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Planning Approach for Robust Manufacturing Footprint Decisions

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Planning Approach for Robust Manufacturing Footprint Decisions

Philipp Sprenger, Matthias Parlings and Tobias Hegmanns

Abstract

The manufacturing footprint strategy of European automotive companies has been determined in the preceding decades by a reduction of labour and operational costs and the development of new markets. Today, the automotive sector is characterised by growing number of logistic-related requirements like customisation, just-in-sequence supply and assembly of vendor parts (FAST 2025, 2013). This leads to the development of footprint planning as a multidimensional and complex decision problem with a significant impact on the competitiveness and finances of the business (Häntschi and Huchzermeier, 2013; Farahani et al., 2013).

In response to this challenge, a literature review of footprint planning and facility selection methods and models for designing supply chain networks will be presented. The comparison of existing approaches shows the necessity of new models that allow robust and adaptable footprint decisions while especially considering project and market-related uncertainties. These uncertainties demonstrate the need to revise the footprint strategy continuously.

Derived from the state-of-the-art analysis, a holistic planning work flow that supports decision makers in automotive industries from a supply chain design perspective with a special focus on the uncertainty of future business opportunities is presented. This approach integrates qualitative planning modules for knock-out-analyses and use-value-analyses and integrates quantitative modules (e.g. Monte Carlo simulation) for future project allocation. This planning procedure adopts a project-driven approach and allows for a

multidimensional evaluation of different footprint scenarios, based on an uncertain future project and contract situation.

Keywords: manufacturing footprint decision, supply chain design, uncertainties, robustness

1. Introduction

Today, automotive business currently has 2% growth in Europe, which is much lower than the US market (6%) or the 8% growth of the Asian-Pacific market (Bratzel et al., 2013). In particular, competition between automotive companies in Europe is intense. OEMs are still working on cost and price reduction and the development of new sales arguments, which lead to innovations like more customer-specific products, shorter product life cycles and multiple models and platforms, to assert their positions in this market (Klug, 2010).

This strategic orientation of the OEM additionally has a strong impact on the supplier side and the design of their manufacturing and logistic networks. The innovations not only influence engineering and manufacturing, but also significantly impact logistics. Competition for suppliers has developed from a purely cost-oriented approach that focuses on labour and manufacturing costs for perspective integrating logistics performance and value-added services. This leads to the development of footprint planning as a multidimensional supply chain management decision problem with a significant impact on the competitiveness and finances of the business (Häntschi and Huchzermeier, 2013; Farahani et al., 2013).

The decision of where a supplier should locate new manufacturing sites is determined by several uncertainties. This could be market-related uncertainties such as changes in incoming projects or changes during a production project like volume variation, in addition to environmental uncertainties like availability of labour. As project a new customer order, in the sense of a new mid-to long-term delivery contract is understand. From the perspective of the supplier,

these contracts represent projects that evolve in different phases over time. From early negotiations with high uncertainty about realisation to confirmed contract which then are specified in joint process of the OEM and supplier. Even confirmed contracts experience changes, such as in volume, parts, logistic requirements, which may lead to fundamental adaptations of the logistic concept and footprint decision. These decisions go beyond facility location problems. Rather, footprint decisions evaluate a firm's value-creation process from a supply chain and business perspective. In particular, this problem lies in creating a robust and adaptable manufacturing footprint decision that considers uncertainties and provides for a solid and competitive manufacturing location and a long planning horizon, while simultaneously allowing for the continuous revision of the footprint strategy.

The first objective within this paper is the depiction of footprint decisions issues for suppliers in automotive supply chain networks. Furthermore a comparison of existing approaches for decision support will be presented. Based on the literature review of robust footprint planning, facility selection methods and planning approaches for the design of supply chain networks, an evaluation in accord with outlined requirements will be presented. A potential planning approach will be presented similarly.

The paper is organized in five major sections. Section 2 introduces key terms like supply chain design and robustness, and details requirements for decision support methods. Section 3 uses a literature review to demonstrate the necessity of a planning approach for robust and adaptable footprint decisions. Section 4 briefly presents the implications of the development of a planning approach. Section 5 summarizes the findings of this paper and discusses the need for robustness in footprint planning in the automotive industry.

