



FBD_BMODEL
FASHION BIG DATA BUSINESS MODEL

D3.2

**Report including market analysis,
stakeholder analysis, survey results,
supplier selection criteria list**



Project Information

Grant Agreement Number	761122
Project Full Title	A Knowledge-based business model for small series fashion products by integrating customized innovative services in big data environment (<i>Fashion Big Data Business Model</i>)
Project Acronym	FBD_BModel
Funding scheme	RIA
Start date of the project	December 1 st , 2017
Duration	36 months
Project Coordinator	Xianyi Zeng (ENSAIT)
Project Website	http://www.fbd-bmodel.eu

Deliverable Information

Deliverable n°	3.2
Deliverable title	Report including market analysis, stakeholder analysis, survey results, supplier selection criteria list
WP no.	3
WP Leader	HB
Contributing Partners	DITF, GZE, Bivolino, Azadora, Kuvera Spa, Beste
Nature	R: Document, report (excluding the periodic and final reports)
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Reviewers	
Contractual Deadline	M6
Delivery date to EC	M6

Dissemination Level

PU	Public	✓
PP	Restricted to other programme participants (incl. Commission Services)	
RE	Restricted to a group specified by the consortium (incl. Commission Services)	
CO	Confidential, only for the members of the consortium (incl. Commission Services)	

Document Log

Version	Date	Author	Description of Change
1.0	28.05.2018	Sara Harper, Rudrajeet Pal	/
1.1	30.05.2018	Other Partners	Minor text revisions, and missing information added
1.2	31.05.2018	Sara Harper, Rudrajeet Pal	Deliverable Complete

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1 Executive Summary

Due to the increasing trend of reshoring to relatively high cost production locations like countries in the EU, there is an emphasis on the need to focus on high value-added small series production. This is especially true in high labour intensive industries like apparel and textiles. In this context, supply network configuration, related interdependencies and trade-offs are required to be addressed to support this transition. However, there are limitations as to the current capabilities to meet these needs. In order to better understand the diverse context of small series apparel and textile production, a comprehensive and structured analysis is required.

Within this scope and as part of the FBD_BModel project, this report offers:

- (i) an overview of the current state of the market, regarding the current capabilities, capacities and focuses on notable or best practice industry examples especially in the EU,
- (ii) a systematic understanding of five representative case companies,
- (iii) a supplier selection criteria list, and
- (iv) a ranked list of the criteria based on a supply chain competitiveness survey.

The focus of the configuration-based analysis in this report is along four elements, value structure of products/services, operational structure, network structures, and relationship structures of the supply network.

Market analysis:

The key aspects within the market analysis highlight that:

- Closer relationships with the customers, with technology as a “tool” to capture customer voices, may lead to greater customer knowledge even in standard production contexts.
- More collaborative relationships and extensive information sharing are crucial, which improves the level of trust among the network actors. Additionally, extensive data sharing is required to build agility in business models e.g. Boohoo, and Zara.
- However challenges are associated with increasing customer involvement that demands higher product/service differentiation and new models for collaboration and data sharing/protection.
- At the manufacturing side, network relationships and customization are dependent on the types of products being produced and demands higher degrees of digital transformations of production. This is currently addressed in few EU companies and demonstrative actions e.g. Hugo Boss, Microfactory, Digimode.
- While maintaining complexity and customization in-house are critical as success factors, partnerships for complementary competences are beneficial in many cases too, e.g. Adidas, Unmade.

Exemplary company cases takeaways:

- The five company cases included are that of a branded garment retailer, a branded retailer of other goods, a luxury full-price garment producer, a fabric + full-price garment producer, and a collaborative service platform for made-to-measure garment production.
- Even though these cases represent diverse business models and characteristics, it could be identified that network structures, collaboration and relationships are depending extensively on the types of products that are produced by each company. Further power dynamics are crucial in the networks.

Criteria for Competitiveness and Supplier Selection:

Numerous supply network configuration-related criteria are potentially relevant to consider when evaluating or developing a company's own competitiveness and evaluating or choosing suppliers. These criteria, organised and presented, along the four elements of network configuration relate to:

- Value structure along 3 aspects: quality, customisation, and innovation.
- Operational structure along 4 aspects: capacity & cost, technology & process capabilities, delivery performance, and flexibility & agility.
- Supply network structures along 2 aspects: internal and external structures both physical and virtual, and network proximity and integration.
- Relationships along types of relationship and relational characteristics.

Survey results in terms of ranked criteria:

Based on a completed supply chain competitiveness survey conducted with 27 respondents representing EU's textile and apparel manufacturing sector the following results were obtained

- The top rated criteria are related to relationships notably trust and skilled human resources, with extensive focus on product and delivery performance and quality, and including some aspects of collaborative structures, though structural aspects were considered more priorities for the companies themselves rather than their suppliers.
- Customization and digital technologies were not highly ranked, indicating that there is a gap between what is extensively discussed as being demanded on the market along with the technology available to support those demands, and the current ways of working in the textile and apparel industry.

2 Supply Network Configuration for Small Series

According to much of the research regarding local production, and reshoring to relatively high cost production locations like countries in the EU, there is an emphasis on the need to focus on high value-added small series production. This is especially true in high labour intensive industries like apparel and textiles. However, there are limitations as to the current capabilities to meet these needs. In order to better understand the diverse context of small series textile and apparel production, a comprehensive and structured analysis of the academic literature is required. Thus enabling the identification of the relevant aspects to consider, with related interdependencies and trade-offs, by addressing the broad area of literature. The definition and four elements of supply network configuration as presented by Srari and Gregory [1] provides a structure for the diverse literature and opportunity to highlight the relevant aspects of configuration that need to be addressed further for these transitions. The emergent themes and interrelationships can be understood within and between the four elements, which focus on the **value structure**, **operational structure**, **network structures**, and **relationship structures** of the supply network. These configuration-based emergent themes then provide a structure to understand and analyse the current state of the market, regarding the current capabilities, capacities and focuses of notable or best practice industry examples especially in the EU. Additionally, the structure provides a foundation for a more detailed understanding through several exemplifying company cases.

2.1 Configuration-based Market Analysis

The more detailed themes in the literature highlight the importance of digitalisation and new production technologies for the context of small series, high cost manufacturing. Throughout these themes both business- and customer- related knowledge in the network is of importance, and collaboration in order to access and deploy this knowledge. Further, based on the detailed configuration-based themes an analysis of current market capabilities and capacities was done regarding small series manufacturing, and supplemented by other relevant examples of digital manufacturing closely related to those emergent themes.

2.1.1 Value Structure of the Product/Service

The most important themes within the literature related to product level considerations (Figure 1), highlight the different considerations in terms of the requirement to produce locally with regards to small volumes of production and a high level of uncertainty of demand. However, for some production strategies there is also a need for the volumes to be sufficiently high, such as balancing custom and non-custom products. This relates to the product mix and variety which encourages local production, with high variety products emphasised as well as many benefits discussed for producing custom and standard products, e.g. protection of flexible capacity, and gaining added customer knowledge [2]. Furthermore, questions of customisation/personalisation, and closely related aspects of product architecture, highlights the importance of technology to enable this production and matching the processes and supply chains to the specific product characteristics. Thus, these aspects all have the potential to be the driving factor in terms of concurrent design of

products, processes and supply chains, either for initial design optimisation, or changes to products, in line with 3 Dimensional Concurrent Engineering (3DCE) approach [3].

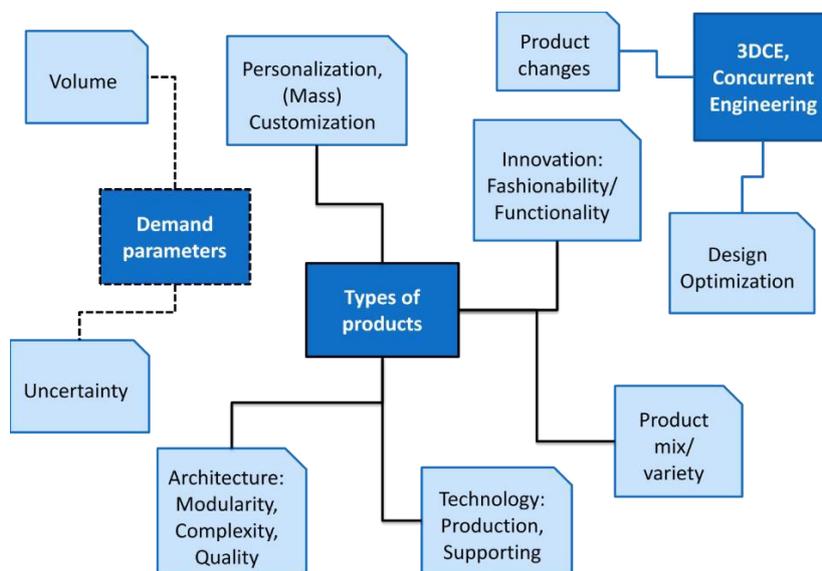


Figure 1 Emergent themes in Value Structure

2.1.1.1 Market Characteristics Related to Product/Service Value Structures

Several notable examples regarding product and service characteristics on the market are presented below, (Table 1). Many examples verify production of high quality and customised products closer to customers, though even lower priced garments are included for fast fashion production. Technology enablers of various types are key, enabling design, and in some cases fit customisation, through digital integration. However, with customers being integrated into the process, there is a need to maintain control over certain aspects, or parameters, to protect against the risks related to extensive personalisation/ democratisation e.g. diminished differentiation.

Table 1 Company examples for themes in product/service value structure

Company examples	Themes	Descriptions
Zara	Low volumes, High variety, Fast fashion	Quick Response, resembling a tech company, small batches of high variety and high frequency of deliveries, slight undersupply and almost no reorders to drive the customers to buy.
Boohoo	Low volumes, High variety, Faster and lower priced, Technology enabled	Online only adaptation of Zara’s model, with even faster ‘Test and Repeat’, small batch production (<300), high variety of low priced garments, released frequently, with quick production ramp up of the ~30% of items that sell very well, enabled by digital technologies e.g. digital relationships with customers and manufacturers

Burberry	High quality, authenticity	Production location in UK for core products like the Trench coat, for authenticity, Britishness, 'Made in' effect.
Hugo Boss	High quality, innovation, authenticity, MTM/ personalised	In line with vision for innovation, premium quality, perfect fit, authenticity, etc. high quality businesswear produced in own facilities in Europe, largest in Turkey, Technical Centre in Germany for development, and to address growing demand for MTM/ personalised, in Poland/Italy high-quality shoe production.
Adidas	Personalised for segments, fit/design customisation, digital production/ supporting technologies	'Speedfactory' with flexible manufacturing systems (robotics, new production technologies e.g.3D printing and highly skilled workers) enabling the production of distinctive shoes, initially customised/ personalised for cities, using data from real runners in those cities, eventually plan to offer customised for individuals. Total volumes small. Also trial 'knit for you' with on-demand design and fit sweater customisation, enabled by whole garment knitting technology and body scanning.
Unmade	High quality, Design customization, digital production/ supporting technologies	Technology platform provider, extensively working with industrial knitting technologies, connecting machinery to front-end customer customisation experience. High quality products customised based on appearance, rather than fit, with certain aspects tightly controlled by the collaborating brand to maintain their strong brand image, other parameters, some of which are controlled by Unmade, and some the customer is free to change.

2.1.1.1.1 Specific Technologies and Other Considerations

As previously discussed, the aspects of personalisation and the related digital technology enablers are highly relevant, with additional relevant examples including:

- **Interactive Avatar** being offered by several companies like Metail, Fitle, iStyling by [TC]², QVIT, Trimirror. Such services include three parts, in general: (i) data gathering using various tools like 3D body scan, Kinetics etc., (ii) offering functionalities – rotation, movements, and (iii) detailing of appearance – features, body types.
- Additionally, **3D sales configurators and interactive rendering** tools offer 3D illustration of the product too, along with realistic and sometimes real-time updating of product customization of fabric drape, simulation of properties, etc. Max Planck Institute for Intelligent Systems has developed a system called DRAPE – DRessing Any Person. Other commercial examples are Tailor4less, World of Alfa, ShirtsMyWay, TinkerTailor, CONSTRVCT, etc.
- **Virtual fitting** is also an extended digital technology-based offering which provides the possibility to simulate fit from 2D measurements by using tension maps, UV mapping, etc.

and is often used to compare sizes from well-known brands. The purpose is to find the right size for each garment, offered commercially by Fits.me, Embodee, Fitizzy, etc.

- Further latest development has been technologies like **augmented/virtual reality**. 'Smart' selling by Uniqlo provides in one of its stores a magic mirror – a technology that integrates physical and digital reality and allows users to add a direct in-store experience. Whilst wearing the same garment, users can see in the mirror the different available colours and take photos to share via email or on the social networks, as well as having all of the product specifications. Even more avant-garde is the Triumph and OgilvyAction proposal for the launch of the Triumph Essence collection which could be worn by clients without taking off their clothes. In this case, the interface is also a screen; the Fantasy Mirror provided with a cam that tracks movements and uses 3D technology with infrared rays to scan the body underneath the clothes and create a digital avatar with the same proportions as the consumer, follows their movements and reproduces the underwear on them. [4]

2.1.2 Operational Structure

With the element related to primary operations is the focus on manufacturing configurations and the dynamics used (Figure 2). Importantly addressed are Flexible Manufacturing Resources, including flexible factories/capacity achieved with machines, more flexible, workers, cellular structures, product/process modularity, flexible suppliers, and automation/new technologies for hyper-flexibility. These flexible manufacturing resources are discussed in relation to product changes, mixes, customer involvement and IT use, virtual supply chain, and new production technologies like Additive Manufacturing with benefits including cost, quality, variety, and innovation, and challenges including level of automation, and traceability. Additionally, the need for reconfigurability or agility is emphasized especially for achieving a balance between supply and demand rather than just maintaining expensive buffer capacities [5]. Further, the ability to be agile in production is suggested to be built on a foundation of lean manufacturing, but with more advanced technology use. The location of the customer order decoupling point (CODP) is crucial to balance the lean/agile trade-off, as well as costs/benefits of customer involvement [2]. Additionally, several aspects are discussed related to strengthening mass customisation capabilities such as technology use, Quality Management practices, and the need for Quick Response Manufacturing/time based performance e.g. [6].

