uncertainty can be reduced or fully eliminated (Pagh and Cooper, 1998). Postponement, therefore, requires a new approach in planning products and processes (modularity, flexibility) (Yang and Burns, 2003).

In the interpretation of Pagh and Cooper (1998), *production postponement* means keeping the product in a neutral and non-committed form as long as possible in the manufacturing process. A standard core product is produced at high volume, and differentiation occurs only at the final stages of production when the exact customer demand is known. Manufacturing postponement allows economies-of-scope and the number of SKU can be reduced radically, and consequently, the cost of stock also decreases. A usual solution of manufacturing postponement when an easy production or assembling process is carried out by not the manufacturer itself, but outsourced to a (logistics) service provider close to the market.

Logistics postponement is to maintain anticipatory inventory at one or a few strategic locations and demand is served from that stock keeping points when the need emerges. This solution makes the delivery process quicker and helps to minimise inventories kept because of poor forecasts and allow for a production economies of scale.

On the whole, postponement improves supply chain responsiveness and at the same time helps to decrease inventory, transportation, warehousing costs and lost sales (Boone et al., 2007).

II.2.2.3 Cross-docking

A cross-docking facility is a member of the distribution channel. Placed between the central warehouse of the manufacturer and the customer, its role is to optimise the delivery process. The application of CD allows exploiting the benefits of the indirect distribution structure by using the economies of scale in transportation, and reducing the disadvantages of centralised distribution by decreasing transportation costs. A CD facility, of course, increases the warehousing costs, but – as it will be discussed later – there is no stock storage. Consequently, adopting CDs is more cost-efficient than operating a horizontally and vertically structured decentralised distribution system. In CD, the consignment spends only a short time in the facility, usually less than 24 hours (Gümüs and Bookbinder, 2004; Schaffer, 2000), this way transportation cost can be reduced between the manufacturer's central warehouse and the CD, because a full truck load can be shipped.

According to Schaffer (2000) the logic behind CD is that for one thing, it is more effective and reduces cost than it is at improving the performance of a stock keeping point – when it is eliminated.

The aim of CD is to hasten the materials flow between the supplier and the customer's sales points, this way the stock keeping and materials handling needs are reduced in the warehouses or distribution centres (Garry, 1994). Regarding the processes carried out within the CD, the incoming pallets (unit loads) are stripped, order picking is carried out according to the need of the sales points serviced, then goods are repacked and prepared for shipping. In the facility, no inventory is held and products are transported in customised form to sales points (Gelei, 2008).

To be able to operate a CD, there are some prerequisites: EDI or other information technology solutions to capture and process incoming goods and orders, barcode or RFID system to quickly identify incoming and outgoing goods. There are some special requirements for the facility as well, such as a low ceiling, huge free operational area, few racks (Harris and Swatman, 1997) and a work force with a flexible schedule (Schaffer, 2000). CD also requires close relationship of cooperating parties, trust and long term view.

The reason for creating CD is that after the appearance of highly customised products the number of SKUs handled in one order dynamically increases. At the same time, competition and low profit margin motivate supply chain members towards increase productivity and customer service level through the application of IT solutions. CD has been the result, which on one hand follows sales data, on the other hand, allows for more accurate inventory registration (Bhutta et al., 2002).

An advantageous solution of CD for reducing inventories is that safety stock levels of the sales points do not increase more than the inventory saved (Waller et al., 2006). It is not practical to reload the inventories of distribution centres to sales points, because reallocation of goods becomes difficult.

II.2.3 Tools supporting cost and performance assessment

This chapter aims to present tools, which help to make costs and performances in the demand chain more transparent. Besides activity-based costing, which supports to discover relevant costs and non-value-adding activities within the demand chain, supplier and customer assessment is also captured to evaluate the value and performance created by the parties and the risks and rewards linked to them.

II.2.3.1 Activity-based costing

The basis of activity-based costing is an accurate information system and transparent processes. It aims to provide accurate information about products, product categories, services, processes, distribution channels, customer segments and other projects by discovering the internal cost structure, its reasons, and the ratio of profit. Its basic role is to assure transparency, and as a controlling tool, calls the attention of managers to the cost saving opportunities and also allows the filtering of non-value-adding activities (Harris and Swatman, 1997; Bhutta et al., 2002).

The general goal of ABC application is not to build the most precise cost-register, but to allocate more accurately costs to cost-drivers than the traditional cost-management systems did. However, in the end the result will be a very accurate cost-register (Stapleton et al., 2004).

Adaption of ABC has to be supported at each level of the company structure, which requires commitment not only from the managers, but the education of workers is also needed to be able to produce structured data for analyses (Wimmer, 1999). In the opinion of Stapleton et al., (2004) ABC demands a new way of thinking also. Implementation necessitates financial and human resources, information technology and a proper amount of time. The key of adaption is a well constructed cost- and performance-driver system, which is neither too meticulous nor too general.

Application of ABC in the field of logistics is not as easy as it is in production. The reason for it is that defining the output is not so easy (service), activities within a service may change and are not so predictable, and because of the common use of several capacities, it is hard to dedicate a cost to one or other output (unit loads, more addressees in one shipping, etc.) (Stapleton et al., 2004).

II.2.3.2 Supplier and customer assessment

Both supplier and customer assessments serve to make demand chain participants aware of the performance of their partners and to be able to handle imperfections and exploit strengths. An important part of the assessment is the profitability analysis of partners and how rewards and risks are divided between cooperating parties.

During supplier assessment – either we regard a dyadic partnership or a series of partnerships within a supply chain – it is important to know the value added by the different players. Vörösmarty (2000) calls attention to that the aim of the supplier assessment is not only to measure the partner's performance, but to select the best performing suppliers, too.

In the opinion of Gordon (2005) in the case of long term, strategic suppliers, the most important is continuous control of their *financial health*, monitoring their sales, profit, liquidity, external funds and other business references to be able to react in advance of a major problem. Such data can be obtained easily about joint-stock companies than about smaller ones. Gordon (2005) also emphasises that besides financial measures, other performance dimensions also have to be taken into consideration. *Operational performance* can be captured by how the supplier matches with the customer service level criteria defined by the customer. *Business processes and practices* can be reviewed also to discover the roots of problems and helps to understand the way the supplier operates. *Enabling behaviours or cultural factors* reflect to the customer focus, agility, continuous improvement, and teamwork capabilities of the supplier. An important aspect of evaluating suppliers is to understand and then mitigate *risks* derived from all of the previous dimensions.

Customer assessment gains less publicity. However, it is very important both in dyadic partnerships and on the supply chain level as well. Customer assessment allows companies to specifically define the customer attributes desired to ensure that the targeted buyer mix will match the products and services sold. According to Meredith (1993), customer assessment is important because companies have to discover those customers in the portfolio who represent high sales potential. Not only the individual customers, but the entire buyer mix has to be assessed (Wimmer, 1999). Evaluation can help in segmenting a customer portfolio, understanding the needs of different customer segments and to find the best marketing mix and offer the proper product and service package. An important task of customer – as well as the supplier – evaluation is to reveal the future risks, which derive from the structure of buyer portfolio or from individual customers. Customer assessment helps to gather the characteristics of a "good customer" and the way to find them.

The distribution-side supply chain management tools presented in the previous pages can be adapted in demand chains generally, irrespectively to the industry the chain operates in. When applying the tools, information supply of demand chain participants increases, tools help to smooth materials flow and costs, performances, risks and rewards become transparent.

III. TYPES OF SUPPLY CHAINS

This chapter aims to present along which dimension researchers differentiate the types of supply chains. The defined types of supply chains are, on one hand, similar to each other in their basic approach, but on the other hand, differ from each other in their primary purpose.

Probably, I do not overstate when I say that Fisher's (1997) supply chain typology is as famous and elementary a model of supply chain literature as Porter' strategies are in the field of strategic management and Kotler in marketing management. A secondary goal of the chapter, therefore, is to present this model in detail as it has become the central model of the dissertation and as well as several other models, which were elaborated on by different authors, which tried to classify supply chains along diverse dimensions. Models were then presented and compared to Fisher's model.

I have chosen Fisher's model for the focal model of the dissertation because this was the first trial to explore: supply chains do not run in a uniform way, rather they can be differentiated along their operational focus. Distinguishing supply chains by product type delivering to the market is an easy and evident need, because the characteristics of a product can substantially determine the operational expectations and circumstances.

Many researchers have been dealing with defining the types of supply chains. However, each of them has somehow been based on Fisher's important, but never verified model. Later many authors have identified other types of supply chains – sometimes on a different basis – but in their roots they derive from Fisher's basic typology and/or are its modulated version.

The third reason for choosing Fisher's model was that despite his fame and large number of citations, I have found only two sources, which have tested the model on a large database (statistical analysis): one examined it amongst Swedish companies (Selldin and Olhager, 2007), and another, which tested it in Australia (Lo and Power, 2010). Several additional tests have been carried out in various industries via case studies (Wong et al., 2006; Li and O'Brien, 2001). Selldin and Olhager (2007) verified the model only partly. Lo and Power (2010) did not succeed, and the others were only able to modulate the concept by distinguishing more supply chain types when analysing a single industry.

Because I have only found two quantitative tests of Fisher's theory amongst Swedish and Australian companies, I think it is worth and interesting testing the model on a Hungarian sample, whether it operates on a Hungarian supply chain basis.

III.1 Differentiating supply chain types along product characteristics

Fisher's (1997) theory is the most widespread of all researchers, which tried to differentiate supply chain types and serve as a basis for almost each classification. According to Fisher, to operate an effective supply chain the first step is to understand the nature of the demand. The demand of a product is a very complex phenomenon, and many aspects are important, like the actual stage of the product life cycle, product variety, predictability of demand and market standards for lead times and customer service level (particularly the percentage of demand filled from in-stock goods). Fisher found that if products are qualified on the basis of their demand patterns, they fall into one of two categories: products are either primarily functional or primarily innovative. The different types of products require managing supply chains differently.

According to Fisher's approach (Fisher, 1997. p. 106), functional products are elementary products, which fulfil everyday needs and which change only a little over time. Consequently, their demand is stable and predictable, and their life cycle is long. The stability, however, attracts many competitors to the market, which causes low profit margins.

Innovative products fulfil fashion or occasional needs, which change quickly during time, and consequently, the demand is unpredictable and the product life cycle is short. High risk is awarded by high profit margin so many companies are entering and leaving the market at the same period of time, the club of competitors' changes quickly.

Table 4 compares functional and innovative products along several emphasised aspects. The author also defines values to different aspects, which call even more attention to the differences between the two product categories.

According to the theory of Fisher, Milner and Kouvelis (2005), they have differentiated products along their demand patterns, but besides functional product, they classified innovative products into two additional groups. In the case of fashion-driven innovative products, demand is unpredictable because of the changes in fashion. Regarding evolving-demand innovative products, demand rate evolves over time based on shocks resulting from advertising, marketing efforts, competition or any changes in the business environment.

Table 4: Attributes of functional and innovative products

Type of product Aspects of demand	**Functional product** (predictable demand)	**Innovative product** (unpredictable demand)
Product life cycle	more than 2 years	3 month to 1 year
*Contribution margin**	5% to 20%	20% to 60%
Product variety	low (10 to 20 variants per category)	high (often millions of variants per category)
Average margin error in the forecast at the time production is committed	10%	40% to 100%
Average stockout rate	1% to 2%	10% to 40%
Average forced end-of-season markdown as percentage of full price	0%	10% to 25%
Lead time required for made-to-order products	6 months to 1 year	1 day to 2 weeks
*The contribution margin equals price minus variable cost divided by price and is expressed as a percentage.		

Source: Fisher, 1997. p. 107

Supply chains – according to Fisher – have a dual function: physical and market mediation. The physical function refers to activities such as product manufacturing from raw materials, assembling, and delivery to the right member in the supply chain and then to the final consumer. The aim of the market mediation function is to assure that the product delivered to the market meets the real consumer demand.

Each function presents different costs. The costs of the physical function are related to production, transportation, inventory holding, and warehousing that serve the real market needs, and contain the costs of the full-price product sold on the market. Market mediation costs arise because of poor demand forecast, which causes a lack in inventory and lost sales or overproduction, which can be sold only at a discount price. This type of cost embodies the adaptation to a changing and unpredictable demand (FISHER, 1997).

Predictable demand of functional products makes market mediation and adaptation relatively easy, because demand can be quite well forecasted. Therefore, companies producing functional products focus on minimising physical costs, which is critical because of the price-sensitivity of the market.

Companies manufacturing functional products thus create a schedule for assembling finished goods and commit themselves to abide by it. Freezing the schedule in this way allows firms to apply MRP software, which harmonises the ordering, production and delivery, thereby enabling the entire supply chain to minimise inventory and maximise production efficiency. Free flow of information within the chain is a key in enabling the supply chain to coordinate activities in order to meet predictable demand at the lowest possible cost. Fisher calls this type of supply chain, physically-efficient.

In the case of innovative products with highly unpredictable demand adaptation can be very costly and uneasy. The high profit margin, the market share position and the market skimming behaviour of the first-mover increase the costs of a lack of inventory. At the same time, short product life cycle may raise the risk of too high stock. Consequently, neither lost sales nor high inventory sold at a discount price is favourable. In the case of innovative products, market mediation costs dominate the aim of managers to minimise them, even through higher physical costs. The uncertain, unpredictable demand is a characteristic of innovative products. Companies which work in such a market have to fight with uncertainty.

Uncertain demand is a characteristic of innovative products. Companies manufacturing that kind of product have to fight with uncertainty and may choose one of the three possible strategies.

Basically, companies have to understand the product characteristics and simply accept that uncertainty is inherent in innovative products, which means that risks and rewards are proportional. To get a higher profit, higher risks also have to be taken. The first strategy companies can follow is to continue to strive to reduce uncertainty by finding sources of new data, analysing them or design and manufacture modular products and assemble only when the demand becomes more predictable (production postponement). The second strategy can be to avoid uncertainty by radically decreasing lead times and increasing supply chain flexibility so that companies can produce to order, or at least manufacture the product at a time when demand materialises and can be accurately forecasted. The third strategy is the hedge against uncertainty by establishing a buffer of raw material and semi-finished product inventories, or capacity surplus.

It is most important in this turbulent environment is to read early sales data and other market signals in order to react quickly during the new product's short life cycle. Flow of information occurs not only among supply chain participants, but also from the marketplace to the chain.

The critical decisions about inventory and capacity are not about minimising costs, but where to place them within the supply chain: where to stock inventory and allocate production capacity in order to hedge against uncertain demand. Selection criteria of suppliers are speed and flexibility, not the purchase price. Fisher calls the supply chains fitting to innovative products, market-responsive. Responsiveness can be defined as the lead time of the materials flow between supply chain members (Hines and Rich, 1997) or by considering inventory availability as well (Hines, 1998).

The next table summarises the characteristics of the supply chain types on the basis of the aspects generated by Fisher. As it was seen in the case of product types, the aim of the table is to contrast the operational characteristics of the chains (Table 5).

Kaipia and Holmström (2007) use the differentiation of functional and innovative products and matching physically efficient and market responsive supply chains, and discovered that the difference can be found in the planning processes also.

Rossin (2007), based on Fisher's theory, uses the physically efficient and market-responsive supply chain classification and emphasises that the quality of shared information is substantial in the success of both supply chains.

Based on the four characteristics: two product and two supply chain types, Fisher compiled a matrix (Figure 4). Applying this, it can be discovered whether a company uses the right supply chain for its product type, or a mismatch exists.

Table 5: Attributes of physically efficient and market-responsive supply chains

Type of supply chain Aspects	**Physically efficient process**	**Market-responsive process**
Primary purpose	supply predictable demand efficiently at the lowest possible cost	respond quickly to unpredictable demand in order to minimize stockouts, forced markdowns, and obsolete inventory
Manufacturing focus	maintain high average utilization rate	deploy excess buffer capacity
Inventory focus	generate high turns and minimize inventory throughout the chain	deploy significant buffer stocks of parts or finished goods
Lead time focus	shorten lead time as long as it doesn't increase cost	invest aggressively in ways to reduce lead time
Approach to choosing suppliers	select primarily for cost and quality	select primarily for speed, flexibility, and quality
Product design strategy	maximize performance and minimize cost	use modular design in order to postpone product differentiation for as long as possible

Source: Fisher, 1997. p. 108

	Functional product	**Innovative product**
Physically Effective Supply Chain	Match	Mismatch
Market-responsive Supply Chain	Mismatch	Match

Figure 4: Supply chain types fitting to product types

Collin (2003) tested Fisher's model in project-based business relationships, and has defined different supply chain types based on the level of production and logistics postponement, in the case of innovative products. He processed case studies of a given project at Nokia and distinguished different supply chains with diverse focuses servicing different stages of the project. In his opinion when choosing the type of supply chain the level of cooperation and relationship of the parties are important.

In their article, Wong et al. (2006) analysed the toy supply chain, and according to their experience, they advise to differentiate more types of products besides functional and innovative. In accordance with the theory of Li and O'Brien (2001) they use the notion of "*intermediate product*". Forecast uncertainty and demand variability of "intermediate products" are not as high as with innovative products. This allows investment in finished goods inventory based on a forecast at bearable risk. Defining similarly, Huang et al. (2002) used the notion of *hybrid* product.

Wong et al. (2006) also introduced the group of "suicide products", which have a high forecast uncertainty, but low contribution margin. "Dream products" are ideal products with low forecast uncertainty and yet high contribution margin. Because of their research based on the toy industry, Wong et al. (2006) define five product categories and five supply chain types matching them (Figure 5).

Physically responsive supply chain strategy was also defined by Li and O'Brien (2001) as fitting to intermediate products, and Wong et al. (2006) keep this kind of supply chain as ideal for dream products as well. However, this means a manufacture-to-stock strategy, which allows serving customers responsively from stock. In the case of intermediate product, this strategy is explained by the middling uncertainty of forecast. When a manufacturer introduces a dream product, many other manufacturers may initiate the idea and introduce similar products with sharp price competition, which may quickly drive the contribution margin down and forecast uncertainty up. That is why keeping huge inventory and servicing customers quickly is important.

Supply chain type matching suicide products is manufacture-to-order. In the opinion of Wong et al., (2006) demand is so unpredictable and a contribution margin is so low that it is relatively risky to invest in finished goods inventory.

Firms cannot always find the supply chain type that fits to their product type as it is suggested by Fisher in Figure 4.

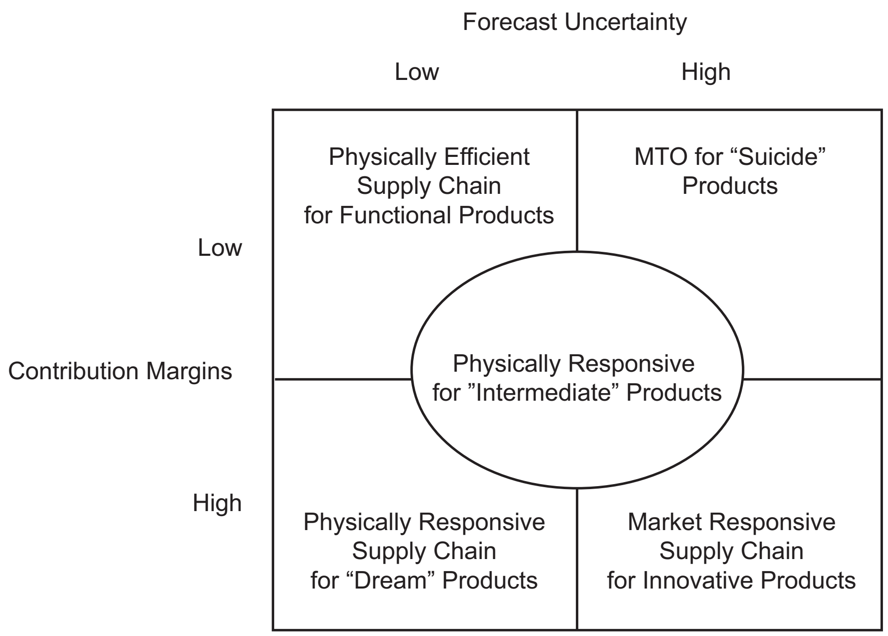

Figure 5: Extension of Fisher's model for volatile supply chain

Source: Wong et al., 2006: p. 719

Wong et al. (2005) in their other article, dealt with toy industry as well, and characterised the toy market with intense seasonality, volatility, unpredictable demand, party highly innovative (electronic toys) and short life cycle products. They analysed in detail that the current supply chain practice in this sector does not fit to the product characteristics. Supply chains explored by them try to operate in a physically efficient (in Fisher's interpretation) way resulting in heaviness, slow reaction and high level of lost sales (Wong et al., 2005).

Sometimes functional and innovative products overlap, because manufacturers of functional products introduce innovations in fashion or technology to give customers additional reasons to buy their offerings and increase the profit margin. Innovation can create a higher profit margin, but newness of product can make demand unpredictable and shorten the life cycle as competitors start to imitate. A short life cycle and vast product variety typically increase demand uncertainty, according to Fisher.

Based on the observations of Fisher the rate of new product introduction in several industries is very turbulent and fueled by the growing number of competitors and the effort of current competitors to save or increase the profit margin. As a result, many companies aim to turn traditionally functional products into innovative products, but in supply chain management they have continued to focus on physical efficiency.

A sure sign that a company needs to move back towards functional products instead of trying to be innovative is if a firm has a product line characterised by frequent introductions of new offerings, great variety and a low profit rate.

Catalan and Kotzab (2003) have analysed the Danish mobile communication industry and defined lead time of information and materials flow and demand transparency as a dimension of responsiveness. They have found the product innovative according to Fisher's classification. However, the supplier-side of the supply chain is operated in a physically efficient way and on the distribution-side customers expect a high level of responsiveness. In the authors' opinion, total responsiveness is not possible without the active cooperation of supply chain participants, the transparency of demand data and a common information system.

III.2 Differentiating supply chain types along market qualifier and market winner criteria

The aim of this chapter is to present more supply chain types, besides Fisher's, and compare them to the focal model of the dissertation.

The concept of agile and lean supply chains derives from the agile and lean production paradigms and aims to capitalise the principles of the latter in supply chain context.

Naylor et al. (1999, p. 108) defined agility as "using market knowledge and a virtual corporation to exploit profitable opportunities in a volatile market place. Leanness was interpreted as developing a value stream to eliminate all waste, including time, and to enable a level schedule."

Agility is advantageous if marketplace demands are extremely volatile both in volume and variety, while leanness can be adapted when demand is predictable leading to a level schedule.

Mason-Jones et al. (2000) derived the need for lean and agile supply chains also from the lean and agile production paradigms. In their opinion, agility and leanness somehow rest on similar bases, e.g. product quality and short lead time are important in each of the production paradigms and supply chains. However, authors found a difference in market qualifier and market winning criteria between the paradigms.

A distinction can be made based on that in agile supply chains the primary value-adding factor for customers is fast service, while in lean supply chains the price and cost. Naylor et al. (1999) agreed with Mason-Jones and her team (2000) in the differentiation.

Characteristics of the lean and agile supply chains are summarised in Table 6 by Mason-Jones et al.

Table 6: Comparison of lean supply chain with agile supply chain

Distinguishing attributes	Lean supply chain	Agile supply chain
Typical products	Commodities	Fashion goods
Marketplace demand	**Predictable**	**Volatile**
Product variety	**Low**	**High**
Product life cycle	**Long**	**Short**
Customer drivers	**Cost**	**Availability**
Profit margin	**Low**	**High**
Dominant costs	Physical costs	Marketability costs
Stockout penalties	Long term contractual	Immediate and volatile
Purchasing policy	Buy goods	Assign capacity
Information enrichment	Highly desirable	Obligatory
Forecasting mechanism	Algorithmic	Consultative

Source: Mason-Jones et al., 2000: p. 56

In the table presented, the characteristics of lean and agile supply chains and the products' delivered is a little bit mixed up. I show product characteristics with italic-bold letters and supply chains with normal ones.

The table points out that the product handled in lean supply chains is very similar to those handled in Fisher's physically efficient supply chain, maybe fewer characteristics are listed. Supply chain characteristics are almost the same, thus Mason-Jones et al. found dominant physical costs in lean supply chains as well as Fisher found in physically efficient supply chains. A contrast between lean-agile and physically efficient-market-responsive theories is the importance of information sharing. Fisher keeps it elementary in operating physically efficient supply chains (and has a key role in a market-responsive supply chain, too), but Mason-Jones and her team dedicate large importance to information sharing only in the case of agile supply chains. Methodology of forecasting was not studied by Fisher, but as he keeps the demand of functional product predictable, the theories correspond.

The agile supply chain does not correspond to a market-responsive supply chain as much as lean to be physically efficient; however, there are similarities. The focal product of agile supply chains, according to Mason-Jones et al., is a fashion-driven product. However, Fisher interprets the innovative product category wider (e.g. computers). All the other product characteristics are the same as in case of innovative products. Mason-Jones et al. uses the notion of marketability cost instead of market mediation costs of Fisher, but regarding their content – the cost of lack or over inventory – they are the same. In the following, I use Fisher's terminology.

Stock-out penalty is an important aspect, which is not mentioned by Fisher; he only refers to it. He observes that stock-out penalty occurs very rarely in functional products and represents a part of market mediation costs. Mason-Jones also keeps market mediation costs dominant in agile supply chains, so the reason for highlighting the stock-out penalty would need explanation.

Assigning capacity as a purchasing policy in agile supply chains also appears indirectly in Fisher's theory, where it is suggested for companies cooperating in market-responsive supply chains to hedge against uncertainty by buffer capacity.

A forecasting mechanism is also highlighted by Mason-Jones et al.. Fisher does not deal with this issue either as a product or as a supply chain characteristic, but when mentioning case studies, he emphasises that in the case of innovative products – if traditional forecasting methods cannot provide trustworthy data – it is necessary for supply chain participants to consult to gain a more accurate demand forecast.

As a summary, it can be stated that the lean supply chain is almost totally similar to Fisher's physically efficient one, and the product handled is the same. Agile and market-responsive supply chains do not correspond that much, agile rather, can be a type of market-responsive supply chain. The reason for this is that it is focusing on a narrower circle of products (fashion goods); however market-responsive supply chain can be applied for not only fashion products but for other innovative products, too. The theory of Mason-Jones et al. lacks an aspect in purchasing policy, which can be found in Fisher's paper of what kind of supplier selection criteria are used. Without mentioning these, I am a little bit confused what they mean by purchasing policy in Table 6.

Lean and agile production and supply chain paradigms can be and have been combined within successfully designed and operated *leagile* supply chains. The basis of the new model is that sometimes companies operate supply chains with different focuses towards upstream than downstream and have to be able to manage both supply chain types. According to Christopher and Towill (2001), such a migratory model aims to exploit the strengths of both supply chain types as well as to allow supply chains to be competitive in a volatile but highly cost focusing environment. In the opinion of Naylor et al., (1999) neither lean nor agile paradigms are better nor worse than the other, indeed they are complementary within the correct supply chain strategy.