2. Footprint decisions from a Supply Chain Management perspective

In the following section, relevant key-terms for footprint decisions are introduced. To obtain a common understanding of footprint decisions, complex supply chain networks are analyzed from a strategic supply chain management perspective. Furthermore, characteristics of footprint decisions are described and the understanding of robustness within this field is presented.

Supply chain management involves not only the efficient movement of goods in a supply chain, but also the strategic decisions such as product production location, the customer allocation to distribution facilities and the design of sourcing, production and distribution processes. These strategic and long-term questions can be summarized as supply chain design (SCD). SCD integrates all long-term and strategic planning problems in supply chain management. Parlings et al. (2013) distinguish SCD tasks in three levels: Superordinate SCD tasks, supply chain structure design tasks and supply chain process design tasks. Structural supply chain design tasks include make-or-buy decisions, supply chain partner selection, product and customer allocation, dimensioning of capacities and facility selection. Based on a literature review of major SCM-related journals between 2008 and 2013, Parlings et al. (2013) state that footprint planning is the most common planning problem in supply chain design. Daskin et al. (2005) and Chopra and Meindl (2010) identify footprint decisions as a key driver for supply chain performance and as the most critical and difficult decision in supply chain design.

Footprint decisions are not only part of the supply chain design, but have been the subject of years of economic research. Weber (1909) determined hard and soft location factors in the beginning of the last century. Kinkel and Buhmann (2009) wrote that accounting for both soft location factors and hard measurable factors results in a more informed choice, which increases the long-term competitiveness of a facility. Thus, a permanent planning approach that allows for an ongoing evaluation is required. While comparing different locations and

supply chain configurations, the robustness of a footprint scenario should be measurable in multiple dimensions such as costs, responsiveness, reliability, agility and assets. Melo et al. (2009) note that the role of footprint planning is decisive for supply chain network planning and that there are several planning approaches accounting for total cost and investments. Furthermore, there is a need for planning approaches in real-life problems, which involve more than costs and investments.

Before answering the question how to support footprint decision, it is important to determine what the decision is about. From the following we will see that the understanding of footprint planning is more than the solving the facility location. Rather, footprint planning is taking into account a firm's value-creation process from a supply chain and business perspective.

There are several criteria which allow a definition of the footprint planning problem. Arnold et al. (2008) are distinguishing footprint planning in internal facility planning and facility location. The internal planning is taking the building and resources within the building into account. The facility location problem is taking care about where to locate a facility and how the footprint of a company should look like. Chopra and Meindl (2010) are separating role or function (manufacturing or warehousing) and the location (geographical dimension) of a facility. Bankhofer (2001) and Neuner (2009) also distinguish the function and the location, and use other criteria to define the planning problem, such as network dimensions and qualitative or quantitative evaluation. Within this research contribution, the scope is on the decision process where to locate a facility. Beyond this rough classification, the facility location problem can be categorized according to different criteria.

To solve the footprint problem, manufacturing facilities in a multinational supply chain network should be evaluated by quantitative and qualitative targets. In addition to the measurability of targets, the footprint decision needs to be robust. The concept of robustness, in combination with decision-making under uncertainty, is discussed in many articles with varying meanings.

The strategic nature of long-term planning problems like footprint planning must consider qualities of an uncertain future (Owen and Daskin, 1998). Some scholars have distinguished model, algorithm and solution (decision) robustness (Klibi et al., 2010; Mulvey, et al., 1995; Freiwald, 2005). In this paper, the understanding of robustness in a manufacturing footprint decision is linked to strategic supply chain planning decisions. A robust supply chain design will not lose its superiority when conditions change when compared to other design alternatives (Bretzke and Barkawi 2010). Developing this idea further, a robust supply chain network is able to carry its functions for a variety of plausible future scenarios (Klibi et al., 2010).

Given the problem and the coherence of supply chain design, footprint decisions and robustness, the following requirements can be deduced.

Requirement 1: SCM-based footprint decision.

