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Development of the Supply Chain Management 2040 – Opportunities and Challenges

Martina Schiffer[1], David Maximillian Dörr[1]
[1]*Fraunhofer Institute for Manufacturing Engineering and Automation IPA, Stuttgart, Germany*

Abstract

Logistics and supply chain management have undergone significant change due to technological changes in the recent years. The classic transport, handling and storage processes with a strict functional orientation have been transformed into a global, network-oriented task-field. The future challenges are individual customer requirements, shorter delivery times and increasing cost pressure. Due to these challenges and the increasing globalization, companies are confronted with ever more complex supply chain networks. The digital transformation is intended to remedy this situation. New technologies, comprehensive real-time information availability and agile value creation networks are just examples to meet these challenges.

This paper provides an overview of the expected developments in supply chain management over the next 20 years. Based on ten future megatrends, four main topics (technology, control tower, value adding and green logistics) were derived. The focus of this paper is on OEMs and Tier 1/n suppliers. Both are undergoing a major change on the customer and supplier side due to their central position within the supply chain.

Keywords

Supply Chain Management; Supply Chain Networks; Digitalization, Industry 4.0; Sustainability; Value Adding

1. Introduction

There are several development phases in logistics: In its beginnings, it was limited to the temporal and spatial optimization of transport processes. The first technologies and approaches for standardized transport and for company-wide coordination of material flow, storage and transport systems were developed. In the following years, this developed into today's understanding of logistics as a holistic management theory. Supply chain management, as well as logistics today, make a decisive contribution to the success of a company and are now even deeply anchored in secondary processes such as financing or insurance of goods [1]. The future challenges for manufacturing companies as well as for the logistics industry lie above all in individual customer requirements, shorter delivery times and increasing cost pressure. Based on these challenges and the increasing globalization as well as the required comprehensive environmental protection, companies today have to cope with increasingly complex supply chain networks [2]. In the course of the fourth industrial revolution, the next development phase also begins for logistics. The previously rigid value chains are developing into increasingly complex, intelligent networks in which goods and information are exchanged not only between individual players, but also between all of them. In concrete terms, digital transformation describes "the transformation of value-added processes through the further development of existing and the implementation of new digital technologies, the adaptation of corporate strategies on the basis of new digitalized business models and the acquisition of the necessary skills and qualifications" [3]. Logistics and

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supply chain management will increasingly be affected by these changes. However, the extent to which companies and the associated processes, products and business models will change is still relatively unclear.

2. Methodic procedure

In order to be able to make as precise a statement as possible on the development of the supply chain management in the next 20 years, a multi-stage approach was chosen.

In the first step, the conventional supply chain was separated from a smart supply chain. In addition, framework conditions and assumptions for the year 2040 were subjected to closer examination from an economic, political and social point of view.

In a second step, an online survey was conducted along the entire supply chain. The aim of the survey was to identify current research topics and technology projects of the participants as well as future challenges and needs. Based on the online survey, expert interviews were conducted to identify further insights into future investment needs, challenges and customer requirements of OEMs, suppliers and logistics providers. In total, the participants are assigned to the individual stages of the supply chain as follows (Figure 1):

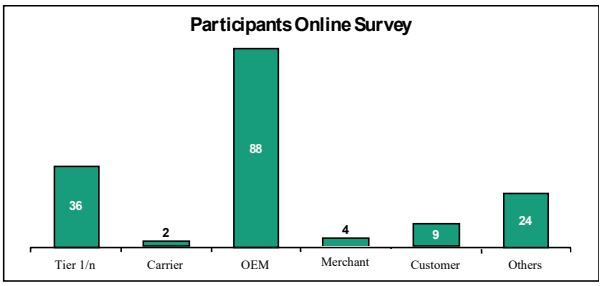

Figure 1: Participants Online survey

In total 164 questionnaires were evaluated for the study, which show a broad distribution across all players in the supply chain, with a clear focus on OEMs. The survey of occupied positions in the company showed a homogeneous picture: 31 % of the respondents were leader of a department (mainly middle management) and further 29 % were "project managers" (lower management). 20 % of respondents were responsible for a specific topic in their company and 11% in business management (e. g. CEO, CIO). From the perspective of "specialist", 4 % of respondents answered the questionnaire.