In their article, Christopher and Towill (2001) present the evolution process of leagile supply chain through the personal computer industry. According to them, in the 80's, PC supply chains were operated as lean but with functional silos, but functionally integrated really lean supply chain evolved in the sector only at the end of the decade. At the beginning of the 90's, supply chain operations started to become leagile and when reaching the millennium a customised leagile supply chain had evolved. A problem with the theory is that PC was classified by Christopher and Towill as a functional product. However, Fisher keeps it rather innovative (volatile demand, short life cycle), and consequently, the Christopherian life cycle stages do not correspond to Fisher's approach. During the evolution process PC supply chain evolves from a poor operating lean supply chain to a customised leagile supply chain where agility appears to respond to volatile customer demand, but the product itself is not regarded as innovative or fashion-driven.

Christopher and Towill (2001. p.239) said that leanness and agility could be married in three ways to provide available and affordable products for the end customer.

1. Many companies manufacturing or distributing a wide range of products find that the Pareto Law can be applied and exploited to determine supply strategy. So it may happen that 80 per cent of total volume is generated by only 20 per cent of the total product line. Consequently, the way the 20 per cent is managed should be quite different from the way the remaining 80 per cent is managed. It can be argued

that the top 20 per cent of products by volume is likely to be more predictable, which allows adapting the lean principles in manufacturing or distribution, while the slow moving 80 per cent requires a more agile mode of management (see Figure 6).

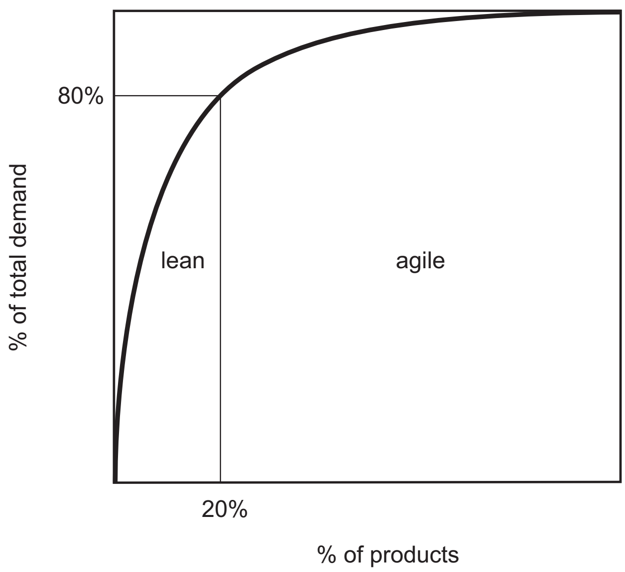

Figure 6: Pareto distribution in leagile supply chains

Source: Christopher & Towill, 2001: p. 240

2. A further mode of combining lean and agile paradigms is the creation of a decoupling point. Naylor et al. (1999) defines decoupling point as a point at which strategic stock is often held as a buffer between fluctuating customer orders and/or product variety and smooth production output. Stock could be raw material, semi-finished product or modularly designed product, which is assembled when a customer order becomes known. In their other article, Christopher and Towill (2000) define a decoupling point as an echelon at which market "pull" meets upstream "push".

   According to Christopher and Towill (2001), two kinds of decoupling points can be differentiated. First is the "material" decoupling point introduced in the previous paragraph. Second, the "information" decoupling point, which should lie as far as possible upstream in the supply chain – it is, in effect, the furthest point to which information on real final demand penetrates. From an agility aspect, it is very important that the information is not distorted and the way it reaches the appropriate supply chain participant.

Naylor et al. (1999) distinguishes five supply chain operation modes based on the position of the (material) decoupling point (see Figure 7).

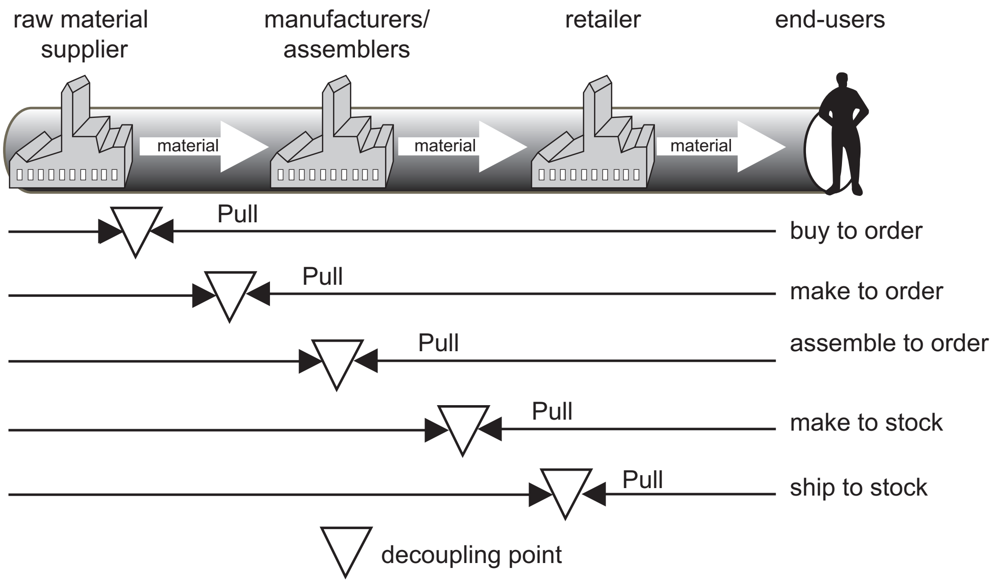

Figure 7: Supply chain strategies

Source: Naylor et al., 2000: p. 57

The first supply chain model is *Buy-to-Order,* which supposes to place a decoupling point at the supplier. This model is suitable if all the products are unique and do not necessarily contain the same raw materials, and end-user accepts long lead times and demand for products is highly variable. If the supply chain holds any inventory it would risk overstocking, which is cost, particularly if the product does not succeed in the market place. However, a supply chain is not able to react to market changes as quickly as the next model.

A *Make-to-Order* supply chain model is focusing on fewer different products made from the same raw materials. It also copes with varied locations, volumes and product mixes. Lead time is shorter than in the BTO case, but the end-users might still have to accept a considerable wait. Holding raw materials and components on inventory is also risky.

In an *Assemble-to-Order* supply chain model, customisation of final product is postponed as late as possible. With this strategy, the supply chain becomes able to respond to a varied product mix from within a range of products, whether customised or not. Risk of overstock or understock increases slightly, but the product will not be of the same value as the fully assembled product.

The first three supply chain models strive to be responsive to customer demand by moving the decoupling point within the supply chain to avoid too high physical costs. Christopher and Towill aim to marry lean and agile paradigms in order to exploit the strengths. The three models emphasise besides customisation and even more responsiveness, which makes them similar to Fisher's market-responsive supply chain type.

The final two supply chains are *Make-to-Stock* and *Ship-to-Stock*. Supply chains are delivering standard products provided from a defined range. MTS serves varied locations and a steady overall demand of standard products. STS provides a standard product in fixed locations. In both cases, it is elementary for supply chain participants to forecast demand accurately. Methodology has to be reliable to be able to hold the correct level of stock to minimise the risk of understock and overstock. In these two models, Fisher's functional product and the related physically efficient supply chain can be discovered.

3. The third mode of marrying lean and agile paradigms – according to Christopher and Towill (2001) – is based in separating demand pattern to "base" and "surge" elements. Base demand is the demand which is usually smooth and able to be forecasted on the basis of past history. Base demand can be served through classic lean procedures to achieve economies of scale. Surge demand is very unpredictable and can be served through more flexible - and probably more costly - processes. Strategies such as these are increasingly employed in the fashion industry where the base demand can be purchased in low cost countries, and the surge demand is served by local locations nearer the market. Even though the unit cost of manufacturing in the local market is higher than sourcing in low cost locations, the supply chain advantage can be considerable. Separation can be made in space (separate production lines) or in time (using slack period to produce base stock). What is particularly important is to broadcast the strategy throughout the entire supply chain (see Figure 8).

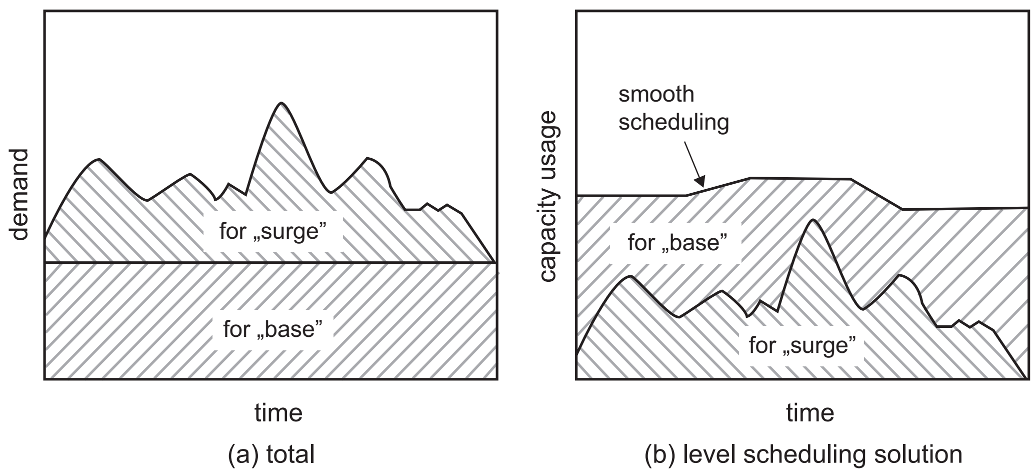

Figure 8: Responding to combinations of base and surge demands

Source: Christopher & Towill, 2001. p. 241

The applicaion of the presented hybrid models is beneficial under certain, different circumstances, which are shown in Table 7.

Table 7: Summary of hybrid strategies

Hybrid strategies	Appropriate market conditions and operating environment
Pareto/80:20 Using lean methods for the volume lines, agile methods for the slow movers	High levels of variety; demand is non-proportionate across the range
De-coupling point The aim is to be lean up to the de-coupling point and agile beyond it	Possibility of modular production or intermediate inventory; delayed final configuration or distribution
Surge/base demand separation Managing the forecastable element of demand using lean principles; using agile principles for the less predictable element	Where base level of demand can confidently be predicted from past experience and where local manufacturing, small batch capacity is available

Source: Christopher & Towill, 2001. p. 242

The leagile strategies presented are all aiming to combine the strengths of lean and agile paradigms depending on the possibilities offered by the product and the supply chain itself. Christopherian strategies are very important, because Fisher also mentions that companies may manufacture or distribute both product types (functional and innovative) and new approaches allow considering the entire product portfolio and the relationships between products.

III.3 Differentiating supply chain types along uncertainties of demand and supply

Lee (2002), as well as Fisher, distinguishes supply chains along product characteristics, but in his opinion products can be characterised the best by two factors: the uncertainty of demand and supply. In his article, Fisher also refers to that companies deploy everything to capture the impulse of consumers and to reduce demand uncertainty.

Demand uncertainty is linked to the predictability of the demand for the product. In correspondence with Fisher, Lee calls functional products the products with a long life cycle and consequently stable demand, and innovative products, which have a short life cycle are therefore highly unpredictable in demand. Characteristics of functional and innovative products are almost the same as in Fisher's theory. Table 8 summarises the characteristics proposed by Lee. The majority of the characteristics are the same as Fisher's, but several aspects are broken down (physical costs). Lee also involves several aspects in the list, which appeared indirectly in Fisher's theory (obsolescence, uncertainty), but the SKU-aspect is very new.

Table 8: Lee's characteristics of functional and innovative products

Functional	Innovative
Low demand uncertainties	High demand uncertainties
More predictable demand	Difficult to forecast
Stable demand	Variable demand
Long product life	Short selling season
Low inventory cost	High inventory cost
Low profit margin	High profit margin
Low product variety	High product variety
Higher volume per SKU	Low volumes per SKU
Low stockout cost	High stockout cost
Low obsolescence	High obsolescence

Source: Lee, 2002. p. 106

Other kinds of uncertainties concerning the supply side of the product are equally important drivers for the right supply chain strategy. In a stable supply process, the manufacturing process and the underlying technology are mature. In an evolving supply process manufacturing process and the underlying technology are still under early development and are quickly changing. Consequently, the supply base may be limited in both size and experience.

In a stable supply process, complexity of manufacturing tends to be low or manageable, usually highly automated and long-term supply agreements are prevalent. In an evolving supply process, the production process requires a lot of fine-tuning and is often the subject of breakdowns and uncertain yields. The supplier base is not as reliable yet, as suppliers are going through process innovation. Characteristics of supply are summarised in Table 9.

Table 9: Characteristics of stable and evolving supply

Stable	Evolving
Less breakdowns	Vulnerable to breakdowns
Stable and higher yields	Variable and lower yields
Less quality problems	Potential quality problems
More supply sources	Limited supply sources
Reliable suppliers	Unreliable suppliers
Less process changes	More process changes
Less capacity constraint	Potential capacity constrained
Easier to changeover	Difficult to changeover
Flexible	Inflexible
Dependable lead time	Variable lead time

Source: Lee, 2002. p. 107

However, the supply of functional products tends to be more mature and stable, this is not always the case. For example, some food products have a very stable demand, but the supply (both quantity and quality) depends on the yearly weather conditions. Similarly, there could be innovative products with stable supply. Fashion products have only a short selling season; consequently, their demand is highly unpredictable (Table 10). However, the supply process is very stable with a reliable supplier base and mature production technology.

Table 10: Examples of uncertain frameworks

		Demand uncertainty	
		Low (functional products)	*High (innovative products)*
Supply uncertainty	*Low (stable process)*	Grocery, basic apparel, food, oil, and gas	Fashion apparel, computers, pop music
	High (evolving process)	Hydro-electric power, some food produce	Telecom, high-end computers, semiconductor

Source: Lee, 2002. p. 108

Lee lists plenty of solutions, which help to reduce the uncertainties in both demand and supply, among which we can find several tools proposed by Fisher to manage the supply chain.

Tools for reducing uncertainty on the demand side:

- information sharing,
- share of demand data,
- collaborative replenishment,
- collaborative planning, forecasting and replenishment (CPFR).

Tools for reducing uncertainty on the supply side:

- exchange of information, starting with the product development to end-of-life phase to reduce the risk of supplier failure,
- sharing product rollover plans with suppliers,
- early design collaboration,
- supplier hubs used by manufacturers.

According to Lee, different uncertainty dimensions require companies to adapt correct supply chain strategies. He also deals with information technology and the Internet and their role in implementing the strategy.

Lee's supply chain type of *efficient* represents a low demand and supply uncertainty environment as it can be seen in Figure 9. The aim of this type of supply chain is to achieve a high level of cost efficiency. To achieve such efficiencies, non-value-added activities should be eliminated, and through deploying optimisation techniques to get capacity utilisation. Efficient, accurate and cost-effective transmission of information is elementary across the supply chain. The internet enables the supply chain to have tight and effortless information integration as well as helps production and distribution schedules to be optimised and transparent (Lee, 2002. p. 113).

In the efficient supply chain, Lee mixes up Fisher's physically efficient supply chain and the lean supply chain. Appellation refers to following Fisher's approach. However, Lee provides a poor insight into the purposes moving efficient supply chains. Optimising costs is a general purpose, but filtering the non-value-adding activities and employing optimisation techniques rather reflect the effect of leanness. Lee neither discusses the forecasting and demand information activity, which are the basis of the efficient operation and inevitable for optimised operations.

Risk-hedging supply chains are operating in a low demand and a high supply uncertainty environment and aim to pool and share resources in a supply chain so that the risk in supply disruption can also be shared. A single entity in a supply chain can be vulnerable to supply disruptions, but if more supply sources or alternative resources are available then the risk can be reduced. A company may choose to increase the safety stock of its key component to hedge against the risk of supply disruption or may share safety stock with other companies that also use this key component. Such inventory pooling strategies are quite common in retailing where different retail stores or dealerships share inventory. The internet plays a key role in providing information transparency among the supply chain participants who are sharing inventory. Having real-time information on inventory and demand allows the most cost-effective transshipment of goods from one site to another (Lee, 2002. p. 113).

Lee keeps both efficient and risk-hedging supply chain types adaptable in the case of functional products. However, in risk-hedging supply chains functional products flow – which also has a low profit rate in the opinion of Lee, he does not mention process optimisation; moreover, holding safety stock is a very costly activity. He mentions neither the information flow between supply chain members nor the flow of forecast or demand data, which is also inevitable for efficient operations. The author does not define the point until which a supply chain invests in holding safety stock – either alone or with partners – because functional products cannot tolerate too high a growth in cost. The primary focus is obviously to reduce the risk of supply disruption, but striving for safety in supply process optimisation also has to be taken into consideration.

Responsive supply chains utilise the strategy to be responsive and flexible to the changing and diverse needs of customers. To be responsive, companies adapt the built-to order and mass customisation processes. Order accuracy is the key to the success of mass customisation. The internet helps companies to capture the highly personalised requirements of customers accurately and timely and to transfer the information to supply chain partners (Lee, 2002. p. 114).

The responsive supply chain is quite similar to Fisher's market-responsive supply chain, but in my opinion, Lee's version is very general. Lee mentions demand uncertainty, which needs a rapid response but the speed – which was emphasised by Fisher many times – does not appear in his theory and which would be elementary in following the changing market in the case of innovative products. Agile supply chains – which are quite similar in Fisher's and Mason-Jones's theories – I rather compare to the final supply chain type of Lee, because an agile supply chain has a special purchasing policy, which should be important from a supply risk point of view.

Lee's *agile* supply chain aims to be responsive and flexible to customer needs, while the risk of supply disruption is hedged by pooling inventory. This strategy combines the strengths of risk-hedging and responsive supply chains. It is agile because it can react to a changing, diverse and unpredictable demand of customers on the distribution side while minimising the back-end risks of supply disruption (Lee, 2002. p. 114).

Lee's agile supply chain is similar to Mason-Jones's in many aspects, but the problem is the same as it was in the cases of previous supply chain types – Lee does not provide detailed information about the operations of the supply chain. Similar aspects are responsiveness to changing customer needs, but this also emerges in *responsive* supply chains. Reducing the risk of supply disruption does not appear in Mason-Jones's theory, but assigning capacity is a form of decreasing risks and innovative products – because of the high profit margin – might tolerate holding safety stock, as well. In this, supply chains – because of the various risks – I very much miss the efforts to study demand and share information from operational characteristics.

		Demand uncertainty	
		Low (functional products)	*Low (functional products)*
Supply uncertainty	*Low (stable process)*	Efficient supply chains	Responsive supply chains
	High (evolving process)	Risk-hedging supply chains	Agile supply chains

Figure 9: Uncertainty and supply chain types

Source: Lee, 2002. p. 114

Summing up the discussion of Lee's theory, it can be appointed that in an appellation and in many characteristics, his concept is similar to Fisher's and Mason-Jones's models, while his approach is based on the product characteristics also, but examines them from a different aspect. He is focusing only on demand and supply uncertainties and interprets supply chain operations only in the way how they can respond to different uncertainties. He also deals with tools reducing demand and supply uncertainty, which however, do not appear when characterising supply chain operations descriptions are very general.

In closing this chapter, I sum up the supply chain typologies in a table (Table 11). Besides Fisher's model, I gathered the main characteristics of the models of Mason-Jones et al. and Christopher and Towill as well as Lee. A comparison was made along the dimensions of differentiation of supply chains, product types handled, operational characteristics and applied supply chain management tools.

Table 11: Summary of basic types of supply chains

	Fisher (1997)		**Mason-Jones et al. (2000)**		**Christopher & Towill (2001)**	**Lee (2002)**
Basis of differentiation	Product type: functional	Product type: innovative	market qualifier + market winner criteria: quality, service level and lead time + cost	market qualifier + market winner criteria: quality, cost, lead time + service level	Market winning criteria: access and lead time	Uncertainty of market demand and supply → 4-box matrix
Product characteristics	Long life cycle Product fills everyday needs	Short life cycle Product with high novelty	Long life cycle Everyday products	Short life cycle Fashion products	Customized products	Demand characteristics, same as Fisher's functional and innovative product characteristics
Market characteristics	Stable demand Predictable demand Low contribution margin	Volatile demand Unpredictable demand High contribution margin	Predictable demand Low profit margin	Volatile demand High profit margin	High customer expectations	Supply characteristics: Stable vs. Evolving S: less breakdowns, less quality problems, more supply sources, reliable suppliers, flexible, dependable lead time E: more breakdowns, potential quality problems, limited supply sources, unreliable suppliers, inflexible, variable lead time

Continue Tabée 11

	Fisher (1997)		**Mason-Jones et al. (2000)**		**Christopher és Towill (2001)**	**Lee (2002)**
Focus of supply chain	Serving predictable demand cost-effectively	Responsiveness to quickly changing customer needs	Avoiding waste (muda) Reduction of costs	Exploiting the volatility of the market Reduction of lead time	Customer orientation, flexible reaction, supply chain is partly operated lean and agile ways between the two parts: decoupling point	Reducing risk coming from demand and/or supply uncertainty
Demand chain management tools	EDI, CRP	Forecasting, buffer capacity, postponement	Information sharing, algorithmic planning and forecasting	Information sharing, consultative forecasting	Forecasting, postponement, information sharing, CRP	Information sharing, harmonised planning and forecasting, modularity, supplier stock—keeping points
Supply chain types	Physically efficient	Market-responsive	Lean	Agile	Leagile	Efficient → Risk hedging → Responsive → Agile

Source: own collection

III. 4 Tests of Fisher-model

In 2007 Swedish authors, Selldin and Olhager, tried for the first time to verify Fisher's model in a quantitative way. In 2010, Australian authors (Lo and Power, 2010) also published a trial to test the model on a large database. Before these experiments, many authors have tested the model in a qualitative way, examining it in different industries (Li and O'Brien, 2001; Wong et al., 2005; Wong et al., 2006). However, the basic hypotheses and assumptions have not been questioned. The Swedish authors were curious if the supply chain type does really fit to the product type, and do the two different supply chain methodologies exist in the company practice. They have also analysed whether the companies operating the right supply chain type fitting to their products achieve a better performance than those firms which do not match the supply chain type and product type.

The type of the product and the supply chain was defined by the characteristics given by Fisher. Authors included them into a questionnaire and analysed the match and mismatch with a scatter diagram.

To test the Fisher-model, Selldin and Olhager edited a questionnaire and distributed it among Swedish manufacturing companies. They analysed the main product line and the related supply chain operation. The term "company" was used in a wide sense to a production unit or a division of a large company as well as a complete company. It is a reasonable decision to focus on the main product line. It made research easier.

Their questionnaire was distributed to the entire body of Swedish Production and Inventory Management Association, which consists of 511 manufacturing companies. They received 148 responses of which 128 were usable (Selldin and Olhager, 2007. p. 44).

The selection of the sample is quite evident, but researchers did not answer the question of what effect the analysed companies have to the supply chain they operate in. The most relevant would be to analyse those firms, which have a strong influence on how the supply chain is organised and operated. This limitation, however, would radically decrease the potential sample size. After all, the method of Selldin and Olhager can be accepted, because if the analysed companies are not the focal companies in the supply chains, they can broadcast the ambition of the real focal company towards the direction it leads the total supply operation.

The fit between the product and supply chain type was analysed by a scatter diagram and regression line. The result did not provide an unambiguous match between the product type and the supply chain type (the regression line was not significant). However, a favourable tendency was discovered by the researchers that the companies manufacturing functional products tend to operate physically efficient supply chains, and those producing innovative products tend to manage market-responsive supply chains. There are also a considerable number of firms in the mismatch cells.

Selldin and Olhager found (2007. p. 46) that the mismatch cell of functional product – market-responsive supply chain – which was kept very rare by Fisher - many Swedish companies belonged. The authors thought that moving along the product life cycle from the introductory phase to the maturity phase may imply a move from basically innovative character of the product to a more functional type of the product, while the company maintains a market-responsive supply chain and does not acknowledge the need to shift the focus to physical efficiency. Another reason can be if companies with functional products implement new management concepts such as quick response and agile manufacturing, improving responsiveness and flexibility to a level that is higher than what the products and market require, overshadowing efficiency.

In the further analysis, researchers excluded all the cases where the products or supply chain of companies had no specific characteristics. The 128-element sample was reduced to 68.

Results show that manufacturers of functional products operate a physically efficient supply chain and vice versa, the companies managing a physically efficient supply chain distribute functional products. However, such a relationship between innovative products and market-responsive supply chains was not found (Selldin and Olhager, 2007. p. 48). When classifying the 68 companies in Fisher's match-mismatch matrix, most of the companies occupied the functional product-physically efficient cell. However, the lesser companies were classified as an innovative product – market-responsive supply chain. In the two mismatch cells, there were more companies than in the two matching cells. In their further analysis, researchers used the results to compare the performance of the matching and mismatching groups of companies.

The Swedish analysis is also a good example for my own research. However, I have to learn from their faults.

First of all, my sample is probably better because I had it filled out on-line. Consequently, I have reached a wider range of companies with less effort. The on-line survey is a very user-friendly method, which influenced a positive response rate. At the same time, I asked the companies to define their position in the supply chain; however, it was stated before, that non-focal companies can broadcast the effort of the focal company in the supply chain operation.

Although my research does not focus on the performance comparison of the matching and mismatching group, it is very important to separate univocally the characteristics of different supply chains. Selldin and Olhager – when formulating their hypotheses on performance – declared that in physically efficient supply chains, costs are more important than in market-responsive supply chains, which is not true. Costs are a very important aspect in both supply chains, but physically efficient supply chains focus on physical costs and market-responsive supply chains on market mediation costs.

The Australian researchers, Lo and Power (2010), tested Fisher's model by quantitative methods as well as Selldin and Olhager. In their approach, the supply chain strategy matching the product characteristics is a further development of the product-process matrix known form operations management. Consequently, the characteristics of a product not only define the production strategy but the supply chain operations as well.

The authors reviewed the results of the previous tests and posed their research question as to whether Fisher's model represents today's business environment appropriately.

Lo and Power (2010) carried out a survey in Australia during which 2000 Australian manufacturing companies were asked to fill out the questionnaire. They received 107 responses. While filling out the survey, respondents had to focus on their main product line and evaluate the statements referring to product and supply chain characteristics on a 5-point Likert-scale.

The statistical methodology of their research was not discussed in detail in their paper, so I could only conclude that the statistical analysis is a relevant method for testing the Fisher-model, but I have to be prepared to handle a large number of mismatching cases.

As a result, researchers experienced that two-thirds of the companies mixed the physically efficient and market-responsive operation. In their opinion, the reason for this is that companies aim to combine the benefits of the two supply chain types to gain a higher performance. A further reason for mismatch is that supply chain operations are defined not only by product characteristics. So the authors concluded that the Fisher-model does not represent today's business environment appropriately.

The researchers preceding me have found many cases in mismatch cells, and authors tried to explain it but not systematically. An important aim of the dissertation is to explain this mismatch-phenomenon, which has never been explored before.

III.5 Mismatching strategies

In the previous chapters, I have introduced theories, which tried to explain why supply chains differ from each other. Many researchers based his/her theory on product characteristics and in many cases the Fisher-model was the basis of the theory, and Fisher's concept was modulated or developed.