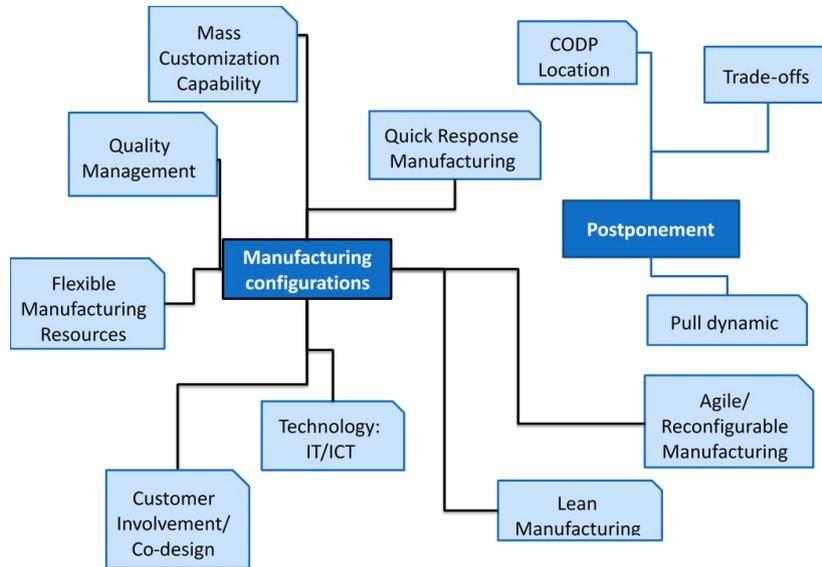


Figure 2 Emergent themes in Operational structures

2.1.2.1 Market Characteristics Related to Operational Structures

Within the market there are many examples highlighting the need for faster, more flexible production, especially enabled by increasing use of technology integration for manufacturing and greater visibility of customer demand (Table 2).

Table 2 Company examples for themes in operational structures

Company examples	Themes	Descriptions
Zara	Quick Response, Flexibility, Lean, Postponement, Technology	Quick Response Manufacturing (hybrid supply chain-flexibility with leanness, and postponement e.g. dyeing greige fabric). In-house activities for scale, e.g. cutting, extreme flexibility enabled by only a small amount of production planned upfront, rest driven by demand information, through extensive digital integration and centralised monitoring and control of network including smaller contract sewing facilities.
Boohoo	Quick Response	Lower priced faster fashion items in frequent small series, with lower risk if they don't sell well, with very fast development times (1-4 weeks) to capitalise on new trends, and production sourced from the local wholesalers and manufactures in Manchester.
Burberry	Quick Response	'See Now Buy Now' model adopted associated with reshoring, higher cost production, and supply chain redesign, restructuring of all the processes from design, production, to methods of sales, February 2018 show only some items offered with this method.

Hugo Boss	Flexible Manufacturing –Smart Factory, Technology/ Digitalisation, Quick Response, Quality	Digital transformation of the business model, all along the value chain wherever economically viable, strong IT/logistics platform, digital prototyping/transfer of product information, automation and digital systems for inventory planning, continuing to develop smart factory (Turkey) digital connection of machinery, employees, processes, and products, working on digital twin for optimisation. Developing 'fast track' for capitalising on short term trends and rapid restocking of successful products. Also, focus on quality management and control.
Adidas	Flexible Manufacturing –Robotics, skilled workers	Adidas 'Speedfactory', with extensive use of robotics and new production technologies for flexibility and minimal human effort, and to enable faster development and prototyping. Certain aspects people more efficient, thus importance of skilled workers and closely related to distinctive qualities of the shoe designs.
Unmade	Flexible Manufacturing –Machinery, Technology/ Digitalisation	IT platform enabling the competitive production of custom products through automatically connecting the front-end co-design customer experience with the manufacturer's industrial knitting machines, enabling optimisation and grouping for colour and tracking of the customised products.

2.1.2.1.1 Specific Technologies and Other Considerations

There are numerous developments related to increasing digitalisation of production and individual production technologies, including:

- New technologies like **Internet of Things (IoT)** where internet enabled objects have the potential to provide visibility within and between actors in the network, supporting data collection for planning, maintenance, tracking and control, autonomous decision-making and quality control [7], while also affecting the nature of the products themselves, with increasingly connected consumer products.
- **Sewbot®** offered by Softwear Automation, which has entered into the European market and adopted by Li and Fung to develop fully digitally integrated supply chains within their large supplier network. These automated production lines are initially focused on simple, basic products, with first product focuses on T-shirts, though considered an enabler of fully custom products in the future.
- The **Amazon** patented on-demand manufacturing system including extensive automation, digital printing and cutting, and the potential for optimization of many different parameters, including location of the customer, material usage etc.
- The **Microfactory**, coordinated by DITF demonstrating a digitally integrated local production chain for fully custom products [8]. Multi-stakeholder collaboration, including companies offering many innovative technologies including 3D simulation, with accurate

colour representation, digital printing with tracking, digital cutting, ultrasonic welding. Highlighting the potential of the model and the speed and ease of adoption.

- Projects like **Digimode** demonstrating a digitally connected local value chain for MTM garments [9], and preceding **Fromrolltobag** highlighting the importance of digitised design and operations for flexibility/agility and an enhanced customer experience [10].

2.1.3 Network Structures for supply chain

Within the element of network structures (Figure 3), it is crucial to address internal organisational structures as well as external structures and related locational aspects. Many works have emphasized the importance of organic organisational structures especially related to functional integration, with both related to and enabling better communication and worker empowerment. Further, the overall design of the network in terms of complexity, as well as the flexibility of the structures is important and closely related to the types of product, as well as the development of Distributed Manufacturing networks [11] or Collaborative networks. Additionally, the degree of integration and information sharing is considered a requirement for collaborative networks, while also being necessary for flexible structures, which can pose some challenges. The locational aspects highlight the qualities necessary for production to be required in a high cost location, or for nearby suppliers, as well as questions of closeness to customers which is fundamental for Distributed Manufacturing [11].

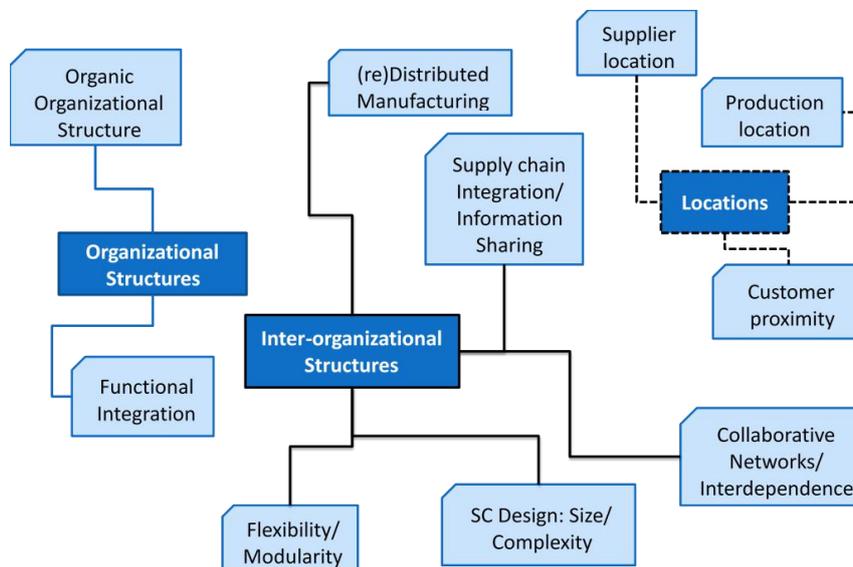


Figure 3 Emergent Themes in Network structures

2.1.3.1 Market Characteristics Related to Network Structures

The companies on the market highlight several aspects related to internal and external structures, (Table 3). Organic organisational structures are highlighted, especially aspects related to cross-functional teams. Additionally, new types of collaborations and intermediaries are seen rather than a clear reduction of intermediaries, especially for technology competences e.g. production and

supporting. Localisation of production, closely related to Distributed Manufacturing, is extensively used for and related to the need for fast speeds.

Table 3 Company examples for themes in network structures

Company examples	Themes	Descriptions
Zara	Localised production, Integration	Zara's established production network, over 50% nearby by mainly contract manufacturers, enabled by extensive integration and information sharing.
Boohoo	Localised production	Manufacturing proximity to customers for fast speeds, with over 50% sourced from UK production facilities.
Burberry	Localised production	More localised production for the Burberry 'See Now Buy Now' model.
Hugo Boss	Functional integration	Multifunctional and empowered employees are important for cross-functional teams and for the development of speed and embracing change at Hugo Boss.
Adidas	Localised production, Collaboration	Localised production with 'Speedfactory', reduced intermediaries with large scale investments in-house, also partnership for 3D Printing technology with start-up Carbon Inc.
Unmade	Collaborative Network, Localised/ Distributed	Supporting technology enabling more collaborative business models/Distributed, as a new kind of intermediary, not limited to exclusively high cost locations, but appropriate for strengthening existing manufacturing capabilities. For example, UMD brand products manufactured in UK by a historic knitwear manufacturer.

2.1.3.1.1 Specific Technologies and Other Considerations

As previously discussed, there are benefits to localisation of production close to customers, however, an alternative force comes from the increasingly digitally connected world. With this increasing connectivity comes the potential for the success of whoever in the world is best. Notably, despite extensive offshoring in these industries, some production capabilities have been maintained in Europe. There are various networking tools that enable the identification and utilisation of this existing network of capabilities. For example:

- **Sqetch.co**, a network of 1000+ textile/apparel producers to connect with brands, with the service cost ranging from free to paid services. The network includes many companies within Europe, while also connecting companies all over the world. Throughout the countries in Europe there are a total of 413 producers (the largest being: Turkey – 93; Italy –

77; Netherlands – 49; Poland – 44, etc.) The producers are categorised and searchable based on the type of products offered, production stages (Concept; Pattern; Materials; Prototype; Production), fabrics, and other services.

- **Makeworks.com** is a community of manufacturers, makers, material suppliers and workshops. Finding factories can be done by browsing or searching and they are categorised and searchable by keywords related to processes, industries, materials, and locations. Industries highlighted in Sweden are: (i) “Fashion Construction” focusing on garments including pattern cutting, tailoring and finishing, and (ii) “Textiles” focusing on fabric production including knitting, weaving, printing and embroidery. Other categories and locations include digital fabrication (6 companies in UK, mainly makerspaces, etc.) and printing (many general printers in UK, few specialised in textiles in general or textile packaging in particular). The mapping of the companies is only done for the UK with 8 companies in Fashion construction and 39 in textiles.
- **Findsourcing.com** provides world-wide mapping, categorisation and search for footwear or footwear component suppliers based on shoe types, customer gender, location, minimum order quantity (from 1 - 2000+), product category, e.g. niche (Waterproof, Safety, Golf, Riding, Medical, Riding, Dance, Orthopaedic), processes, capabilities (pre-Development, Development, Production, Logistic), lasting method, daily production quantity (1-2000), and size range. In total 128 suppliers are mapped within Europe (UK - 2; Netherlands - 1; Poland - 1; Italy - 1; Spain - 2; Portugal – 119; Turkey – 2). Additionally, the service is offering a knowledge base to help facilitate more work within this industry.

2.1.4 Relationship structures in networks

Within the relational element of configuration (Figure 4), customer focus and closeness, potentially enabled by co-design, is highlighted and closely related to the need for knowledge throughout all the types of relationships. Additionally, trust is important for both supplier and customer relationships both leading to and being enabled by extensive communication and information sharing, as well as collaborative relationships. The notion of the level of leadership and power is relevant within the wider network and within the organisation itself. Additionally, due to the importance of flexibility within the other elements, skilled human resources with high levels of worker authority is key, especially with highly customised products [12]. Further, flexibility and modularity of supplier relationships is important in some situations. Many of these aspects are closely related to aspects related to learning, which is required both internally and externally, and issues of culture, often which are more related to corporate culture and resistance to collaboration rather than national culture.

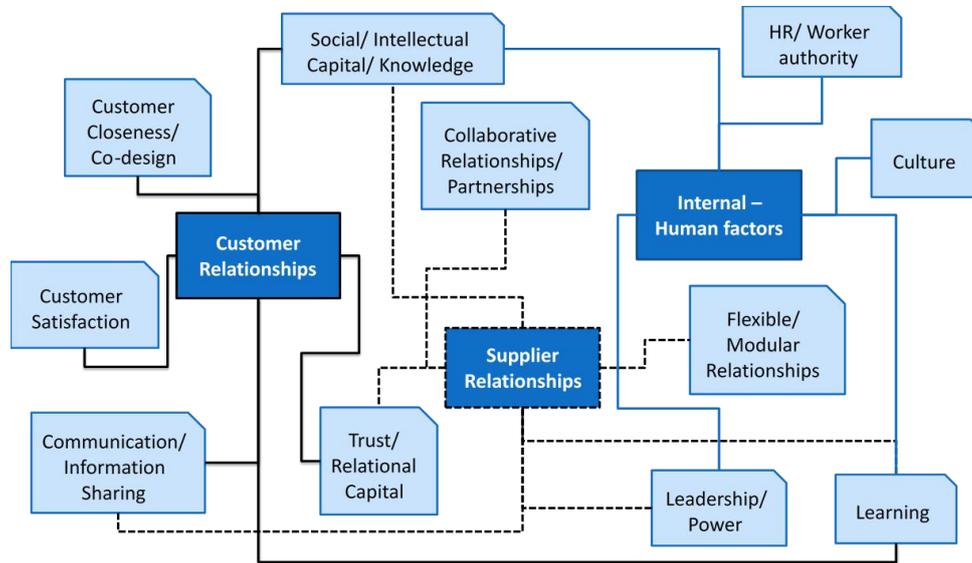


Figure 4 Emergent Themes in Relationship structure

2.1.4.1 Market Characteristics Related to Relational Structures

Some relational themes prominent on the market include customer focus and co-design, collaborative relationships and partnerships, and the requirement for extensive communication and an empowered workforce (Table 4).