3. Results

By the year 2040, politics, economy and society will change dramatically and place new demands on manufacturing companies. The nature will also change dramatically and offer new challenges for the physical supply chain. These changes can already be seen today and can be described in the form of megatrends. For decades, megatrends have brought about a slow, far-reaching change in society as a whole and have influenced the framework conditions for economic activity. New technologies and innovations contribute to this, as do cultural and political developments. Based on literature research and expert assessments from industry and research, the following 10 megatrends could be identified [4–7].

1. Individualization
2. Digitization / Connectivity
3. Demographic change
4. Urbanization
5. Globalization
6. Sustainability and social responsibility
7. Mobility
8. Data security and ownership
9. Servitization
10. Knowledge culture and information society

Based on these megatrends, **four main topics** were derived for this study. These form the basis for the detailed analysis of the results, which will be discussed in more detail below.

3.1 Technology

The global transport volume will continue to rise in the short and medium term. On the one hand there will be an increasing need for individualization in the consumer goods sector and a growing demand for such products in emerging markets such as Asia or Africa. On the other hand, there will be increased global sourcing in the industrial goods sector in order to further cut costs and secure competitiveness. According to 65 % of respondents, this leads to a more complex and growing supply chain. Contrary, 30 % of those surveyed assume that there will be a decline, since individualization can be localized using additive manufacturing processes or individualization can be mapped using software. However, until these trends have become established, there will be an increase.

The increase leads to the need for a supply chain aligned to the latest technologies. A large number of technologies are currently available for this purpose. In the study, the participants were asked about their assessment of these technologies.

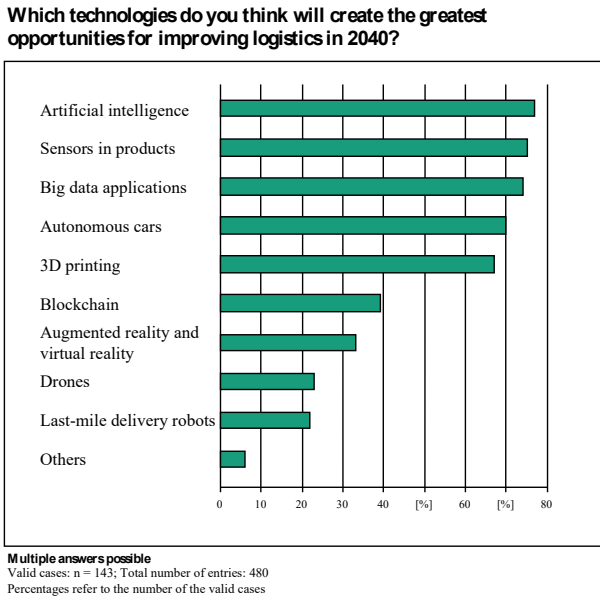

Figure 2: Opportunities for logistics improvement

Figure 2 shows which technologies the respondents see as the most promising for coping with supply chain challenges. A clear dichotomy between technologies can be seen. Thus, a group of the first five technologies can be formed, which most respondents (> 60%) regard as trend-setting. Only a small number of the interviewees (< 40%) believe that the other technologies have a chance.

The greatest chances of success are attributed to artificial intelligence technologies. Fields of application include the analysis of large amounts of data in a short period of time. Fields of application are the reduction of freight costs, the improvement of delivery performance and machine learning in collaborative supply chain networks [8]. However, large amounts of data are required for this as described. Therefore, the following technologies from the survey cannot be considered separately. Sensors, for example, generate data automatically and thus more frequently and more cost-effectively than manual human input. Big Data stores, manages and makes this data available.

Another technology that will have a major impact on the supply chain of the future is autonomous driving. While previous technologies will support the human work, activities will be completely taken over here. Large changes are often attributed to the autonomous driving of passenger cars in a media-effective way. However, the respondents assume that there is great potential in the autonomisation of aircraft such as drones. The networking of transport vehicles, such as trucks, which can be combined into a network through "platooning" [9], also has great potential for future supply chains. Despite its disruptive character, the impact of autonomous driving is still very small at present, as the technology is still under development and many companies shy away from high development costs, see Figure 3.