Manufacturing sites of global automotive suppliers are parts of complex internal and external supply chains. These manufacturing locations should be monitored as a part of a supply chain network. Isolated footprint planning will destroy many planning potentials and adversely affect coordination of the distribution and procurement sides of the network. Manufacturing footprint decisions have an essential impact on the overall supply chain performance, especially when considering the high vertical integration of the internal supply chains of suppliers (Daskin et al., 2005). The footprint decisions should be integrated in the supply chain configuration, to ensure an efficient and operational supply chain network used on both a daily basis, and a long planning horizon (Klibi et al., 2010).

Requirement 2: Multi-objective evaluation

In practice manageable methods that provide quick and measurable results are required. Many companies, especially small and medium-sized enterprises, still based footprint decisions on simple qualitative or quantitative cost studies

(Kinkel and Buhmann, 2009). These unilateral evaluations can lead to wrong decisions, which can have enormous consequences on the business.

Requirement 3: Robustness

To account for a highly dynamic environment with unpredictable changes, the footprint decision should be robust for new projects while being similarly prepared for the logistic requirements during the project life time. For example, the uncertainty of contract negotiations should be taken into account, so that flexibility is created to adapt to changing contract conditions, such as volume, redesigns or other logistic requirements in later phases. Automotive suppliers struggle with model changes, facelifts and the frequent redesign of products. The footprint decision should be robust to both environmental and social uncertainties, such as changes of political situations or changing availabilities of labour.

Requirement 4: Adaptable to a dynamic project environment

The variance of future order situations and the current project makeup should be considered during the entire decision process of a new manufacturing footprint. An adaptable planning approach for robust footprint decision is required.

Requirement 5: Permanent decision support

Permanent footprint decision support is required as significant changes on the supply chain network and its manufacturing site can be considered in early stages of the footprint planning process. Previous footprint decisions can be repealed if necessary. A permanently available, reactive decision support method can support further planning steps, such as the quotation process, where an effective location can positively influence competitiveness.

Figure 1 summarizes the requirements for a robust and adaptable manufacturing footprint decision in supply chain design.

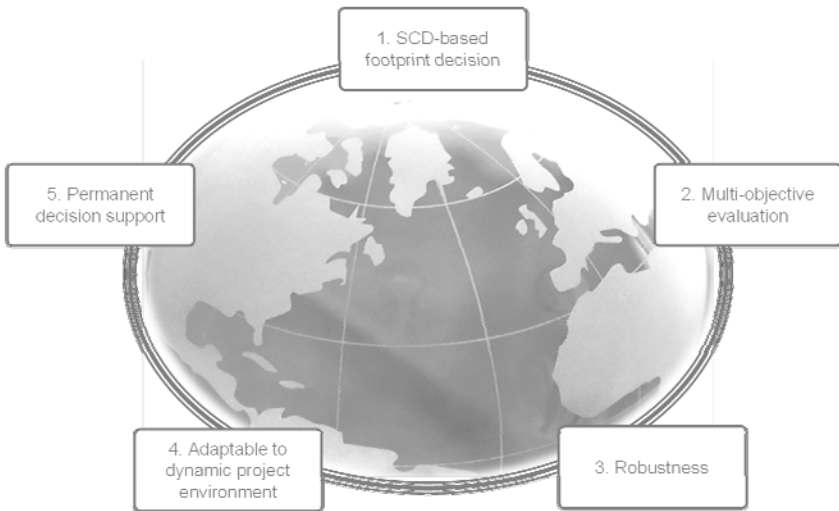


Fig. 1: Requirements for a robust manufacturing planning approach

3. State of the Art Review

This chapter presents a state-of-the-art review of different methods for supporting manufacturing footprint decisions. In the second subsection, supply chain design approaches that utilize the presented methods are analyzed in detail. This evaluates approaches where the manufacturing footprint decisions impact the supply chain network. The last subsection summarizes the results of the literature review and provides an intermediate conclusion.

3.1 Methods in manufacturing footprint planning

Recently, methods that allow for the assessment of interdependencies between hard and soft location factors like investments and levels of education on evaluation systems, have been published in response to different planning problems relating to footprint planning in the context of strategic supply chain management (e. g. Daskin et al., 2005; Klibi, et al., 2010; Amin and Zhang,

2013; Farahani et al., 2014). Methods allow for evaluation. Figure 2 shows typical quantitative and qualitative methods for evaluation.