In Fisher's approach, the supply chain type matching to product characteristics ensure competitiveness and better profitability. However, this correspondence has not been significantly confirmed by Selldin and Olhager (2007). Lo and Power (2010) also met a lot of companies following the mismatching strategy. Christopher and Towill (2001) then declared that it is very beneficial to combine the lean supply chain, which is similar to physically efficient with the agile supply chain which is similar to market-responsive in order to gain a competitive advantage. A similar conclusion is made by Selldin and Olhager, too, who explain the mismatch by combining the strength of the two supply chain types resulting in higher performance. Selldin and Olhager call this phenomenon a *supply chain performance frontier*, because the companies combining the two supply chain management strategies are able to achieve the maximum performance. Lon and Power (2010) found that two-thirds of the companies follow mismatching strategy, and at the same time their operation is successful.

Fisher and the authors of the leagile concept also call the case studies to present the matching and mismatching situations. However, they cite each other for a different situation: the example of National Bicycle represents the innovative products and the fitting market-responsive supply chain. The same example is used by Christopher citing Fisher for exhibiting the third-type leagile strategy (separating demand patterns).

The supply chains presented by the authors are not always clearly physically efficient or market-responsive. Fisher has also met with companies following the mismatching strategy, and he explained the phenomenon by poor management, which cannot identify the type of the product. Consequently, it is not able to operate the correct supply chain with the correct focus. Further researchers have also met the phenomenon in their own research, and they also tried to provide some explanation, but neither of them had studied the phenomenon systematically nor tried to analyse it empirically (Table 12).

That is why it is important for me to analyse the phenomenon and complete Fishers theory with the explanation of mismatching strategy.

During the analysis - as the researchers before me – I have found many mismatching companies, which I explain with poor management and a low level of supply chain development. Meaning that the company is not so developed to be able to apply the specific tools needed to manage a supply chain according to given product characteristics. This can be a specific reason for companies following mismatching strategy in Hungary.

Table 12: Explanations of mismatch between product type and supply chain type

	Supply chain types	Methodology	Explanation of mismatch strategy
Fisher, 1997	**Physically efficient** **Market-responsive**	Case study, consultancy experience, mainly consumer goods	Poor management which cannot identify the operational focus of the supply chain matching with the product characteristics
Wong et al., 2006 *Li és O'Brien, 2001* *Huang et al., 2002*	**Physically efficient** **Market-responsive** Physically responsive MTO Physically responsive	Quantitative methodology, toy industry	The market is so volatile and seasonal that more product types are necessary consequently, more supply chain types needed. Hybrid product.
Naylor et al., 1999 *Mason-Jones et al., 2000* *Christopher* & *Towill, 2000 and 2001*	Lean Agile Leagile	Case study PC industry Case study Electronic industry Case study PC industry	Better supply chain performance by combining lean and agile paradigms. Better product availability. Better fit to environment and market.
Lee, 2002	**Efficient** **Responsive** Agile Risk-hedging	Literature review	Not only demand but supply can be uncertain at a different level which also has to be considered while managing the supply chain.
Selldin & *Olhager, 2007*	**Physically efficient** **Market-responsive**	Quantitative test on large database	At the beginning of the life cycle functional product may behave as innovative. Combining strategies in order to increase performance.

Source: own collection

IV. RESEARCH QUESTIONS AND HYPOTHESES

The aim of the dissertation is to test a model which is well known in supply chain literature and was cited many times, and about which only two quantitative tests were published in management literature. The focal question of the dissertation is whether it is possible to distinguish supply chain types in company practice based on the product characteristics provided by Fisher.

The analyses presented in the previous chapters verified the linkage only between functional products and physically efficient supply chains and a positive tendency towards applying market-responsive supply chains by the manufacturers of innovative products, but researchers were faced with a large number of mismatching companies which at the same time achieve good performance.

As it was presented in the introductory chapter, I analyse three research questions and I formulate three hypotheses corresponding to them. The logic of the hypotheses can be seen in Figure 10. Besides testing the hypotheses, the dissertation also aims to describe the Hungarian company practice in demand chain management based on the sample collected.

Based on Fisher's product characteristics and the definition of a supply chain, the Fisherian supply chain types can be separated. According to Fisher, these supply chain types have different operational focuses e.g. physically efficient supply chains focus on use of capacity, market-responsive supply chains strive to reduce lead times. Because of the different focuses, it is also important to know what management tools have to be used to achieve goals. Fisher himself also mentions several tools applied by either supply chains (EDI, CRP, postponement) but I have undertaken to collect more management tools – focusing on the distribution side of the supply chains – which can be dedicated to one supply chain type or other and support supply chains in achieving their goals.

The first hypothesis concerns the expected match of the Fisherian product types and supply chain types. The second hypothesis tries to discover the reason of the mismatch strategy. The third hypothesis aims to complete Fisher's theory with the idea that supply chains differ from each other, not only in the type of product delivered to the market and in the operational focus but in the management tools as well, which are applied in the distribution processes. An additional aim of mine with the dissertation is to provide a description about the demand chain management practice of Hungarian firms.

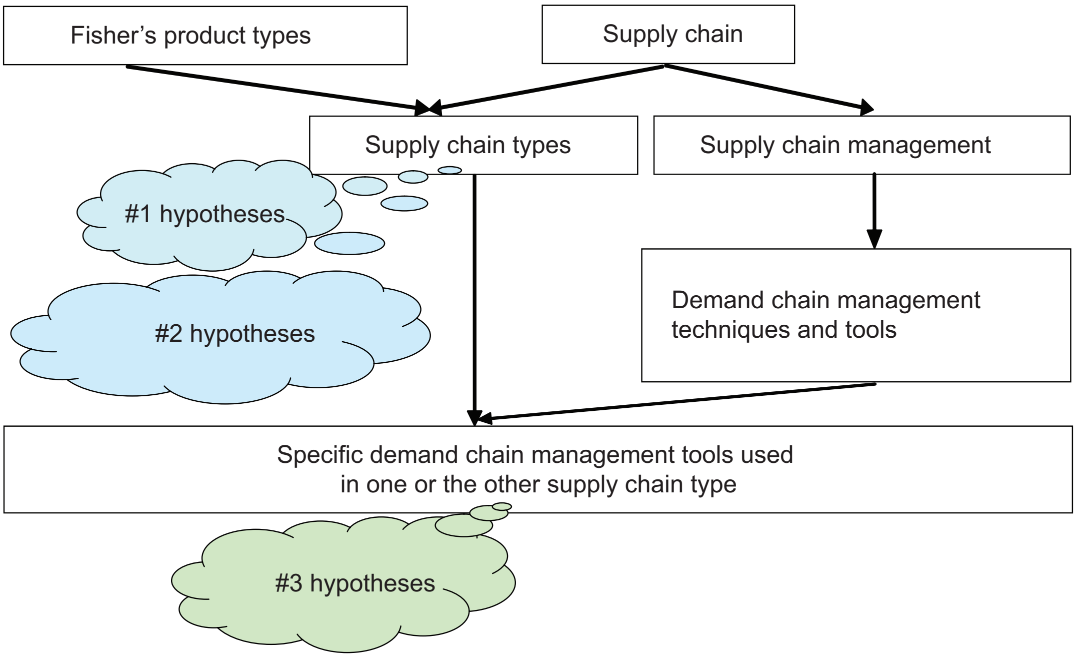

Figure 10: Logic of questions of research

The first hypothesis to test the Fisher-model is the following:

H1: the Fisherian type of product defines the supply chain type applied consequently, Fisher's theory is correct.

To verify this hypothesis, two sub-hypotheses also have to be tested:

H1a: companies manufacturing functional products operate physically efficient supply chains;

H1b: companies manufacturing innovative products operate market-responsive supply chains.

Examining these hypotheses is very important, because in Fisher's model product types are definitely separated, and an unambiguous recommendation is formulated about which supply chain types to apply for which product type. This match, however, could be problematic in the case when a company manufactures or distributes a wide

portfolio of product types. At the same time, the model is very famous and cited and is elementary in learning the operational focuses of different supply chains. My aim is to test the match of product type and supply chain type in practice and modulate the theory by calling attention to other factors influencing the supply chain operation.
Other authors have found many mismatch cases in their research where supply chains still operate successfully. Many reasons were provided to explain the phenomenon (see Table 12) but neither of them has been tested empirically. My aim is to test the reasons provided before and complete the list with additional reasons.

After reviewing the literature I have found, almost every author has a different explanation to this mismatch strategy. The explanations are summarised in Table 12 and the one which was mentioned by more authors I captured as a second hypothesis as the most possible reason for mismatch. Besides the most frequently mentioned reason, it is important to analyse the remaining reasons discovered in the literature. To test the reasons, first the survey database was used but - because nobody has analysed systematically, the mismatch problem before – not only the collection of possible reasons but discovering new reasons is also important.

H2: The reason for mismatch between the Fisherian product type and supply chain type is that a higher performance is available when combining the strength of both supply chain types.

Authors have found many other reasons for mismatches, which also have been tested as sub-hypotheses:

H2a: The reason for mismatch between the Fisherian product type and supply chain type is that the *market is too volatile*, customer needs change quickly.

H2b: The reason for mismatch between the Fisherian product type and supply chain type is *poor management,* which cannot identify the product type and the operational focus of the supply chain matching it.

H2c: The reason for mismatch between the Fisherian product type and supply chain type is that the product is a *hybrid*.

H2d: The reason for mismatch between the Fisherian product type and supply chain type is the *uncertainty of demand*.

H2e: The reason for a mismatch between the Fisherian product type and supply chain type is the *uncertainty of supply*.

H2f: The reason for a mismatch between the Fisherian product type and supply chain type is that company incorrectly identifies the *actual life cycle stage* of the product.

To complete the statistical analysis used for the explanation of mismatch strategy. I also applied a *qualitative research methodology*. I have made semi-structured in depth interviews with six company managers and asked them what they think about why companies do not adapt the correct supply chain type (in Fisher's meaning) fitting to the product which is defined as either functional or innovative? I asked the interviewees about the reasons discovered in the literature, and as well I inspired them to provide additional reasons too.

Interviews served two goals: first to test the mismatch strategy reasons provided in the literature and second, to discover new possible reasons which would explain the phenomenon. In my opinion, mismatch has not only one reason in practice but many reasons might influence its application and my aim was to discover these as much as possible. The new reasons collected are mainly based on the individual experiences and subjective opinion of the company managers and the new aspects have not been tested empirically.

When formulating the third hypothesis, I followed the research model presented in Figure 11. After defining the companies manufacturing functional or innovative products and operating physically efficient or market-responsive supply chains I intended to discover whether supply chains differ from each other in the tools applied to manage the distribution side of the supply chain.

H3: Supply chain types differ from each other in the distribution-side supply chain management tools, which are not itemized in Fisher's model, but exist in company practice.

Besides verifying this hypothesis, I intended to describe the Hungarian company practice in demand chain management, what tools they use and how developed they are. During the description, I prefer the sectors which have the largest population in the sample.

Demand chain management tools are elements of demand chain management techniques discussed intensely in management literature and which aim to coordinate demand chain flows. As it can be seen in Figure 11, I suppose that there are tools which are applied by the demand chains irrespectively to the product or supply chain type, because these tools are elementary to operate all the other tools. In physically efficient supply chains, to balance the distribution-side processes of different materials flow management (CRP, cross-docking), information flow management (CAO) tools are applied. To ensure transparency, a sophisticated cost and performance assessment tool is also adapted (ABC). In market-responsive supply chains, distribution-side processes are supported by tools which aim to increase responsiveness such as postponement, common planning and forecasting, RFID and vendor-managed inventory. Consequently, I suppose that supply chain types differ from each other in the tools used to manage distribution-side processes.

The basis of the idea is that if supply chains manufacture different products and the chain is operated with different focuses, too, they have to differ in the tools used for managing processes on the distribution-side considering the different challenges chains have to respond to.

The reason why proposing this research idea is important, is because if managers can identify the type of the product their company manufactures as well as the supply chain type they have to operate to fight specific challenges, *they also have to know what tools to use during managing the distribution-side processes, within either a physically efficient or market-responsive chain*.

In my opinion, *EDI* or other *standardised communication methods* (linked ERP, intranet or other network) used to share information amongst supply chain participants are needed to manage a supply chain successfully. It is elementary for basic coordination and data sharing (Holweg and Pil, 2008). But, it is a different question of what kind of data, with who and in what extension is shared using the communication technology.

H3a: The application of inter-firm communication systems (EDI, etc.) as a demand chain management tool is not dependent on the type of supply chain.

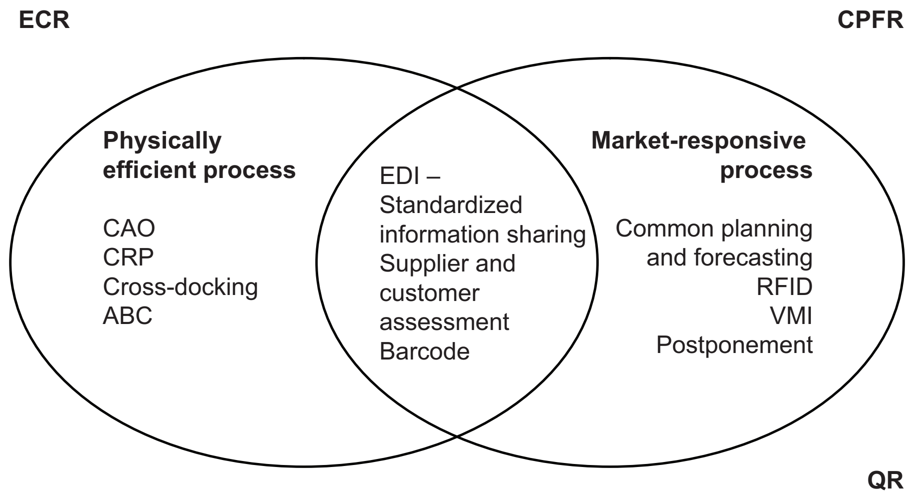

Figure 11: Research model of hypothesis H3

A *product identification* system within a supply chain is very important in order to be able to track and trace its route between partners. We have to differentiate barcode systems and radio frequency identification. Barcodes – thank to their prevalence – cannot be especially dedicated to either supply chain type. RFID, however, is less prevalent because of the high cost of application. Therefore, I suppose it is applied rather by in market-responsive supply chains where the high profit margin of the innovative (high value-density) products can cover the costs of implementation (White et al. 2008).

H3b: The application of a barcode system as a demand chain management tool is not dependent on the type of the supply chain.

H3c: The application of RFID as a demand chain management tool is significantly more prevalent in market-responsive supply chains than in physically efficient supply chains.

Supplier and customer assessment are elementary in coordinating the supply chain participants. Assessment helps to define how effectively partners operate, how risks and rewards, costs and profits, are distributed among supply chain members, and towards what direction partners need to develop their operations. These demand chain management tools therefore, are so widely used that are also independent of the product or supply chain type (Gordon, 2005; Meredith, 1993).

H3d: Supplier assessment as demand chain management tool is not dependent on the type of the supply chain.

H3e: Customer assessment as a demand chain management tool not dependent on the type of the supply chain.

The optimisation of physical processes in a physically efficient supply chain can be supported by automated materials processes based on a common information system. Such an automated solution can be the continuous replenishment program (CRP) which is operated between the supplier (manufacturer) and the central warehouse of the customer. The supplier gets the demand and inventory data of the customer's warehouse and is familiar with the common forecast, which allows him to replenish the correct amount of stock when it is needed. Fisher also mentioned CRP as a supportive mechanism to optimise physically efficient supply chains. Another automated solution is computer-aided ordering which eases the ordering process between the central warehouse and the sales points based on similar information and mechanisms as CRP.

H3f: The application of CRP as a demand chain management tool is significantly more prevalent in physically efficient supply chains than in market-responsive supply chains.

H3g: The application of CAO as a demand chain management tool is significantly more prevalent in physically efficient supply chains than in market-responsive supply chains.

A physically efficient supply chain strives to reduce physical costs and is familiar with the expected demand. Therefore, the application of a cross-docking facility is ideal in this chain. In cross-docking, there is no real storage of materials thus companies do not have to invest in inventories while still offering a wide variety of products (Schaffer, 2000).

H3h: The application of cross-docking as a demand chain management tool is significantly more prevalent in physically efficient supply chains than in market-responsive supply chains.

Activity based costing intensely supports the fair share of costs belonging to functional products with a low profit margin. The physical costs of a physically efficient supply chain arise during predictably designed processes, which help to dedicate the costs to the right cost-driver. Stapleton et al. (2004), emphasises that ABC can especially be used to discover physical (logistics) costs and to filter redundancies. The accurate registration of costs is more important in case of physically efficient supply chains, in market-responsive supply chains a greater emphasis laid on the quick reaction to market changes. Processes linked to innovative products may change quickly, which does not support the application of a unified, coherent and transparent cost management system.

H3i: The application of activity-based costing as demand chain management tool is significantly more prevalent in physically efficient supply chains than in market-responsive supply chains.

Common planning and forecasting allow companies to totally harmonise the activities of supply chain participants by sharing relevant data and tracking the expected demand. In the opinion of Attaran et al. (2007), common planning and forecasting are especially useful for companies experiencing variation in demand, and which buy or sell products on a periodic basis and deal with highly differentiated or branded products.

H3j: The application of common planning and forecasting as a demand chain management tool is significantly more prevalent in market-responsive supply chains than in physically efficient supply chains.

The method of vendor-managed inventory is a perfect tool for reducing lead times in market-responsive supply chains. According to Waller et al. (1999), VMI is capable of serving highly unpredictable demand. It quickly allows the moving of inventory all along the supply chain to ensure a quick reaction. VMI is based on intense information sharing which means that supplier has an insight into the inventory and demand data of his customer and is able to replenish the stock at the right time.

H3k: The application of VMI as a demand chain management tool is significantly more prevalent in market-responsive supply chains than in physically efficient supply chains.

Production postponement is a part of the operations of market-responsive supply chains as it is also stated by Fisher. Supply chain participants keep the product in a neutral and non-committed form as long as possible in the manufacturing process until the final customer demand arrives then it is customised. Sometimes logistics service providers make quasi-production activities (packaging, labelling), customising the product in accordance with the market needs. Building stock at the different stages of the supply chain enables those not to start the entire production process at the beginning, but to just use the semi-assembled modules. Postponement can be carried out either in production (modular production) or in logistics (building stock).

H3l: The application of postponement as a demand chain management tool is significantly more prevalent in market-responsive supply chains than in physically efficient supply chains.

Concluding the chapter, the dissertation aims first to test the existence of the two Fisherian supply chain types, second to explain if there is a mismatch between the product type and the applied supply chain type. Third, it aims to verify that supply chain types differ not only in their operational focuses, but in the toolbox, they apply to manage the demand chain processes. An additional goal of the dissertation is to provide a description about the demand chain management practice and development of Hungarian companies based on the sample collected.

V. RESEARCH METHODOLOGY

In the previous chapter I presented my hypotheses based on the literature review carried out. The aim of the current chapter is first, to show the logic of the methodology chosen and second, to verify its relevancy.

V.1 Choice of research methodology

Social research could have many purposes according to Rubin and Babbie (2010. p. 41), but there are many ways to categorise the different purposes. Although a given research can have more than one purpose, I examine them separately: exploration, description, explanation, evaluation.

Many times, social research is conducted to *explore* a topic or to provide a beginning familiarity with it. According to Malhotra (2002), such researches are flexible and volatile and often a starting point of further researches. Its role is particularly important in defining and approaching a problem. Methodological variability allows researchers to integrate new ideas arising during the research process.

In descriptive research, the aim is to *describe* a situation, an event or the spread of a phenomenon which can be the single purpose of the entire study without further research phases (Babbie, 1999). A basic difference between the explorative and descriptive studies is that the explorative study aims to test previously defined hypotheses. Consequently, the explorative study is well-designed and structured, based on a large sample and a formalised research plan that summarises the methodology used for data collection and analysis.

Explanatory research aims to explain the relevancy of a research model or a hypothesis (Forza, 2002). In this case, the notions and the construction of the model have already been worked out and accepted and sampling aims to verify, extend or modulate the coherence of the model.

Evaluative research encompasses all three of the preceding purposes (Rubin and Babbie, 2010. p. 42). Evaluative studies might ask whether social (e.g. business) events are effective in achieving their stated goals. Evaluations of goal achievement can be done in an exploratory, descriptive or explanatory way.

Social studies usually have elements of several of these purposes simultaneously, and almost each purpose arises during the different stages of research work.

In my doctoral dissertation, my aim is to test a theoretical model empirically, to make an attempt to add to it, and to describe the practice of Hungarian companies in the sample.

After reviewing the literature, the dissertation's focal model – Fisher's model – was presented in detail, many results were shown produced by researchers that tested the model in various ways, and the model was contrasted with the categorisation of other authors that tried to define additional supply chain types. In the dissertation, first I test the model's relevancy whether the type of the product really defines the type of the supply chain so the first hypothesis has an *explanatory* purpose. In the second hypothesis, when I follow *explorative* goals to find the reason for the mismatch between product type and supply chain type. When testing the third hypothesis, I also try to *explore* whether supply chain types differ in the tools used for managing the distribution side of the supply chain. Finally, I carry out a *descriptive evaluation,* when I analyse the current demand chain management practice of the Hungarian firms.

V.1.1 Quantitative research phase: survey

During the research, individuals, groups or organisations can be observed, and according to Rubin and Babbie (2010) exploration, description, explanation and evaluation concern these observation units. In the opinion of Babbie (1999), observation units have three special attributes which are worth studying. *Characteristics* are attributes of an observation unit which describe its actual status. *Orientation* refers to the attitude; the tendency of observation units, individuals, groups and organisations can also be characterised by their aims, policies and rules. *Activities* – the most important attribute of observation units in my own research – refer to the acts and behaviour of the studied units. During my research, I analyse manufacturing companies operating in Hungary which are members of supply chains and I focus on their activities within these supply chains. In the survey, I asked managers to characterise the company's behaviour. The targeted group of managers was the sales (or key account), logistics or supply chain managers. These kinds of managers are the closest to the business partners and, consequently, are the most competent people in the company that have effect on and are familiar with the supply chain processes carried out with supply chain partners.

When choosing the research methodology, Babbie (1999) thinks that social research quantitative analysis is used frequently when the aim is not to work out a definition or a model, but rather to test hypotheses based on well-defined definitions and models. Social research strives to explore the regularity of phenomena, to find logic and lasting coherence.

Probably, the survey and the related statistical analysis is the most frequently used methodology in social sciences (Babbie, 1999). It is appropriate for explorative, descriptive, explanatory and evaluative studies, too, and is the best method if researchers want to collect original data about a larger sample than which is observable by direct observation.

According to Malhotra (2002), when designing a survey, researchers have to take three issues into consideration: first, the information required has to be captured by relevant questions which can be answered and respondents tend to answer them. Second, researchers have to create interest and motivate respondents to fill in the survey. Third, response failures have to be minimised by providing appropriate answer options for respondents.

In the opinion of Rubin and Babbie (2010), a strength of questionnaires is it allows for describing a large sample and to analyse the sample data in detail by various methods – and also provides (depending on the topic) a good generalisablility. Self-completed questionnaires, questionnaires filled together with interviewers, telephone or internet-based questionnaires allow collecting a large sample which is particularly important in descriptive and exploratory researches. If we want to analyse a large number of variables, a large sample is also needed. Surveys are flexible enough regarding that a phenomenon can be captured by many questions (Rubin and Babbie, 2010). A weakness of questionnaires is that the same questions are asked from different respondents who can choose among the same answer options which is too standardised and minor differences vanish (Bryman, 2004). A survey does not allow understanding of the context in which the respondent has chosen either answers, and there is no possibility to integrate new questions or variables into the questionnaire during the process of the survey. A survey cannot measure present activities. It can only provide self-reports about past or future activities. Therefore, a survey can be characterised with a high reliability and low validity.

In the first section of my questionnaire, I posed general questions about the company size, industry, revenue, number of employees, and ownership structure. In the second section, questions concerned the Fisherian product and supply chain characteristics (see Table 4 and 5) to ensure that during the analysis I can identify the product and supply chain types. I also asked questions about the tools applied to manage the demand chain as well as about reasons for product and supply chain types' mismatch (see the entire questionnaire in Appendix 1).

I published the questionnaire on-line only for the targeted company managers. Link of the on-line page, together with an invitation letter was distributed amongst addressees, who were selected from a source presented later.

Thanks to the spread of the internet and the easy and inexpensive availability of web-based survey software or on-line services, on-line survey methodology has become widely used due to its cost-effective nature (Andrews et al., 2003). This also means that individuals and companies have to deal with the fact that they are reached by many voluntary or unrequested contacts and surveys. It is quite hard then to compose a questionnaire which excels from the mass of surveys. In the opinion of Wright (2005) a huge advantage of on-line surveys is that they allow you to reach certain populations which otherwise are impractical or financially unfeasible to access (e.g. large geographical distance). On-line surveys spare time for researchers, because a large number of respondents can be reached in a short period of time. On-line surveys also spare cost because publication, receiving and processing are carried out electronically in contrast with the large cost and human effort requirement of a paper-based or personal contact-based survey.

From the perspective of researchers, the strength of on-line surveys is cost-effectiveness, and they can be distributed in endless quantity at the same quality. The electronic solution also provides an environment friendly method for a survey, to avoid the use of paper, and archiving data is also easier.

In my opinion, on-line surveys are not used so widespread in Hungary by research companies, and according to the experiences of previous on-line surveys carried out in our research group, companies like this flexible research method in contrast with paper-based or personal-contact-based and consequently, time-consuming methods. The strength of my own on-line survey is that the link to the questionnaire can be forwarded easily, can be read and filled anywhere where the respondent wants to – however, an internet connection is needed. The respondent can also save his answers and continue the survey anytime he/she wants to. Providing data was safe because I used my own on-line surface, and every respondent has had his own password to reach his own questionnaire. With the on-line questionnaire, I reached the entire territory of the country so I overcome the geographical distance, saved huge monetary and human resource cost and time.

However, the following on-line survey concerns present themselves according to Wright (2005). A directory of contacts may possibly contain multiple contact e-mail addresses of the same person or company which may even cause different answers or e-mail addresses to be provided, which could be invalid. Several programs solve this problem with a preliminary registration request which means that the respondent first needs to register and be given a password, then he/she is only allowed to start filling in the survey afterwards. This extra effort, however, could dramatically decrease the response rate. Other software forbids you to fill in the survey more than one time per domain. Repeating the survey participation invitations many times, aggressively, could lead to the opposition of potential respondents and the mail or the sender can be put on a SPAM list (Andrews et al., 2003).

I tried to avoid these failures in my own research by checking the entire directory in advance by contacting the targeted person at the targeted firm by phone, and a survey participation request was repeated only two times after three weeks.

When requesting people to attend an electronic survey the distrust of potential respondents has to be also handled (Wright, 2005). We ask him/her to provide data about himself/herself or the operations of the company he/she is working for. A good tool to reduce distrust is to provide contact data about the researcher and/or research institute in the survey participation request, which can be checked by the respondents and also allows direct availability in case of a problem. During the research, I published my contact data both in the invitation letter and the on-line page to ensure potential respondents about the originality of the request, and I emphasised the name of Corvinus University as a trustful background.