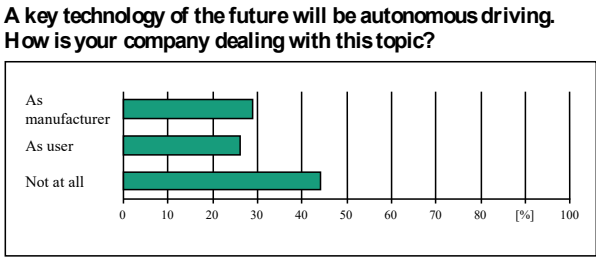

Figure 3: Participation in Autonomous Driving

While additive manufacturing is only slowly gaining acceptance in the consumer sector, it has great potential in the B2B environment. Additive manufacturing processes can be used, for example, to produce moulds that are not possible using ablative manufacturing processes. Thus, they are not seen as a substitute for classical manufacturing processes. They show further advantages through decentralized service-oriented business models. For example, railway and aircraft operators and service companies use 3D printers for repairs in order to manufacture spare parts on site and thus save transport costs [10].

In summary, the study on technology shows that the most rapidly changing parameter will be the lead time. However, there is disagreement among the respondents as to whether the duration will increase or decrease. 66 % of the respondents see a shortening of the cycle time through the technologies described above, see Figure 4.

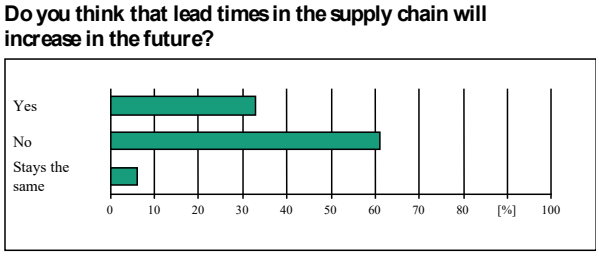

Figure 4: Development Lead Time

The flow of goods and information will continue to increase as a result of automation and digitization. However, 33 % of those surveyed see an increase in throughput time, as increased environmental restrictions will have a far greater impact than technological innovations.

3.2 Value Adding

Technical innovations in communication and information processing, permanent organizational change, the internationalization and digitization of business systems and processes, and the concentration on core competencies right through to virtual companies are leading to a new competitive landscape and suggest that logistics will continue to play a key strategic role as a company-specific value creation factor in the future

[11]. Consequently, logistics is no longer seen as a pure cause of costs, but as a means of differentiation from the competition. The first idea behind the term "value adding" is the refinement of products in the course of the value creation process. But value adding is also possible in the context of supply chain management. The magic word for logistics service providers is: Value Added Services. This is not about increasing the value of the actual physical product, but about offering the customer an additional benefit/value or optimizing the cost-benefit ratio along the supply chain. This increases both customer satisfaction and customer loyalty. It would be conceivable, for example, to offer additional products related to logistics services. The value creation options today range from the configuration of e-commerce kits to the insertion of coupons or brochures in packages. It is also conceivable that the logistics service provider could reduce the number of suppliers by taking over upstream and downstream processes. Production or assembly during the transport process will also be possible in the future. The respondents see product monitoring with the aid of sensors in and on products in the supply chain as the most widespread in 2040, see Figure 5. Real-time tracking of products and processes as well as integrated condition monitoring (e. g. temperature, gases, vibrations, etc.) are conceivable areas of application here.