Traditionally, qualitative methods are used to reduce the number of potential footprint scenarios to a manageable number. Methods like use-value-analysis are widely used in practice. These methods generally use a criteria-scheme which is scored and weighted by experts and have a significant advantage in that many location factors can be considered without the need for a high amount of quantitative input data (Kinkel and Buhmann, 2009). In contrast, quantitative methods require measureable data to be effective. At the same time, these methods provide a comprehensible result. Most of the presented quantitative methods focus on economic targets, such as costs, profit or investment calculations. Many of these methods are limited by the linkage between soft location factor and economic or performance targets.

Using information processing, some qualitative and some quantitative methods can be distinguished as static or dynamic methods. Reference in long-term footprint decisions is one of the important key factors (Freiwald, 2005). Several quantitative methods like net present value method or pay-of-calculation methods allow for a dynamic assessment. These dynamic methods account for parameter changes based on prognoses over an extended planning horizon. Unpredictable changes with large influences on the footprint decision, such as

Quantitative methods	Qualitative methods
<ul style="list-style-type: none"> ▪ Static and dynamic capital budgeting ▪ Break-Even-Analysis ▪ Costs, profit and earning calculation methods ▪ Net present value method ▪ Static and dynamic payoff period calculation methods 	<ul style="list-style-type: none"> ▪ Use-value analysis ▪ Checklist methods ▪ Country risk indicators ▪ Scoring methods ▪ Tradeoff studies ▪ Profile method ▪ Analytic hierarchy process

Fig. 2: Method classification (Kinkel and Buhmann, 2009; Günther and Tempelmeier, 2005; Neuner, 2009)

changes in the incoming order situation or changes during a production project like volume variations which do not meet the forecasts, cannot be taken into consideration. If considering uncertainties typical for automotive supply chain networks, these methods reach their limits (Kinkel and Buhmann, 2009).

Furthermore, methods for footprint decisions support can be either deterministic or stochastic (Freiwald, 2005). Stochastic methods are especially used to account for uncertainties when working with probabilities and distribution functions. In Operations Research, optimization and simulation are often used as methods which model stochastic coherences (Freiwald, 2005; Amin and Zhang, 2013). To evaluate the robustness of a supply chain network and the facilities therein, a simulation-based sensitive-analysis is recommended (Bretzke and Barkawi, 2010). The change in a footprint will have an effect on the network, the supply chain and its performance. Simulation is a manageable method to measure these effects and to determine coherences of structural (footprint) or parameters (changing demands) of a complex system (Kuhn et al., 2009). Simulation is the representation of a system (in our case a supply chain network) with its dynamic processes in an experimentable model to reach findings which are transferable to reality (VDI 3633, 2010).

Based on the requirement of an adaptable and quick decision support, the advantages of qualitative methods are obvious. Using a small number of quantitative input data, measurable results can be provided. Due to several aggregations during the scoring process, the scored results of use-value-analysis can become incomprehensible (Adam, 1996). Strategic network decisions and robust footprint decisions should not be made exclusively on methods with highly abstracted results.

3.2 Planning approaches for supply chain design

Kinkel and Buhmann (2009) point out that there is no single method that integrates all variables of a complex decision and covers its depth completely. A combination of methods should be implemented in a planning approach. Thus, a literature review of different SCD planning approaches is presented in

detail. Approaches were selected that are well known in practice and research, starting from the year 2000. Suitable keyword, supply chain design, strategic supply chain management and robust footprint decision in supply chain design were derived from the problem description and analyzed according to the requirements given in the first section.

The planning approach from Sabri and Beamon (2000) supports decision-makers according to multi-echelon (four echelons) supply chain design. A unique characteristic of this method is the simultaneous optimization of strategic and operative structure problems. The strategic sub-model optimizes the supply chain configuration and the related material flows. The operational sub-model is integrated into planning the strategic sub-model in order to accommodate uncertainty, such as customer demand variations, and to evaluate costs, customer service level and flexibility (Sabri and Beamon, 2000). This level of detail can be increased by implementing optimizations. However, the manufacturing footprint planning covers only a small part of the planning approach.