In an on-line survey, respondents are left alone with completing the questionnaire. He/she has to interpret the questions which could be influenced by the industry the company operates in, the educational background of the person and his/her role in the firm hierarchy. Therefore, it is very important to compose the questions as simply and univocally as possible. In my survey, I also strove to compose questions accurately, univocally and encouraged the respondents to contact me if they needed clarification on anything. Only two respondents took advantage of this opportunity. One asked for refining a given question via e-mail, and another via phone call. The problem they faced came from the difference between the terminology of the questionnaire and the company's internal interpretation.

The general opinion about on-line surveys is that it is similar or more effective than paper-based ones (Wright, 2005). To follow up this however, could be quite hard since a researcher uses not only his own directory but draws on others, e.g. public directories with unknown content and structure. A good tool for increasing the response rate is to organise a sweepstake for respondents but to apply it in business or any scientific research is not relevant. To offer them something after completing the survey, I informed the potential respondents in the survey participation request that if they would like, I send a copy of the research findings which could be a useful tool. 66% of respondents registered for the copy of the study results. The completion of the questionnaire was anonymous and consequently, those who wanted a copy of the research findings provided their names and e-mail addresses.

An additional weakness of on-line surveys is that even the directory of requested respondents is representative, always will be firms or industries which do not want to provide data. Consequently, this worsens the representativity (and generalisability) of the sample. In my survey, I targeted industries and size of companies which are likely to be members of supply chains and operate different demand chain management tools.

Data collection began in May 2010 and was finished by August 2010. During the sampling, I did not strive to collect a representative sample; rather I was focusing on industries and manufacturing companies in which the application of supply chain management is well known from previous research and literature. I searched for at least mid-size or large companies (based on annual revenue and number of employees) which are in Hungarian or international ownership and operate primarily in food, light (textile and packaging), machine (automotive) or other processing industries. According to my preliminary experiences, firms of that size and in these industries are more likely to be a part (or focal company) of supply chains. International ownership increases the likelihood of being a member of an international supply chain and that firm captures sophisticated demand chain management practice from its parent company. While sampling, I relied on the databases of previous researches carried out in our research group with my cooperation at the University, of which I selected the company contacts fitting to my own criteria. To reach more firms, I also used the directory of Hungarian Central Statistical Office (2009/Q1). Construction of my own directory was based on two pillars: first, I gathered the contact data of firms which we have already been researched in the past; second, I also collected new contacts. To those who we have already researched, I sent a survey participation request in which I thanked them for their help in past studies and invited them to fill in the new questionnaire, too. Unknown firms were first contacted by phone and after that a survey participation request was also sent via e-mail for those concerned.

I have collected 92 responses, of which 79 could be analysed. My approach was to test each research question with a double methodology. To test the Fisher-model, I used cluster analysis, which I applied to separate product types and supply chain types, then I explored the overlap of the groups. To separate product and supply chain types. I also used indices. Researchers that tested Fisher's model before me used different statistical methods. Selldin and Olhager (2007) applied scatter diagrams and tried to separate groups with regression lines, which did not provide a significant result. Lo and Power (2010) measured Fisher's product characteristics on a 5-point Likert-scale. They defined the value which separated functional and innovative product types. The method did not succeed so they created a mean line for each characteristic. Below the mean line, they regarded the product functional, above the mean line, innovative. The same methodology was used to separate supply chain types and then to compare the overlap of groups they used χ^2 test.

In my opinion, to formulate groups from companies cluster analysis is also an adequate method, and provides a good basis for comparing and analysing the difference between groups. I also learned from the previous studies that although Fisher offers plenty of characteristics for both products and supply chains, not all of them are relevant, so variables had to be filtered.

In further analyses, I used the clusters I gained in the first research step. I compared the demand chain management tools used by supply chain clusters (ANOVA, Levene's F-probe). To analyse the match-mismatch question, I applied descriptive statistics and mainly the interviews, made in the qualitative phase. To discover the demand chain management practice of Hungarian companies, I also used cluster analysis as well as descriptive statistics.

V.1.2 Qualitative research phase

To complete the findings of the quantitative research phase, and to analyse the second hypothesis (see page 75) deeper, I applied qualitative research methodology and I conducted interviews. The aim of the interviews was to discover the reasons for mismatch between the Fisherian product and supply chain types. Regarding the mismatch problem, literature also provided several explanations, which were tested first, quantitatively second, in the interviews. I also tried to find additional reasons with the help of the interviewees.

The applied methodology was a semi-structured, in-depth interview. The general purpose of the interviews is to help the researcher understand the circumstances (and through him/her the entire company) and the aspect of the interviewee, how he/she sees the world – in this case the company and supply chain operations (Kvale, 1994). *Validity* can be expressed by the question: "are we measuring what we think we are measuring?" (Kvale, 1994. p. 166). Kvale interprets the above rather quantitative definition of validity to a qualitative case as he says "method validity if it investigates what it aims to investigate, and to the extent to which observations reflect the phenomena of interest" (Kvale, 1994. p. 167). Consequently, the qualitative interview may, in principle, be a valid research method. Usually, the *reliability* of interviews is low because of the wording of a question, the subjective interpretation of the interviewer, his/her terminology and preliminary perceptions, which may influence the answer. Consequently, the research cannot be repeated later by others with the same result (Kvale, 1996). To increase reliability, I prepared the interview questions in advance which I asked from each interviewee – but not always in the same order. I strove to compose interview questions, trying to avoid special terminology, and we discussed the content of a notion when it was necessary (e.g. product life cycle ≠ product life length).

Generalisability of interviews is also low, since I only conducted a few of them to supplement the quantitative research phase. I consider it a significant result that my research analysed a phenomena (reasons for mismatch), which were never analysed before. The main contribution is the discovery of the problem, to collect as many explanations to the phenomena as possible, which can be researched later in a large sample with various research methods.

I formulated the interview questions in advance, and I tried to touch each of them during the interview. However, I did not stick to the order of the questions. I rather followed the way of thinking of the interviewee which helped me to understand the context and circumstances the company operates in. During the interview I applied open, descriptive questions.

After the introduction, I let the interviewee know the general purpose of the research, and that I was testing Fisher's theory. In the second part of the interview, the interviewee was talking about the supply chain operations of his company to help me to find the Fisherian characteristics of both products and supply chains. To discover the reasons for mismatch, I composed a brief questionnaire which was completed at the interview. I asked them to evaluate the possible reasons found in the literature on a 7-point Likert-scale (1= not a reason at all; 7=the most possible reason of mismatch). After the short questionnaire, I asked them to find additional explanations why product types and supply chain types may mismatch at companies.

While selecting interviewees, I focused on industries which participated in surveys the most. Therefore, I selected food sector which is a set of industries manufacturing basically functional products, machine industry and other processing industry (plastic products manufacturing) in which innovation is important but on different levels. I interviewed two managers (and companies) in each sector to ensure the control.

Interviewees were mainly (4) logistics managers that – particularly in large firms with a structured hierarchy – had a good overview about the supply chain operations. In one case, I interviewed a sales manager that previously led the logistics department at the firm, therefore, he was able to provide relevant information. One additional interview was conducted with a director assistant who worked at a mid-size firm – with an unstructured organisation – and who was responsible for export sales and logistics, so he also could provide relevant data. I offered anonymity to all of the interviewees but Table 13 contains the most important data about the interviews and the companies.

Interviews were recorded by Dictaphone which is inevitable according to Kvale (1994). I also took notes during the interview to capture the core of the discussion. Right after the meeting I recorded my additional feelings and impressions, making a brief summary about the session. I did not feel it was necessary to type up the interviews because my notes were very detailed and almost each interview took one hour. I could listen to it again anytime, as well my notes helped me find the correct part of the audio file.

Table 13: Data of interviews

Name (nick) of company and industry	Size of company	Position of interviewee	Date of interview
Company A, FMCG	large	Warehousing and distribution manager	13/08/2010
Company B, machine	large	Sales manager	02/09/2010
Company C, machine	large	Logistics manager	08/09/2010
Company D, other processing	large	Regional logistics manager	14/09/2010
Company E, FMCG	medium	Director assistant (responsible for export sales)	17/09/2010
Company F, other processing	medium	Logistics manager	20/09/2010

V.1.3 Ethical questions in research

There are many stakeholders in research activity so it is important to look at the ethical issues in relation to each of them (Kumar, 2005. p. 211):

- the participants or subjects
- the researcher
- the funding body.

As my doctoral research does not have any funding body, I focus on examining the ethical questions concerning the two other stakeholder groups.

In every discipline, it is considered unethical to collect data without the knowledge of the *participants* and their expressed consent. It is very important to have the participants' consent and make them aware of the type of information we want from them, what purpose it will be used for and how the participation in the research will directly or indirectly affect them (Kumar, 2005). An additional important ethical issue is the handling and storage of confidential information.

In my research, I handled these questions by contacting company managers that have already participated in our researches and who were open to cooperate. Those who were never contacted before I asked for consent first by phone and then by sending a survey participation request. The survey participation request contained detailed information about research aims and the type of the questions. Confidentiality was ensured first, by filling the questionnaire in anonymity which allowed me to know the company and contact data only of those respondents who requested a copy of the research findings. Second, the questionnaire was published on my own on-line page which ensured that only those who have access to the survey were granted access to the on-line page by me. Third, respondents have their own random-generated passwords to their own questionnaires which they could use to delay filling in. As I managed the survey through my own web page, I was the only one who could reach the data of the filled in questionnaires.

To carry out the interviews, I also needed the consent of my interviewees. I explained to them the aims of the research and that I was interested in their personal opinion and experiences in the subject. I also asked for their consent to use a Dictaphone, and ensured them that the audio file will be used only for research purposes, which serves to support me to recall the entire interview.

Among the ethical issues concerning the *researcher* Kumar (2005) mentions bias first. Bias is not the same as subjectivity. Subjectivity is related to the researcher's educational background, and philosophical perspective. Bias then is a deliberate attempt either to hide what have been found or highlight something disproportionately, both of which are unethical. To carry out an ethically unexceptionable research, we have to avoid unethical data collection (without the consent of the respondent) and information gathered is allowed to be used only for the purpose it was collected for. When composing the research report, the researcher must use and published data correctly and unbiased.

In my research, I edited a questionnaire which asked respondents for their opinions and evaluation about given statements. Questions so closely related to and formulated along the hypotheses that illegal usage of data is almost impossible. Questions and hypotheses match, and during the analysis, I examined these preliminary fixed hypotheses which I strove to answer all and publish univocal results.

In the interviews, I had to consider the formulation of questions and not to influence the interviewees. To do so, I composed simple questions and strove to observe and understand their perspective and interpretation.

VI. RESEARCH FINDINGS

This chapter consists of five parts. First, I introduce the characteristics of the company sample, which was collected in the quantitative phase and which is used in further analyses. The second and third part aims to present the results of testing Fisher's model based on the data collected. In the fourth part I show the results of the qualitative research phase which completes the quantitative results of finding reasons why Fisherian product types and supply chain types may mismatch. The interviews helped to complement and modulate the result of quantitative research findings. In the fifth part, I am dealing with the Hungarian company practice in demand chain management using the information of the survey database.

VI.1 Characteristics of quantitative sample

The survey was conducted from May 2010 until August 2010. Link of the on-line questionnaire was sent to 577 companies, and I also asked several trade associations (Hungarian Association of Logistics, Purchasing and Inventory Management, Hungarian Association of Packaging and Materials Handling) to distribute the link and survey participation request letter among their partner companies. I chose these associations because they pool professionals from different logistics areas of firms, and I have good connections with them.

After receiving the survey participation request, 234 addressees opened the link, and 92 responses were received. Unfortunately, not all of the 92 responses could be analysed because some of them provided data only about the company characteristics and did not fill out the part concerning the product and supply chain characteristics. For this reason, some companies had been filtered out from the sample which finally resulted in data from 79 firms.

Even though the sampling is not representative, it is particularly appropriate for analysis.

I primarily targeted manufacturing companies with the survey which represent important industries of Hungarian economy, and the presence of conscious supply chain management is the most likely. As it can be seen in Figure 12, the machine industry represents the largest part of the sample, in addition to other processing and food industry. In these sectors, supply chain management has already been studied by other researchers.

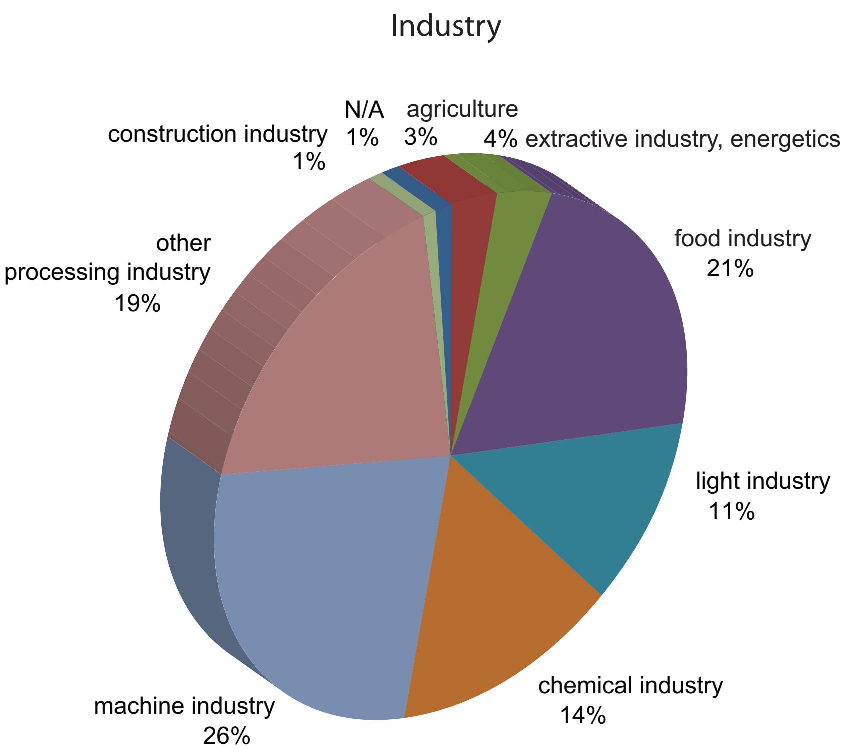

Figure 12: Distribution of sample by industry

If we regard the sample structure from the company size aspect (Figure 13), we find that large companies dominate the sample (65%), there are many mid-size companies (28%) and a few small firms (7%). When defining company size, I used the classification of the Competitiveness Research Program at the Corvinus University of Budapest. In this classification, small companies have less than 50 employees and revenue below 2.5 million € (700 M HUF); the number of employees is between 50 and 250 at mid-size companies and revenue is between 2.5 and 14.5 million € (700 M - 4 B HUF); large companies have more than 250 employees and more than 14.5 million € revenue (WIMMER and CSESZNÁK, 2005).

The large share of big companies in the sample is very advantageous, because they are more likely to play a focal role in the supply chain and have an effect on the supply chain management practice applied.

Regarding the ownership structure (Figure 14), the largest share of the sample consists of subsidiaries of international companies (63%), Hungarian private ownership is also frequent (32%) and in 1% Hungarian state ownership is represented.

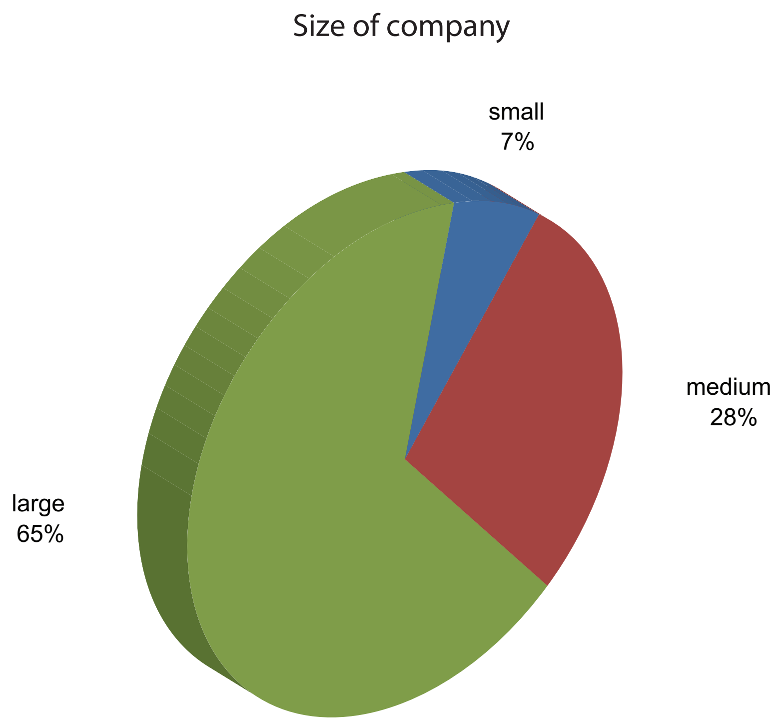

Figure 13: Distribution of sample by company size

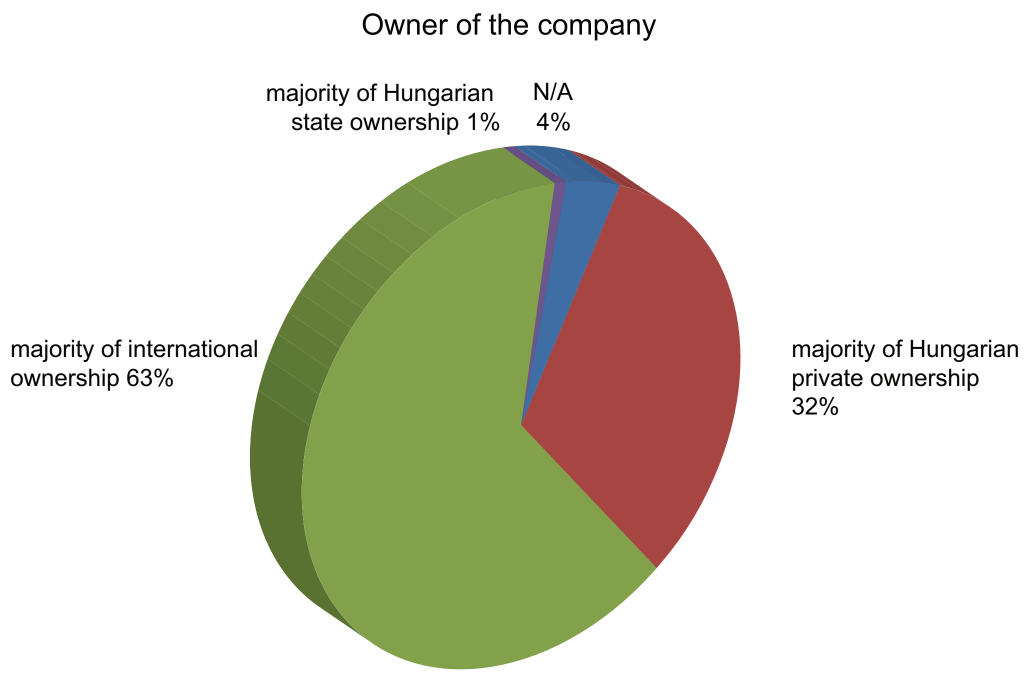

Figure 14: Distribution of sample by ownership structure

The larger share of international ownership is advantageous because it is very likely that these companies adapted a good working supply chain management practice from their parent companies.

The questionnaire also asked the status of the company within the supply chain (Figure 15). The majority of respondents kept themselves a focal company in the supply chain (53%) 4 and 11 percent of the firms have a retailer or wholesaler position in a chain, and 20% of respondents are first-tier suppliers of focal companies. An additional 4 and 1 percent operate as second-and third-tier suppliers.

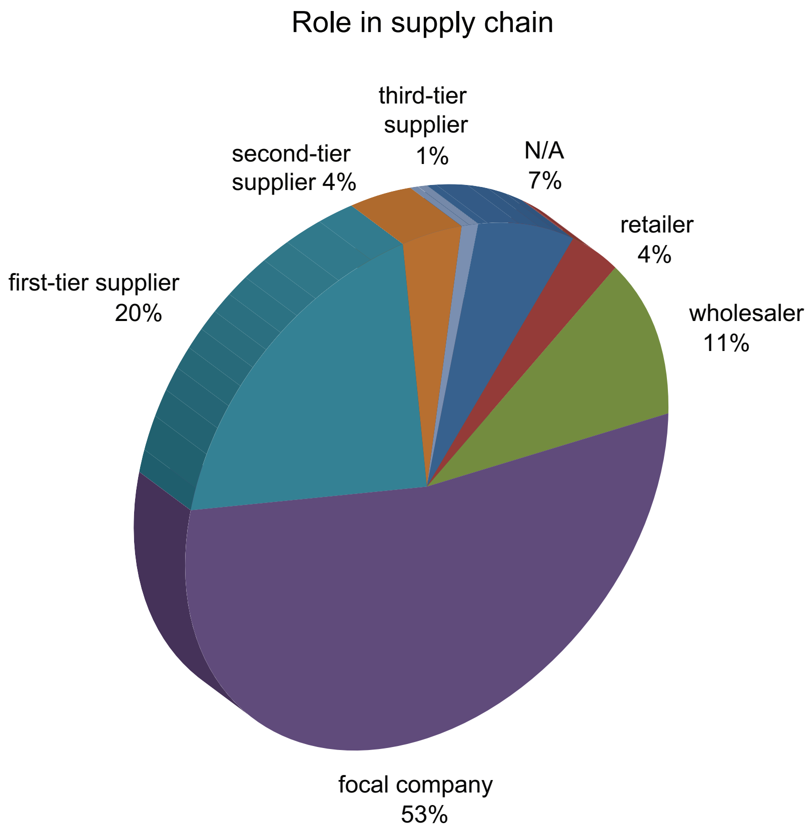

Figure 15: Distribution of sample by role in supply chain

On the whole I think the sample is very advantageous for testing the hypotheses, because my wish came true when the sample consists of mainly large companies, in international ownership and the majority of them are focal companies, also industry distribution is good.

VI.2 Analysis of the match of Fisher's product and supply chain types

This chapter aims to present the findings of the first hypothesis. In Chapter V, among the explanation of research questions, the first hypothesis was that according to Fisher's theory product characteristics define supply chain characteristics (H1). To test this statement, I used the characteristics of Fisher listed in Table 4 and 5 and transformed them to survey questions. As it can be seen in Appendix 1, questions B1–B7 capture product, questions B8-B17 are related to supply chain characteristics.

VI.2.1 Identifying Fisher's product types

Look at product characteristics first. The first step was to test the correlation of product characteristics defined by Fisher. As it can be seen in Appendix 2, the level of correlation is low or medium between the selected variables in the sample. However, there are many variables in which case the correlation is not significant, which were therefore, filtered out from further analysis.

Product characteristics (Table 4) based on Fisher's theory:

- forecast error frequency (B1)
- frequency of late delivery – stock-out (B2)
- length of product life cycle (B3)
- lead time from manufacturing to delivery (B4)
- product variety (SKUs) (B5)
- profitability of the product (B6)
- level of end-of-season markdowns (if there is any) (B77).

The consistency of variables was tested by Crombach's alpha which showed a very low level of consistency (0.387). Because of the non-significant correlation and the bad effect they had on data consistency I filtered out the variables B5 and B6. Consequently, I kept B1, B2, B3, B4 and B77 which were tested again by Cormbach's alpha. A new examination provided an acceptable result which exceeds the minimum level of alpha needed (0.638>0.6).

After filtering out the distortive variables the remaining product characteristics were classified by cluster analysis (hierarchical cluster analysis, between-groups linkage and Ward's method) in order to separate Fisher's functional and innovative product groups. My experience then was that because many respondents do not apply end-of-season markdowns, there were too few responses for question B77, which resulted in almost two-thirds of the sample cases being dropped out. To avoid this, I had to filter out variable B77 (new Crombach's alpha is 0.614) and repeated the cluster analysis with the reduced number of variables.

The remaining variables (B1, B2, B3, and B4) were classified again by both cluster analysis methodologies. I have two clusters defined by product characteristics. The average population of clusters gained by the between-groups linkage method was 40 and 30 while those of by Ward's method 32 and 38. When examining the overlap of groups I found that 31 and 29 cases are the same in the clusters produced by the different methods.

Summing up the analysis carried out, I first filtered the variables related to product characteristics considering the correlation and the consistency of data. I found that characteristics which really define the product are forecasting error frequency (B1), frequency of late delivery – stock-out (B2), length of product life cycle (B3) and lead time from manufacturing to delivery (B4). These variables show an acceptable level of consistency (Combach's alpha= 0.614) which allowed me to run a cluster analysis applying two methods. The two cluster analysis methods produced two-two clusters and after examining their overlap, I have two almost balanced clusters along the narrowed list of product characteristics.

In order to get a reliable result, I have chosen another method to classify cases along product characteristics: indices. When formulating indices, I used the variables that remained after filtering (B1, B2, B3, and B4). Each variable was measured on a 5-point Likert-scale. I counted the mean value of the four variables which resulted in a **product-type-index** for each case. To be able to count mean from given values, the scale of some questions had to be reversed (transformed), which resulted in low values to reflect to functional, high values to innovative products.

Forecast accuracy was measured by question B1. The frequency of forecast errors was measured on a 5-point Likert-scale where 1 meant that forecast error is not frequent, 5 meant very frequent. If the response was 1 or 2, I kept the product functional, if 3 or larger I kept it innovative, because a medium level of forecast error could significantly ruin delivery efficiency.

Frequency of late delivery – stock-out was captured by question B2. The frequency of the problems was measured on a 5-point Likert-scale as well, where 1 meant a low frequency, 5 meant a high frequency of late delivery, stock-out. I kept a product functional if responses were 1 or 2, and innovative if 3 or higher, because a middling level of late delivery, stock-out assort with servicing a well-predictable demand.

Length of a product life cycle was captured by question B3. This question was also measured on a 5-point Likert-scale where 1 meant very short, 5 meant very long life cycle. This *scale had to be reversed,* which resulted that 1 meant long, 5 meant short product life cycle. This way the values of 1 and 2 refer to functional, 3 and higher values to innovative products, because a medium level product life cycle is about one year, as it is recommended by Fisher.

Lead time length was measured by question B4. As well as the previous questions, B4 was measured on a 5-point Likert-scale where 1 meant very short (i.e. days), 5 meant very long (i.e. months) lead time. *This scale also had to be reversed* to make 1 mean a long, less reactive process (functional products) and 5 a quick, responsive process (innovative products). Consequently, the values of 1 and 2 refer to functional products, 3 or higher values to innovative products because a middling level of lead time could mean weeks in delivery.

When formulating indices, I considered only those variables which remained after filtering and proved consistent (B1–B4). I added up the values given by respondents to each question, counted the mean, which resulted in values of indices spread between 1.5 and 4.5. The cutting point was 3, so under 3 I kept the product functional while an index value of 3 and above referred to innovative products. This way I have two groups of cases with the population of 41 and 32.

Sample cases were then classified by two methods: cluster analysis and indices. After getting the two clusters and two groups along indices, I compared them and found that they overlap quite well.