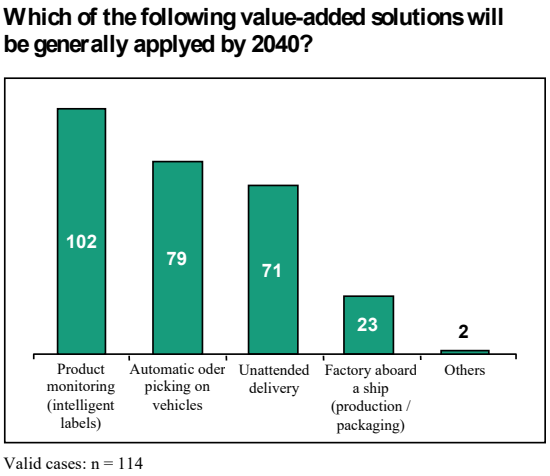

Figure 5: Value Adding

Product monitoring also has a high potential in the trade sector. Examples include real-time monitoring of ripening processes or full-time monitoring of the cold chain. On the one hand, this increase or ensure the quality of the products, facilitate documentation processes and reduce product rejects. The data obtained from product and process monitoring can also have an influence on the planning and control of processes. In the course of the expert interviews, the thesis of best-before date-controlled logistics was expressed. The products independently determine their flow rate in the supply chain on the basis of previously defined characteristics. Such a paradigm shift in the supply chain requires not only sensors on products, but also the adaptation of numerous processes and IT systems. Dynamic pricing depending on the condition of the product is also conceivable, e.g. in the food sector. The own control of the products through the supply chain and the pricing based on the condition is mainly made possible by IoT chips in/at the food product. An extension of the application cases to the pharmaceutical or feed industry is realistic.

A further aspect in the area of value adding is increasing safety. This includes threats that can be influenced (e. g. supplier failures, mistakes) as well as threats that cannot be influenced (e. g. natural disasters, environmental influences) [12]. Theft of goods also poses a threat to companies. In 2016 alone, goods worth 1.3 billion euros were stolen from trucks in Germany [13]. By using IoT or GPS data, customers can, for example, be offered real-time goods traceability down to package level across the entire supply chain and at the same time minimize susceptibility to theft. In addition, it is also conceivable that the logistics service provider might offer its customers additional insurance policies in order to financially cushion any

disruptions, e.g. in the process. Premiums could be determined dynamically based on the condition and position of goods.

The automatic picking of goods for delivery is another option in the area of value adding. Possible applications include automatic palletizing, depalletizing and container stacking as well as container destacking. On the one hand, this shortens throughput times and also avoids errors during order picking. Logistics employees are relieved of heavy, but also sometimes monotonous work and can thus devote themselves to other tasks. The unattended delivery of goods is also conceivable, e.g. by means of drones. Logistics companies can dynamically offer unloading locations and thus enable a higher delivery rate for the customer.

The parallelization of production or assembly with the transport process (e.g. on trains or container ships) has been discussed in practice and research for some time. On the one hand, parallelization would significantly shorten delivery times and also enable companies to increase their internal production capacities. The respondents are rather skeptical about the possibility of parallelization. On the one hand, it is unclear which safety requirements would be necessary for this, and on the other hand, the necessary requirements for stability during the transport process are difficult to achieve. Another important aspect that is difficult to overcome is the imbalance of the transport streams and thus the imbalance of the machine utilization. According to experts, parallelization would be desirable, but not feasible.

3.3 Control Tower

The trade with services and data is already almost more lucrative in many places than with goods. Due to the growing importance of data and its analysis, digital services will become increasingly important in the future. For example, a survey of experts from the forwarding industry shows that the pure transport of physical goods will almost no longer be profitable in the future [14]. The recording of all relevant transport parameters, their analysis, as well as the passing on of data/information to third parties is developing into a decisive competitive advantage. Another possibility is the networking of global trading and transport companies. Companies are increasingly developing into complex value creation networks in which information must be exchanged not only between two instances, but between all. 72 % of those surveyed also see growing complexity and gave the following reasons for this, among others:

- Developing and emerging countries as further players in the supply chain
- Supply chain disruptions due to political and environmental influences
- Increasing transport volumes due to improved transport processes and transparency
- Expansion of the customer and supplier network leads to disproportionate increase in the number of players
- Shorter product life cycles increase transport quantity and speed; both in delivery and return logistics

A further factor is the difficulty of efficiently managing the entire supply chain due to growing transport volumes and the constant demand for shorter lead times. In the past, for example, communication and transport organization with the freight forwarder and, if necessary, an agent used to take place. Nowadays, portal systems are in use at every transport break and startups support every actor in the transport chain with web platform solutions.