Chopra's and Meindl's planning approach additionally describes a framework for decision support in network configuration. According to supply chain strategy, structural problems will be solved when using optimization (Chopra and Meindl, 2001). This approach is similar to everyday planning in operations. Chopra and Meindl (2010) have shown that a solution can be realized with the help of MS Excel, which is a general use calculation software. Realistic uncertainties and dynamic factors of a supply chain disappear with highly abstracted KPI-analysis. However, Chopra and Meindl have designed a highly practical conceptual planning approach for strategic network problems, which allows quick decision support. This planning approach, however, does not support adaptation.

The planning approach from Wolf and Nieters consists of eight planning steps. In the first step, a project team is set up. Secondly, the planning tasks need to be defined. The next step describes the generation of planning data. The next two steps describe the modelling process and the parameterization of data.

Step six and seven give the analyses (simulation or optimization) and evaluation methods. The last step supports decision makers (Wolff and Nieters, 2002).

Reiner and Schodl's approach provides a support for the evaluation of different supply chain optimizations. The efficiency is comparable to the satisfaction level of the customer. The approach regards both enterprise-specific and product-specific requirements. The approach provides different KPI, but the focus is on supply chain efficiency (Reiner and Schodl, 2003). This is a highly aggregated approach, and it is not developed specifically for footprint decisions in supply chain design. However, it can be transferred, and it provides a framework for the integration of supply chain strategy into the manufacturing planning problem.

Kinkel et al. (2004) developed a scenario-based planning approach designed for footprint decisions. In contrast to the other planning approaches that are presented in this subsection, this approach focuses on the footprint decisions while accounting for the network perspective as a constraint. The approach provides modules for facility controlling, scenario management, knowledge management and for the optimization of the existing footprint. Kinkel does not provide methods like simulation to account for uncertainties. This approach works with optimistic, realistic and pessimistic scenarios.

The planning approach from Freiwald (2005) describes a decision support model based on a mathematical supply chain design optimization model. Dimension and network structure capacity and material flow are considered in addition to the cooperation with different suppliers (Freiwald, 2005). This planning approach considers different uncertainties and allows for an evaluation of robustness, but disregards adaptability.

Günther's and Tempelmeier's planning approach describes a quantitative procedure for footprint planning. In detail, it is a discrete optimization model for a fixed number of footprint scenarios (Günther and Tempelmeier, 2005). The evaluation is based fixed costs and transportation costs. The planning approach does not provide any KPI's for supply chain performance or

efficiency. Günther and Tempelmeier provide with general heuristics and an optimization framework. There is no regard for other factors like performance.

The planning approach from Goetschalckx and Fleischmann (2005) consists of four planning steps which are developed in an iterative procedure. They consider quantitative and qualitative factors and provide methods for optimization, simulation and benchmarking (Goetschalckx, 2000). This approach is very generic and do not focus specifically on manufacturing footprint decisions.

The planning approach for strategic supply chain planning, according to Seidel (2009), begins with the definition of enterprise strategies and targets. It names planning fields and performs an analysis of potential. Based on the established scenarios, a basic material flow optimization will be implemented. Using the results of this optimization, a detailed simulation of the supply chain design planning problem will be constructed. This is an iterative planning procedure and the results can be used for both the decision and implementation.

Kuhn et al. (2010) have developed a general procedure for strategic logistics planning based on Seidel's planning approach. The central method is the simulation of both basic and detailed planning. This approach provides also other methods for evaluation. In comparison to Seidel's model, the implementation phase is much more detailed.

The planning approach by Straube et al. describes a procedure that evaluates different scenarios and gives a comparative framework. Parts of the evaluation include logistic performance KPI's and ecologic efficiency. The approach consists of five different planning steps. This planning approach provides the demand on internal resources in addition to typical logistics KPI's like costs, performance and quality. The focus of the approach is primarily on sustainability (Straube et al., 2011). This planning approach can only be used for preexisting scenarios.

After the presentation of different planning approaches that are relevant for the following subsection, an intermediate conclusion is given. Within this conclusion the results are summarized and reviewed.