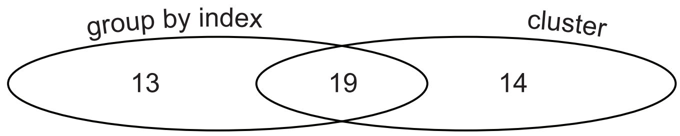

Figure 16: Functional product index-based group and cluster (between-groups linkage) common set: 41%

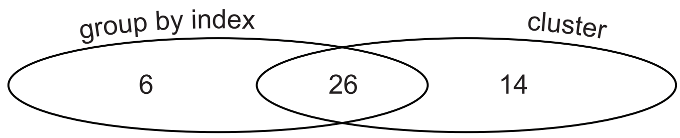

Figure 17: Functional product index-based group and cluster (Ward's method) common set: 57%

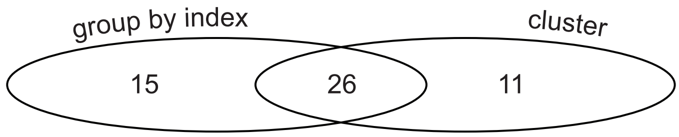

Figure 18: Innovative product index-based group and cluster (between-groups linkage) common set: 50%

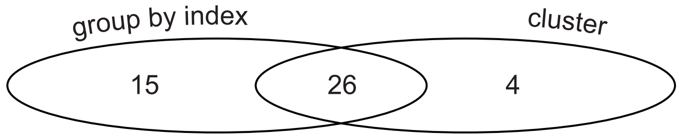

Figure 19: Innovative product index-based group and cluster (Ward's method) common set: 58%

After examining the overlap of clusters and index groups, I chose the option which allows me retaining as many cases as possible and the level of overlap is also high. Consequently, I have chosen the option produced by index groups and Ward's method of cluster analysis. I retained 52 company cases for further analysis, of which 26 represent functional and additional 26 innovative products. From now on, I will use the expression **product category cluster** to refer to them.

In the next step, I compared the two clusters, whether there is a significant difference between them concerning product characteristics. The difference was tested by ANOVA table. A complete ANOVA table is available in Appendix 3; here I only show the significant results (Table 14.)

Table 14: ANOVA table for comparison of two clusters by Fisher's product attributes

Variables		Product type cluster mean	F	Sig.
length of product life cycle (B3)	innovative	1,88	109,192	0,00
	functional	4,04		
lead time from manufacturing to delivery (B4)	innovative	2,23	35,337	0,00
	functional	3,85		
product variety (SKUs) (B5)	innovative	4,08	4,21	0,045
	functional	3,38		

The results suggest that a significant difference ($p<0.05$) can be experienced primarily between the product characteristics filtered in the first part of the analysis that is the length of product life cycle (B3) and lead time (B4), but means are significantly different in the case of product variety (B5), as well. Levene's F-probe provided almost the same result. This method found a significant difference between the variances of B4 and B5 variables (Table 15). (The complete table is shown in Appendix 4.) Analysis suggests that from the list of Fisher's product characteristic length of lead time, product variety and length of the product life cycle make a real difference between functional and innovative products.

Table 15: Levene's F probe for comparison of two clusters by Fisher's product attributes

Levene's F probe					
	Product type cluster	**N**	**mean**	**F**	**Sig.**
lead time from manufacturing to delivery (B4)	innovative	26	2,23	7,334	0,009
	functional	26	3,85		
product variety (SKUs) (B5)	innovative	26	4,08	15,359	0,000
	functional	26	3,38		

VI.2.2 Identifying Fisher's supply chain types

The first step of this analysis was to test the correlation of variables describing supply chain characteristics. Appendix 5 exhibits the correlation table of which we can see that variables correlate on a low or medium level. Several values are not significant, which had to be filtered out.

Supply chain characteristics (Table 5) based on Fisher's theory:

- level of effort to reduce operational costs (B8)
- level of effort to achieve high stock turnover (B9)
- level of final product inventory in case of modular product (B10)
- level of semi-finished product inventory in case of modular product (B11)
- level of final product inventory in case of non-modular product (B12)
- level of safety stock in the supply chain (B13)
- level of effort to use capacity at most (B14)
- building buffer capacity in supply chain (B15)
- quick reaction to demand changes (B16)
- radical lead time reduction (B17).

Consistency of variables was tested by Crombach's alpha which provided an even lower value than in the case of product characteristics (0.07); consequently, some of the variables needed to be filtered again. Based on the result of the correlation analysis, Crombach's alpha and the experiences of product characteristics, I excluded all the variables to which too few answers arrived (B10, B11, B12) which would cause a dramatic reduction of cases in cluster analysis. After that, I also excluded B9, B14 and B16, because of the bad effect they have on the correlation and data consistency. This way the level of Crombach's alpha reached an acceptable level (0.601).

From then on, I focused only on the remaining variables (B8, B13, B15 and B17), which were classified with a cluster analysis as well as indices.

I made cluster analyses for the retained variables (hierarchical cluster analysis between-groups linkage and Ward's method) to separate Fisher's physically efficient and market-responsive supply chain types. I ran both cluster analyses which produced two-two clusters along the supply chain characteristics. The between-groups linkage method produced clusters with the population of 31 and 40, while with Ward's method the population of two groups is 28 and 43. When examining the overlap of the clusters gained by the different methods I have found that 28 and 39 cases are the same in the two-two clusters.

On the whole, first I reduced the number of variables in order to increase data consistency and filter the non-correlating variables. Consequently, I selected those variables which define the supply chain characteristics: effort to reduce operational costs in a supply chain (B8), holding safety stock (B13), buffer capacity all over the supply chain (B15), and radical reduction of lead times (B17). I ran two different cluster analyses on these variables. The two cluster analysis methods produced two-two clusters, and after examining their overlap, I had two almost balanced clusters along the narrowed list of supply chain characteristics.

To get a reliable result, I have chosen another method to classify cases along supply chain characteristics: indices. When formulating indices, I used the variables that remained after filtering (B8, B13, B15, B17). Each variable was measured on a 5-point Likert-scale. I counted the mean value of the four variables which resulted in a **supply chain-type-index** for each case. To be able to count the mean from given values, the scale of some questions had to be reversed (transformed), which resulted in low values reflecting physically efficient, high values to market-responsive supply chains.

Operational costs were captured by question B8. Responses were measured on a 5-point Likert scale where 1 meant “low priority” and 5 meant “this is the primary goal”. This *scale had to be reversed,* which resulted in 1 meaning high priority, 5 meant low priority. This way the values of 1 and 2 refer to physically efficient, which reflect a strong effort in cost reduction, while 3 and higher values refer to market-responsive supply chains.

Market-responsive supply chains tend to hold *safety stock* all over the supply chain which was captured by question B13. The level of safety stock was measured on a 5-point Likert-scale as well, where 1 meant a low level, and 5 meant a high level of safety stock. I kept a supply chain physically efficient if responses were 1 or 2 and market-responsive if 3 or higher, because a middling level of safety stock could mean high invested capital.

Holding a *buffer capacity* all over the supply chain is frequent in market-responsive supply chains and which was described in question B15. The level of the buffer capacity was measured on a 5-point Likert-scale where 1 meant a low level, 5 meant a high level of buffer capacity. I kept a supply chain physically efficient if responses were 1 or 2 and market-responsive if 3 or higher, because a middling level of buffer capacity could mean a high level of reserves.

The effort to *reduce lead times* was captured by question B17. Responses were measured on a 5-point Likert-scale where 1 meant that lead time reduction is not important, 5 meant high importance. I kept a supply chain physically efficient if responses were 1 or 2 and market-responsive if 3 or higher, because a middling level of effort to reduce lead time could cost a lot of resources.

When formulating indices, I considered only those variables which remained after filtering and proved consistent (B8, B13, B15, and B17). I added up the values given by the respondents to each question, counted the mean which resulted in the values of indices distributed between 1.75 and 4.25. The cutting point was 3, so under 3, I kept the supply chain physically efficient while an index value of 3 and above referred to market-responsive supply chains. This way I have two groups of cases with the population of 41 and 32.

The classification of cases along supply chain characteristics was carried out both by cluster analysis and indices. After getting the two clusters and two groups along indices, I compared them and found that they overlap very well.

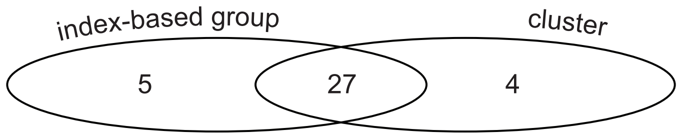

Figure 20: Physically efficient supply chain index-based group and cluster (between-groups linkage) common set: 75%

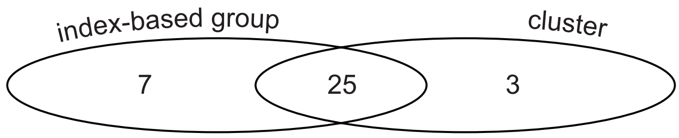

Figure 21: Physically efficient supply chain index-based group and cluster (Ward's method) common set: 71%

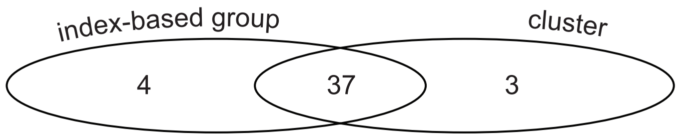

Figure 22: Market-responsive supply chain index-based group and cluster (between-groups linkage) common set: 86%

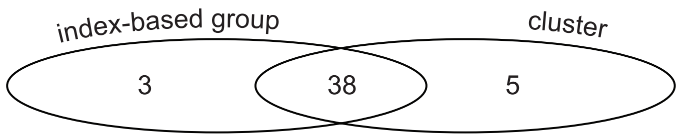

Figure 23: Market-responsive supply chain index-based group and cluster (Ward's method) common set: 82%

After examining the overlap of clusters and index groups, I chose the option which allowed me retaining the most cases possible, and the level of overlap was high. I then selected the option produced by index groups and the between group linkage method of cluster analysis. I retained 64 company cases for further analysis, of which 27 represent physically efficient and additional 37 market-responsive supply chains. From now on, I will use the expression **supply chain category cluster** to them.

In the next step, I compared the two clusters whether there is a significant difference between them concerning supply chain characteristics. The difference was tested by ANOVA table. The ANOVA table is available in Appendix 6; here I only show the significant results (Table 16.)

Results suggest that a significant difference ($p<0.05$) can be experienced in cases of operational cost reduction (B8), reduction of final product inventory in modular products (B10), holding safety stock (B13), buffer capacity (B15), and lead time reduction(B17). Analysis suggests that from the list of Fisher's supply chain characteristics, only these five characteristics make a real difference between physically efficient and market-responsive supply chains.

Table 16: ANOVA table for comparison of two clusters by Fisher's supply chain attributes

		Supply chain type cluster mean	**F**	**Sig.**
level of effort to reduce operational costs (B8)	Market-responsive	3,89	5,245	0,025
	Physically efficient	4,31		
level of final product inventory in case of modular product (B10)	Market-responsive	3,63	4,625	0,041
	Physically efficient	4,22		
level of safety stock in the supply chain (B13)	Market-responsive	3,58	24,034	0,000
	Physically efficient	2,46		
building capacity surplus in supply chain (B15)	Market-responsive	3,58	87,369	0,000
	Physically efficient	1,77		
quick reaction to demand changes (B16)	Market-responsive	4,43	5,403	0,023
	Physically efficient	3,88		
radical lead time reduction (B17)	Market-responsive	4,37	12,707	0,001
	Physically efficient	3,58		

VI.2.3 Examining the match between Fisher's product and supply chain types

This chapter aims to test the H1 hypothesis. That is, do companies that manufacture functional products really operate physically efficient supply chains as well as those which produce innovative products operate market-responsive supply chains?

The next cross table (Table 17), shows the overlap of product category clusters and supply chain category clusters.

Table 17: Comparison of matching of product types and supply chain types

		Clusters of supply chain types		**Total**
		Physically efficient	**Market-responsive**	
Clusters of product types	Functional	7	15	22
	Innovative	8	15	23
Total		15	30	45

As it can be seen from the table, there is not a univocal match between product types and supply chain types. I have found only seven companies in the sample which manufacture functional products and operate physically efficient supply chains, while 15 firms, which produce innovative products and operate market-responsive supply chains. The sample was narrowed to 52 firms along product characteristics, while supply chain characteristics narrowed the number of cases to 64, but only 45 firms were common in the two groups. 49% of the 45 companies show matching behaviour and 51% show mismatch. Consequently, Fisher's theory cannot be confirmed, and **H1 hypothesis has been rejected**. Because of this result, it cannot be stated that manufacturers of functional products operate exclusively physically efficient, and those of innovative products operate market-responsive supply chains.

The aim of the next chapter is to discover the management practice of the matching 22 firms and to examine, whether in case of matching companies, a difference between supply chains could be captured in the applied demand chain management tools as well.

VI.3 Analysis of the difference between Fisher's supply chain types along demand chain management tools

The previous chapter highlighted that Fisherian product types show a significant difference in lead time, product variety and length of the product life cycle. A significant difference between the characteristics of supply chains was found only in operational costs, final product inventory held from modular products, buffer capacity, safety stock, and lead time reduction.

The aim of this chapter is to find the difference between Fisher's supply chain types in the way they manage their demand chain. To answer the question, I used the question group of B18 which listed demand chain management tools. Demand chain management tools have been surveyed in detail, so I needed to filter out the variables which describe the same phenomenon or are deviant by correlation and factor analysis.

I tested the following 19 demand chain management tools:

- EDI (B18a)
- sharing of POS data(B18b)
- sharing of inventory data (B18c)
- sharing capacity information (B18d)
- computer-aided ordering (B18e)
- common planning (B18f)
- common forecasting (B18g)
- barcode (B18h)
- RFID (B18i)
- VMI (B18j)
- continuous replenishment (B18k)
- cross-docking (B18l)
- supplier assessment (B18m)
- customer assessment (B18n)
- activity-based costing (B18o)
- manufacturing postponement (B18p)
- logistics postponement (B18q)
- modular production (B18r)
- modular product design (B18s).

As it can be seen in the correlation table (Appendix 7), many of the variables correlate significantly, and in some cases correlation is very high which refers to these variables describing the same phenomenon. Consequently, not each of them is necessary (common planning and common forecasting: 0.824; modular production and modular product design 0.849). From these pairs of variables I excluded one-one (B18g and B18s). I kept that variable from the pair which had a better effect on data consistency analysed by Crombach's alpha. However, barcode, RFID and supplier assessment correlated with almost neither other variables and after excluding them, consistency did not damage. After selecting these five variables, the remaining ones were tested by Crombach's alpha and results showed very good consistency of data (0.823).

The remaining variables were also analysed by factor analysis (principal component analysis with Varimax rotation). I have found that the share of POS data (B18b) variable did not move together with the other variables describing information sharing and behaved deviant. Consequently, I excluded it from further analysis.

I then narrowed the list of 19 demand chain management tools to 13. The Crombach's alpha of these 13 variables is 0.805, which is also very good, and the result of new factor analysis is shown in Table 18.

Table 18: Result of factor analysis made on demand chain management tools

Rotated component matrix			
	Component		
	1	**2**	**3**
EDI (B18a)		0,669	
sharing of inventory data (B18c)		0,716	
sharing capacity information (B18d)		0,705	
computer-aided ordering (B18e)		0,631	
common planning (B18f)		0,655	
VMI (B18j)		0,507	0,600
continuous replenishment (B18k)		0,567	0,603
cross-docking (B18l)			0,767
customer assessment (B18n)	0,719		
activity-based costing (B18o)	0,693		
manufacturing postponement (B18p)	0,829		
logistics postponement (B18q)	0,701		
modular production (B18r)	0,699		

I interpreted the results of the factor analysis as Factor 1 pools the demand chain management tools necessary for **market-responsive customer service** (manufacturing and logistics postponement, modular production), and tools which ensure the control of costs related to this flexibility (customer assessment, activity-based costing). Factor 2 sums up the tools of **information sharing** all over the supply chain (EDI, share of inventory and capacity data, CAO, common planning). Factor 3 pools the tools of managing the **materials flow** effectively (VMI, CRP, cross-docking). The result of factor analysis then supports my model presented in Figure 3, that while demand chain management companies combine tools in order to service customers better, which is supported by information sharing, smooth the materials flow and control the related costs and performances.

In the following, I analysed the two matching clusters in which either manufacturers of functional products operate physically efficient supply chains (seven firms), or producers of innovative products operate market-responsive supply chains (15 firms), in accordance with Fisher's theory. I examined whether a difference exists between the applied demand chain management tools as well. A comparison was made by applying the methods of ANOVA mean-comparison and Levene's F-probe to compare variances.

Unfortunately, neither ANOVA mean comparison nor Levene's F-probe provided significant results (Appendix 8 and 9). On a 95% significance level, ANOVA could not show any differences between the applied demand chain management tools in the two supply chain clusters. As well, Levene's F-probe failed to produce a significant difference.

On the whole, H3 hypothesis has not been verified, but considering the sub-hypotheses, we found partial results (Table 19).

Regarding the sub-hypotheses of information sharing with EDI and customer assessment, my presumption was correct; that is these tools are applied irrespectively to the supply chain type, they are important on an elementary level in operating supply chains. Consequently, the difference between the chains has to be non-significant. However, regarding all the other tools, I cannot find a difference between the two Fisherian supply chain types based on the tools they use to manage the demand chain.

Table 19: Testing of sub-hypotheses of hypothesis H3

Sub-hypothesis	Content of sub-hypothesis	Result of testing
H3a	The application of inter-firm communication systems (EDI, etc.) as a demand chain management tool is not dependent on the type of supply chain.	Confirmed, as the difference between the two chains is not significant
H3b	The application of a barcode system as a demand chain management tool is not dependent on the type of the supply chain.	Cannot be tested
H3c	The application of RFID as a demand chain management tool is significantly more prevalent in market-responsive supply chains than in physically efficient supply chains.	Cannot be tested
H3d	Supplier assessment as a demand chain management tool is not dependent on the type of the supply chain.	Cannot be tested
H3e	Customer assessment as a demand chain management tool is not dependent on the type of the supply chain.	Confirmed, as the difference between the two chains is not significant
H3f	The application of CRP as a demand chain management tool is significantly more prevalent in physically efficient supply chains than in market-responsive supply chains.	Rejected
H3g	The application of CAO as a demand chain management tool is significantly more prevalent in physically efficient supply chains than in market-responsive supply chains.	Rejected
H3h	The application of cross-docking as a demand chain management tool is significantly more prevalent in physically efficient supply chains than in market-responsive supply chains.	Rejected
H3i	The application of activity-based costing as a demand chain management tool is significantly more prevalent in physically efficient supply chains than in market-responsive supply chains.	Rejected
H3j	The application of common planning and forecasting as a demand chain management tool is significantly more prevalent in market-responsive supply chains than in physically efficient supply chains.	Rejected

H3k	The application of VMI as a demand chain management tool is significantly more prevalent in market-responsive supply chains than in physically efficient supply chains.	Rejected
H3l	The application of postponement as demand chain management tool is significantly more prevalent in market-responsive supply chains as in physically efficient supply chains.	Rejected

VI.4 Analysing mismatch of Fisher's product types and supply chain types

This chapter aims to find an explanation why there is mismatch between product types and supply chain types in contrast to Fisher's theory. In chapter III.5, when formulating the research question, I presented that the researchers that also experienced mismatch during their own researches while testing the Fisher-model, tried to explain the phenomenon, but without any systematic analysis behind them.

As it came up in the previous chapters, in my own sample, there are more companies with mismatch strategy (23) than with match strategy (22). When analysing the reasons of mismatch, first I start with the results of the survey and in the second part of the chapter I present the findings of the qualitative research phase.

VI.4.1 Analysing mismatch strategy along survey data

In Table 12, I collected all the explanations researchers made to explain why Fisher's product types and supply chain types could mismatch. These explanations were transformed to H2 hypothesis and its sub-hypotheses (H2a-f):

- combining the strength of two supply chain types to achieve a higher performance (H2)
- volatile market (customer expectations) (H2a)
- poor management (H2b)
- hybrid product (H2c)
- uncertainty of demand (H2d)
- uncertainty of supply (H2e)
- company cannot identify the actual life cycle stage of a product (H2f).

When editing the questionnaire, I transformed the hypotheses into questionnaire questions directly or indirectly.

Companies that answered question B1 (forecast errors) with a value 3 are likely to produce a *hybrid product* because forecast error is neither low as it is in case of functional products nor high as it is in case of innovative products. *Uncertainty of demand and supply* were captured by questions B2 (frequency of late delivery – stock-out), and B13 (level of safety stock), and if companies gave a high value answers (4;5) uncertainty was likely to be high.

All the other mismatch reasons were directly transformed into questionnaire questions. *Poor management* was captured by question B19 "Do you agree with the statement: the supply chain of your company is managed correctly considering the specialities of the product and the market?" Responses were measured on a 5-point Likert scale where 1 meant "highly disagree" and 5 meant "highly agree". In this question, I regarded suspicious if both matching and mismatching companies considered their own management correct, because in these cases, companies with mismatching strategy think their practice is good and management really cannot realise that they are doing something wrong – according to Fisher.

A *volatile market* was described with question B20, "Do you agree with the statement: the market of your main product (line) is very volatile?" On a 5-point Likert-scale 1 represented respondent highly disagrees, 5 meant highly agrees. High value responses referred to mismatch strategy.

Supply chain performance was captured by the question group B21a-f, where respondents had to answer the questions "How good is the performance of your supply chain in these aspects: price; product quality; reliability; accuracy in volume; accuracy in time; responsiveness to changing customer needs?" Each aspect was measured on 5-point Likert-scale where 1 meant very poor, 5 meant excellent performance. This way the performance of Fisher's supply chain types can be measured and differences may come up.

Product life cycle status was tested by question B22. Respondents had to answer which life cycle stage their main product (line) is actually in: introductory; growth; maturity? I examined whether the number of cases increased in growth-stage, which – according to Selldin and Olhager (2007) – would refer to a mismatch situation.

In this situation, the product behaves like an innovative product – has unpredictable demand – although it is a functional one, but in the growth-stage – consequently, the supply chain operated is market-responsive.

Analysis was started with *hybrid products,* and I experienced that 3 of the 22 matching firms marked 3 on the Likert-scale, while 6 of 23 did the same in the mismatching category. Consequently, it cannot be stated univocally that the reason for mismatch is based on forecast error, H2c sub-hypothesis was therefore, rejected.

Uncertainty of demand and supply was tested by comparing the matching and mismatching groups, and I have found that mismatching companies did not give high value Likert-scale scores to the questions. ANOVA did not provide a significant difference between the two groups (Appendix 10), while Levene's F-probe (Appendix 11), found a significant difference in the single case of frequency of late delivery – stock-out (B2) (Table 20). Consequently, H2d and H2e sub-hypotheses have also been rejected.

Table 20: Levene's F probe on explanation of mismatching for question B2

Levene's F probe						
		N	**Mean**	**St. dev.**	**F**	**Sig.**
frequency of late delivery - stock-out (B2)	Mismatch	23	2,22	1,204	5,174	0,028
	Match	22	2,00	0,926		

Poor management was tested by question B19, and the results show that both matching and mismatching companies are convinced that their supply chain is managed correctly in accordance with the specialities of the product and the market. No significant difference can be found between the company groups (Table 21, 22). Therefore, this reason *can be accepted as a reason for mismatch,* because management does not recognise the Fisherian product types. Consequently, they do not know what kind of supply chain their operation would fit into. **H2b sub-hypothesis was therefore, accepted**.

Table 21: ANOVA table on explanation of mismatching for question B19

ANOVA				
		Cluster mean	**F**	**Sig.**
The supply chain is managed correctly (B19)	Mismatch	3,87	0,025	0,876
	Match	3,91		

Table 22: Levene's F probe on explanation of mismatching for question B19

Levene's F probe						
		N	**Mean**	**St. dev.**	**F**	**Sig.**
The supply chain is managed correctly (B19)	Mismatch	23	3,87	0,869	0,047	0,830
	Match	22	3,91	0,811		

A *volatile market* refers to a market where customer expectations change dynamically and unpredictably, which also can be a reason for mismatch strategy. Scores given by respondents to this question, however, do not differ significantly in the two groups; as ANOVA and Levene's F-probe show (Appendix 12 and 13). Consequently, H2a sub-hypothesis has been rejected.

The next analysis concerned the mismatch reason of companies striving to achieve *higher performance* by combining the strength of the two supply chains. Matching and mismatching company groups were compared along six aspects. Neither ANOVA (Appendix 14), nor Levene's F-probe (Appendix 15), provided significant results about the difference. Therefore, the effort to achieve a higher performance by combining the supply chain strategies cannot be accepted as a reason for mismatch. H2 hypothesis was rejected.

When examining *product life cycle,* the companies with a matching product-supply chain combination have products, mainly in the stages of growth and maturity, while only one of the companies following mismatch strategy have a product in an introductory phase. Four of them have a product in growth, 18 of them in the maturity stage (Table 23). This result suggests that the mismatch reason as a functional product behaves as innovative in the introductory phase of the product life cycle therefore, the company operates a market-responsive supply chain for it, cannot be accepted. H2f hypothesis was rejected, too.

Table 23: Number of companies having their main products in different life cycle stages (pcs)

Matching/mismatching supply chains	Introductory phase	Growth phase	Maturity phase
Matching supply chains	0	5	17
Mismatching supply chains	1	4	18

Summing up the findings of the survey concerning the mismatch strategy, all the reasons provided by previous researchers were tested but only one of them has been accepted. Fisher's presumption, therefore, proved correct; that management cannot identify the product type. Consequently, they do not choose the right supply chain strategy (H2b hypothesis is correct). (H2 hypothesis and H2a, H2c, H2d, H2e, H2f sub-hypotheses were rejected.)

In the following part of the chapter, I examine the mismatch problem by using the results of the interviews, as well as I try to discover additional possible reasons.

VI.4.2 Analysing mismatch strategy by interviews

Interviews were carried out during August and September of 2010, and I targeted company managers from those industries which are traditionally well known for their supply chain management practice as well as represent a large share of the survey sample. The analysed companies also took place in the survey and followed mismatch strategy. I have interviewed two-two firms in each sector, and the selected industries are machine, food and other processing industry (manufacturing plastic products).

In the first part of the interview, I talked with the interviewees about their products and supply chain in order to let myself know about the product and market characteristics. To test the match-mismatch problem, I first informed interviewees about Fisher's theory in brief, and I asked them to assess its relevancy in real business circumstances. Possible mismatch reasons were evaluated by them in a short questionnaire. Each reason discovered in the literature was evaluated on a 7-point Likert-scale. The 7-point scale allowed me to gain a more detailed picture of their opinions. After the short questionnaire, I asked them to try to explain the mismatch of Fisher's product type and supply chain type with other reasons (see interview questions and short questionnaire in Appendix 16 and 17).

In general, in the six managers' opinion (Figure 24), the main reason for mismatch strategy is that companies aim to *use the strength of both supply chain types* as well as companies usually manage a wide product portfolio, including both functional and innovative products. Consequently, they *do not want to run different supply chain types* for each product. The third most important reason is that Hungarian companies are *not so developed* in supply chain management as to be able to differentiate their supply chains, even along product characteristics.

If we focus on the different industries separately – although there are only two-two firms in the sample – explanation of mismatch is a little bit different.