Table 4 Company examples for themes in relationship structures

Company examples	Themes	Descriptions
Zara	Information sharing, Leadership/ Power	Extensive real time customer information, both what is selling (quantitative) and why it is selling (qualitative), and integration and monitoring of suppliers is crucial and maintains the brand power in the supply chain.
Boohoo	Customer relationships, Supplier communication, Learning	Faster fashion model, with the network of local manufacturers as crucial with ease of sharing digital inspiration, along with close digital relationships with customers, enabling 'test and learn' model, nature of their production matched to the needs/outlook and price point of the young women that they target, through leanness and flexibility with online only.
Hugo Boss	Human resources,	Key objectives include having the right people and maximizing customer satisfaction, actively transforming the corporate culture for 'fast track', encouragement of employees to embrace change.

	Customer focus, Culture, Learning, Trust	Regular training is undertaken with suppliers for quality in addition to the controls integrated into the production process, Trustworthiness emphasised along with customer focus.
Adidas	Flexibility, Collaborative partnership	'Speedfactory' model intended to produce the majority of the materials needed in-house providing the flexibility required. Strategic collaborative partnership with Carbon Inc., supporting the ability to produce accurately, according to the demands of the customers.
Unmade	Collaborative relationships, Customer satisfaction, Co-design	Collaborations highlighting the importance of co-design with customers, collaborative relationships between the digital service provider, the manufacturer, the brand, and in some cases a retail platform e.g. Farfetch. Importance with luxury for high quality visuals and experiences that can be maintained with this model.

2.2 Key Takeaways

The key aspects within the market analysis include:

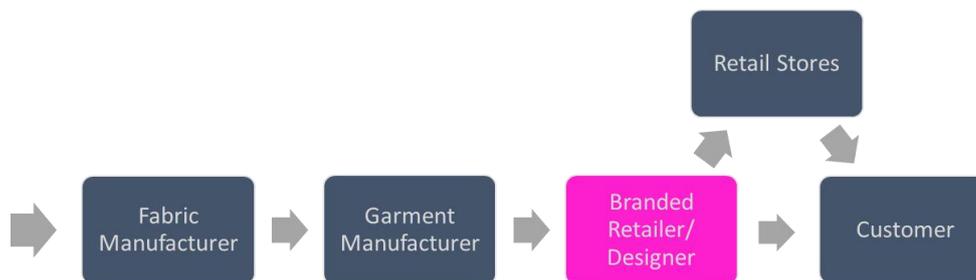
- Closer relationships with the customers, with technology being used to capture customer voices, leading to greater customer knowledge, which can be applied to standard production.
- With these types of production is the need for more collaborative relationships and extensive information sharing in the value chain. This communication and information sharing is enabled by, as well as strengthening the level of trust between the network actors. Additionally, extensive data sharing is related to the requirement for agility in business models e.g. Boohoo, and Zara.
- Further, challenges are associated with increasing customer involvement e.g. maintaining differentiation and the need for new models for collaboration and data sharing/protection [11].
- The flexibility and types of relationships in the network are dependent on the types of products being addressed, with increasing complexity and customisation maintained in-house wherever possible. However, partnerships for complementary competences are beneficial in many cases e.g. Adidas, Unmade.
- Overall the focus on accurately meeting customer demands is crucial in a high-cost environment, and increasingly world-wide due to increasing global competition. Thus, with all activities focused on customer satisfaction e.g. with Quality Management, comes the need to understand what level of customisation and involvement is desired or demanded.
- Additionally, the digital transformations of production e.g. Hugo Boss, Microfactory, Digimode, and the consumer products themselves is crucial consider, especially for the context of high value-added production in textiles and apparel.

2.3 Configuration-based exemplary company cases

Following are several company cases which are understood in relation to their business model in the textile and apparel value chain, the most notable aspects of their supply network configurations, as well as their priorities within their network configuration. The presentation of these exemplifying cases highlights some relevant aspects of the current capabilities within the European textile and apparel industry.

2.3.1 Branded Retailer/Designer of Garments

The supply network configuration overview can be seen in (Figure 5). The Brand mainly sells larger volumes through external retail stores. Overall, the style and persona of the company is linked to the country of origin, and they seek to offer innovation at competitive prices. Currently, the company is focused on larger volume MTS production, outside of Europe. A small portion of the production is offering late stage, minimal customisation, through their direct to consumer sales channel. Though not currently undertaking small series EU based manufacturing, the company plans to develop nearby production to strengthen their existing innovative offering.



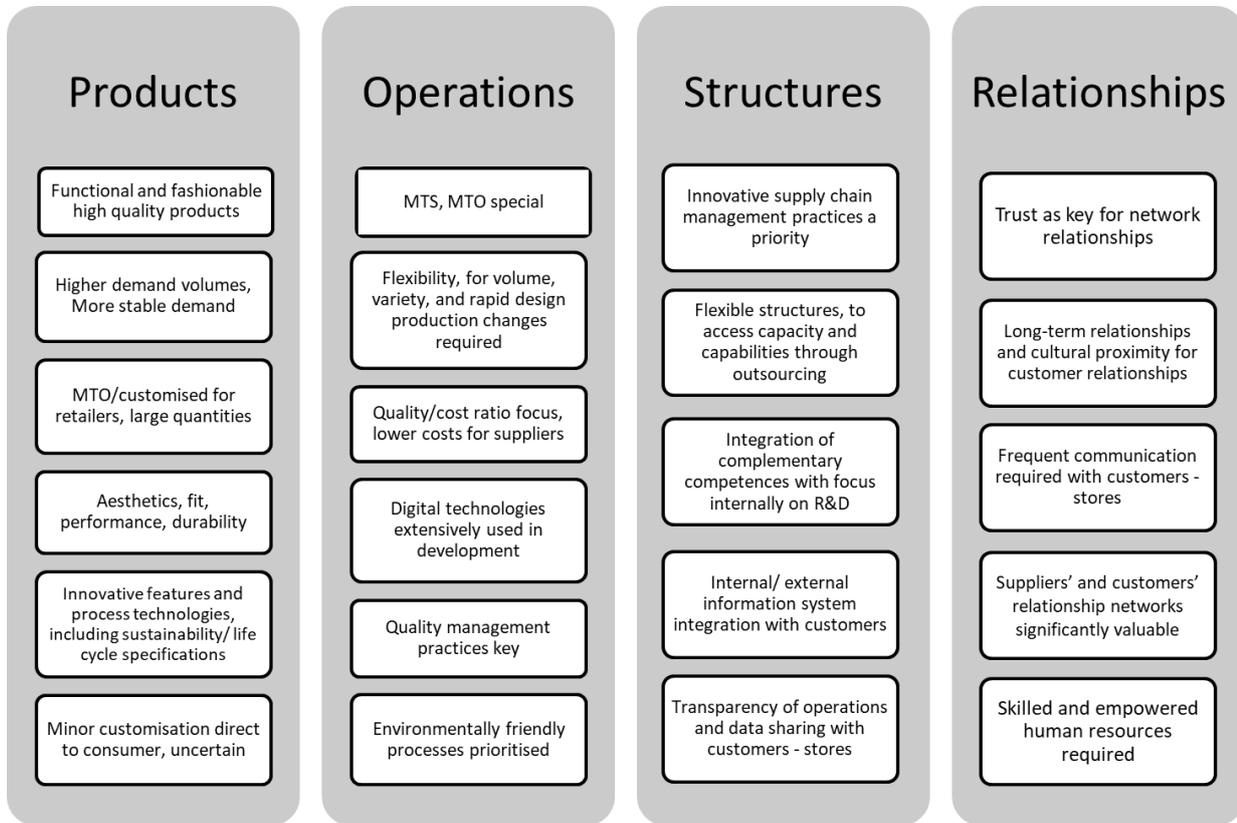
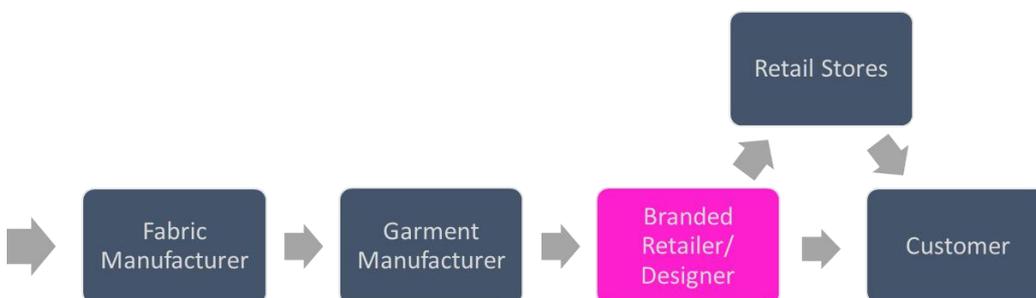


Figure 5 Network configuration Branded Retailer/Designer

2.3.2 Branded Retailer/Designer of Other Goods

As with the previous company, the Brand mainly sells larger volumes through external retail stores and the network configuration overview can be seen in (Figure 6). As with the previous company, though not currently undertaking small series EU based manufacturing, there are plans to develop nearby production options.



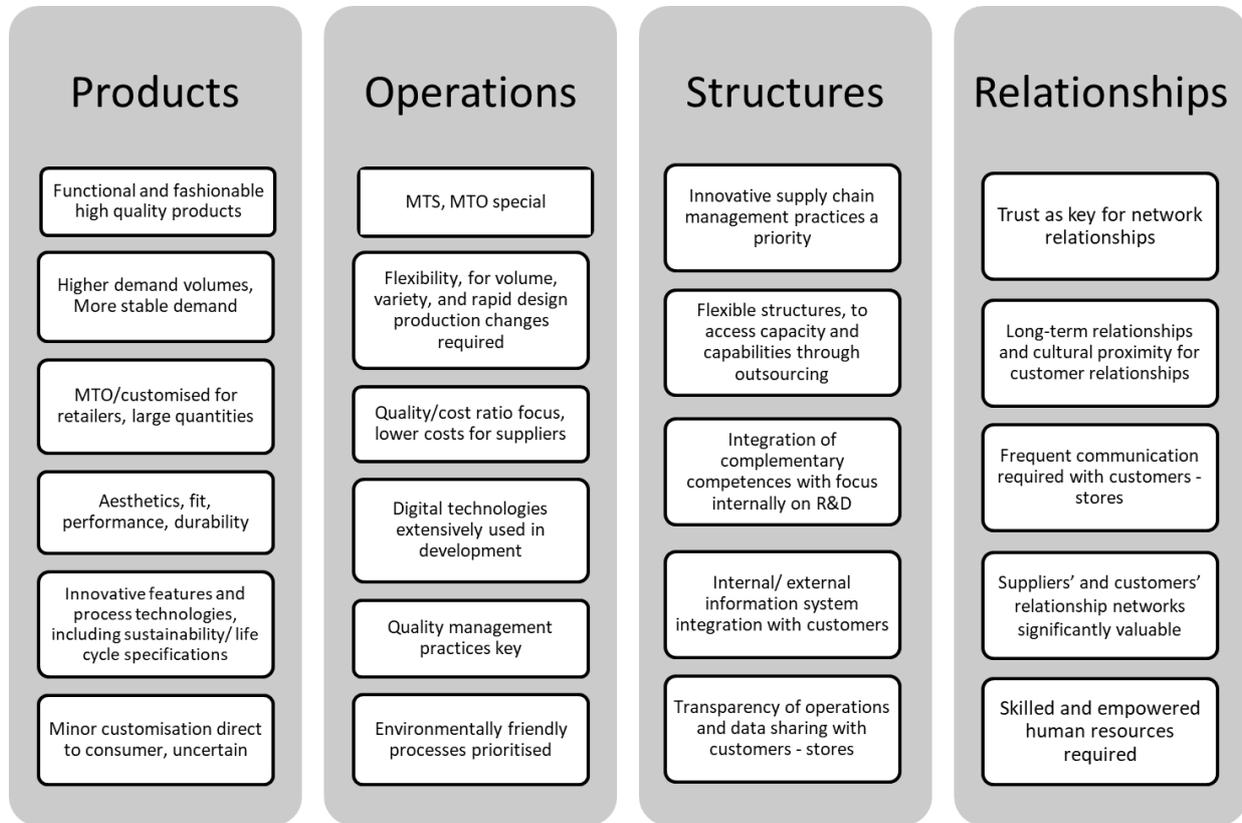


Figure 6 Network configuration Branded Retailer/Designer

2.3.3 Luxury Full Price Garment Producer

The overview of the supply network configuration can be seen in (Figure 7), with the company offering innovative, full package solutions/Cut-make-trim production on-demand in small volumes for luxury brands. The flexibility to provide exactly what is demanded is crucial, in their production focusing on small series garment manufacturing (e.g. collections for showing). The types of garments demanded/produced is highly unpredictable, but the volume of production is more predictable. The overall volume is dependent on the number of brands with orders at the same time. The ways of working in terms of design, development, production, etc. must be highly flexible dependent on the specific demands of the customers, and the nature of the products demanded. Thus, highly skilled and flexible workers, and a flexible supplier network, are required to achieve this flexibility as the structure of the production must be stable based on the steps of garment production. Learning, digital technologies, and integration are prioritised internally, with close relationships throughout a wider network to consistently offer the innovation required. In line with their Quality Management certification, all activities are focused on customer satisfaction, and close face-to-face relationships with customers are key, benefitting from close proximity.