3.3 Intermediate conclusion

This literature review has shown that there are several qualitative, quantitative, static, dynamic, deterministic and stochastic methods that are used in footprint decision support. Regarding complex manufacturing networks with market and environment-related uncertainties, single methods are limited and should be used in planning approaches. Different planning approaches have been evaluated in accord with outlined requirements (see figure 1). The results of the review are summarized in Table 1, and consider the requirements of Section 2. Nearly all presented planning approaches regard different planning problems of the supply chain design and deliver a cost evaluation in the majority of cases. Seidel's approach provides KPIs and an indicator system for multi-dimensional evaluation. This approach uses methods like optimization and simulation. But most supply chain design planning approaches are too generic, and footprint planning is just a generic problem. Particularly, Kinkel's planning approach contrasts the other presented procedures, because the focus is on footprint planning. This approach weights qualitative and quantitative factors and targets and is scenario-based, but does not address the impact on the supply chain and its configuration. Nearly all presented approaches regard dynamic demands and changing capacity.

However, the impact of future variations in order situation and current project constellation on supply chain configuration and individual performance is not a detailed part of manufacturing footprint decisions. Variations that come up quickly will have a large impact on the decision are not in the scope of current planning approaches. The comparison of existing approaches shows that there is no single method that simultaneously accounts for all outlined requirements. This necessitates new models that allow for robust and adaptable footprint decisions while especially considering project, market and environmental uncertainties while continuously evaluating itself. An approach to regard these gaps in footprint decision support is presented in the following section.

Requirements/ Authors	1.	2.	3.	4.	5.
Sabri/Beamon, 2000	(X)	X	-	-	(X)
Chopra/Meindl, 2001	X	X	-	-	-
Wolf/Nieters, 2002	X	X	(X)	(X)	-
Reiner/Schodl, 2003	-	-	-	-	(X)
Kinkel et al., 2004	(X)	X	(X)	-	-
Freiwald, 2005	(X)	(X)	X	-	-
Günther/ Tempelmeier, 2005	X	-	(X)	(X)	-
Goetschalckx/ Fleischmann, 2005	(X)	(X)	-	-	(X)
Seidel, 2009	(X)	(X)	X	-	-
Kuhn et al., 2010	X	X	X	-	-
Straube et al., 2011	X	X	-	-	-

Tab. 1: Summarized requirement evaluation of SCD planning approaches

4. Planning approach for robust footprint decisions

In this section, a new planning approach for footprint decisions is presented. In relation to the requirements, (see figure 1) there are many theoretical scenarios to locate a manufacturing plant. Given a high number of potential locations, the planning approach should provide static and/or qualitative methods for reducing the number footprint decisions to a manageable number. The planning

approach should provide for support of robust and adaptable footprint decisions while especially considering project and market-related uncertainties that reflect the need to continuously revise the footprint strategy. The planning approach in Figure 3 is an example of how to support decision holders in the automotive industry make future footprint decisions. Generally, a plant is used for multiple customers, and the footprint strategy can be aimed at reducing costs and following customer. The planning approach which is displayed in the figure combines the requirements in 6 different modules.

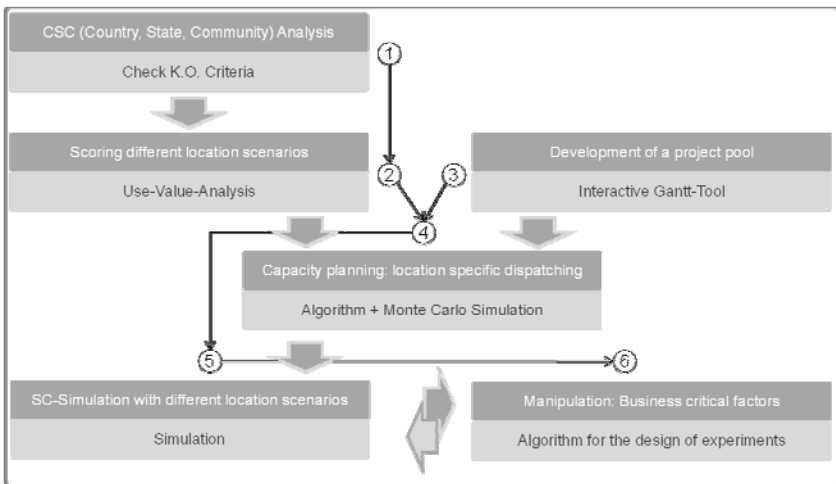


Fig. 3: Planning approach for robust manufacturing footprint decisions

1. Module: Country, State and Community-analysis (CSC)

Within the CSC-analysis countries, states and communities will be evaluated according to enterprise-relevant knock-out criteria. Criteria can be, for example, the minimal number of customers in a country for which at least more than one customer can be supplied just-in-sequence within a defined time window. Alternatively, infrastructural criteria can be used, such as the ability to reach an international airport within at least two hours. There are several lists of location factors (Wisner et al., 2005; Kinkel et al., 2009). The result will be a list of

communities, states and countries that may be potential manufacturing locations.

