

An analysis of strengths and weaknesses of SCM strategies in medical technology OEMs: a perspective from German manufacturers

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Abstract

Original Equipment Manufacturers (OEMs) in the German Medical Technology (MT) sector are facing a strong competition from low-wage countries developing, manufacturing, and distributing high-quality products globally. For this reason, organisations in this sector require orientation in the implementation of SCM policies to reduce operating cost and to create value for their customers. A multiple case study was conducted to identify SCM issues and best practices in this sector. This study contributes to healthcare operations management literature with a tailor-made assessment tool. Its findings offer new priorities for managers, particularly if they are contemplating a re-engineering of their SCM strategies.

Keywords: Supply chain network design and analysis, Collaboration and coordination issues in SCM, Medical technology industry

Introduction

Medical technology is an innovative, fast-growing and promising industry, particularly so in Germany as it is the third largest market in the world behind the US and China (BVMed, 2018). Around 1,200 small and medium-sized enterprises (SMEs) represent the core of this sector (BMBF, 2017). In 2017, the sales volume of MT organisations rose to 29.9 billion euros, with an export rate of 64% (BVMed, 2018).

Despite this remarkable growth, the Medical Technology industry in Germany is faced with a number of challenges. Reportedly, Germany's statutory health insurance fund (*gesetzliche Krankenversicherung*) has experienced funding difficulties, forcing administrators to reduce fees and thus expenditures on Medical Technology (Hartford, 2014; Focus, 2016). Furthermore, manufacturers rely strongly on new product development to sustain or increase their market share, and with products having lifecycles not longer than 3 years, short development times and regulatory approvals become critical issues (Hempel, 2017; BVMed, 2018). Additionally, Chinese and Indian companies are also lined up to be frontrunners in terms of cost, workforce, and market capture, pressuring German manufacturers to produce and distribute cost-efficient

devices (Marucheck et al, 2011; Hempel, 2017). In this environment, the search for rationalisation potential becomes critical. Studies (J & M, 2010) show that a defined supply chain strategy often falls short in this sector. Major deficiencies reported are the absence of a formulated strategy, the lack of efficient planning and coordination processes, along with unreliable sales forecasts.

In this paper, the authors investigate multiple cases of OEMs involved in Medical Technology Supply Chains (MTSCs) in Germany and use the results of the analysis to identify both areas at which these organisations excel as well as areas of improvement which require addressing during the design and operation of their SCM strategies. This paper builds on previous research conducted by the authors (Garcia-Villarreal et al, 2019) and is organised as follows: first, a review of the literature is reported. Then, the research aim and focus are formulated, followed by the justification of the selected methodology and case study design. Next, the findings are presented and analysed. Finally, this paper concludes by stating the implications for theory and management practice along with research limitations and avenues for further research.

Literature review

Healthcare & Medical Technology Supply Chains

Supply chain management as an area in operations management literature is extremely well served whereas there is a real dearth regarding its focus on medical technology supply chains and their agility as exemplified by recent literature (Gligor, 2014; Mandal, 2017). Mentzer et al (2001, p. 4) define supply chains as a “*set of three or more entities directly involved in the upstream and downstream flow of products, services, finances, and information from a source to the customer*”. There are three major players in the Medical Technology supply chain: producers (product manufacturers), purchasers (group purchasing organisations, or GPOs, and wholesalers/distributors), and healthcare providers (hospital systems and integrated delivery networks, or IDNs) (Burns et al, 2002).

The manufacturers (producers) in the supply chain can be broadly classified into three groups namely, pharmaceutical, medical-surgical, and device manufacturers, the latter being the object of this study. Their products are then purchased by GPOs, wholesalers, distributors and in some cases independent contractors, and then delivered to providers like hospitals, integrated delivery networks (IDNs), physicians (individual clinics) and pharmacies. Customers (payers) in this supply chain are local governments, employers, and individuals. They pay the providers through fiscal intermediaries like insurers, health maintenance organisations (HMOs) and pharmacy-benefit managers. Smith et al (2012) provides a detailed view of the medical devices supply chain, in which the main product flows between the key players are clearly represented (see Figure 1), underlining the heavy influence of intermediaries or third-party players.