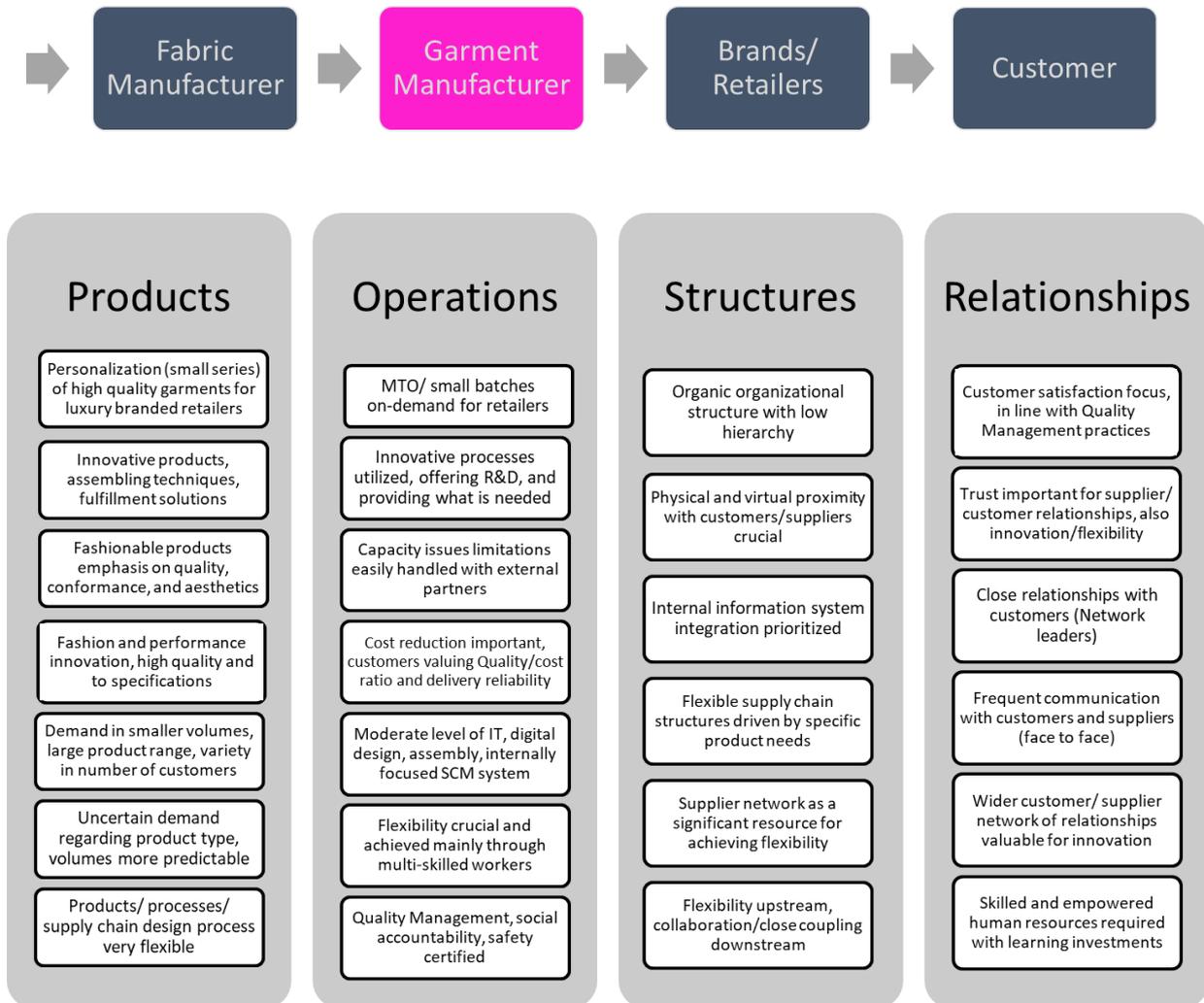


Figure 7 Network configuration Garment Producer

2.3.4 Fabric/Luxury Brand/Full Price Garment Producer

The overview of the supply network configuration is presented in (Figure 8), with largest focus on innovative, and sustainable fabric finishing/production. Secondary focus is on an own brand of luxury fashionable, high performance garments for men. Additionally offering co-branding and full price garment production, focused on complex, niche, luxury, performance garments, not limited to own fabric. Relationships with other brands are strengthened by the ability to offer fabric and keep crucial aspects in-house and controlled. This is achieved through a centralised and vertically integrated structure, though geographically dispersed. Focuses on efficiency, and digital tracking are mainly regarding the larger volumes of fabric production. For garments the production is very product driven, with garment design driving the nature of sourcing and related processes. Closeness to customers is important for garments, though not geographically, rather regarding the

knowledge of the needs within the specific niche. Existing integration of end-customers and offering of customisation is minimal, focusing more on highly innovative and complex garments. The innovative and sustainable fabric is roughly produced half on-demand and half popular fabrics MTS.

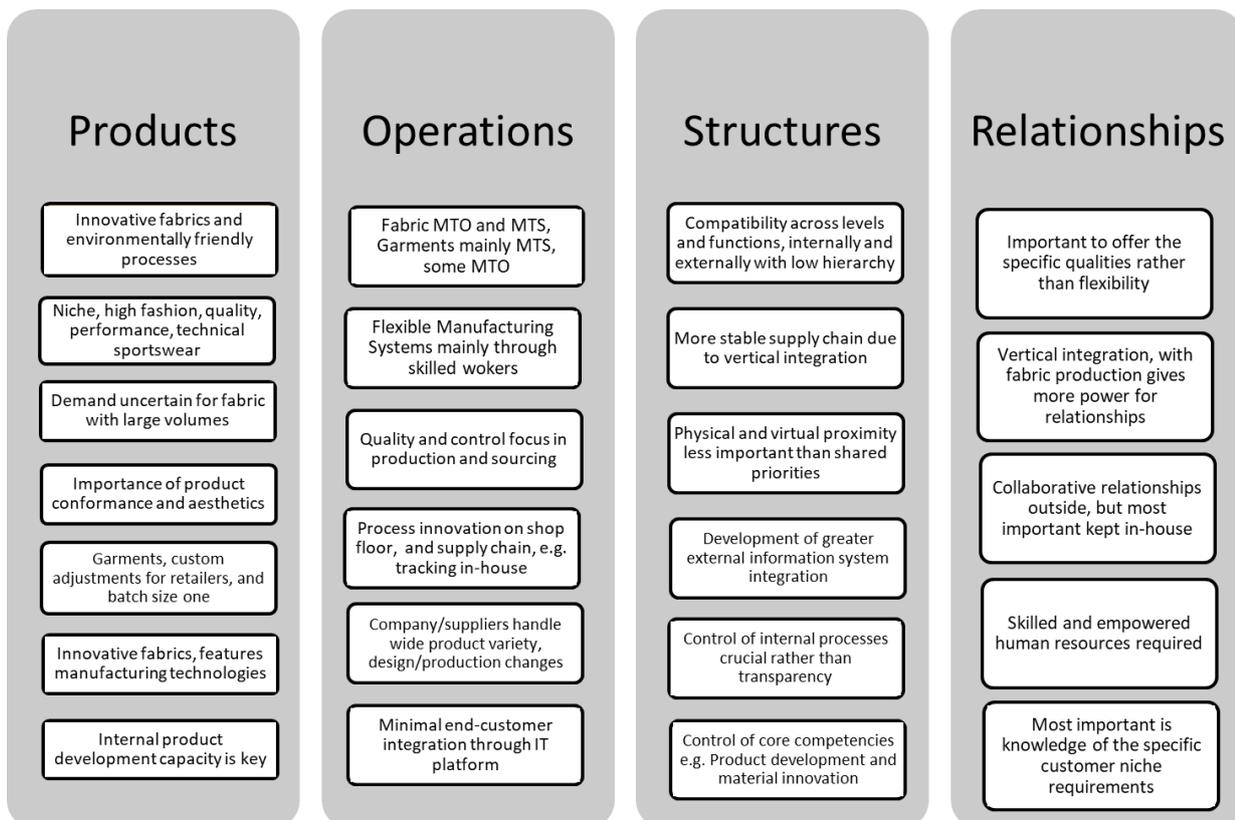
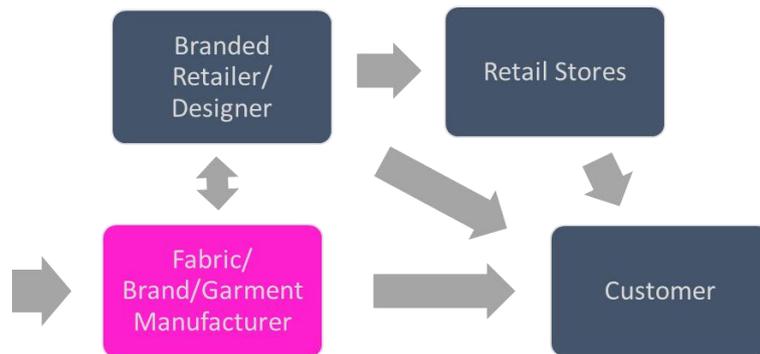


Figure 8 Network configuration Fabric, Brand, and Garment Producer

2.3.5 Collaborative Platform for MTM Production

The overview of the supply network configuration is presented in (Figure 9), from both sides of the platform providing integrated solutions for companies to offer MTM production (Platform provider

on top and platform user/retailer on the bottom). The platform consists of a front-end customer interaction/configurator integrated into existing webshops, with order integration into existing shopping baskets, and information automatically being sent to any manufacturer that the retailer chooses that has the required digital cutting capability. Thus, the platform enables flexibility or stability in production locations and sourcing, as well as simplifying the experience for the customers. The service is customised to the aspects that the specific brand/retailer wants to offer to their customers, with the main on-going activities being the input of new fabrics into the platform by the service provider. Thereafter, the required activities are handled automatically.

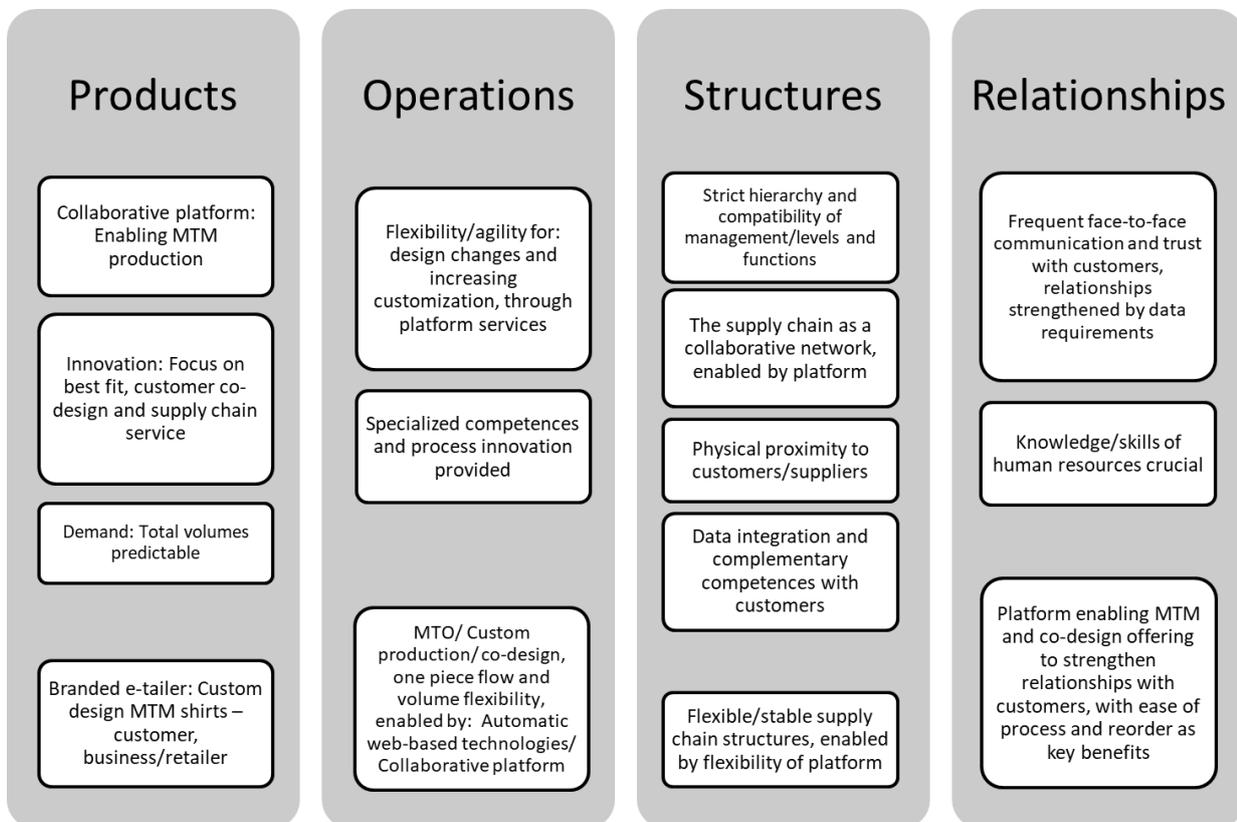
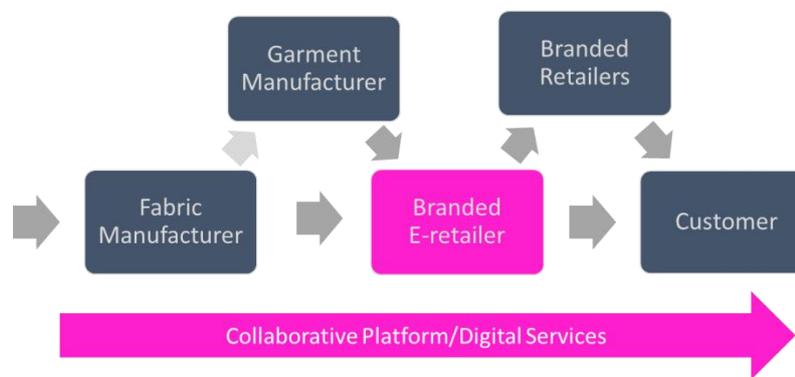


Figure 9 Network configuration Collaborative Platform/MTM Production

3 Network Configuration-based Supplier Selection

3.1 Criteria for Competitiveness and Supplier Selection

The following list of criteria was generated from a review of literature on the topic of small series manufacturing, as well as the general literature on supplier selection criteria, with a maintained focus and orientation on the supply network configuration. The criteria are organised and presented below along the four elements of network configuration [1] and sub-categorised thematically. Aspects related to the value structure are thematically related to quality, customisation, and innovation. The operational aspects have to do with cost, technology, process capabilities, performance, flexibility and agility, etc. The network structures take into account the internal and external structures both physical and virtual, which closely relate to the types of relationship and relational characteristics.