2. Module: Use-Value-analysis

Using the results from the CSC-analysis, experts of the company will evaluate the potential facility locations according to other location factors in a use-value-analysis. The method especially accounts for soft location factors. For some factors, like corruption level or political instability, a quantification of the impact is quite difficult. Therefore the weighting and the scoring should be done by experts within the company. The result will be a short list of regions and communities for a potential manufacturing plant, ordered by company related priorities.

3. Module: Development of a project pool

As mentioned before, a lot of footprint decisions are triggered by the revenue and sales-planning of a company. Today, there is an entire industry that provides suppliers and OEM with new platforms and innovation trend information in addition to sales volumes forecasts. A systemized method is required to monitor the network occupation and to track the required capacities for the long-term planning horizon. A possible method can be an interactive Gantt-chart. This chart can support both the business planning team and the footprint planning team in a company. With relevant decision data, the current capacity situation can be monitored and new footprint decisions can be triggered.

4. Module: Dispatching

The combination of information and internal sales planning can be used as import for rough analysis of future business projects within a new footprint. All possible future business opportunities are collected, evaluated and given confidence level. Information about to volumes can be added from providers like Verband der Automobilindustrie (VDA), IHS or internal sales information.

To account for uncertainty, uncertainty a Monte Carlo simulation is used and linked with the project specific confidence level. Concurrently, the main cost drivers such as manufacturing costs and/or incentives will be calculated using a linear programming method. As a result, the potential locations are listed with a cost evaluation depending on the project constellation of the upcoming years.

5. Module: Supply Chain Simulation

Planning module CSC-analysis, use-values analysis and dispatching will be used to lower the number of potential locations and to transform and safe relevant data for further planning steps of simulation. In a first step, different supply chain configurations are modelled and evaluated using the method of simulation. For example, input parameters project information from the dispatching module and are used within the simulation model as system loads. Depending on the different project constellations, different sourcing strategies, transportation variants and distribution strategies will be modeled.

6. Module: Manipulation of business critical parameters

In a second step, parameters of the simulation model are systematically manipulated and systems behavior are investigated. Manipulated parameters are, for example, volumes, exchange rates and custom rates efficiency factors of a plant. Based on an empirical analysis of the model's behavior, an evaluation of robustness is possible. For a reliable realization of different simulation experiments, Virtual Experiment Fields (VEF) and experiment plans are defined. VEF are an effective approach to increase the speed of decision support based on simulation (Deiseroth et al., 2013).

5. Conclusion and Outlook

Within this paper, the motivation has been to examine the need for robust and adaptable footprint decisions in the automotive industries. To respond to the requirements, a review of relevant SCD planning approaches covering the topic

of integrated robust footprint decisions in strategic supply chain management has been carried out and the terminology in this context has been analyzed. The findings have been summarized and critically evaluated in terms of meeting the named requirements. Nearly all presented planning approaches regard different planning problems of the supply chain design and deliver a cost evaluation in most cases. In particular, Kinkel's planning approach contrasts the other presented procedures, as the focus is on footprint planning. However, nearly all presented approaches regard dynamic demands and changing capacity.

However, the impact of future variations in order situation and current project constellation on the supply chain configuration and individual performances is not a detailed part of the manufacturing footprint decisions. In particular, the impact of market and environmental uncertainties and on the supply chain and its manufacturing footprint should be analyzed in more detail. Thus, an approach for a robust manufacturing footprint decision has been developed. This approach integrates different methods for decision support throughout a decision making process. However, the application of the developed planning approach must still be carried out. Moreover, a concrete concept for implementation is required in addition to an analysis of how to use a specific input data to support a powerful planning approach.