Studies by Burns (2000), Dacosta-Claro (2002), J and M Research (2010), and Mayer (2013) indicate that a significant portion of the costs associated with supply chains in the health care sector can be reduced by adopting strategies already deployed by the industry sector (e.g. automotive). For this reason, identifying areas of opportunity and areas managed successfully by these organisations becomes very important.

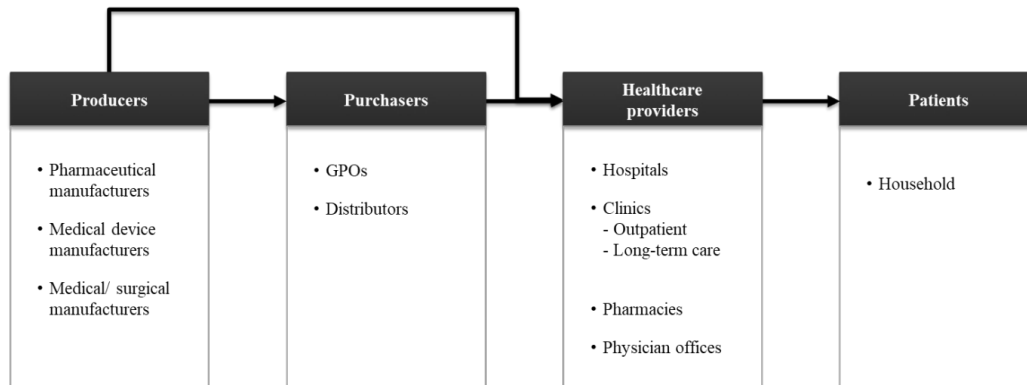


Figure 1: Detailed view of the medical devices supply chain (Smith et al, 2012, p. 3)

Review of SCM assessment tools available in academic literature

The literature review identified a number of tools available for assessing the performance of logistics and manufacturing companies within their supply chains, which are briefly presented and discussed in this section.

Tummala et al (2006) conducted a survey research with top and middle managers within a large enterprise as respondents in order to examine operational issues concerning success factors that are necessary when implementing SCM plans in one large manufacturing firm. Dimensions for evaluation were *'customer-supplier relationship'*, *'information and communication technology (ICT)'*, *'re-engineering material flow'*, *'creating corporate culture'*, and *'performance measurement'*. Their study revealed that resource allocation could be enhanced in areas such as information systems, goal-setting, training personnel, and aligning SCM initiatives with current priorities and committed resources in that particular organisation. Although this assessment tool did focus on many factors related to logistics and SCM, neither *'make'* (e.g. manufacturing issues) nor *'return'* processes (e.g. reverse logistics, green supply chain) were considered in it.

Gunasekaran and Ngai (2003) conducted an interview-based case study on a small third-party logistics (3PL) company in Hong Kong that had been successful in its overall business performance and in satisfying its customers. In this study, they designed a framework for developing an efficient 3PL system. While their assessment tool appeared easy to use, it only included five major dimensions for evaluation (*'strategic planning'*, *'inventory management'*; *transportation planning'*; *capacity planning'*; and *'information technology'*). It can be noted that this assessment tool was not intended for manufacturing firms, but rather for 3PL companies, as neither of the dimensions considered any form of evaluation criteria aimed at identifying issues in the development, production, and quality assurance of items (*'make'* processes).

Finally, Thakkar et al (2011) used a case study approach to identify issues in SMEs of Indian origin. The assessment tool developed for this study offered a thorough approach, consisting of the evaluation of Critical Success Factors (CSFs) *'effective partnership'*, *'improve communication'*, *'logistics integration'*, *'supply chain business strategy'*, *'buyer-supplier relationship'*, *'effective planning and control'*, *'trust among supply chain partners'*, and *'availability of performance management tools'*. However, the dimensions under review appear to be too much leaned against the *'source'* side of the business.