Value Structure of Products/Services:

- Product quality
 - High performance of products
 - Product durability
 - Product reliability
 - Conformance to technical specifications
 - Conformance to standards (chemical/physical)
 - Quality of design/aesthetics
 - Conformance to life-cycle specifications (e.g. ease of repair)
 - Environmentally friendly products
- Product innovation
 - Innovative products (customer service)
 - Innovative products (new products/features)
 - Innovative products (new processes/technologies)
- Product customisation
 - Standard products with late stage customisation
 - Custom adjustments for a certain order quantity (smaller batch)
 - Mass customised products (batch size one)
 - Fully customised products (unique design/batch size one)
 - Wide product range

Operational structure:

- Operational capacity and cost
 - Capacity available (utilisation/expansion)
 - Cost reductions/low cost
 - Quality/cost ratio
- Operational technology and capabilities

- Automation/digital manufacturing/Flexible Manufacturing
- Available web-based business activities
- IT level for real time information accessibility/digital integration
- Reduction of defective rate/Quality assurance system
- Capabilities of machinery
- Process/product/competence specialization
- Offering additional services or capabilities
- Innovation of shop floor management
- Innovation of supply chain management
- Innovation of process technologies
- Environmentally friendly processes
- Operational delivery performance
 - Fast delivery speeds
 - Delivery reliability (as promised)
 - Delivery dependability (on-time)
- Operational flexibility and agility
 - Producing/handling both large and small order sizes
 - Mix flexibility (product types)
 - Wide range within each product type
 - Making rapid design changes
 - Making rapid production changes
 - Variety of packaging/distribution activities
 - Rapidly reducing product development cycle time
 - Rapidly increasing the level of product customisation
 - Rapidly increasing the level of customer service
 - Rapidly improving delivery reliability
 - Rapidly reducing delivery lead times

Supply Network Structures:

- Supply network organisational structures
 - Top management compatibility
 - Organic organizational structure (flat, decentralized)
 - Compatibility across levels and functions
 - Part of a collaborative network
- Supply network proximity and integration
 - Physical proximity (to customers or suppliers)
 - Virtual proximity (to customers or suppliers)
 - Internal knowledge/information system integration
 - External knowledge/information system integration
 - Transparency of operations and data/information sharing
 - Integration of complementary competences
 - Integration of planning/processes (e.g. PD)

- Shared/supply chain wide goals

Network Relationships:

- Cultural proximity (Business or regional)
- Long-term or close relationships
- Loose, flexible relationships
- Cooperative/collaborative relationships
- Frequent communication
- Relationships with other customers/suppliers
- Personnel/ skilled human resources

3.2 Survey for Supply Chain Competitiveness

The survey undertaken was targeted to textile and apparel companies in the EU, with special focus on Fabric Manufacturers, Garment Manufacturers, Brands, and Retailers. The survey was sent to a large number of companies in EU. Among the targeted countries, Sweden was a key target as the survey was officially administered by HB. Company list was obtained from Retriever – a Swedish company database. Additionally, the invitation to participate was sent out through the Swedish textile and fashion industry organisation - TEKO. Additionally, personal requests were made to company contacts of the group of researchers, at the different universities and research centres, for participation. The request was made to various different actors within the companies, ranging from CEOs to production and supply chain managers (39 respondents in total). The participants were asked to evaluate the individual criteria, first regarding what makes their company competitive to their customers, and thereafter what makes their suppliers competitive to them. The questions were focused on the context of small series, high value-added EU based production or sourcing, of which ~63% of the 36 responses to the question are already actively participating in, and ~11% plan to in the near future.

3.2.1 General Characteristics of Responding Companies

The characteristics of the responding companies are presented in the following tables and figures. (Table 5) highlights the location of the companies and where the majority of their internal operations are located. Thereafter, (Table 6) shows the breakdown in terms of primary business model in the textile/apparel value chain.

Table 5 Location of Responding Companies and Majority of In-house Operations

Country Location	# of Companies /39	In-house Operations
Sweden	26	26
Germany	4	4
Italy	5	3
Belgium	1	

UK	1	1
France	1	1
Finland	1	1
Netherlands		1
China		2

Table 6 Business Model of Responding Companies

Primary Business Model	Num	% /39
Fabric manufacturer	7	20%
Garment manufacturer – CM (Cut-Make)/ CMT (Cut-Make-Trim)	4	10%
Garment manufacturer - Full price (Whole garment)	7	17,5%
Brand/ Branded Manufacturer	11	27,5%
Retailer	3	7,5%
Other	7	17,5%

Within the other category of business model types included answers such as separation of main activities into locations like knitting in Sweden and sewing in the Baltic countries, being a specialized 'branded manufacturing fashion e-tailer', being a B2B technology company focused on alternative supply chain solutions, and offering garment decoration. (Figure 10) presents the breakdown of regional sourcing and production activities.

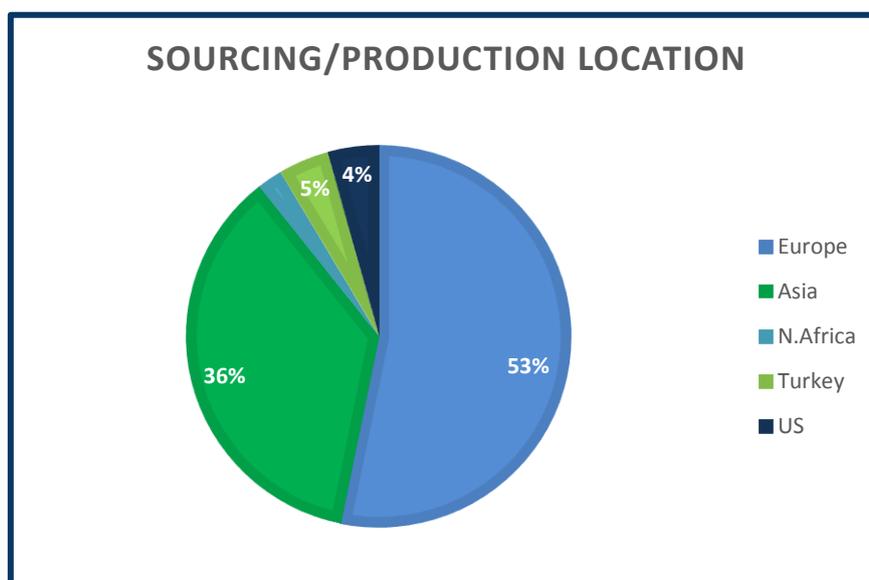


Figure 10 Primary region/country for sourcing materials/production

(Figure 11) presents the types of products/product ranges that the responding companies are involved with, followed by (Figure 12) showing which type is their main focus. The other category responses included product types involved with such as shoes and Interior decorations, made to measure and fit predictions for online shopping, work wear, sportswear (footwear), combat suit systems, technical textiles and special products for industry. Product focuses mentioned were described as including fashion MTM products, flight suits/systems, and design, manufacturing/management software.

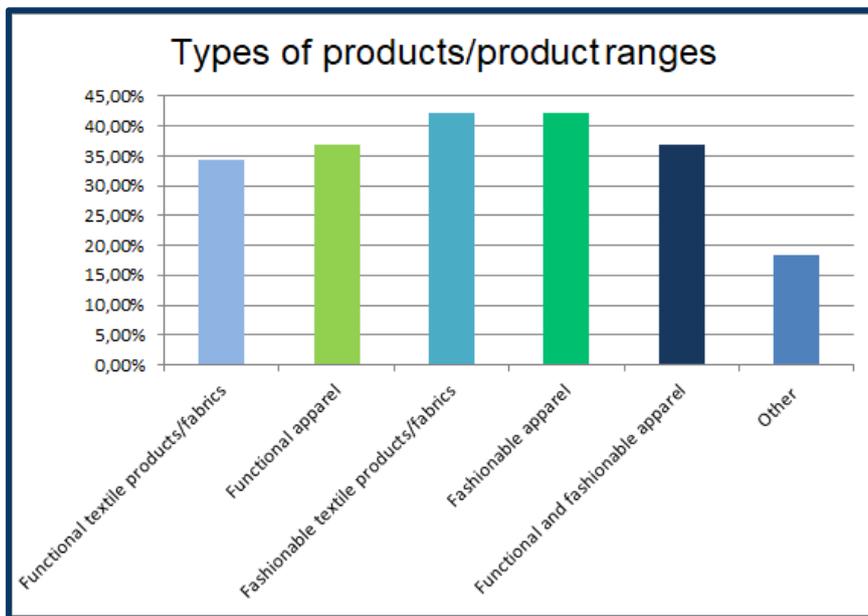


Figure 11 Companies' different types of products/product ranges

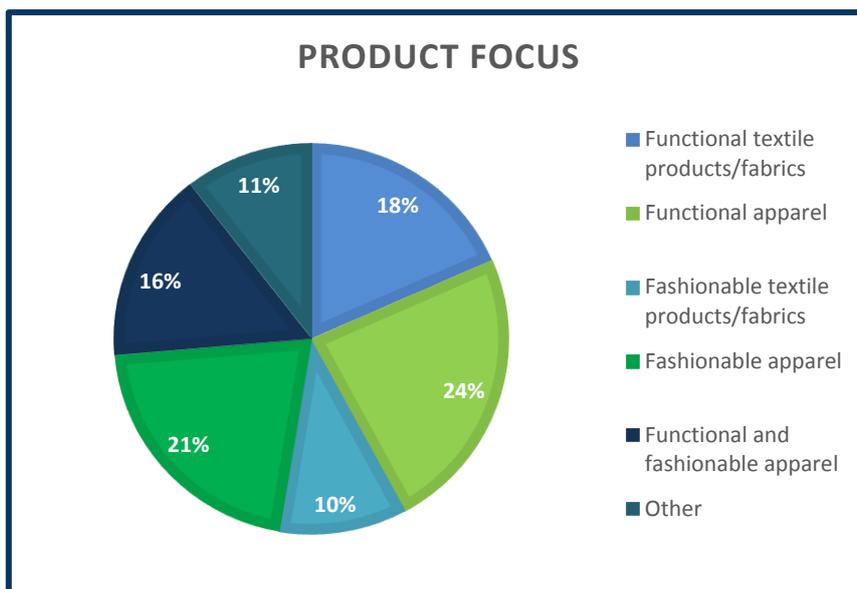


Figure 12 Companies' main product type focuses

3.2.2 Criteria Rankings and Evaluations

There were a total of 39 respondents, with specified 8 - CEOs; 3 - Owner/Founders; 5 - General Managers/Managing Directors; 5 - Supply Chain Managers; 9 - Production Managers/Product focus; 2 - R&D Managers; 2 - CFO/Chief Accountants; 1 - Business Developer; 1 - Head of Design; 1 - Plant Manager; 1 - Sustainability focus. Of the total respondents, there was a 69% complete response rate. The detailed results are presented below, with (Figure 13) showing the overview of the top ranked criteria items for companies themselves and their suppliers based on average ratings, and (Figure 14) listing the criteria in descending order. Thereafter the individual criteria are presented within thematic groupings, showing their weighted averages (3.2.2.1 – 3.2.2.4). For the thematic groups related to product customisation, and technology/capabilities, with no criteria items that made it into the top ranked lists for either companies or their suppliers a complete breakdown of responses is presented (Figures 18; 19) and (Figures 22; 23).

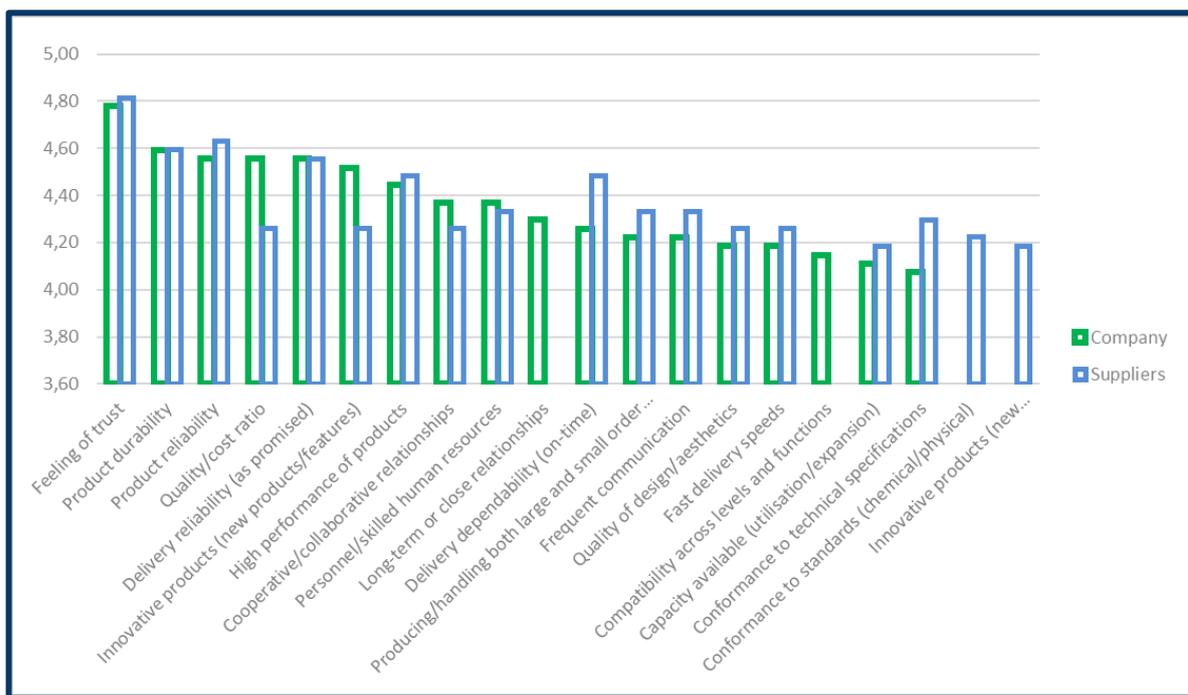


Figure 13 Average of top ranked criteria for companies and their suppliers

Company	Suppliers
<ul style="list-style-type: none"> • Feeling of trust • Product durability • Product reliability • Quality/cost ratio • Delivery reliability (as promised) • Innovative products (new products/features) • High performance of products • Cooperative/ collaborative relationship • Personnel/skilled human resources • Long-term or close relationships • Delivery dependability (on-time) • Producing/handling both large and small order sizes • Frequent communication • Quality of design/aesthetics • Fast delivery speeds • Compatibility across levels and functions • Capacity available (utilisation/expansion) • Conformance to technical specifications 	<ul style="list-style-type: none"> • Feeling of trust • Product reliability • Product durability • Delivery reliability (as promised) • High performance of products • Delivery dependability (on-time) • Producing/handling both large and small order sizes • Frequent communication • Personnel/skilled human resources • Conformance to technical specifications • Quality of design/aesthetics • Innovative products (new products/features) • Quality/cost ratio • Fast delivery speeds • Cooperative/ collaborative relationships • Conformance to standards (chemical/physical) • Innovative products (new processes/technologies) • Capacity available (utilisation/expansion)