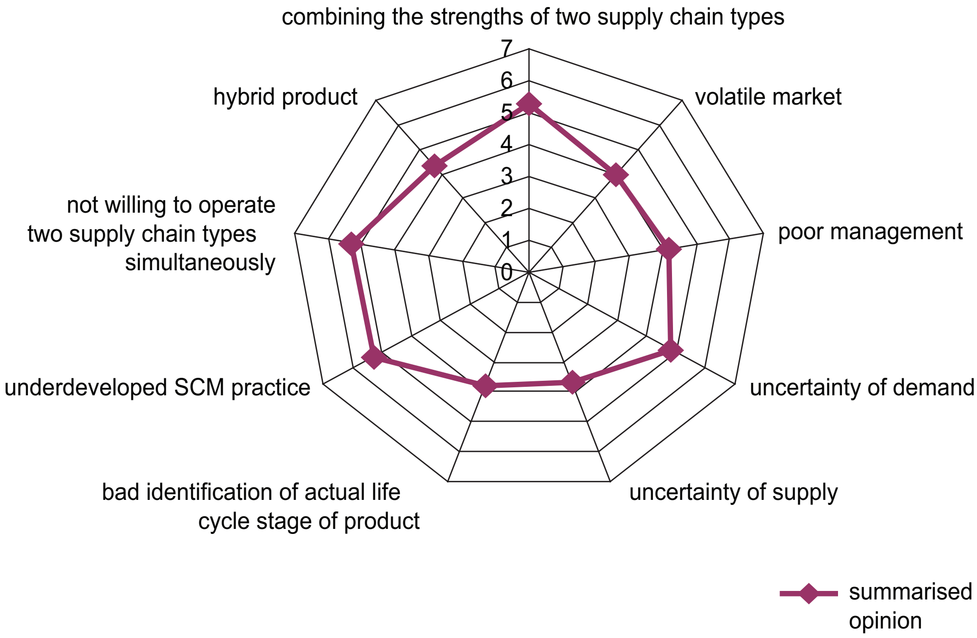

Figure 24: Summarised opinion of interviewees on the reasons of mismatching

Managers in the **machine industry** have a very diverse opinion about the main reason of mismatch strategy, but they almost completely agree with the reason of *volatile market* (Figure 25). In addition, the sales manager of Company B emphasised that they have to be able to serve diverse customer needs: some of them fight for each euro cent during a price negotiation, as well as there are customers who expect a high level of flexibility and independence in designing and manufacturing a completely new product while the question of price becomes less important. According to his experience, the wide customer portfolio including customers with diverse expectations, and complexity hinders companies to fit the correct supply chain type to the product type.

Machine industry companies highlighted two additional reasons of mismatch strategy: companies want to *exploit the strengths* of both supply chain types as well as firms are *not so developed* in supply chain management to be able to differentiate their supply chain operations along product characteristics. Both managers of Company B and C stated, that in their opinion, SME companies in Hungarian private ownership, *have not recognised* yet the importance of conscious management of logistics and supply chain processes and these functions fade out in the firm hierarchy as well as the *knowledge* of top management also *lacks* the know how to organise these processes effectively.

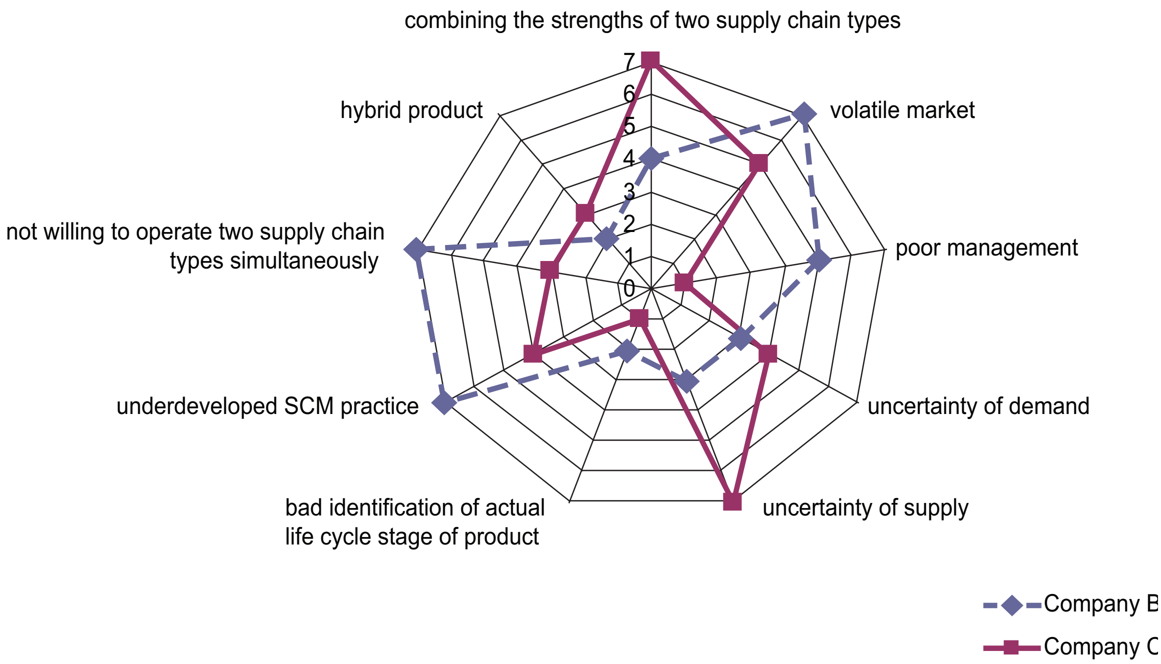

Figure 25: Opinion of machine industry companies about the reasons of mismatching

The opinion of **food industry** managers was also diverse regarding the main reasons of mismatch strategy (Figure 26). They found as a main reason that companies want to *exploit the strengths* of both supply chain types, and in food industry products sometimes not exclusively functional or innovative, but rather *hybrid*. Both managers of Company A and E emphasised that *customers* (particularly retail chains) have such a *strong bargain position* that their expectations substantially define the supply chain operations, and manufacturers have to take all possibilities to serve these customers as best as possible. Besides exploiting the strengths of both supply chain types, food industry managers also keep important the *uncertainty of demand*, the *underdevelopment of supply chain management practice* and that companies *do not want to operate different kinds of supply chains*.

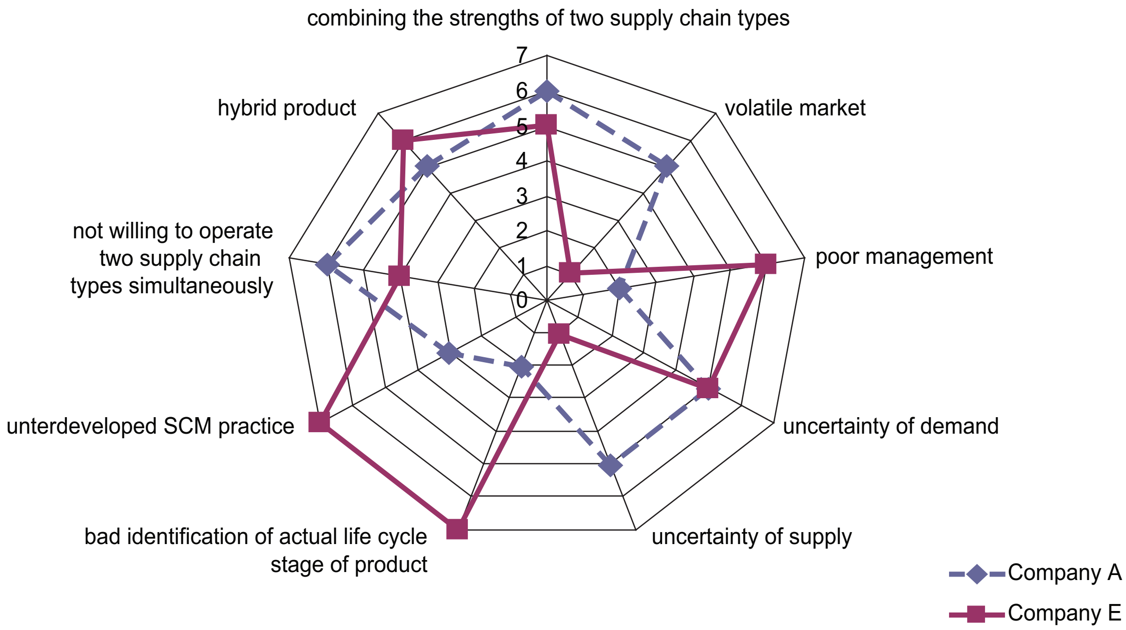

Figure 26: Opinion of food industry companies about the reasons of mismatching

In the opinion of other **processing industry** managers, the primary reason of mismatch strategy is the uncertainty of demand (Figure 27). An almost similarly important reason is that *companies do not want to operate different kinds of supply chains*, even if they have a diverse product portfolio. According to the interviewees, *poor management* can also be an important influencing factor, which cannot recognise the Fisherian product type, and consequently, is not able to find the correct supply chain type. In the opinion of Company F, logistics and supply chain are managed less consciously – as it should be supposed after the literature – companies have little knowledge about how to organise materials flow effectively.

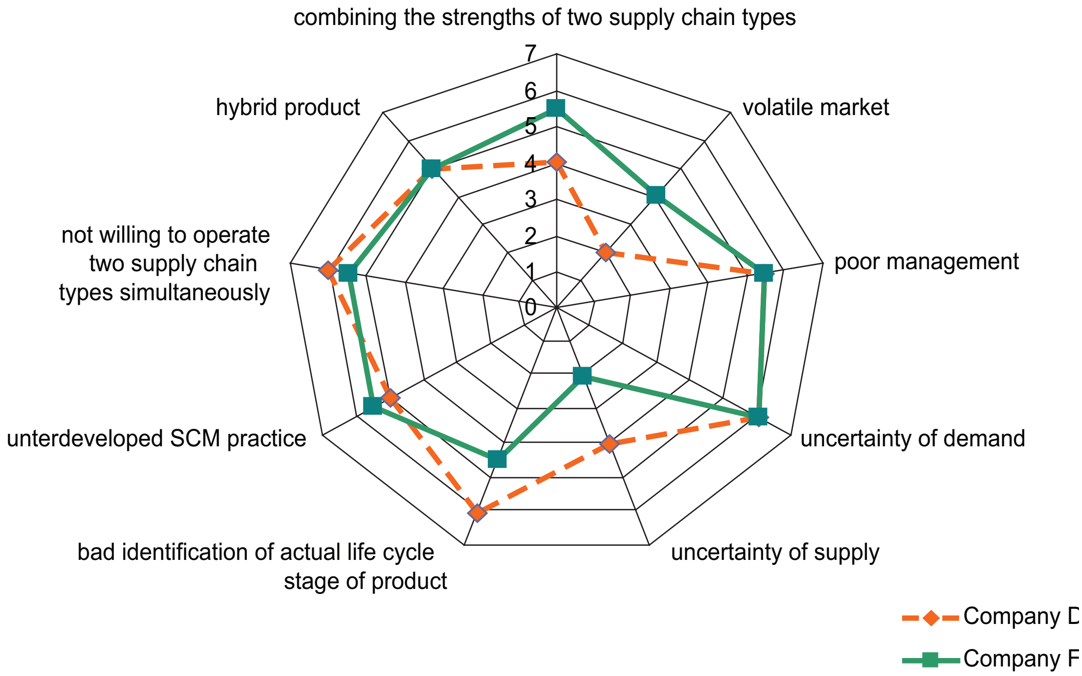

Figure 27: Opinion of other processing industry companies about the reasons of mismatching

When discovering **additional reasons** for explaining mismatch strategy I leaned on the opinions of the interviewees.

Every interviewee found Fisher's theory interesting as well as the distinction of the two product types valid with some exceptions, however. The logistics manager of Company C mentioned that not each product can be univocally categorised as functional or innovative in a company's product portfolio, while the regional logistics manager of Company D emphasised that in his opinion this product differentiation is valid only in B2C relationships, in the market of consumer goods. Interviewees agreed if characteristics of products differ, it is necessary for supply chains which deliver them to the market, to be different. However, they found that usually both Fisherian product types are available in a company's product portfolio; therefore, it is difficult to operate different kinds of supply chains.

When exploring new reasons for mismatch strategy, I asked interviewees to think not only about their own industry or market, but every response given reflected somehow the influence of the sector the managers worked in.

The manager of Company E mentioned as a reason of mismatch that the structure and the operations of a supply chain are defined by the means of reaching **the target market the most effectively**. In the food industry environment, his company operates with the aim that – even if it is a basic functional product or a complex innovative one – to distribute the product in as many sales channels as possible to make it available to consumers. The manager of Company A, which also manufactures food products emphasised that in their industry retail chains have the largest effect on defining the structure of the supply chain so manufacturers – in the case of any Fisherian type of products – have no possibility to match supply chain type with the product type.

The sales manager of Company B in the machine industry thought that the supply chain type has to match the customer's expectations; even if the product is functional the customer may expect responsiveness. In his interpretation, **customer expectations** determine the supply chain type.

The logistics manager of Company C in the machine industry as well proposed that the main reason for mismatch strategy in their industry is that companies are **"putting out fires"** all the time in this market and have no time to think about what kind of supply chain would fit to their product characteristics, rather they always try to match the actual expectations of the customer. My own explanation that is "*underdeveloped supply chain management practice*" was also completed by the interviewee who mentioned that the organisation of supply chains **lacked the long term view** and **concept.** Companies always try to solve the actual situation as well as **lack the intellectual capacity,** which could deal with the optimisation of the supply chain processes. Manager of Company D also had an opinion about the underdeveloped supply chain management practice, which is that the sector of **logistics service providers** is so fragmented and **underdeveloped** that the firms cannot service the diverse expectations of manufacturers in managing different supply chain types. Logistics service providers lack the infrastructural and intellectual capacity necessary to serve the physical efficiency or market-responsiveness.

The interviewee at Company D drew the attention to macro (market) effects too, which could influence that the type of product and supply chain does not match. In his opinion **activity of competitors** can also influence the structure of the supply chain, e.g. if competitors organise their supply chain more effectively with a different operational focus, which gains a competitive advantage, all companies on the market will try to imitate the system. Another macro effect could be if customer **demand moves towards more expensive goods** – which are not necessarily more innovative – which mean that the company will strive to be responsive to capture the customers generating high income. In the opinion of the interviewee, uncertainty of demand can be broken down to partial-reasons, e.g. companies in the consumer goods market have to be prepared to affect that which influences the demand, but there are also predictable such as **cyclical factors** like household tendencies to make their weekly purchase on Fridays and Saturdays. Consequently, on these days a higher demand is experienced which has to be calculated in while planning and forecasting. A demand distorting factor can be if **salesmen** of the manufacturer are **motivated the wrong way,** they generate huge sales and intense promotions just before a bonus payment period, not continuously and smoothly all along the planning period.

In the opinion of the logistics manager of Company F, even if it is a functional or innovative product, high SKU numbers cause a lot of problems for firms and the need to strive to rationalise it. Even in the case of functional products, it may happen that a large part of the product portfolio is changed within one or two years, which means that the newly launched functional products faced with unpredictable demand, and companies organise the supply chain operations on an ad-hoc basis.

Summing up the experiences of explaining mismatch strategy, there are many other reasons than those found in the literature. Table 24 summarises the reasons discovered through the interviews.

Based on the results of the survey findings, the main reasons of mismatch between Fisher's product types and supply chain types are poor management, and the effort of companies to achieve higher performance by combining the two supply chain types. Evaluation of the interviewees about the reasons – considering the different aspects of different sectors – was quite diverse, even within one industry. Their opinion and the new aspects and explanations provided by them were very useful to modulate mismatch strategy reasons and to test them later on.

Table 24: Reasons of mismatching based on interviews

Group of reasons	Reason for mismatching
Customer attributes	The targeted customer group determines the supply chain
	Customer expectations determine the supply chain
Underdeveloped supply chain management practice of Hungarian companies	"putting out fires"
	Lack of long term supply chain concept
	Lack of the intellectual capacity
	Underdeveloped logistics service providers
Macro effects	Activity of competitors
	Customer demand moves towards more expensive goods
Uncertainty of demand	Cyclical factors
	Wrong motivation of sales force
Need to rationalise SKU	Need to rationalise SKU

VI.5 Demand chain management practice of companies operating in Hungary

The supply chain management practice of companies operating in Hungary was captured by the management tools applied on the distribution side of the supply chain. I analysed the tools used, explored their spread, and tried to differentiate companies along the advanced or less advanced practice they show in demand chain management, as well as tried to point out the positive effect of the application of tools on supply chain performance.

First, let us look at the general spread of different demand chain management tools in the practice of Hungarian companies (Table 25). (The level of application was measured on 5-point Likert-scale where 1 meant not applied at all, 5 meant applied at an advanced level.)

Based on the table, it can be seen that the level of application of different tools distributes between a weak (1.61) and a strong medium (3.86) but the variance is very high, which means that the responses are distributed in a wide range. I concluded that there are many companies in the sample which pointed to high values on the Likert-scale, as well as many which pointed to low values. These two groups of companies, which apply demand chain management tool at different level – if they exist – can be separated by cluster analysis.

Table 25: Spread of demand chain management tools among companies operated in Hungary

	N	Mean	St. dev.
EDI (B18a)	73	3,84	1,258
sharing of POS data (B18b)	69	2,39	1,274
sharing of inventory data (B18c)	73	3,05	1,201
sharing capacity information (B18d)	73	2,70	1,288
CAO (B18e)	73	3,63	1,399
common planning (B18f)	73	2,73	1,294
common forecasting (B18g)	73	2,88	1,258
barcode (B18h)	73	3,56	1,527
RFID (B18i)	72	1,61	1,170
VMI (B18j)	72	2,21	1,233
CRP (B18k)	70	2,34	1,361
cross-docking (B18l)	72	2,18	1,293
supplier assessment (B18m)	73	3,86	1,205
customer assessment (B18n)	73	3,66	1,261
ABC (B18o)	69	2,88	1,399
manufacturing postponement (B18p)	67	2,09	1,111
logistics postponement (B18q)	71	2,14	1,004
modular production (B18r)	64	2,42	1,295
modular product design (B18s)	64	2,45	1,296

I have already dealt with demand chain management tools in chapter VI.3, where I have realised that some of the tools (variables) have to be excluded because of the bad effect on consistency or have too high correlation. Because of this the 19 tools represented by question B18 were narrowed down to 13 tools.

The first step was to carry out cluster analyses to these 13 variables to separate companies which apply demand chain management tools at an advanced level, and another group, which applies them at a low level. In order to see what number of clusters the SPSS software suggests, I first ran a hierarchical cluster analysis, second – as a control – a non-hierarchical cluster analysis (K-mean), although Sajtos and Mitev (2005. p. 298) point out that K-mean cluster analysis can be applied only on a large sample.

Hierarchical cluster analysis methods (between-groups linkage and Ward's method) suggested formulating two clusters, which was controlled by a non-hierarchical, K-mean cluster analysis as well. I then analysed the overlap of the clusters gained by the three methods.

The between-groups linkage method produced two clusters with a population of 27 and 33 cases, while clusters by Ward's method contain 30–30 cases and clusters of non-hierarchical K-mean method produced clusters with 31–29 elements. After analysing the overlap of the cluster I kept only those cases which are found in the same cluster by all the three methods. This way I gained two clusters along demand chain management tools which represent different development stages and which have 26–26 elements.

The next step was to describe the characteristics found in the two clusters. What types of demand chain management tools are applied by them, and on what development level? To compare the clusters, I used ANOVA mean comparison. On a 95% significance level, except the share of inventory data and cross-docking application, level of all the other tools was significantly different, while on a 90% significance level the difference was significant in the case of all tools except cross-docking (Figure 28).

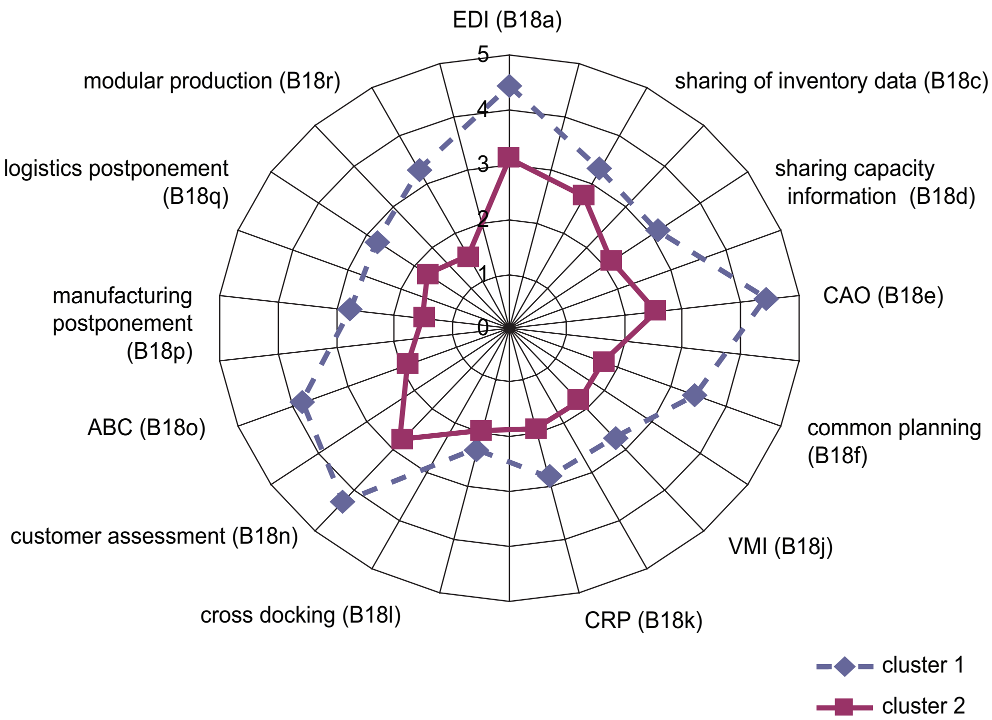

Figure 28: Comparison of clusters based on the degree of the usage of demand chain management tools

When comparing the two clusters (Appendix 18), the difference is significant in the case of almost all the demand chain management tools (Table 26). Therefore, I could separate a group of companies in the sample which uses the demand chain management tools at an advanced level and another cluster in which the demand chain management practice is much less developed. In the following, I call the first group the **Cluster of companies with advanced demand chain management tools** and the second group, the **Cluster of companies with underdeveloped demand chain management tools.**

Table 26: Comparison of clusters' usage of demand chain management tools by ANOVA table

ANOVA				
		Mean of clusters	**F**	**Sig.**
EDI (B18a)	Underdeveloped cluster	3,12	20,210	0,000
	Developed cluster	4,42		
sharing capacity information (B18d)	Underdeveloped cluster	2,15	8,833	0,005
	Developed cluster	3,12		
CAO (B18e)	Underdeveloped cluster	2,54	37,966	0,000
	Developed cluster	4,42		
common planning (B18f)	Underdeveloped cluster	1,77	32,143	0,000
	Developed cluster	3,38		
VMI (B18j)	Underdeveloped cluster	1,81	7,106	0,010
	Developed cluster	2,69		
CRP (B18k)	Underdeveloped cluster	1,92	5,923	0,019
	Developed cluster	2,81		
customer assessment (B18n)	Underdeveloped cluster	2,73	26,420	0,000
	Developed cluster	4,27		
ABC (B18o)	Underdeveloped cluster	1,85	55,059	0,000
	Developed cluster	3,81		
manufacturing postponement (B18p)	Underdeveloped cluster	1,46	28,445	0,000
	Developed cluster	2,77		
logistics postponement (B18q)	Underdeveloped cluster	1,69	18,774	0,000
	Developed cluster	2,77		
modular production (B18r)	Underdeveloped cluster	1,46	51,087	0,000
	Developed cluster	3,27		

VI.5.1 Comparing clusters created along demand chain management tools

In this chapter, I compare the two clusters created in the previous section along with the demand chain management tools they use on different development levels. **Cluster of companies with advanced demand chain management tools** consists of mainly large companies (65.4%), which the majority of them have international ownership (65.4%), and operating mainly in machine (23.1%), and other processing industries (19.2%). But also a large share of them is from light and chemical industry (15.4-15.4%). Regarding their role played in the supply chain the majority of them are focal companies (57.7%), and first-tier suppliers (23.1%).

While managing the demand chain in **information flow,** they apply EDI and computer-aided ordering at an advanced level (means: 4.42 on a 5-point Likert scale), to coordinate the information between supply chain partners. However, the share of inventory and capacity data, as well as common planning, is only carried out at a medium-developed level (means in order: 3.31, 3.12, and 3.38). In chapter II.2, I presented the logic and connection of the three demand chain management toolsets that are tools supporting information flow, materials flow and tools for managing costs and performance (Figure 3). This link was verified in chapter VI.3, by factor analysis, which supported also that the level of managing information flow in demand chains substantially influences the development level of tools managing the materials flow and those used in managing costs and performances. In the Cluster analysed, we can see that information sharing goes quite well, but primarily concerns the sales and order data while the information necessary for a strategic cooperation and medium-long term planning is shared at a middling level. Regarding the tools, **managing materials flow** in demand chain cross-docking cannot be analysed because the two clusters do not show a significant difference ($p<0.1$). VMI and continuous replenishment, however, are applied at a weak-medium level (means in order: 2.69, 2.81) in the developed cluster. The tools supporting the responsiveness of the materials flow (postponement of manufacturing and logistics) are applied at a weak-medium level (means: 2.77, 2.77), however, modular production is more spread amongst the analysed companies (mean: 3.27).

In the category of tools **managing costs and performance** only, customer assessment and activity-based costing were significantly different in the two clusters.

Results show that customer assessment is a very widespread tool (4.27) and ABC is also applied at a good level (3.81). In the analysed cluster, we can see that the intense information sharing primarily supports cost and performance management, they both are quite developed, while balancing the materials flow by using the shared information is only a secondary purpose.

Summing up the experiences of Cluster of companies with advanced demand chain management tools, it can be stated that the extent and level of information sharing allow effective medium and long term cooperation, and the continuous monitoring of its results and controlling costs make it possible to adapt tools – which sometimes represent complex transaction-specific investments – to smooth materials flow in the demand chain.

Overviewing the findings of Cluster of companies with advanced demand chain management tools, we can see that companies operating in Hungary are medium-developed in adapting demand chain management tools, they primarily lay emphasis on information sharing, on which a medium-developed cost and performance assessment toolset is built, but the adaptation of tools supporting smoothing materials flow is only at a weak-medium level.

The **Cluster of companies with underdeveloped demand chain management tools** consists of mainly large companies (56%), half of them are in the Hungarian private sector, and the other half has international ownership. Companies primarily operate in machine (26.9%), food (23.1%) and chemical (19.2%) industries. Their role played in the supply chain is mainly focal company (46.2%), first-tier supplier and wholesaler (19.2–19.2%).

The spread of demand chain management tools is very poor in each tool-category. In **information sharing** companies use of EDI is at a medium level (3.12), but sharing inventory data and the adaption of computer-aided ordering are at a weak-medium level only (means: 2.73, 2.54). The spread of sharing capacity information and common planning is very low amongst the companies analysed in this cluster (means: 2.15, 1.77).