Research methodology

The research objective of this study is to explore key areas of improvement of German MT OEMs during the design and operation of their supply chain strategies. Therefore, this study was driven by the following research question:

- *What are the strengths and weaknesses of German MT OEMs in regard to their supply chain strategies?*

In order to answer this question, an exploratory research with a multiple case study approach was selected for three reasons: (1) the literature review revealed limited insights concerning weaknesses and strengths in SCM practices in the MT sector. In such an embryonic research field, a qualitative research provides better means to identify patterns and develop theory (Edmondson and McManus, 2007). (2) As the researchers were able to interact with respondents, perspectives were better understood (Boyer and Swink, 2008). (3) Case studies encourage management involvement, which helped this research to generate managerially relevant knowledge. Established methodological guidelines for case study research were observed (Eisenhardt, 1989; Robson, 2011; Yin, 2009). Fourteen in-depth case studies of manufacturing organisations were conducted to obtain a greater understanding of the main issues of German MTSCs (see Table 1). In order to enrich the results, the selected case study organisations were of different subsectors (e.g. laboratory equipment manufacturing, electromechanical MT, non-active implantable technology, etc.) and sizes, with eight Large Enterprises (LEs) and six SMEs participating.

Table 1: Summary of the respondent demographics

Nr.	Company	Classification according to the GMDN Agency (2012) ¹	Position of respondent	Company size according to IfM (2017) ²	Number of employees
1	A	Laboratory equipment	Vice President of Supply Chain	Small and Medium Enterprise (SME)	300
2	B	Electromechanical medical technology	Vice President Global Logistics	Large Enterprise (LE)	53 000
3	C	Electromechanical medical technology	Manager of Logistics Planning	Large Enterprise (LE)	12 500
4	D	Non-active implantable technology	Director of Supply Chain Management	Large Enterprise (LE)	3 400
5	E	Electromechanical medical technology	Head of Supply Chain	Large Enterprise (LE)	6 000
6	F	Reusable instruments	Manager of Logistics Planning	Large Enterprise (LE)	4 400
7	G	Hospital hardware	Vice President of Global Logistics	Large Enterprise (LE)	6 300
8	I	Non-active implantable technology	Vice President of Supply Chain	Small and Medium Enterprise (SME)	180
9	J	Electromechanical medical technology	Head of Supply Chain Operations	Small and Medium Enterprise (SME)	400
10	K	Diagnostic and therapeutic radiation technology	Director of Supply Chain Management	Large Enterprise (LE)	49 000
11	L	Single use technology	Director of Supply Chain	Small and Medium Enterprise (SME)	500
12	M	Healthcare facility products and systems adaptations	Head of Supply Chain	Small and Medium Enterprise (SME)	200
13	N	Anesthetic and respiratory technology	Director of Purchasing, Global Supply Chain	Small and Medium Enterprise (SME)	200
14	O	Hospital hardware	Head of Outbound Logistics	Large Enterprise (LE)	15 200

¹ = (GMDN-Agency, 2012)

² = (Institut für Mittelstandsforschung (IfM), Bonn, 2017)

A suitable assessment tool was required for this study. The literature review identified and discussed available assessment tools, which were deemed too simplistic, too complex for practitioners to use regularly, missing processes featured in the SCOR-Model (Supply Chain Council, 2008), or not suited for the context of this study. For these reasons, an assessment tool was designed, piloted, and implemented to identify strengths and weaknesses of SCM strategies in the case organisations (see Figure 2). The theoretical foundations of this tool as well as the dimensions under review are based on identified CSFs by the authors in previous research (Garcia-Villarreal et al, 2019).