Figure 14 Top ranked criteria for companies and their suppliers in descending order

3.2.2.1 Value structure of products/services

3.2.2.1.1 Product quality

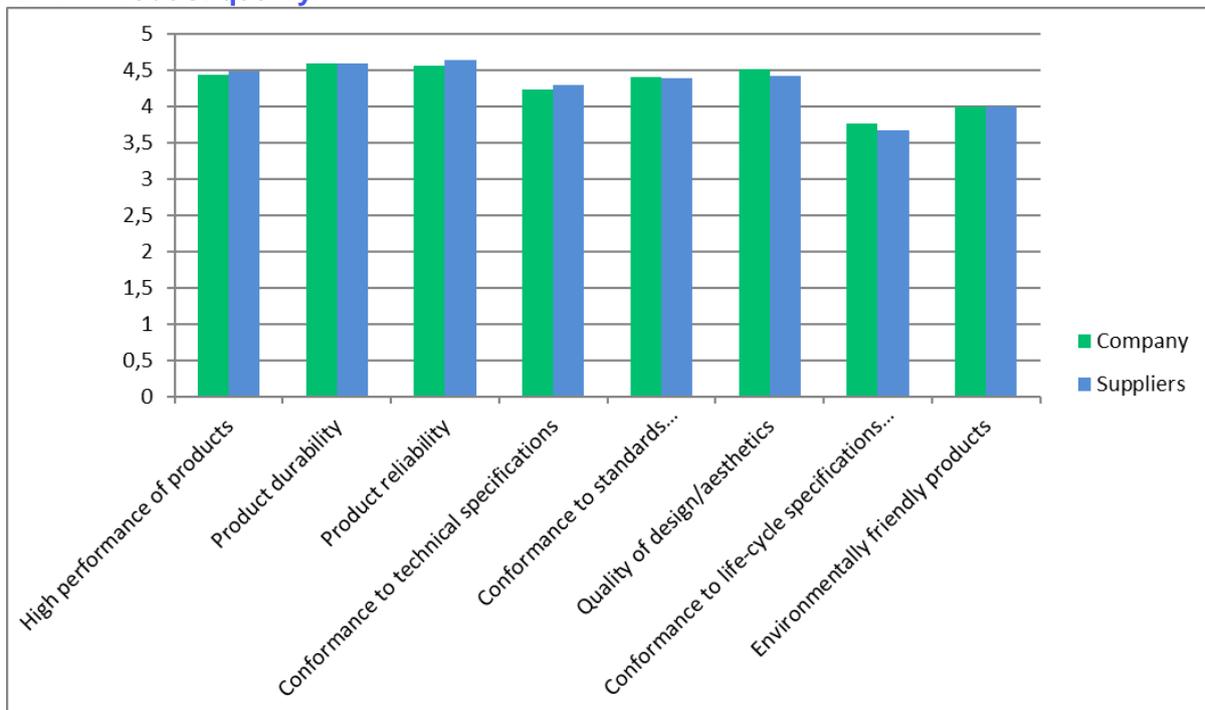


Figure 15 Product quality criteria weighted averages

3.2.2.1.2 Product innovation

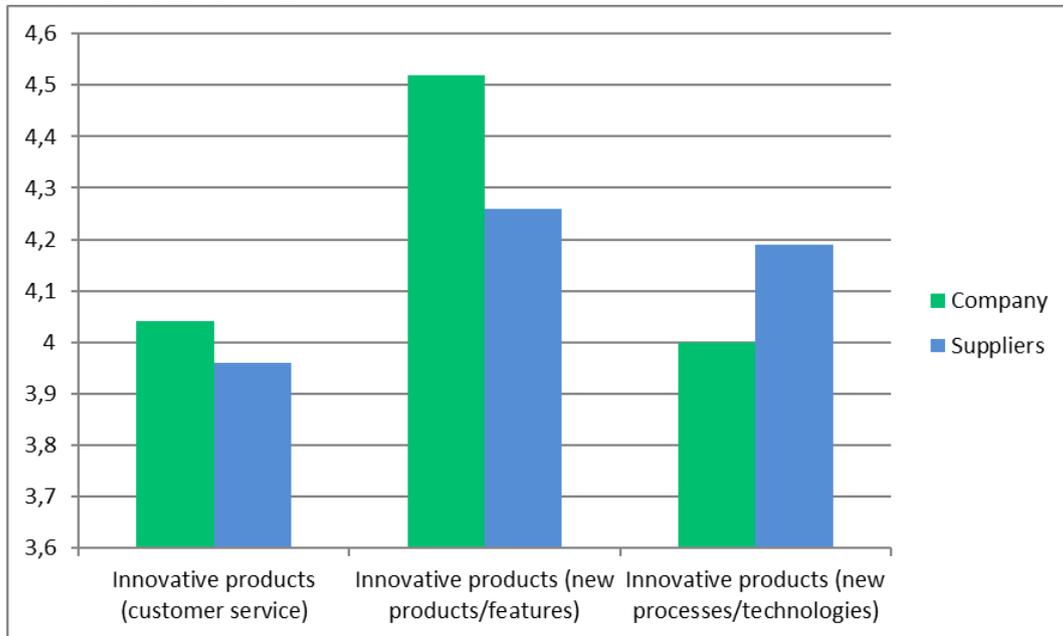


Figure 16 Product innovation criteria weighted averages

3.2.2.1.3 Product customisation

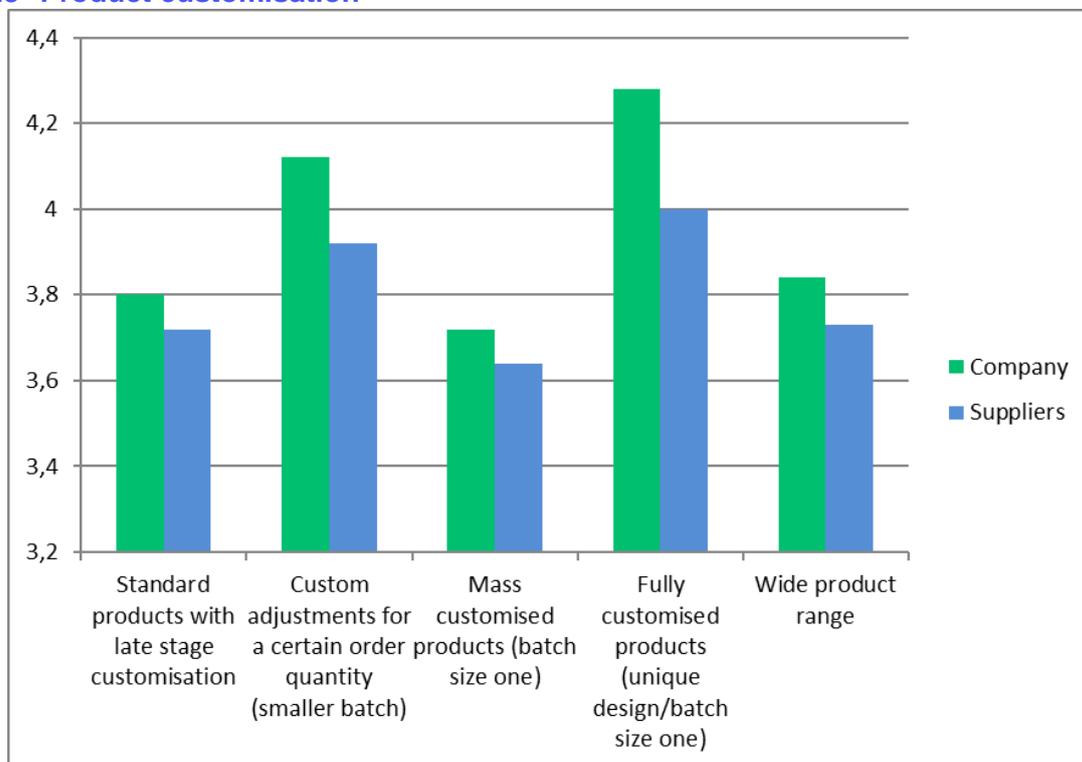


Figure 17 Product customisation criteria weighted averages

Based on the lack of items from the product customisation category being included in the top ranked list, a detailed presentation is shown to better understand the breakdown of respondent ratings in (Figure 18) for companies and (Figure 19) for their suppliers. Though the criteria were not ranked the highest on average, it can be seen that many individual companies consider these abilities as important, especially offering full customisation to customers, though being slightly less prioritised for their suppliers.