Each tool for **managing materials flow** is applied at a very low level. The spread of VMI and continuous replenishment is as low (means: 1.81, 1.92) as the application of manufacturing and logistics postponement and modular production (means: 1.46, 1.69, and 1.46) allowing responsiveness.

Adaptation of **cost and performance assessment tools** is a little bit higher than tools of materials flow, customer assessment tools reach the weak-medium level (mean: 2.73), but the spread of Activity-based costing is lower (mean: 1.85).

In the Cluster of companies with underdeveloped demand chain management tools, we also experience that the largest – but still low – emphasis is laid on information management tools, which support cost and performance assessment tools adapted at a lower level, but companies have not invested too much effort in tools to smooth the materials flow yet.

I also compared the clusters along supply chain performance dimensions with ANOVA table (Table 27). Results show that in the dimensions of **price, operational costs and responsiveness to customer needs** two clusters differ significantly (see whole table in Appendix 19). The Cluster of companies with advanced demand chain management tools performs significantly better in these dimensions than the Cluster of companies with underdeveloped demand chain management tools.

Table 27: Comparison of supply chain performance of two clusters

		Mean of clusters	**F**	**Sig.**
supply chain performance: price (B21a)	Underdeveloped cluster	3,38	13,160	0,001
	Developed cluster	4,04		
supply chain performance: operational cost (B21b)	Underdeveloped cluster	3,00	19,084	0,000
	Developed cluster	3,88		
supply chain performance: responsiveness to changing customer needs (B21f)	Underdeveloped cluster	3,35	13,508	0,001
	Developed cluster	4,27		

However, the Cluster of companies with advanced demand chain management tools is still under development, but the promising effect of the application of demand chain management tools on supply chain performance has already been showing (Figure 29).

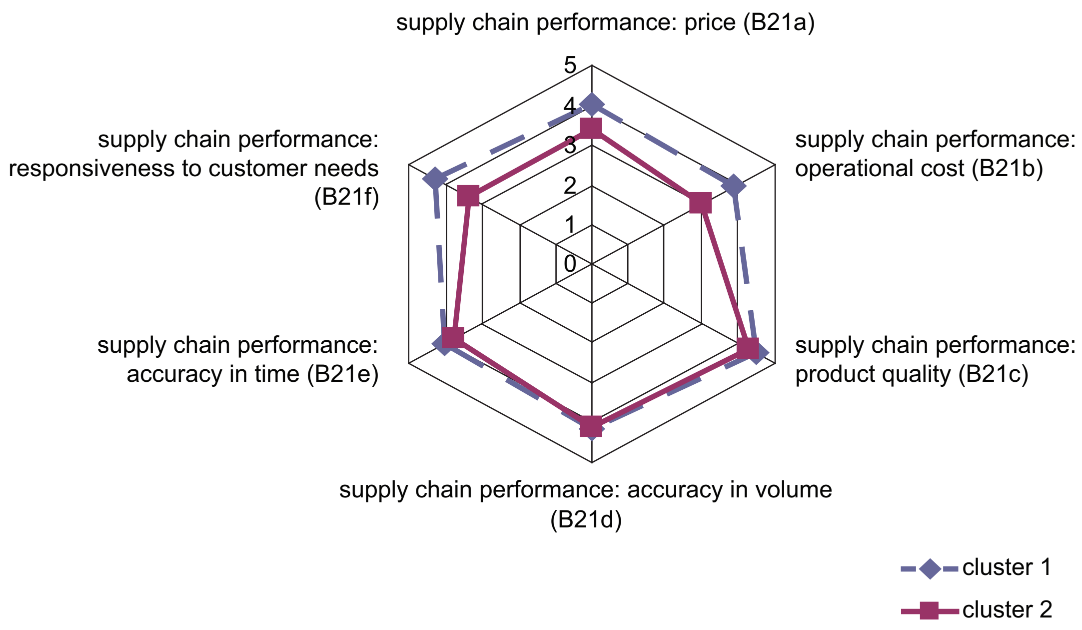

Figure 29: Performance dimension of clusters

VI.5.2 Demand chain management practice of the three largest industries in the sample

In this chapter I analyse the demand chain management practice of three industries representing the largest parts of the sample. The majority of the sample came from the machine (26%), food (21%) and other processing (19%) industries. Deep analysis is important because – according to the literature – in these industries a huge emphasis is laid on the conscious supply chain management.

In the **machine industry** EDI as an **information management tool** is adapted very intensely (mean 4.16), the spread of sharing inventory and capacity data as well as computer-aided ordering are at a middling level (means: 3.16, 3.32, and 3.58). However, common planning is used at a weak-medium level (2.79) by the companies. Each of the **tools supporting materials management** is adapted at a weak-medium level. Spread of VMI, continuous replenishment and modular production (means: 2.47, 2.76, and 2.58) is a little bit higher than that of manufacturing and logistics postponement supporting responsiveness of the supply chain (means: 2.11, 1.95), which, however, would also be useful in machine (particularly in automotive) industry. Regarding the **cost and performance assessment** tools, the spread of customer evaluation is at a medium level, but the adaption of activity-based costing is only at a weak-medium level (2.33) (Figure 30).

In the case of the machine industry, the spread of demand chain management tools is very similar to that in Cluster of companies with advanced demand chain management tools. Information sharing is carried out at a high level and includes the order and sales data as well as inventory and capacity information; however, the medium-long term view is missing because of the weak-medium level of common planning. In the machine industry, it is also correct that on the basis of the information sharing cost and performance assessment that it is built up first, and the spread of tools to smooth materials flow does not reach the average level of Cluster of advanced demand chain management tools. From the three analysed sectors, the machine industry is the closest to the level of Cluster of companies with advanced demand chain management tools, but never exceeds it.

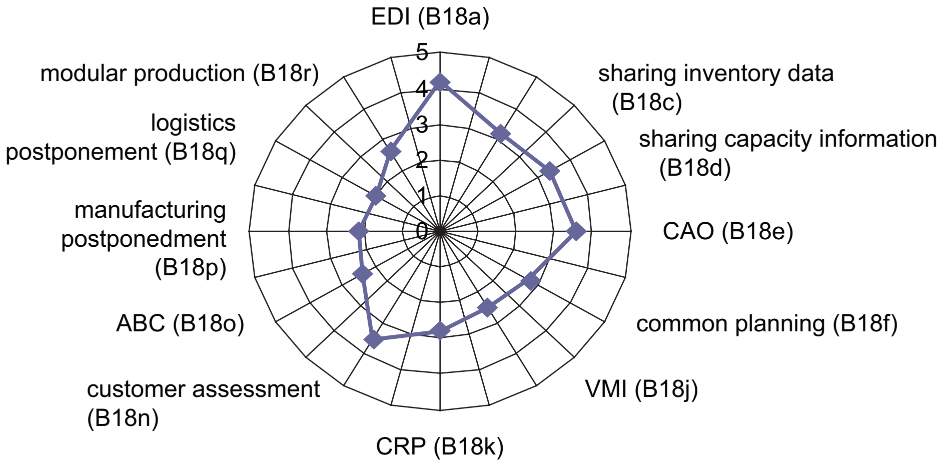

Figure 30: Demand chain management tools in machine industry

In the **food industry,** EDI and CAO as demand chain management **tools supporting information management** are adapted at a medium level (means: 3.21, 3.36). It is assumed that through these channels mainly order – and with less intensity – inventory data (mean: 2.93) are shared because both capacity data sharing and common planning are at a very low level (means: 1.86, 2.00). The spread of **materials flow management tools** is very low as well (VMI: 1.71, CRP: 1.50). Manufacturing and logistics postponement and modular production, which would support responsiveness, are applied at a low level (means: 1.92, 1.79, and 1.83), too.

Adaption level of **cost and performance assessment tools** – based on the medium level information sharing – is carried out at a medium level, too, in the case of both customer evaluations (3.36) and activity-based costing (3.43) (Figure 31).

From the three analysed sectors, the food industry is the less developed from a demand chain management aspect. Information sharing is rather transaction-oriented and reflects a short-term view, which somehow results from the fragmented structure of the industry and the dominant market strategy of the large retailer chains. Regarding the level of information sharing, the food industry exceeds the level of Cluster of companies with underdeveloped demand chain management tools, but is far away from the developed cluster. The tendency of how demand chain management tools are built on each other can be studied in the food industry practice; while cost and performance assessment is adapted at a medium level, as well as information sharing, but to invest in materials flow management tools, there is no resource – or effort. From a materials flow management tools aspect, the food industry is very similar to Cluster of companies with underdeveloped demand chain management tools.

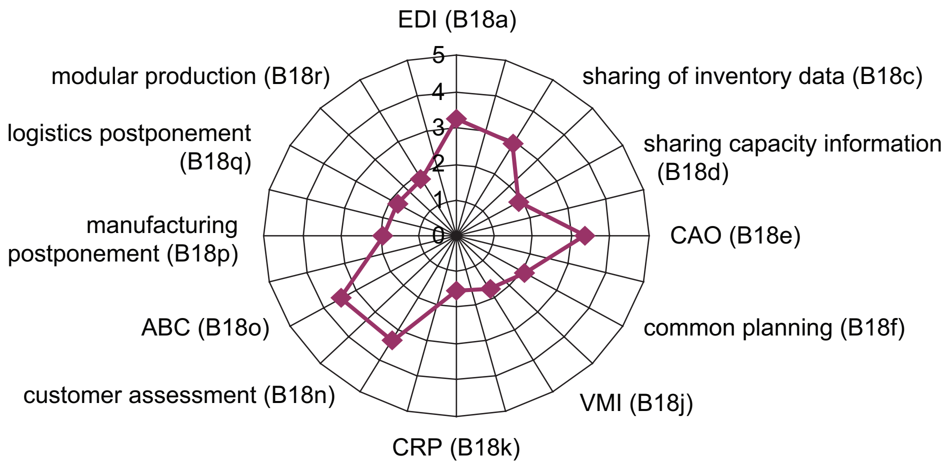

Figure 31: Demand chain management tools in food industry

In **other processing industry** companies, the use of EDI as **information flow management tools** is intense (4.07) and at a strong-medium level CAO (3.79), too. Through these communication channels besides order information, inventory data are also shared (3.00), but the sharing of capacity information is weak (2.86) and common planning is even less spread (2.36). Regarding the **materials flow management tools,** only modular production is spread at a weak-medium level (2.55), but all the other tools such as VMI, CRP, manufacturing and logistics postponement are adapted at a low level (means in order: 1.92, 2.08, 2.27, and 2.41). From **cost and performance assessment tools,** customer evaluation is built on information sharing the most (4.29), but activity-based costing is spread only at weak-medium level (2.83) (Figure 32).

From the three analysed sectors, the other processing industry is the *golden mean*. In this case, we also find intense information sharing just like in Cluster of companies with advanced demand chain management tools, but supply chain participants lack medium-long term commitment, and common planning is carried out only at a low level. Based on the effective sharing of information, a quite good cost and performance assessment toolkit is operated, but the application of a sophisticated method is less spread. This sector also suffers a lag in application of materials flow management tools. It exceeds the level of Cluster of companies with underdeveloped demand chain management tools, but is far away from the level of Cluster of companies with advanced demand chain management tools.

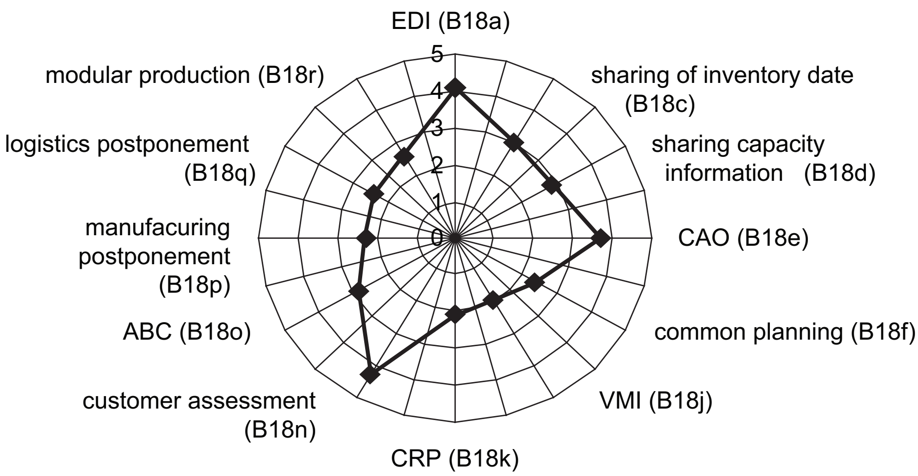

Figure 32: Demand chain management tools in other processing industry

Summing up the conclusions of the three analysed industries, we can see that their level of information sharing is developed, and based on this, a more or less sophisticated cost and performance assessment toolkit is built up, but the spread of materials flow management tools is poor, only in case of the machine industry can it be regarded as a medium developed.

VII. SUMMARY AND CONCLUSIONS

As I mentioned before, in my doctoral dissertation, I had four goals. The *first* was to **test a theory** which is widely known in supply chain literature, however, **never has been verified** completely. Fisher's model says that there were two basic types of products on the market (functional and innovative), which behave in a different way (e.g. predictability of demand), and require a supply chain with a different operational focus. My aim was to test this match between product types and supply chain types on a Hungarian sample, and whether it really exists. *Second*, to **complete the theory** with the case that **supply chain types can be distinguished along distribution side supply chain management tools** as well, besides Fisher's characteristics.

Third, I intended to **find a rationale** to the phenomenon **when the product type and the supply chain type do not match** – which also was experienced by earlier researchers – but nobody has examined the question systematically.

My *fourth* goal was to give a general – but not representative – **overview about how companies operating their supply chain in Hungary**; what tools they use on the distribution side, and how developed they are.

Findings of my doctoral research are summarised as follows:

- Fisher's theory about matching product types and supply chain types **cannot be verified**, because almost the same numbers of companies show matching (22) as mismatching behaviours (23).
- Fisher's supply chain types **cannot be differentiated along the demand chain management tools**. However, several sub-hypotheses were supported, which said that the application of some demand chain management tools (EDI, customer assessment) had not been dependent on a supply chain type because they had been inevitable in each supply chain.
- Mismatch between Fisher's product and supply chain types was tested by the survey and through interviews as well.

  According to the results of the **quantitative** analysis, the main reason of mismatch is the **poor management which cannot identify the product type, or consequently, how it would be the most efficient to operate the supply chain**.

In the **qualitative** phase, the six company experts found that the main reasons of mismatch are that companies are **trying to achieve the best performance by combining the strengths of both supply chain types**, and **companies are not willing to operate different supply chain types at the same time** to support their heterogenic product portfolio, and the **supply chain management practice of Hungarian firms is not so developed,** consequently, they cannot fit the supply chain to the product characteristics. Interviewees have discovered several additional reasons for mismatch as well, which was indicated by their own experiences or industry specifications. These reasons were summarised in the dissertation as *customer characteristics and SKU rationalisation*. My own explanation is that *Hungarian companies are not developed enough* to match product and supply chain types was supported by them. A reason derived from the literature – *demand uncertainty* – was also refined, modulated.

- In the fourth part of the analysis, I explored the demand chain management practice of Hungarian firms. According to the spread of demand chain management tools I differentiated two clusters. The first cluster is called **Companies with Developed demand chain management practice;** the second is called **Companies with Underdeveloped demand chain management practice**.
- I analysed the demand chain management practices along the triple structure of demand chain management tools: information management tools, materials flow management tools and cost and performance assessment tools. In a **Developed company cluster,** I have found that the most developed is the information sharing practice. On this basis, a mid-developed cost and performance assessment toolset is operated, but materials flow management tools are at a weak middling level. **Underdeveloped company cluster** operates a weak middling level of information sharing methodology, and all the other toolsets are at an embryonic stage.

I could make a **distinction** between the clusters **along supply chain performance** as well. Companies of a Developed company cluster have performed significantly better in dimensions of price, operation costs and responsiveness to customer expectations than Underdeveloped company cluster.

The demand chain management practice has been analysed in the case of the three largest industries represented in the sample. The **machine industry** companies adopt information management and cost and performance assessment tools at a medium level; however, they apply materials management tools at a weak middling stage. This industry is the closest to the previously identified Developed company cluster. The application of information sharing and cost and performance assessment tools among the **food industry** companies are at a weak middling level, but the adaptation of any materials management tools is very poor. In the case of information and cost and performance management tools the sector exceeds the level of Underdeveloped company cluster but when regarding the materials management tools it represents a similar stage. In **other processing industry,** companies apply the simple cost and performance assessment tools (customer assessment) at a better stage than the other two sectors. Information management tools are at a medium level, but materials management tools are adapted only at a weak middling level. Consequently, other processing industry far exceeds the level of the Underdeveloped company cluster, but lags behind the level of both machine industry and Developed company cluster.

Summing up the results of the dissertation, we can see that although Fisher's theory is a logical explanation of why supply chains differ from each other, in real company practice the model does not appear so clearly, and it is also not true that firms that match the supply chain type with the product type are more effective. I was not able to complete the model by pointing out that supply chains also differ in the demand chain management tools applied based on the different operational focuses the supply chains have in servicing the end consumer.

Analysing the spread of demand chain management tools was edifying. I have found that the Hungarian company practice is still under development in such industries, contrary to international academic literature, which has reported for years that they have very sophisticated supply chain management methods.

The main **theoretical contribution** of the dissertation is that I made a new attempt to test Fisher's model, but I was not satisfied by the result as the model cannot be verified. I then continued the research, and with various research methods, I tried to find the reason for a large number of mismatching strategies. I have found certain circumstances, which move companies towards applying mismatch strategy consciously, and their operations can be still regarded effective. To find the reasons, I used a double methodology (quantitative and qualitative), and I succeeded in completing the work of many other researchers that also tested the Fisher-model and failed to confirm that. I examined the explanations provided by them, and by using the sample, I managed to find the most likely explanation, as well as I have found new explanations based on the interviews conducted with active company managers.

I also find that a great achievement of the dissertation is that I managed to verify the internal structure of demand chain management tools. Based on different researchers, I composed the model which can be seen in Figure 3, which highlights that demand chain management tools can be categorised as tools supporting the information flow, tools supporting materials flow and tools of cost and performance assessment. The demand chain management toolset of a company can be a combination of the tools in these categories, which help the firm coordinating the processes on the distribution side of the supply chain. Survey results support the existence of the tool categories and the links between them.

A **managerial application** of the research findings is also available. On one hand, the dissertation drew the attention to a theoretical model, which is well-known in international literature, but whose logic is less known among Hungarian company managers that could find the differentiation of product along demand characteristics, as well as differentiation of supply chains along operational focuses, interesting. The most important finding of the dissertation for managers is that I revealed the current company practice in demand chain management and pointed out the imperfections and showed the way for evolution. Results could draw companies' attention to the importance of conscious supply chain management and to the toolset which is available for improving their distribution operations. To publish the message of the dissertation is even more important, because the application of the demand chain management tools leads to significantly *higher customer service performance*. When looking at the current development stage of the Hungarian companies improved performance achieved by applying different demand chain management tools, it can be a source of a *competitive advantage*.

Based on the research findings, future researches can be formulated. First, the recently discovered explanations to Fisher's product and supply chain type mismatch reflect only the opinions of interviewees; consequently, it cannot be generalised. The new reasons for mismatch can be tested by further interviews in different industries, or can be verified by quantitative methods.

A longitudinal study of demand chain management practices of Hungarian firms could be an additional future research topic. Present analysis discovered that regarding the triple structure of demand chain management tools companies are quite developed in the application of information management tools, but the other two pillars, cost and performance assessment and materials management are at a lower level of evolution. Several years later it would make sense to repeat the survey to discover the changes that have happened with the penetration and development of demand chain management tools.

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APPENDICES

Appendix 1.

Survey questionnaire

Section 1

General descriptive questions

Please provide general data about the company! Approximate values are acceptable, too.

Question 1

[A1] Average number of employees in 2009:

☐ *employees*

Question 2

[A2] Net revenue of the company in 2009:

☐ *million HUF*

Question 3

[A3] Ownership structure of the company:

- ☐ *1. [A3a] majority of Hungarian private ownership*
- ☐ *2. [A3b] majority of international ownership*
- ☐ *3. [A3c] majority of Hungarian state ownership*

Question 4

[A4] Industry in which the company ('s main business unit) operates:

- ☐ *1. [a4a] agriculture*
- ☐ *2. [a4b] extractive industry and energetics*
- ☐ *3. [a4c] food industry*
- ☐ *4. [a4d] light industry*
- ☐ *5. [a4e] chemical industry*
- ☐ *6. [a4f] machine industry*
- ☐ *7. [a4g] other processing industry*
- ☐ *8. [a4h] construction industry*
- ☐ *9. [a4i] services*

Question 5

[A5] Role of company in the supply chain:

- ☐ *1. [a5a] logistics service provider*
- ☐ *2. [a5b] retailer*
- ☐ *3. [a5c] wholesaler*
- ☐ *4. [a5d] focal company (dominant manufacturing company in the supply chain)*
- ☐ *5. [a5e] first-tier supplier of the focal company*
- ☐ *6. [a5f] second-tier supplier of the focal company*
- ☐ *7. [a5g] third-tier supplier of the focal company*

Section 2

The company and the supply chain

When filling this section please focus on the main product/product line of the company!

Question 1

[B1] Frequency of forecast errors in the demand forecast of the main product/product line:

1=very rare, 5=very frequent

☐ *1* ☐ *2* ☐ *3* ☐ *4* ☐ *5*

Question 2

[B2] Frequency of late delivery because of stock out in case of the main product/product line:

1=very rare, 5=very frequent

☐ *1* ☐ *2* ☐ *3* ☐ *4* ☐ *5*

Question 3

[B3] Length of the product life cycle (the length of time the product is available on the market):

1= very short, 5= very long

☐ *1* ☐ *2* ☐ *3* ☐ *4* ☐ *5*

Question 4

[B4] If the product is not available on stock how long does it take to produce it from purchasing raw materials until delivery?

1=very short, 5=very long

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 5

[B5] Number of product variations (SKU) of the main product:

1=very few, 5= vast

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 6

[B6] Average profitability of the industry the company ('s main business unit) operates in:

1= very low, 5= very high

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 7

[B7] Does the company apply end-of-season markdowns to dispose stock?

☐ 1. *[B7a] yes*

☐ 2. *[B7b] no*

Question 8

[B77] If previous answer was „yes" then how large is the volume of the end-of-season markdown in comparison with the total sales?

1= very low, 5= very high

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 9

[B8] How important is to reduce operational costs as much as possible when operating the supply chain?

1-low priority, 5= high priority

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 10

[B9] How typical in your company practice is to achieve high inventory turnover?

1= not at all, 5= very typical

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 11

[B10] If your main product (line) is modular product (if not please continue with Question 13) how important is in inventory management to reduce the stock of final products in the supply chain?

1= not at all, 5= very important

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 12

[B11] If your main product (line) is modular product how important is in inventory management to reduce the stock of semi-finished products in the supply chain?

1= not at all, 5= very important

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 13

[B12] If your main product (line) is not modular how important is in inventory management to reduce the stock of final products in the supply chain?

1= not at all, 5= very important

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 14

[B13] How typical is in your supply chain to build large safety stock (even of different modules)?

1= not at all, 5= very typical

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 15

[B14] How typical is in your company practice when operating the supply chain to use out the capacities at most?

1= not at all, 5= very typical

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 16

[B15] How typical is in your supply chain to build buffer capacity?

1= not at all, 5= very typical

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 17

[B16] How important is in your supply chain to react quickly to the changes of the unpredictable demand?

1= not at all, 5= very important

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 18

[B17] How important is in your supply chain to radically reduce the lead time?

1= not at all, 5= very important

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 19

[B18] Do you apply the following solutions in your supply chain management?

1= not at all, 5= very typical

1. *[b18a] electronic data interchange (EDI)*	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
2. *[b18b] sharing of POS data*	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
3. *[b18c] sharing of inventory data*	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
4. *[b18d] sharing capacity information*	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
5. *[b18e] computer-aided ordering (automatic)*	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
6. *[b18f] common planning*	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
7. *[b18g] common forecasting*	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
8. *[b18h] barcode*	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

9. [b18i] radio frequency identification ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
10. [b18j] vendor-managed inventory ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
11. [b18k] continuous replenishment (automatic) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
12. [b18l] cross-docking ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
13. [b18m] supplier assessment ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
14. [b18n] customer assessment ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
15. [b18o] activity-based costing ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
16. [b18p] manufacturing postponement (modular product) ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
17. [b18q] logistics postponement ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
18. [b18r] modular production ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
19. [b18s] modular product design ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 20

[B19] Do you agree with the statement: the supply chain of your company is managed correctly considering the specialities of the product and market?

1= highly disagree, 5= highly agree

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 21

[B20] Do you agree with the statement: the market of your main product (line) is very volatile?

1= highly disagree, 5= highly agree

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 22

[B21] How good is the performance of your supply chain in these aspects?

1=very poor, 5= excellent

1. [b21a] price ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
2. [b21b] operational costs ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
3. [b21c] product quality ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
4. [b21d] accuracy in volume delivered ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
5. [b21e] accuracy of delivery time ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5
6. [b21f] responsiveness to customer needs ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5

Question 23

[B22] In your opinion in which life cycle stage the company's main product is actually in?

- *1. [B22a] introductory phase*
- *2. [b22b] growth phase*
- *3. [b22c] maturity phase*

Question 24

[C1] If you are interested in the findings of the research please provide your name and e-mail address and the study will be sent to you!