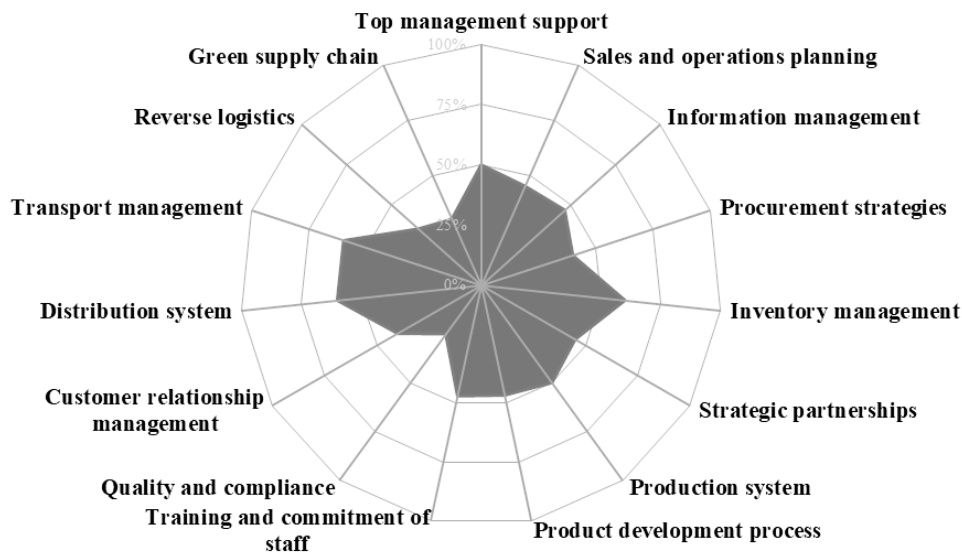


Figure 2. Example of mapping results of Case Organisation L using the assessment tool for this study

Research findings

This study identified areas where case organisations excelled at their SCM strategies as well as areas requiring immediate attention by SCM practitioners. These are reported here.

Strengths in SCM practices of MT organisations

Strengths of MT organisations (predominantly LEs) were found in four areas: (1) the design of OEMs' supply chain capabilities according to their customer value propositions; (2) the deployment of intelligent product design; (3) the use of 'track and trace' systems to increase supply chain visibility; (4) an expansion of the role of OEMs to deliver more value for their customers.

In terms of the design of the supply chain capabilities according to their customer value propositions, this study identified three fundamental approaches: a flow-oriented approach, a batch-oriented approach, or a combination of both. The flow-oriented supply chain is set up on the basic condition of a quite fixed series of repetitive transactions (material, information, payments). Case Organisations A, E, L, and N had a flow-oriented approach to their supply chains. What these companies had in common is the production of mass articles with a low degree of variation and in high volumes. These companies strived to reduce costs in their supply chains by improving their standard, repetitive

operations. Conversely, Case Organisations D, M, and I had adopted a batch-oriented supply chain strategy for their operations. These companies had three things in common: they produced niche products according to customer specifications, they did not manufacture these products in high volumes, and they sold these items at a high price. The supply chain required to carry these products needed several arrangements: Manufacturers had to interact with a larger number of raw material suppliers; each contract with hospitals or clinics needed to be individually priced and logistics details had to be arranged individually; instead of a continuing number of shipments, there was a limited number of batch deliveries.

The basis for the economic success of German MT is the broad range of innovative products it creates, with about a third of its revenues generated from products that are less than three years old (BMBF, 2015). For this reason, the product development process becomes crucial for the supply of innovative products to their customers (Medina et al. 2013). Case organisations in the study reported a transition from an inwardly-oriented approach to product design (first developing a product then searching for a market) to a more customer-oriented approach (understanding customer needs and developing products thereafter). Involving surgeons in the innovation process proved beneficial to OEMs, as development, product test, and regulatory approval times could be reduced (Lettl, 2013), while increasing product variety to address users' specific needs (Al-Zu'bi & Tsinoopoulos, 2012). Given the importance of the role of users in the design of products, Case Organisation D cooperates actively with surgeons in the design of medical devices and names their finished products after the physician that inspired or co-designed them. Activities in product development process have an influence on the performance of other organisational functions, such as procurement, manufacturing, marketing and sales, and service. Case Organisation A launched a project to standardise information flows between sales, product development, and procurement in order to reduce the risk of dependency to niche suppliers. These efforts enhanced their material availability while reducing the risk of material obsolescence. Case Organisation J analysed their product portfolio in an effort to standardise their raw materials and their part numbers, with the effect of decreasing their supplier base and streamlining their purchasing, order picking, and assembly processes. Case Organisation D focused on reducing manufacturing costs (technology, methods, and materials) through a re-examination of their product portfolio. Finally Case Organisation H launched a project to improve their product update services in order to cut manufacturing, procurement, inventory, and after-sales costs.