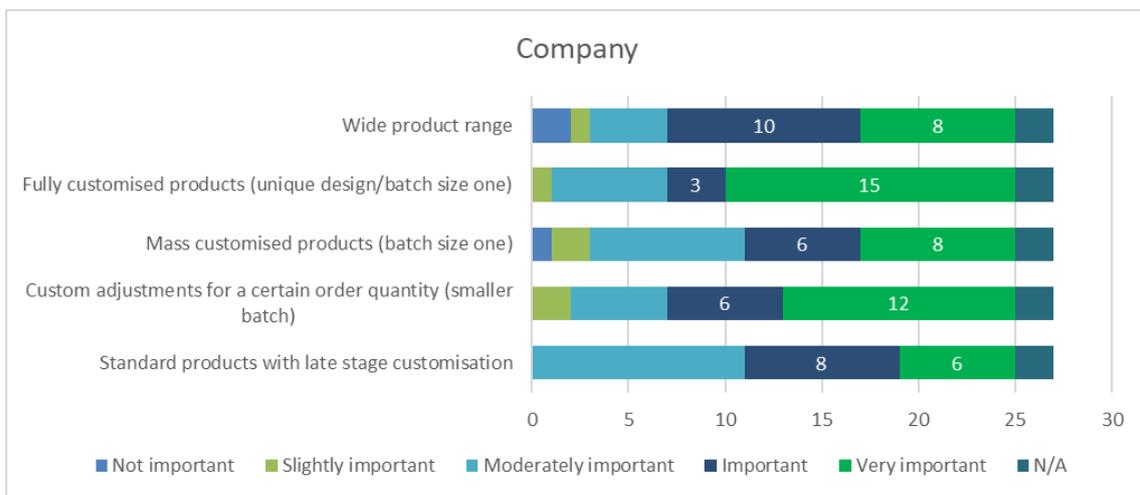


Figure 18 Product customisation criteria detailed responses for companies

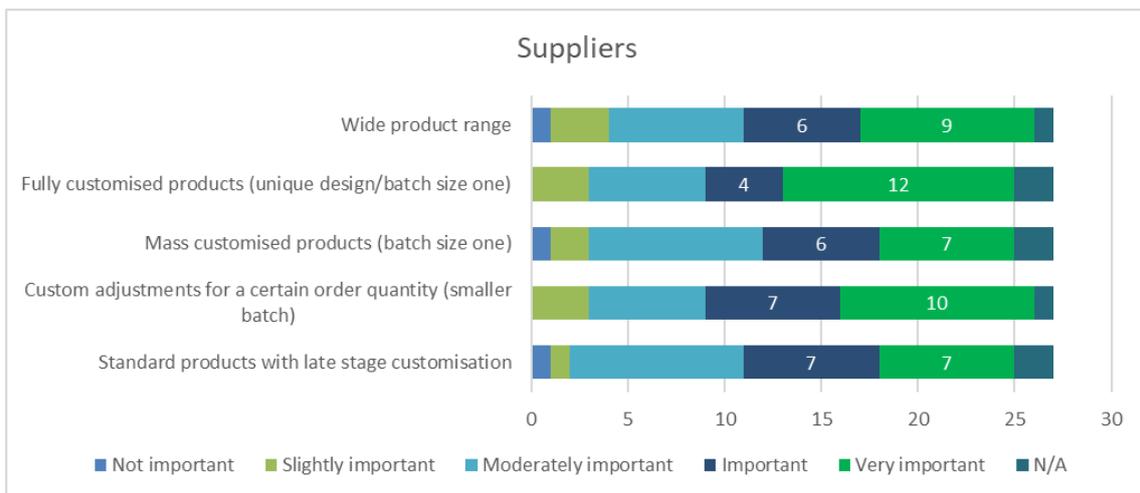


Figure 19 Product customisation criteria detailed responses for suppliers

3.2.2.2 Operational structure

3.2.2.2.1 Operational capacity and cost

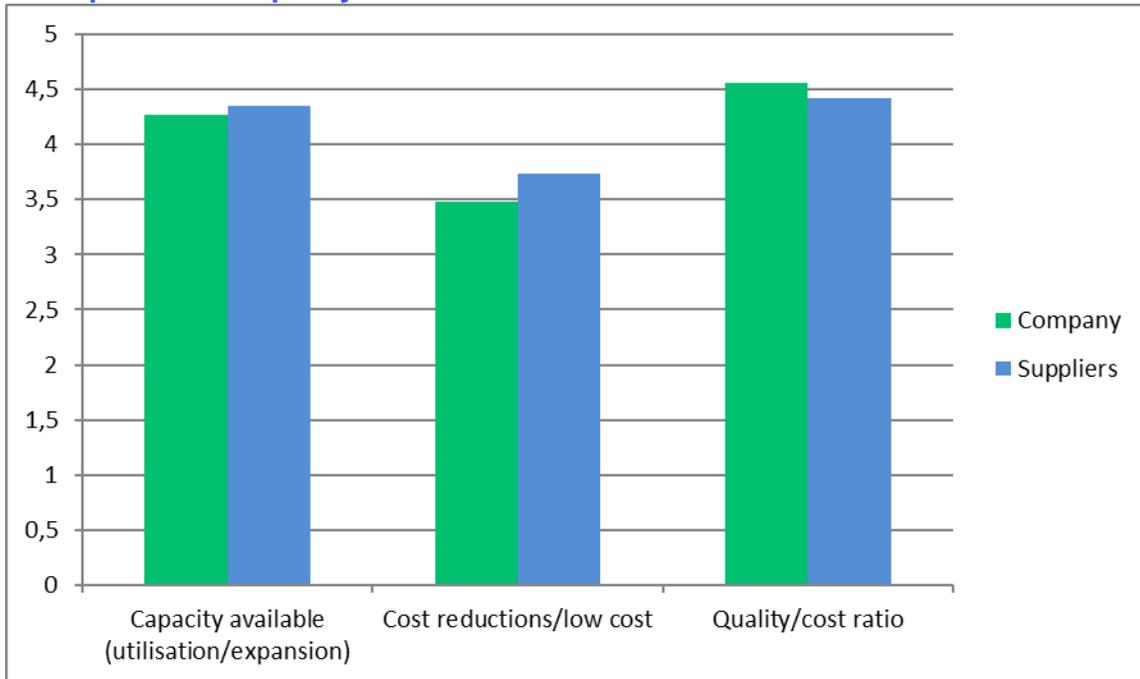


Figure 20 Operational capacity and cost criteria weighted averages

3.2.2.2.2 Operational technology and capabilities

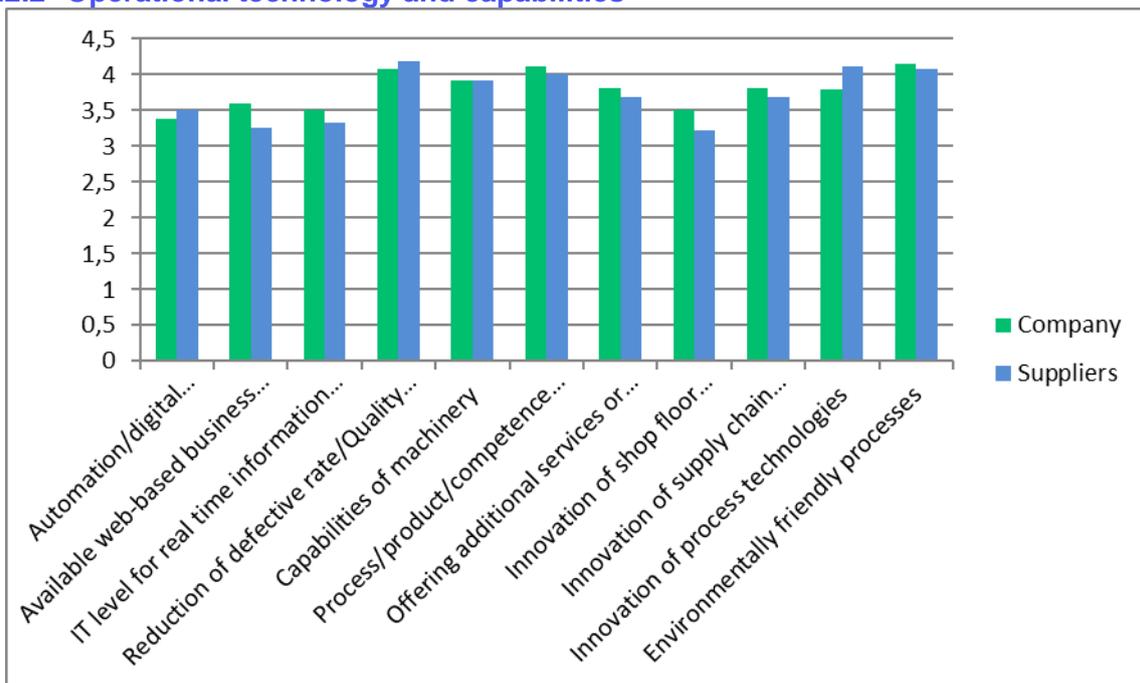


Figure 21 Operational technology and capabilities criteria weighted averages

As none of the items from the operations technology category were included in the top ranked list of criteria, a detailed presentation is shown to better understand the breakdown of respondent ratings in (Figure 22) for companies and (Figure 23) for their suppliers. The most prioritised are the overall specialisation of competences, and quality assurance, with digital technologies not widely considered important currently.

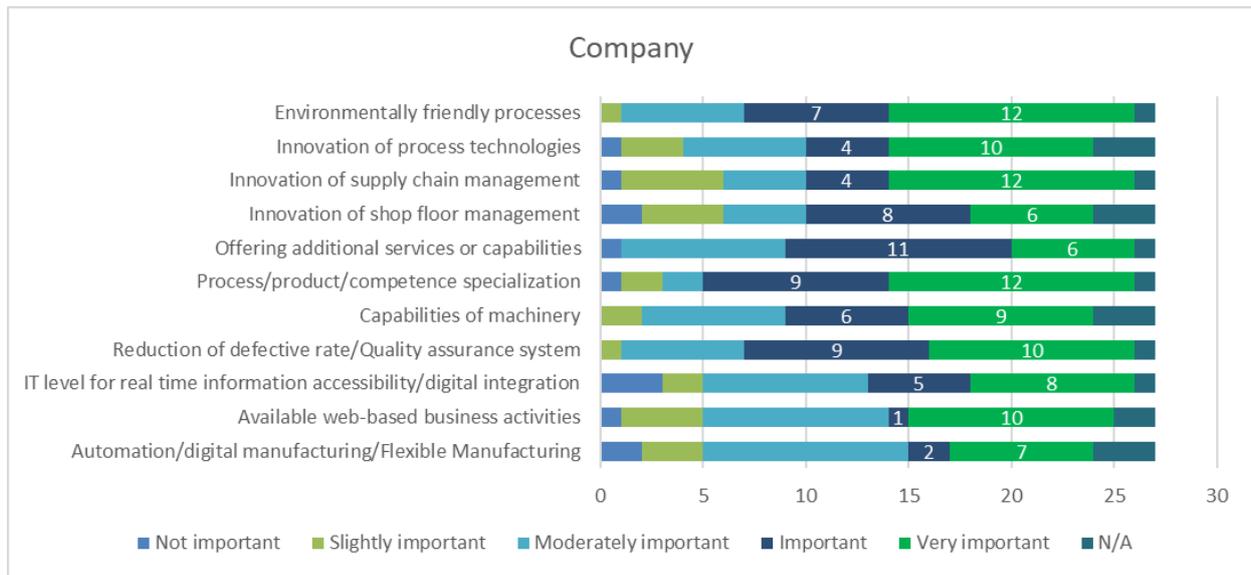


Figure 22 Operational technology and capabilities criteria detailed responses for companies

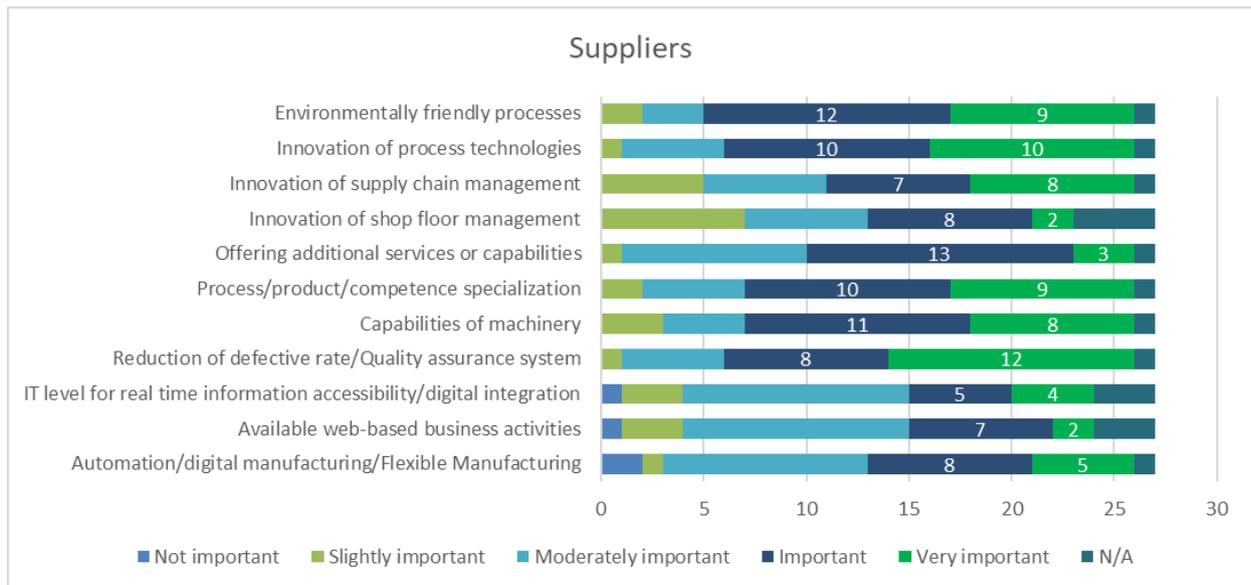


Figure 23 Operational technology and capabilities criteria detailed responses for suppliers