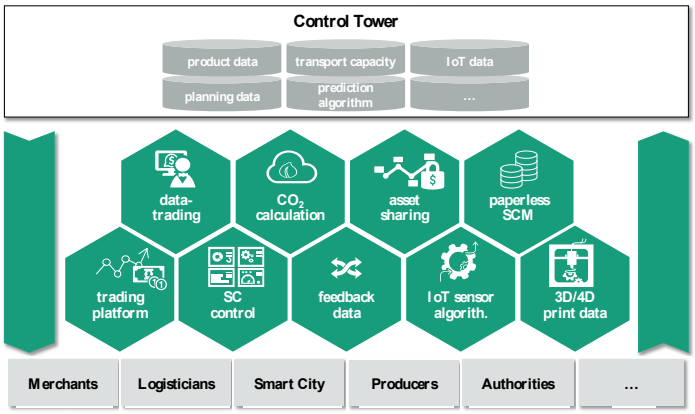

Figure 6: Vision control tower

In order to meet these future challenges, a central planning instance must be set up. The Control Tower is a central, independent and self-optimizing platform for the comprehensive regulation of the information flow and exchange of all data. In a conventional network the information is exchanged directly between the actors. The final stage of the Control Tower is a network in which all data flows with a 1:1 connection between the Control Tower and the respective actor. The overriding goal is an overall optimum of all actors within the supply chain network through secure and efficient data exchange.

3.4 Green Logistics

The following premise applies predominantly to the ideas presented for future logistics: Logistics must become much more environmentally friendly. This is not only demanded by politicians and environmental associations, end consumers, but also by companies. For example, Daimler is aiming for CO_2-neutral plants in Germany by 2022 [15]. It is highly probable that logistics in 2040 will be significantly more environmentally friendly, but not completely emission-free. There are many trends in this direction. As more and more goods are transported around the world, not only the transport volume but also the number of participants in the transport chain will increase. As a consequence, any environmentally harmful empty transports and relocation processes will increase proportionally [16]. The positive trend towards 100 % recycling of materials (circular economy) means that further transports are caused. All in all, this means that more transport vehicles have to be produced - even if they are driven emission-free. Finally, it must be realistically estimated that aircraft and container ships, among other things, will probably not be able to operate completely free of kerosene or heavy fuel oil in the next 20 years. In the future, customers will show more and more willingness to pay for a green and sustainable (complete) supply chain. A surcharge for sustainably produced and transported products is also conceivable. According to the experts surveyed, it will be a challenge in the future to get away from "greenwashing" or "marketing sustainability".

Reverse logistics, a kind of recycling economy, will be one of the main components of green logistics in the future. Around one third of the experts surveyed believe that in 2040 there will be a comprehensive use of return logistics and that almost every product can be reused / recycled. 54 % of the respondents, on the other hand, are of the opinion that a partial use of return logistics will take place in 2040.

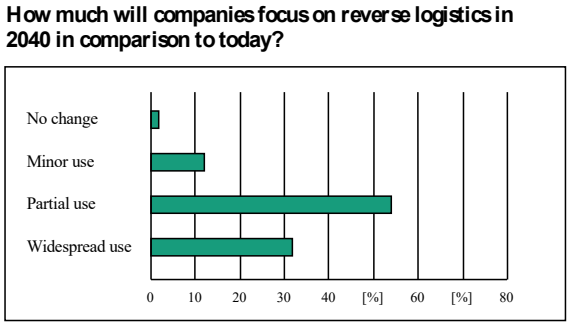

Figure 7: Focus reverse logistics

The aim of recycling management is the sustainable and efficient use of resources. The driving forces behind this are legislation, corporate responsibility and potential economic benefits.

4. Conclusion

The year 2040 will reach us faster than we can imagine. Looking back, it is about 20 years ago that we have dealt with the Millennium Problem. Likewise, it is less than 20 years since the agile manifesto was defined. The possibilities for innovation in the supply chain are virtually limitless thanks to modern technology. But they will always be limited by the speed of change and adaptability of the users. In addition, external conditions and natural events will continue to restrict or at least slow down the further development of the supply chain.

Against this background, how must companies set up their supply chains in order not only to survive in 2040, but also to be able to offer first-class products and even better services? In the future, profits will not be made by the cheapest, but by the most innovative and flexible companies. Likewise, there is a need for a major rethink from looking at a flow of (raw) goods to the entire value chain.

Based on the identified focal points, the next step is to identify fundamental conflicts of objectives (e.g. reusable packaging increases the number of empty trips) as well as fields of action. Based on the fields of action, recommendations for action are to be developed for the manufacturing industry as well as for the logistics sector.