1. [C1a] Name

2. [C1b] E-mail

Appendix 2

Correlation matrix of product characteristics

Correlations

		forecast errors	late delivery - stockout	length of product life cycle	length of lead time	product variations (SKU)	profitability	level of end-of-season markdown
forecast errors	Pearson Correlation	1	,424**	,004	,177	,229	-,051	,134
	Sig. (2-tailed)		,000	,974	,134	,051	,675	,496
	N	73	72	71	73	73	71	28
late delivery - stockout	Pearson Correlation	,424**	1	,213	,386**	,237*	-,162	,232
	Sig. (2-tailed)	,000		,077	,001	,045	,179	,244
	N	72	72	70	72	72	70	27
length of product life cycle	Pearson Correlation	,004	,213	1	,489**	-,032	-,024	,156
	Sig. (2-tailed)	,974	,077		,000	,794	,847	,428
	N	71	70	71	71	71	69	28
length of lead time	Pearson Correlation	,177	,386**	,489**	1	,087	,062	-,133
	Sig. (2-tailed)	,134	,001	,000		,463	,608	,501
	N	73	72	71	73	73	71	28
product variations (SKU)	Pearson Correlation	,229	,237*	-,032	,087	1	-,065	,381*
	Sig. (2-tailed)	,051	,045	,794	,463		,588	,045
	N	73	72	71	73	73	71	28
profitability	Pearson Correlation	-,051	-,162	-,024	,062	-,065	1	-,201
	Sig. (2-tailed)	,675	,179	,847	,608	,588		,315
	N	71	70	69	71	71	71	27
level of end-of-season markdown	Pearson Correlation	,134	,232	,156	-,133	,381*	-,201	1
	Sig. (2-tailed)	,496	,244	,428	,501	,045	,315	
	N	28	27	28	28	28	27	28

Appendix 3

ANOVA table for comparison of two clusters by Fisher's product attributes

Variables		Cluster mean	F	Sig.
forecast error frequency (B1)	innovative	3,54	1,833	0,182
	functional	3,19		
frequency of late delivery - stock-out (B2)	innovative	2,23	0,433	0,514
	functional	2,04		
length of product life cycle (B3)	innovative	1,88	109,192	0,00
	functional	4,04		
lead time from manufacturing to delivery (B4)	innovative	2,23	35,337	0,00
	functional	3,85		
product variety (SKUs) (B5)	innovative	4,08	4,21	0,045
	functional	3,38		
profitability of the product (B6)	innovative	2,96	0	1
	functional	2,96		
level of end-of-season markdowns (if there is any) (B77)	innovative	2,00	0,447	0,511
	functional	1,71		

Appendix 4

Levene's F probe for comparison of two clusters by Fisher's product attributes

Levene's F probe					
	Clusters	**N**	**Mean**	**F**	**Sig.**
forecast error frequency (B1)	innovative	26	3,54	0,004	0,948
	functional	26	3,19		
frequency of late delivery - stock-out (B2)	innovative	26	2,23	0,001	0,973
	functional	26	2,04		
length of product life cycle (B3)	innovative	26	1,88	0,135	0,715
	functional	26	4,04		
lead time from manufacturing to delivery (B4)	innovative	26	2,23	7,334	0,009
	functional	26	3,85		
product variety (SKUs) (B5)	innovative	26	4,08	15,359	0,000
	functional	26	3,38		
profitability of the product (B6)	innovative	25	2,96	0,482	0,491
	functional	25	2,96		
level of end-of-season markdowns (if there is any) (B77)	innovative	15	2,00	0,647	0,431
	functional	7	1,71		

Appendix 5

Correlation matrix of supply chain characteristics

Correlations

		reducing operational costs	stock turnover	modular product: reducing final product inventory	modular product: reducing semi-finished product inventory	non-modular product: reducing final product inventory	safety stock in supply chain	use out capacities at most	buffer capacity in supply chain	quick reaction to changing demand	radical reduction of lead time
reducing operational costs	Pearson Correlation	1	,198	,403*	,136	,343**	-,095	,011	-,021	,130	,211
	Sig. (2-tailed)		,093	,020	,452	,009	,424	,929	,862	,277	,073
	N	73	73	33	33	57	73	73	71	72	73
stock turnover	Pearson Correlation	,198	1	,271	,270	,245	-,369**	,207	-,028	,206	,095
	Sig. (2-tailed)	,093		,127	,128	,066	,001	,079	,816	,083	,425
	N	73	73	33	33	57	73	73	71	72	73
modular product: reducing final product inventory	Pearson Correlation	,403*	,271	1	,574**	,031	-,238	,011	-,287	-,151	,250
	Sig. (2-tailed)	,020	,127		,001	,900	,183	,954	,117	,402	,161
	N	33	33	33	32	19	33	33	31	33	33
modular product: reducing semi-finished product inventory	Pearson Correlation	,136	,270	,574**	1	,015	,069	,008	-,002	,094	,274
	Sig. (2-tailed)	,452	,128	,001		,954	,701	,965	,992	,605	,123
	N	33	33	32	33	18	33	33	31	33	33
non-modular product: reducing final product inventory	Pearson Correlation	,343**	,245	,031	,015	1	-,371**	,259	-,030	,000	,219
	Sig. (2-tailed)	,009	,066	,900	,954		,005	,052	,826	,998	,101
	N	57	57	19	18	57	57	57	55	56	57
safety stock in supply chain	Pearson Correlation	-,095	-,369**	-,238	,069	-,371**	1	-,196	,345**	,211	,066
	Sig. (2-tailed)	,424	,001	,183	,701	,005		,096	,003	,075	,577
	N	73	73	33	33	57	73	73	71	72	73
use out capacities at most	Pearson Correlation	,011	,207	,011	,008	,259	-,196	1	,073	-,005	,177
	Sig. (2-tailed)	,929	,079	,954	,965	,052	,096		,544	,969	,134
	N	73	73	33	33	57	73	73	71	72	73
buffer capacity in supply chain	Pearson Correlation	-,021	-,028	-,287	-,002	-,030	,345**	,073	1	,311**	,267*
	Sig. (2-tailed)	,862	,816	,117	,992	,826	,003	,544		,009	,024
	N	71	71	31	31	55	71	71	71	70	71
quick reaction to changing demand	Pearson Correlation	,130	,206	-,151	,094	,000	,211	-,005	,311**	1	,362**
	Sig. (2-tailed)	,277	,083	,402	,605	,998	,075	,969	,009		,002
	N	72	72	33	33	56	72	72	70	72	72
radical reduction of lead time	Pearson Correlation	,211	,095	,250	,274	,219	,066	,177	,267*	,362**	1
	Sig. (2-tailed)	,073	,425	,161	,123	,101	,577	,134	,024	,002	
	N	73	73	33	33	57	73	73	71	72	73

Appendix 6

ANOVA table for comparison of two clusters by Fisher's supply chain attributes

		Cluster mean	F	Sig.
level of effort to reduce operational costs (B8)	Market-responsive	3,89	5,245	0,025
	Physically efficient	4,31		
level of effort to achieve high stock turnover (B9)	Market-responsive	3,32	1,655	0,203
	Physically efficient	3,65		
level of final product inventory in case of modular product (B10)	Market-responsive	3,63	4,625	0,041
	Physically efficient	4,22		
level of semi-finished product inventory in case of modular product (B11)	Market-responsive	3,95	0,018	0,895
	Physically efficient	4,00		
level of final product inventory in case of non-modular product (B12)	Market-responsive	3,52	3,560	0,065
	Physically efficient	4,05		
level of safety stock in the supply chain (B13)	Market-responsive	3,58	24,034	0,000
	Physically efficient	2,46		
level of effort to use capacity at most (B14)	Market-responsive	3,95	0,078	0,781
	Physically efficient	3,88		
building buffer capacity in supply chain (B15)	Market-responsive	3,58	87,369	0,000
	Physically efficient	1,77		
quick reaction to demand changes (B16)	Market-responsive	4,43	5,403	0,023
	Physically efficient	3,88		
radical lead time reduction (B17)	Market-responsive	4,37	12,707	0,001
	Physically efficient	3,58		

Appendix 7

Correlaton table of demand chain management tools

Correlations

		EDI	sharing POS data	sharing inventory data	sharing capacity data	CAO	common planing	common forecasting	barcode	RFID	VMI	CRP	cross-docking	supplier assessment	customer assessment	activity-based costing	manufacturing postponement	logistics postponement	modular production	modular product design
EDI	Pearson Correlation	1	,362**	,456**	,406**	,517**	,407**	,329**	0,186	0,095	,324**	,418**	0,089	0,131	0,218	0,06	0,163	,237*	,249*	0,232
	Sig. (2-tailed)		0,002	0	0	0	0	0,004	0,115	0,427	0,006	0	0,455	0,268	0,064	0,627	0,186	0,047	0,047	0,065
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
sharing POS data	Pearson Correlation	,362**	1	,333**	0,192	,424**	,238*	0,128	0,225	0,2	0,038	0,177	,307*	-0,082	0,126	0,204	0,006	0,218	0,239	,329**
	Sig. (2-tailed)	0,002		0,005	0,114	0	0,049	0,296	0,064	0,102	0,755	0,152	0,01	0,505	0,301	0,098	0,959	0,074	0,062	0,009
	N	69	69	69	69	69	69	69	69	68	69	67	69	69	69	67	65	68	62	62
sharing inventory data	Pearson Correlation	,456**	,333**	1	,388**	,450**	,332**	,354**	0,203	0,215	,391**	,331**	0,089	-0,167	-0,107	0,025	0,055	0,02	0,14	0,096
	Sig. (2-tailed)	0	0,005		0,001	0	0,004	0,002	0,086	0,07	0,001	0,005	0,46	0,157	0,369	0,838	0,658	0,866	0,271	0,448
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
sharing capacity data	Pearson Correlation	,406**	0,192	,388**	1	,423**	,450**	,406**	-0,026	0,103	0,18	0,201	-0,195	0,009	0,055	0,16	0,147	0,144	,265*	0,126
	Sig. (2-tailed)	0	0,114	0,001		0	0	0	0,829	0,387	0,13	0,096	0,1	0,941	0,642	0,19	0,235	0,231	0,035	0,322
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
CAO	Pearson Correlation	,517**	,424**	,450**	,423**	1	,618**	,431**	,254*	0,139	,244*	,368**	,288*	-0,047	0,116	,289*	,372**	,275*	,438**	,382**
	Sig. (2-tailed)	0	0	0	0		0	0	0,03	0,246	0,039	0,002	0,014	0,693	0,328	0,016	0,002	0,02	0	0,002
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
common planing	Pearson Correlation	,407**	,238*	,332**	,450**	,618**	1	,824**	0,051	0,085	,404**	,375**	0,138	0,136	,231*	,338**	,319**	0,214	,485**	,376**
	Sig. (2-tailed)	0	0,049	0,004	0	0		0	0,669	0,476	0	0,001	0,249	0,252	0,049	0,005	0,009	0,073	0	0,002
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
common forecasting	Pearson Correlation	,329**	0,128	,354**	,406**	,431**	,824**	1	0,109	0,138	,441**	,288*	0,012	0,172	0,078	,282*	,297*	0,203	,293*	0,181
	Sig. (2-tailed)	0,004	0,296	0,002	0	0	0		0,359	0,248	0	0,016	0,917	0,146	0,511	0,019	0,015	0,09	0,019	0,151
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
barcode	Pearson Correlation	0,186	0,225	0,203	-0,026	,254*	0,051	0,109	1	,364**	0,035	0,17	,239*	0,148	,354**	0,186	0,217	,293*	0,21	0,179
	Sig. (2-tailed)	0,115	0,064	0,086	0,829	0,03	0,669	0,359		0,002	0,772	0,159	0,043	0,212	0,002	0,125	0,078	0,013	0,096	0,158
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
RFID	Pearson Correlation	0,095	0,2	0,215	0,103	0,139	0,085	0,138	,364**	1	0,168	,261*	0,024	0,11	0,126	0,044	-0,058	0,16	0,025	0,016
	Sig. (2-tailed)	0,427	0,102	0,07	0,387	0,246	0,476	0,248	0,002		0,16	0,029	0,843	0,357	0,292	0,722	0,644	0,187	0,848	0,899
	N	72	68	72	72	72	72	72	72	72	71	70	71	72	72	68	66	70	63	63
VMI	Pearson Correlation	,324**	0,038	,391**	0,18	,244*	,404**	,441**	0,035	0,168	1	,609**	0,171	0,145	0,076	0,194	0,18	0,092	0,119	0,134
	Sig. (2-tailed)	0,006	0,755	0,001	0,13	0,039	0	0	0,772	0,16		0	0,152	0,225	0,524	0,111	0,146	0,444	0,348	0,292
	N	72	69	72	72	72	72	72	72	71	72	70	72	72	72	69	67	71	64	64
CRP	Pearson Correlation	,418**	0,177	,331**	0,201	,368**	,375**	,288*	0,17	,261*	,609**	1	,299*	0,205	0,072	0,01	0,089	0,117	0,227	0,234
	Sig. (2-tailed)	0	0,152	0,005	0,096	0,002	0,001	0,016	0,159	0,029	0		0,012	0,089	0,556	0,935	0,48	0,339	0,075	0,067
	N	70	67	70	70	70	70	70	70	70	70	70	70	70	70	67	65	69	62	62
cross-docking	Pearson Correlation	0,089	,307*	0,089	-0,195	,288*	0,138	0,012	,239*	0,024	0,171	,299*	1	-0,136	0,058	0,141	0,152	-0,009	0,1	0,171
	Sig. (2-tailed)	0,455	0,01	0,46	0,1	0,014	0,249	0,917	0,043	0,843	0,152	0,012		0,256	0,629	0,249	0,219	0,94	0,431	0,178
	N	72	69	72	72	72	72	72	72	71	72	70	72	72	72	69	67	71	64	64
supplier assessment	Pearson Correlation	0,131	-0,082	-0,167	0,009	-0,047	0,136	0,172	0,148	0,11	0,145	0,205	-0,136	1	,334**	0,075	0,101	0,185	0,146	0,129
	Sig. (2-tailed)	0,268	0,505	0,157	0,941	0,693	0,252	0,146	0,212	0,357	0,225	0,089	0,256		0,004	0,542	0,416	0,123	0,249	0,308
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
customer assessment	Pearson Correlation	0,218	0,126	-0,107	0,055	0,116	,231*	0,078	,354**	0,126	0,076	0,072	0,058	,334**	1	,547**	,380**	,281*	,500**	,469**
	Sig. (2-tailed)	0,064	0,301	0,369	0,642	0,328	0,049	0,511	0,002	0,292	0,524	0,556	0,629	0,004		0	0,001	0,018	0	0
	N	73	69	73	73	73	73	73	73	72	72	70	72	73	73	69	67	71	64	64
activity-based costing	Pearson Correlation	0,06	0,204	0,025	0,16	,289*	,338**	,282*	0,186	0,044	0,194	0,01	0,141	0,075	,547**	1	,377**	,367**	,291*	,263*
	Sig. (2-tailed)	0,627	0,098	0,838	0,19	0,016	0,005	0,019	0,125	0,722	0,111	0,935	0,249	0,542	0		0,002	0,002	0,022	0,039
	N	69	67	69	69	69	69	69	69	68	69	67	69	69	69	69	66	69	62	62
manufacturing postponement	Pearson Correlation	0,163	0,006	0,055	0,147	,372**	,319**	,297*	0,217	-0,058	0,18	0,089	0,152	0,101	,380**	,377**	1	,510**	,651**	,538**
	Sig. (2-tailed)	0,186	0,959	0,658	0,235	0,002	0,009	0,015	0,078	0,644	0,146	0,48	0,219	0,416	0,001	0,002		0	0	0
	N	67	65	67	67	67	67	67	67	66	67	65	67	67	67	66	67	67	63	63
logistics postponement	Pearson Correlation	,237*	0,218	0,02	0,144	,275*	0,214	0,203	,293*	0,16	0,092	0,117	-0,009	0,185	,281*	,367**	,510**	1	,318*	,302*
	Sig. (2-tailed)	0,047	0,074	0,866	0,231	0,02	0,073	0,09	0,013	0,187	0,444	0,339	0,94	0,123	0,018	0,002	0		0,011	0,016
	N	71	68	71	71	71	71	71	71	70	71	69	71	71	71	69	67	71	63	63
modular production	Pearson Correlation	,249*	0,239	0,14	,265*	,438**	,485**	,293*	0,21	0,025	0,119	0,227	0,1	0,146	,500**	,291*	,651**	,318*	1	,849**
	Sig. (2-tailed)	0,047	0,062	0,271	0,035	0	0	0,019	0,096	0,848	0,348	0,075	0,431	0,249	0	0,022	0	0,011		0
	N	64	62	64	64	64	64	64	64	63	64	62	64	64	64	62	63	63	64	64
modular product design	Pearson Correlation	0,232	,329**	0,096	0,126	,382**	,376**	0,181	0,179	0,016	0,134	0,234	0,171	0,129	,469**	,263*	,538**	,302*	,849**	1
	Sig. (2-tailed)	0,065	0,009	0,448	0,322	0,002	0,002	0,151	0,158	0,899	0,292	0,067	0,178	0,308	0	0,039	0	0,016	0	
	N	64	62	64	64	64	64	64	64	63	64	62	64	64	64	62	63	63	64	64

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix 8

ANOVA analysis of matching of demand chain management tools in matching strategy situations

		Cluster mean	F	Sig.
EDI (B18a)	innovative - market-responsive	3,87	0,255	0,619
	functional - physically efficient	4,14		
sharing of inventory data (B18c)	innovative - market-responsive	3,00	0,063	0,804
	functional - physically efficient	3,14		
sharing capacity information (B18d)	innovative - market-responsive	2,67	0,686	0,417
	functional - physically efficient	2,14		
CAO (B18e)	innovative - market-responsive	3,87	2,659	0,119
	functional - physically efficient	2,86		
common planning (B18f)	innovative - market-responsive	2,93	1,578	0,223
	functional - physically efficient	2,14		
VMI (B18j)	innovative - market-responsive	2,13	0,622	0,440
	functional - physically efficient	2,57		
CRP (B18k)	innovative - market-responsive	2,40	0,002	0,964
	functional - physically efficient	2,43		
cross docking (B18l)	innovative - market-responsive	2,00	0,306	0,586
	functional - physically efficient	1,71		
customer assessment (B18n)	innovative - market-responsive	3,87	0,977	0,335
	functional - physically efficient	4,29		
ABC (B18o)	innovative - market-responsive	3,07	1,058	0,317
	functional - physically efficient	2,43		
manufacturing postponement (B18p)	innovative - market-responsive	2,47	2,290	0,147
	functional - physically efficient	1,50		
logistics postponement (B18q)	innovative - market-responsive	2,20	0,011	0,916
	functional - physically efficient	2,14		
modular production (B18r)	innovative - market-responsive	2,93	3,734	0,069
	functional - physically efficient	1,60		

Appendix 9

Levene's F probe of matching of demand chain management tools in matching strategy situations

Levene's F probe						
		N	**Mean**	**St. dev.**	**F**	**Sig.**
EDI (B18a)	innovative - market-responsive	15	3,87	1,246	0,539	0,472
	functional - physically efficient	7	4,14	1,069		
sharing of inventory data (B18c)	innovative - market-responsive	15	3,00	1,195	0,069	0,796
	functional - physically efficient	7	3,14	1,345		
sharing capacity information (B18d)	innovative - market-responsive	15	2,67	1,345	0,083	0,777
	functional - physically efficient	7	2,14	1,464		
CAO (B18e)	innovative - market-responsive	15	3,87	1,187	0,998	0,330
	functional - physically efficient	7	2,86	1,676		
common planning(B18f)	innovative - market-responsive	15	2,93	1,335	0,053	0,820
	functional - physically efficient	7	2,14	1,464		
VMI (B18j)	innovative - market-responsive	15	2,13	1,302	0,446	0,512
	functional - physically efficient	7	2,57	0,976		
CRP (B18k)	innovative - market-responsive	15	2,40	1,352	0,000	0,992
	functional - physically efficient	7	2,43	1,397		
cross docking (B18l)	innovative - market-responsive	15	2,00	1,069	0,543	0,470
	functional - physically efficient	7	1,71	1,254		
custom assessment(B18n)	innovative - market-responsive	15	3,87	0,990	1,024	0,324
	functional - physically efficient	7	4,29	0,756		
ABC (B18o)	innovative - market-responsive	14	3,07	1,269	0,583	0,454
	functional - physically efficient	7	2,43	1,512		
manufacturing postponement (B18p)	innovative - market-responsive	15	2,47	1,356	0,543	0,470
	functional - physically efficient	6	1,50	1,225		
logistics postponement (B18q)	innovative - market-responsive	15	2,20	1,146	0,162	0,692
	functional - physically efficient	7	2,14	1,215		
modular production (B18r)	innovative - market-responsive	15	2,93	1,335	0,022	0,884
	functional - physically efficient	5	1,60	1,342		

Appendix 10

ANOVA table on explanations of mismatching for questions B2 and B13

		Cluster mean	F	Sig.
frequency of late delivery - stock-out (B2)	Mismatching	2,22	0,458	0,502
	Matching	2,00		
level of safety stock in the supply chain (B13)	Mismatching	3,13	0,094	0,761
	Matching	3,23		

Appendix 11

Levene's F probe on explanations of mismatching for questions B2 and B13

Levene's F probe						
		N	Mean	St. dev.	F	Sig.
frequency of late delivery - stock-out (B2)	Mismatching	23	2,22	1,204	5,174	0,028
	Matching	22	2,00	0,926		
level of safety stock in the supply chain (B13)	Mismatching	23	3,13	0,968	1,212	0,277
	Matching	22	3,23	1,152		

Appendix 12

ANOVA table on explanation of mismatching for question B20

		Cluster mean	F	Sig.
market is very volatile (B20)	Mismatching	3,95	2,359	0,132
	Matching	3,41		

Appendix 13

Levene's F probe on explanation of mismatching for question B20

Levene's F probe						
		N	**Mean**	**St. dev.**	**F**	**Sig.**
market is very volatile (B20)	Mismatching	22	3,95	1,214	0,007	0,933
	Matching	22	3,41	1,141		

Appendix 14

ANOVA table on explanation of mismatching for question group B21

ANOVA				
		Cluster mean	**F**	**Sig.**
supply chain performance: price (B21a)	Mismatching	3,78	0,002	0,966
	Matching	3,77		
supply chain performance: operational cost (B21b)	Mismatching	3,52	0,009	0,924
	Matching	3,55		
supply chain performance: product quality (B21c)	Mismatching	4,26	0,013	0,911
	Matching	4,29		
supply chain performance: accuracy in volume (B21d)	Mismatching	4,26	0,017	0,897
	Matching	4,23		
supply chain performance: accuracy in time (B21e)	Mismatching	4,09	0,020	0,887
	Matching	4,05		
supply chain performance: responsiveness to changing customer needs (B21f)	Mismatching	4,09	0,189	0,666
	Matching	3,95		

Appendix 15

Levene's F probe on explanation of mismatching for question group B21

Levene' F probe						
		N	**Mean**	**St. dev.**	**F**	**Sig.**
supply chain performance: price (B21a)	Mismatching	23	3,78	0,671	0,898	0,349
	Matching	22	3,77	0,869		
supply chain performance: operational cost (B21b)	Mismatching	23	3,52	0,665	3,968	0,053
	Matching	22	3,55	0,963		
supply chain performance: product quality (B21c)	Mismatching	23	4,26	0,689	0,074	0,787
	Matching	21	4,29	0,784		
supply chain performance: accuracy in volume (B21d)	Mismatching	23	4,26	0,964	2,683	0,109
	Matching	22	4,23	0,752		
supply chain performance: accuracy in time (B21e)	Mismatching	23	4,09	1,041	1,777	0,190
	Matching	22	4,05	0,899		
supply chain performance: responsiveness to changing customer needs (B21f)	Mismatching	23	4,09	1,041	0,001	0,970
	Matching	22	3,95	0,999		

Appendix 16

Supply chain management practice of Hungarian companies
Interview questions

What is your opinion, do the companies in Hungary really manage their supply chains (assuming that managing a supply chain is a conscious activity)?

How does your company manage the supply chain? Who are the players? What coordinating tools do you use?

In the research I am testing a theoretical model. The model suggests that products on the market can be allocated into two categories. The first category contains products which fulfil everyday needs, have long life cycle and stable and predictable demand. The supply chain which delivers such products to the market has to serve this well predictable demand as much as possible. Because of the relatively low profit margin firms in this supply chain aim to use out capacities at most and reduce the cost of physical operations.

The second category contains products with short life cycle and very unpredictable demand because demand usually affected by fashion or trends and those who step first on the market can skim the demand and achieve high profit. In supply chains delivering such products to the market a great emphasis is laid on to launch the product at first and deliver customers as soon as possible even it causes extra costs. Firms also have to make effort to avoid over-stock or under-stock because these cause wastage if the product has to be sold on discount price or firm misses sales.

What do you think product types and consequently supply chain types can be really separated the way the theory suggests? Or there will be a mismatch? What could be the reason of mismatch?

Besides the reasons of mismatch listed in the short questionnaire what other explanations can be to that behaviour when a company does not apply the supply chain type which would match its product characteristics?

Appendix 17

Interview questionnaire

In your opinion how correct the following explanations are for the mismatch between the product type and the supply chain type? (1 – not at all, 7 – very typical)

a) companies aim to exploit the strength of both supply chain types

1	2	3	4	5	6	7

b) the market is too volatile to be able to decide which supply chain type is worth to be operated

1	2	3	4	5	6	7

c) the management cannot identify the type of the product and the operational focus of supply chain matching that

1	2	3	4	5	6	7

d) hybrid product

1	2	3	4	5	6	7

e) the demand is too volatile, unpredictable

1	2	3	4	5	6	7

f) the supply is too volatile, unpredictable

1	2	3	4	5	6	7

g) companies cannot identify that their product is functional, but is in the introductory phase of the life cycle, and behaves as an innovative one and therefore, firms operate market-responsive supply chains, however, when reaching the maturity phase the physically efficient would match more

1	2	3	4	5	6	7

h) the supply chain management practice of Hungarian firms is not so developed to be able to choose a supply chain strategy which matches their product type

1	2	3	4	5	6	7

i) companies do not want to operate different supply chain types at the same time

1	2	3	4	5	6	7

Appendix 18

ANOVA comparison of clusters' usage of demand chain management tools

ANOVA				
		Cluster mean	**F**	**Sig.**
EDI (B18a)	Underdeveloped cluster	3,12	20,210	0,000
	Developed cluster	4,42		
sharing of inventory data (B18c)	Underdeveloped cluster	2,73	3,346	0,073
	Developed cluster	3,31		
sharing capacity information (B18d)	Underdeveloped cluster	2,15	8,833	0,005
	Developed cluster	3,12		
CAO (B18e)	Underdeveloped cluster	2,54	37,966	0,000
	Developed cluster	4,42		
common planning (B18f)	Underdeveloped cluster	1,77	32,143	0,000
	Developed cluster	3,38		
VMI (B18j)	Underdeveloped cluster	1,81	7,106	0,010
	Developed cluster	2,69		
CRP (B18k)	Underdeveloped cluster	1,92	5,923	0,019
	Developed cluster	2,81		
cross docking (B18l)	Underdeveloped cluster	1,96	1,018	0,318
	Developed cluster	2,31		
custorme assessment (B18n)	Underdeveloped cluster	2,73	26,420	0,000
	Developed cluster	4,27		
ABC (B18o)	Underdeveloped cluster	1,85	55,059	0,000
	Developed cluster	3,81		
manufacturing posponement (B18p)	Underdeveloped cluster	1,46	28,445	0,000
	Developed cluster	2,77		
logistics postponement (B18q)	Underdeveloped cluster	1,69	18,774	0,000
	Developed cluster	2,77		
modular production (B18r)	Underdeveloped cluster	1,46	51,087	0,000
	Developed cluster	3,27		

Appendix 19

Comparison of supply chain performance of two clusters

		Cluster mean	F	Sig.
supply chain performance: price (B21a)	Underdeveloped cluster	3,38	13,160	0,001
	Developed cluster	4,04		
supply chain performance: operational cost (B21b)	Underdeveloped cluster	3,00	19,084	0,000
	Developed cluster	3,88		
supply chain performance: product quality (B21c)	Underdeveloped cluster	4,27	1,188	0,281
	Developed cluster	4,48		
supply chain performance: accuracy in volume (B21d)	Underdeveloped cluster	4,12	0,028	0,867
	Developed cluster	4,15		
supply chain performance: accuracy in time (B21e)	Underdeveloped cluster	3,73	1,000	0,322
	Developed cluster	4,00		
supply chain performance: responsiveness to changing customer needs (B21f)	Underdeveloped cluster	3,35	13,508	0,001
	Developed cluster	4,27		