3.2.2.2.3 Operational delivery performance

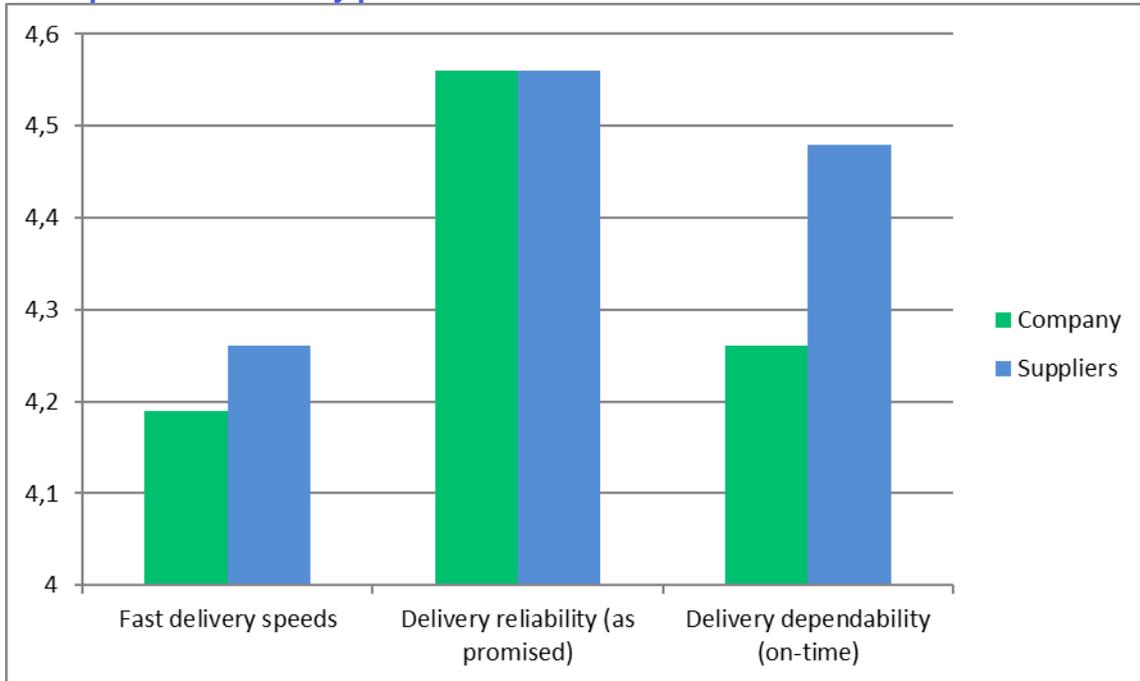


Figure 24 Operational delivery performance criteria weighted averages

3.2.2.2.4 Operational flexibility and agility

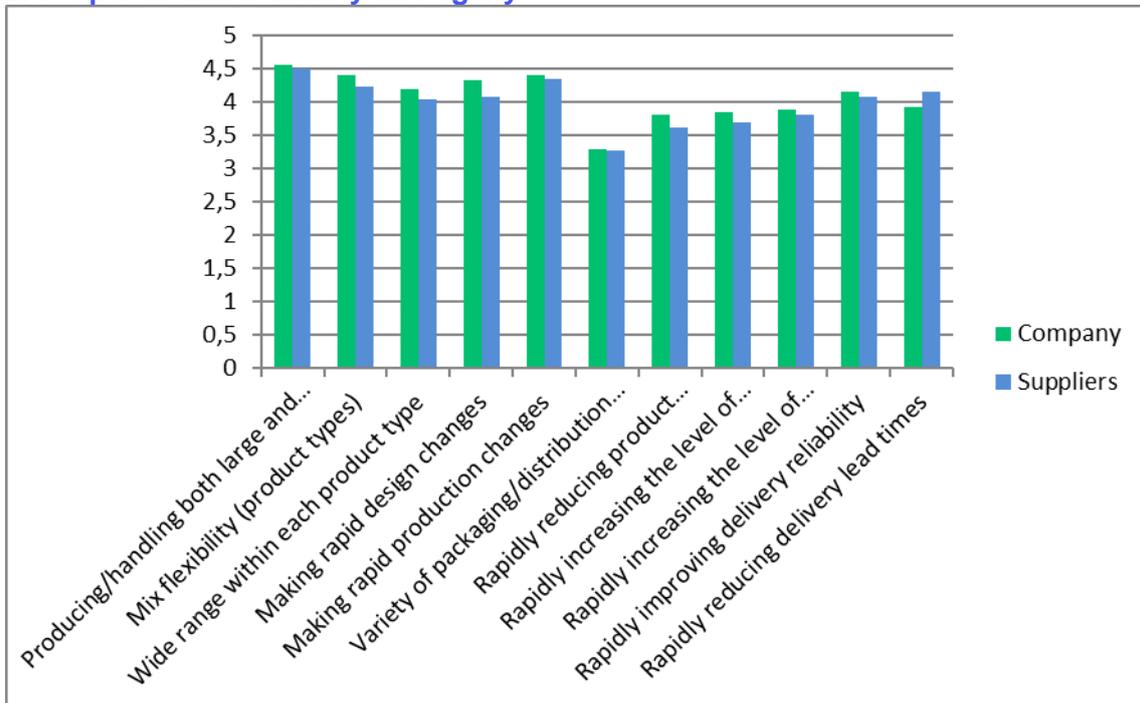


Figure 25 Operational flexibility and agility criteria weighted averages

3.2.2.3 Supply network structures

3.2.2.3.1 Supply network organisational structures

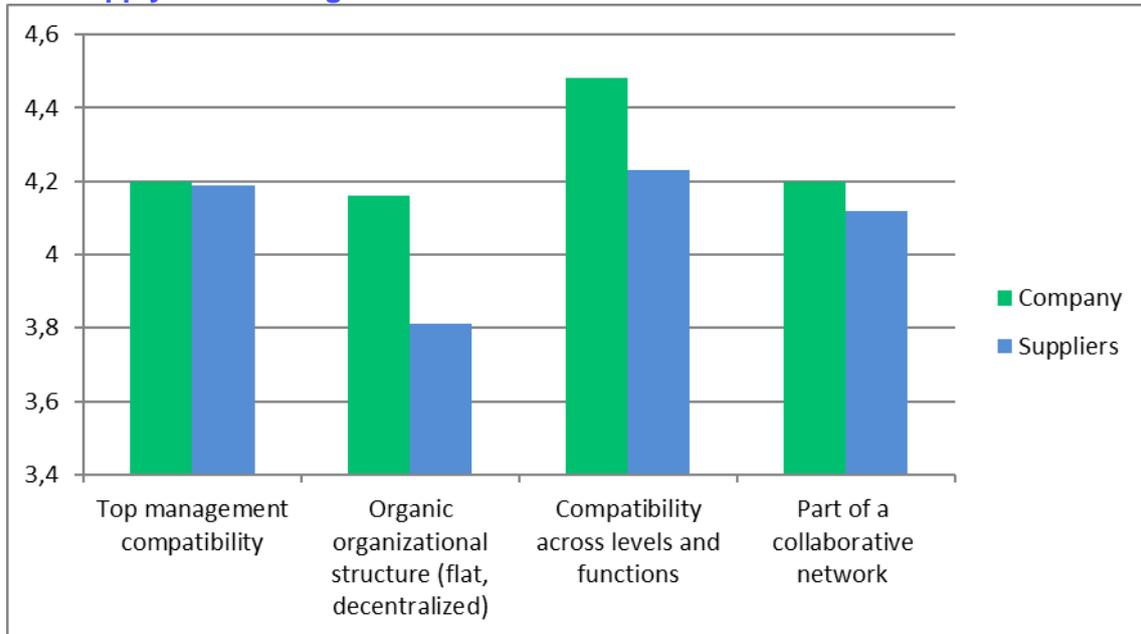


Figure 26 Supply network organisational structure criteria weighted averages

3.2.2.3.2 Supply network proximity and integration

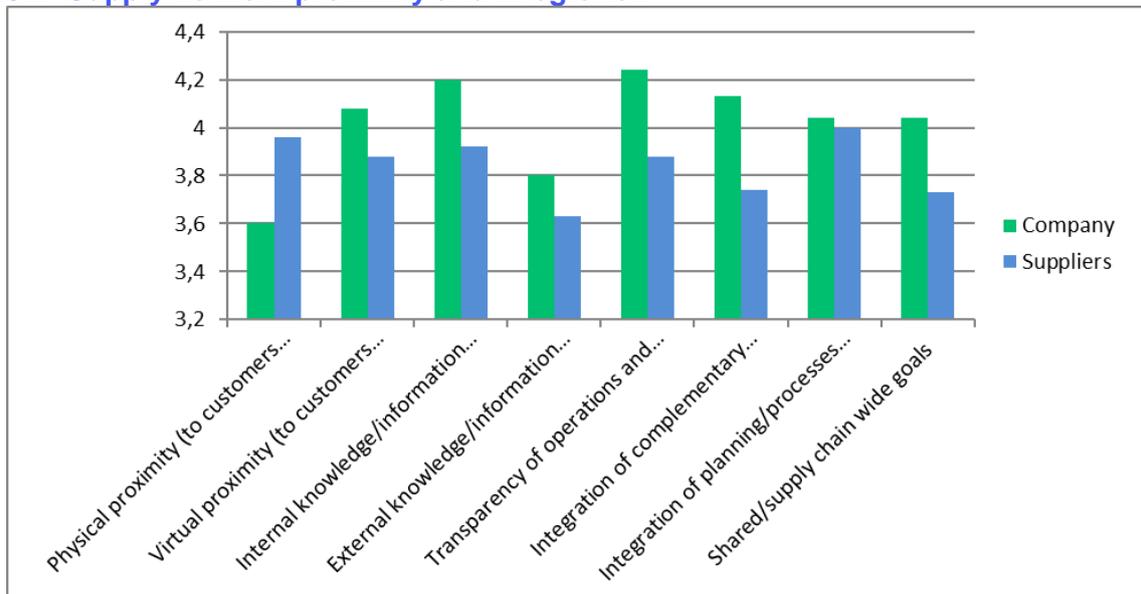


Figure 27 Supply network proximity and integration criteria weighted averages

3.2.2.4 Network relationships

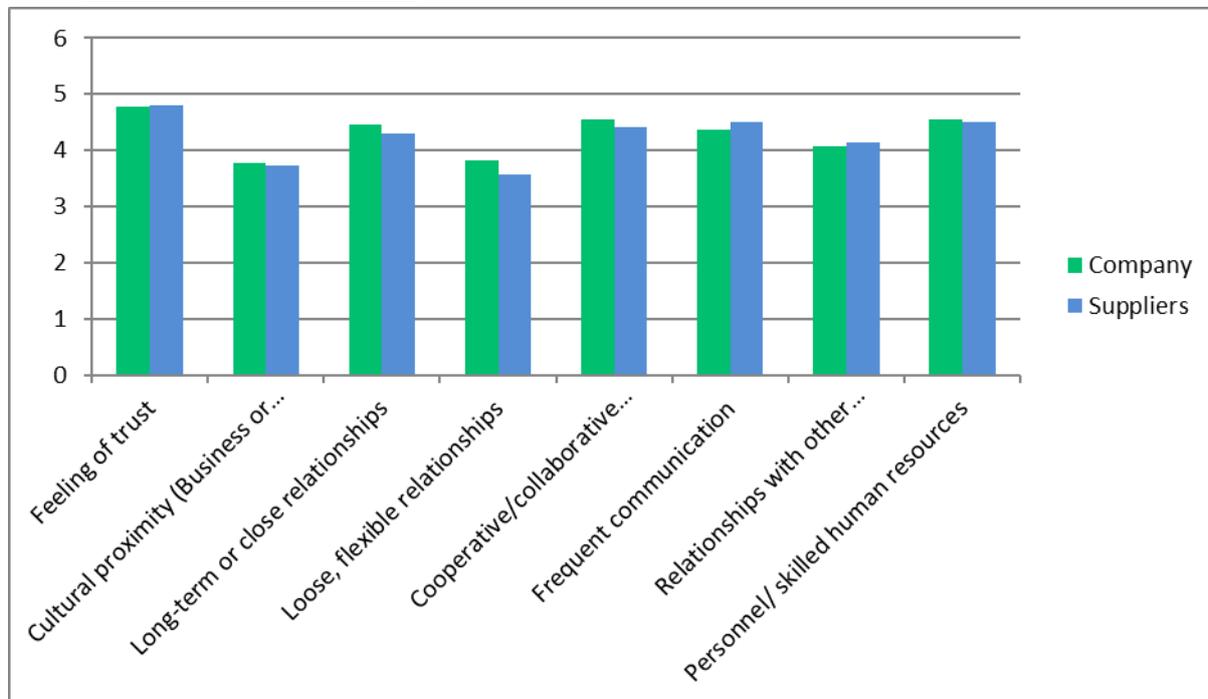


Figure 28 Network relationship criteria weighted averages

3.3 Summary of Survey Results

The following sections highlight the most important performance indicators according to the survey results and the enablers which are considered most relevant. Section (3.3.1) details the highly ranked criteria that can be understood as Key Performance Indicators (KPIs), whereas the remaining criteria not included but also highly ranked (Figures 13; 14) are mainly those categorized under relational and collaborative aspects. As these aspects are key to support these measurable KPIs, they are discussed in the following section (3.3.2) along with other enablers.

3.3.1 Key Performance Indicators for EU supply network competitiveness

Based upon the top ranked factors shown in (Figures 13; 14) the most important performance indicators are extracted and presented in (Table 7). For the responding companies, the most important indicators of performance include the Quality/Cost ratio, with aspects of products quality that are prioritized including durability and reliability, innovation, high performance and design/aesthetic quality, as well as conformance to technical specifications. Overall, dependability of delivery, followed by on-time delivery, are higher priorities than fast delivery speeds. In order to

meet their customers' needs they expect their suppliers to also focus on product reliability and durability, high performance and conformance to technical and chemical/physical specifications, and innovation of products themselves as well as the processes used. The overall reliability and on-time/dependability of suppliers' delivery is prioritized along with their Quality/Cost ratio, with slightly higher expectations of fast delivery speeds, all of which take precedence over cost reductions. It can be seen that all three separate aspects of delivery performance are in some way a priority for the supply chain, whether required of suppliers, or for the customers, or both. Notably one participant highlighted that the specific priorities differ significantly depending on the specific product range/group in question, providing strength to the importance of configuration based on product characteristics.

Table 7 Top Ranked Key Performance Indicators for EU supply network competitiveness

Top Performance Criteria – Average Rank	Company	Suppliers
Product durability	2	3
Product reliability (as promised)	3	2
Quality/cost ratio	4	13
Delivery reliability	5	4
Innovative products (new products/features)	6	12
High performance of products	7	5
Delivery dependability (on-time)	11	6
Volume flexibility (Producing large and small order sizes)	12	7
Quality of design/aesthetics	14	11
Fast delivery speeds	15	14
Capacity available (utilisation/expansion)	17	18
Conformance to technical specifications	18	10
Conformance to standards (chemical/physical)		16
Innovative products (new processes/technologies)		17

3.3.2 Most Important Enablers

The most important enablers according to the responding companies included trust, ranked number one for both companies and their suppliers. Additionally, collaborative relationships, frequent communication, skilled human resources, long-term relationships with customers, expectations of innovative, specialised, and environmentally processes for suppliers, as well as a focus on quality improvements are also highly important. Companies are focused on internal

compatibility across levels and functions, and both internally and externally focused on capacity issues, including potential capacity expansion. While none of the customisation criteria were included in the top ranked list of criteria, volume flexibility along with product mix flexibility and ability to rapidly change production were considered vital. Additionally, within the customisation criteria priorities such as being able to offer fully customised products (batch size one) and offering some adjustments (small batches) for customers/retailers were most important, with slightly lower priority for their suppliers to offer the same. Overall, the structural elements are more prioritized for the company than for their suppliers, either slightly as with integration of planning, or significantly as with transparency of operations and data sharing, which is the highest structural priority for companies to offer to their customers. The other top priorities for companies included knowledge system integration internally, integration of competences throughout the network, and virtual proximity to customers. The top priorities for their suppliers structurally include integration of planning and physical proximity. Notably the manufacturing technology and capability related criteria were not highly ranked, specifically very few considered digital technologies, and Flexible Manufacturing/ automation, and digital manufacturing to be important for their own or their suppliers' competitiveness. Within the category quality assurance, and general specialisation of competences were more highly rated by the respondents.

4 Conclusion

- Market analysis main takeaways:
 - Quick Response, high quality products, and various types of customisation are often benefitting from production localised nearby to customers, benefitting from customer knowledge and information.
 - Increasing digitalisation and new production technologies are enabling production to be done more competitively in high-cost locations, with emphasis on customer closeness and co-design for customer knowledge, and business knowledge related to quality and flexibility.
 - Reduced intermediaries can be seen e.g. direct to consumer, along with new types of collaborations and partnerships e.g. to access valuable technology or competences, of which there are significant examples within Europe, either existing or being developed.
 - Collaborative relationships with customers and throughout the value chain are crucial, depending on trust and benefitting from increased communication and information sharing, but with related challenges.
- Exemplary company cases takeaways:
 - Network structures, collaboration and relationships are depending extensively on the types of products that are the focus and the power dynamics in the network.
- Supplier selection criteria:

- Numerous supply network configuration related criteria are potentially relevant to consider when evaluating or developing a company's own competitiveness and evaluating or choosing suppliers.
- Ranked KPIs and enablers:
 - The top rated criteria are related to relationships notably trust and skilled human resources, with extensive focus on product and delivery performance and quality, and including some aspects of collaborative structures, though structural aspects were considered more priorities for the companies themselves rather than their suppliers.
 - Customisation and digital technologies were not highly ranked, indicating that there is a gap between what is extensively discussed as being demanded on the market along with the technology available to support those demands, and the current ways of working in the textile and apparel industry.

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