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References

[1] Kersten, W., Schröder, M., Indorf, M., 2017. Potenziale der Digitalisierung für das Supply Chain Risikomanagement: Eine empirische Analyse, in: Seiter, M., Grünert, L., Berlin, S. (Eds.), Betriebswirtschaftliche Aspekte von Industrie 4.0, vol. 109. Springer Fachmedien Wiesbaden, Wiesbaden, pp. 47–74.

[2] Jung, H.-H., Kraft, P. (Eds.), 2017. Digital vernetzt. Transformation der Wertschöpfung: Szenarien, Optionen und Erfolgsmodelle für smarte Geschäftsmodelle, Produkte und Services. Hanser, München, 403 pp.

[3] Kersten, W., Seiter, M., See, B.v., Hackius, N., Maurer, T., 2017. Chancen der digitalen Transformation: Trends und Strategien in Logistik und Supply Chain Management. DVV Media Group GmbH, Hamburg, 74 pp.

[4] Logistik und Konsum im Wandel: Trends, die den Sektor beeinflussen, in: Arbeitskreis Innovative Logistik (Ed.), Praxisleitfaden Logistik für Nachhaltige Lebensstile. Springer Fachmedien Wiesbaden, Wiesbaden, pp. 3–4.

[5] Arbeitskreis Innovative Logistik (Ed.), 2018. Praxisleitfaden Logistik für Nachhaltige Lebensstile. Springer Fachmedien Wiesbaden, Wiesbaden.

[6] Kuczyńska-Chałada, M., Furman, J., Poloczek, R., 2018. The Challenges for Logistics in the Aspect of Industry 4.0. Multidisciplinary Aspects of Production Engineering 1 (1), 553–559.

[7] Zanker, C., 2018. Branchenanalyse Logistik: Der Logistiksektor zwischen Globalisierung, Industrie 4.0 und Online-Handel. Hans-Böckler-Stiftung, Düsseldorf, 1164 pp.

[8] Min, H., 2010. Artificial intelligence in supply chain management: theory and applications. International Journal of Logistics Research and Applications 13 (1), 13–39.

[9] 2015. Heavy-Duty Vehicle Platooning for Sustainable Freight Transportation: A Cooperative Method to Enhance Safety and Efficiency. IEEE Control Syst. 35 (6), 34–56.

[10] Deutsche Bahn AG. 17 Kilo aus dem Drucker. https://www.deutschebahn.com/de/konzern/im_blickpunkt/17-Kilo-aus-dem-Drucker-4256938. 10.10.2019

[11] Wildemann, H., 2016. Supply chain management: Leitfaden für ein unternehmensübergreifendes Wertschöpfungsmanagement, 17. Auflage ed. TCW-Verlag, München, 308 pp.

[12] Fraunhofer IML. Sicherheit in der Transportlogistik: Safety and Security. https://www.iml.fraunhofer.de/content/dam/iml/de/documents/OE%20320/Infoseiten%20Produkte/safety_and_security_WEB.pdf.

[13] Laszlo Dobos, 2019. Schutz vor Ladungsdiebstahl, 1. Auflage ed. Huss-Verlag, Berlin.

[14] VDMA. Plattformökonomie: Maschinenbau treibt digitalen Wandel voran. www.vdma.org/v2viewer/-/v2article/render/22743546. 15.10.2019

[15] Daimler AG. CO2-neutrale Werke ab 2022. www.daimler.com/nachhaltigkeit/betrieblicher-umweltschutz/co2-neutrale-produktion.html. 23.10.2019

[16] MM Logistik, 2018. Leerkilometer und Leerfahrten - Wie man sie reduziert und vermeidet. leerkilometer-und-leerfahrten-wie-man-sie-reduziert-und-vermeidet-a-673353.

Biography

Martina Schiffer (*1984) is a research associate at the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA). Her research focuses on supply chain management and production planning and control. Before joining the Fraunhofer IPA, she worked 3,5 years as a Process Engineer for a plant manufacturer for metallurgical and rolling mill technology.

David Maximilian Doerr (*1989) is a research associate at the Fraunhofer Institute for Manufacturing Engineering and Automation (IPA). He studied industrial engineering at the RWTH Aachen University. Since 2017 he is coordinator for business models at the Fraunhofer IPA. Since 2019 he has been working in the Corporate Strategy and Development Department and is Deputy Manager of the Fraunhofer Project Centre for Smart Manufacturing in Shanghai.