Several organisations in this study have made supply chain visibility a top priority in their agendas and have made significant investments in this area. One major reason is to fight product counterfeits. Another reason is that their customers require status reports about shipments in real time: hospitals are increasingly under pressure to schedule both patients and surgeries more efficiently, both for humanitarian and economic reasons, as costly hospital equipment (e.g. computer tomographs) cannot afford downtimes. Therefore, the recipients are requiring effective "*track and trace*" instruments to monitor the shipping status in real-time. Clinics expect real-time information, especially for unplanned maintenance work. At Case Organisation K, 30 to 50 per cent of the maintenance services are unplanned. Case Organisation K needs to supply 98 per cent of all spare part orders within 24 hours – and, if possible, in all 132 countries covered by the manufacturer. This poses a challenge for freight forwarders: if the shipment is half an hour too late, it is already considered late. Therefore, Case Organisation K has been working with third party logistic providers to digitalise their distribution chain. In order to enhance their response rate, Case Organisation K defined milestones with the freight forwarders along the supply chain. Once a milestone had been reached during the

transportation of products, it was the freight forwarder's responsibility to deliver a push message to both manufacturers and recipients.

One of the largest cost items for hospitals and clinics, as reported by some case organisations, is the management of products such as endoprosthetics, pacemakers or surgical covers. Some case organisations are reportedly working to improve hospitals' operational procedures in the sterilisation departments, in operating rooms, as well as in the hospitals' internal logistics. Effects of these projects are shorter throughput times for the supply of instrument trays to operating rooms, reduced stocks of instrument trays in storage rooms, and streamlined logistics processes for hospitals. Additionally, Case Organisation K reported working on taking over the repair management functions of hospitals in order to consolidate internal cost and reduce the replacement rates of instruments. In the same context, Case Organisations D and K have been working on expanding their capacities for the repair of used instruments, in order to reduce the hospitals' replacement rates. For this reason, it is expected that OEMs can gain a competitive advantage by working together with their customers to streamline their internal processes and to reduce managerial efforts.

Weaknesses in SCM practices of MT organisations

In terms of the main SCM issues in this sector, this study identified four areas where the severity of SCM issues is critical: (1) a lack of rigour in the deployment of sales and operations planning; (2) poor first-tier integration; (3) distribution networks not set up according to customer needs of product availability; and (4) a strong emphasis on quick wins and quarterly savings hindering change at management level.

Regardless of their products and services or their size, 11 (C, E, F, G, O, A, I, L, J, M, N) of the 15 case organisations in the study have experienced some form of disruption in their respective supply chains that has hindered their ability to harmonise customer demand with production and distribution capacities. Reasons for these disruptions are, among others, a low level of trust, integration, and information sharing between OEMs and both customers and suppliers; and a lack of rigour in the deployment of their existing Sales and Operations Planning (S&OP) process, fostered by conflicting target and performance appraisal systems within the organisations and developing counter-productive behaviours such as silo-thinking within organisational departments. This issue has particularly affected SMEs, which, in the absence of joint planning with customers, has made the position of their supply chains vulnerable.

Several organisations reported having issues related to their current procurement strategies and approaches. Similar patterns were identified for both LEs and SMEs: LEs reported on having adopted select procurement strategies (Kanban, Vendor-Managed Inventory (VMI), Electronic Data Interchange (EDI), Just in Time (JIT)) and have come to expect their supplier base to become JIT suppliers, but in the absence of cross-functional integration within the OEMs, the implementation of these strategies appeared to be disjointed and did not lead to a full utilisation of their systems' capabilities. In addition, approaches to procurement of Case Organisations E, G, and O seemed to be one-sided, apparently seeking no win-win situations with suppliers and thus hindering collaboration. In contrast, issues shared by SMEs range from underprivileged power relationships with suppliers (cases M and L), inaccurate master data hindering an efficient information exchange with suppliers (cases J, A, N), and raw material shortages due to fluctuating prices and an almost exclusive focus on local sourcing (cases I, L, M). Evidence of this disconnect in the relationship with suppliers could be found in the presence of the high raw material inventories and slow turnover ratios for almost all cases referenced above.

Additionally, Cases B, G, O, A, L, I, J, and I shared that their distribution network was not set up according to customer needs of product availability. Therefore, these companies were forced to ship their products via express delivery at high cost. In the case of Case Organisations I, L, and N, this is partly explained due to the fact that reportedly, the design of efficient logistics structures had not been focus of much work, as before the crisis in 2009, there had not been a need to change. Now these companies are catching up with several concepts well established in the automotive industry. For instance, Case Organisations L, J, M, and N – all SMEs -, are currently embarking on projects of their own seeking to integrate external logistics service providers. They believe that outsourcing distribution will help them focus on their core competencies, access new markets, optimise transport routes, and save them the time and money they would have invested in setting up their own distribution facilities.

Finally, it appeared that several managers have merely added the term ‘supply chain’ to their jargon without adopting a SCM mind-set. A strong emphasis on quick wins seemed to limit the ability of several case organisations to establish appropriate processes and relationships or to anchor them in the organisational culture. For instance, Case Organisations G and O seemed to have organised all their SCM activities around their logistics and customer service activities, yet these efforts were focused primarily on direct ‘A’ customers and were reactive in nature, neglecting ‘B’ customers with the potential to transform into ‘A’ customers. While all respondents believed that SCM could assist their respective companies to succeed in their marketplace, they did recognise the difficulty to bridge organisational boundaries in their relationship with suppliers. In this sense, the procurement strategies of several case organisations (e.g. Cases E, O, G) appeared to be one-sided, seeking no win-win situation, thus hindering collaboration.

Furthermore, several case organisations seemed willing to invest in technological solutions to solve operational challenges. Respondents I, M, and L made a case for investments on better information technologies hoping that this would provide their supply chains with substantial improvements in terms of efficiency, collaboration, and responsiveness. While this may be partially true, some respondents warned that improving collaboration between stakeholders required more than an enhanced information platform. Therefore, they had been working with core first-tier suppliers and customers to (1) define the boundaries and strength of their relationships; (2) establish communication requirements; and (3) select appropriate technologies based on an analysis of these requirements.

Only a few companies have established a SCM culture that promotes fact-based decision-making. For instance, case organisations such as C and D had been installing common goals in SCM for all departmental functions within their organisation. Furthermore, these organisations have understood that cultures change slowly and that changing long-standing ways of doing things require appropriate strategies and serious commitment from management. Therefore, they have been involving owners, senior managers, and middle management in transformation projects, as they understood that a real change could only occur with direct involvement of stakeholders.

In this context, the middle management seemed to have a key role both as an intermediary between the goals of senior management and the priorities of the operational staff, and as an agent for sustainable changes in operational policies. For these companies, SCM was not seen a project but as a long-term journey.

Conclusion

The objective of this study was to identify strengths and weaknesses of current SCM practices of OEMs in the German MTSC sector. The interactions with fourteen OEMs

have helped to identify both areas where these organisations excel and areas where the severity of the issues requires immediate attention.

Areas where MT organisations excel are (1) the design of OEMs' supply chain capabilities according to their customer value propositions; (2) the deployment of intelligent product design to reduce sourcing costs and to build stronger partnerships with physicians; (3) the enhancement of supply chain visibility with “*track and trace*” systems; and (4) designing and implementing individual concepts for supply and management of medical devices for hospitals and clinics.

On the other hand, major issues identified in this sector include: (1) a lack of rigour in the deployment of sales and operations planning; (2) poor first-tier and second-tier integration; (3) misaligned distribution networks; and (4) a strong emphasis on quick wins and quarterly savings hindering change at management level.

This research contributes to knowledge in the form of an assessment tool that identified strengths and weaknesses of SCM strategies in the MT sector. Although a number of tools available for assessing the performance of organisations within their supply chains were identified, these appeared to be either too simplistic, too complex for practitioners, lacking important dimensions for evaluation, or not suited for this research context. In an effort to fill this gap, this study developed its own tool, providing an approach to evaluation that considers the five basic business processes required to satisfy customer demand (‘*Plan*’, ‘*Source*’, ‘*Make*’, ‘*Deliver*’, ‘*Return*’) (Supply Chain Council, 2008).

Researchers can use it as a means to conduct further research work in other contexts. Additionally, managers of MT OEMs who wish to develop or restructure their organisations' SCM policies can benefit from this tool, as it provides them with an orientation for resource allocation. The main limitation is that this tool is tailor-made for organisations in the MT sector. Although this is a limitation, it does however give evidence to how closely this tool is designed for the sector in focus, as it considered this industry's characteristics. Further research work can use this assessment tool to test its applicability in other contexts other than the German MT sector.

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