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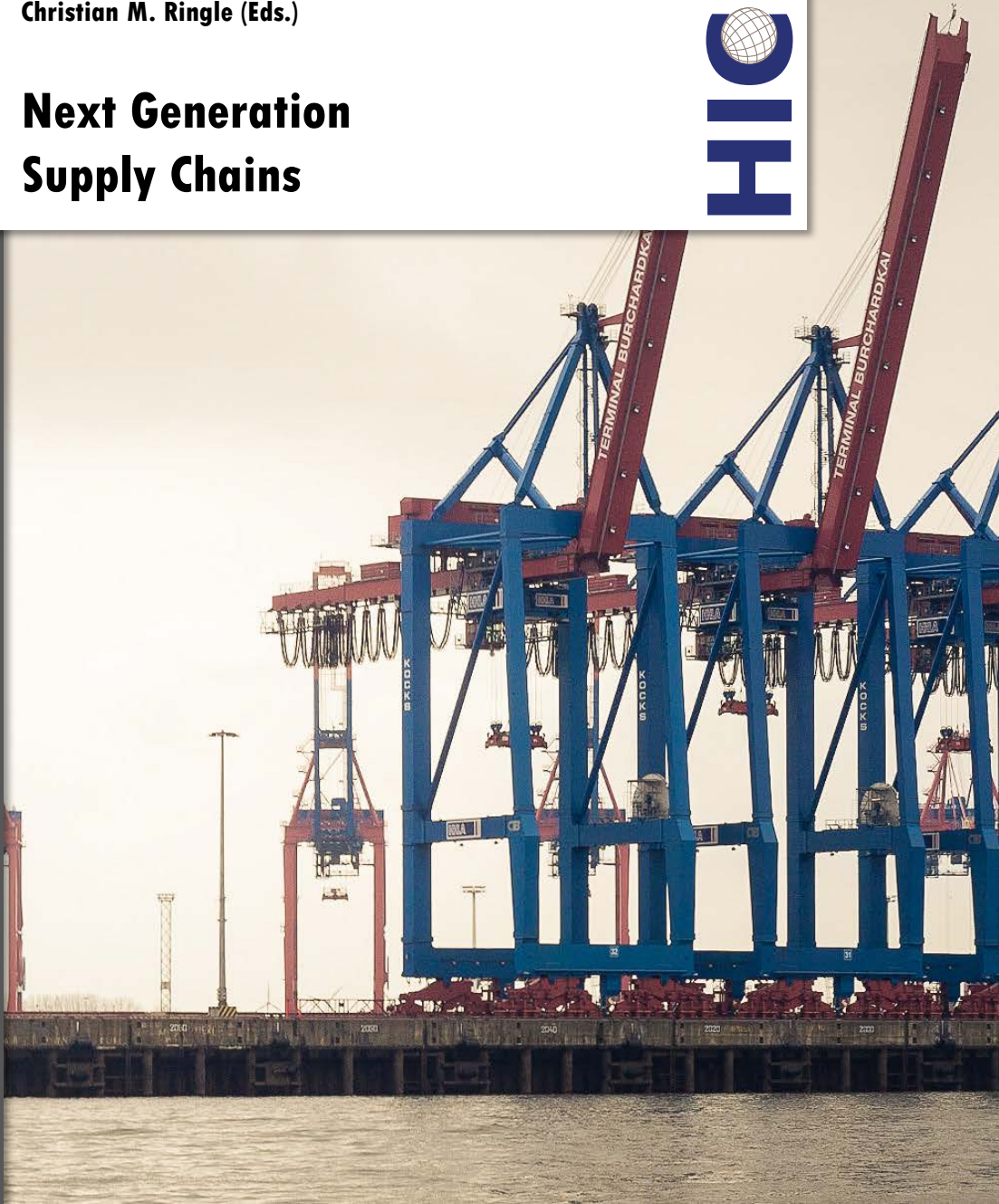
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**Wolfgang Kersten, Thorsten Blecker and
Christian M. Ringle (Eds.)**

Next Generation Supply Chains



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(Editors)

Next Generation Supply Chains

Trends and Opportunities

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Preface

Today's business environment is undergoing significant changes. Demand patterns constantly claim for greener products from more sustainable supply chains. Handling these customer needs, embedded in a sophisticated and complex supply chain environment, are putting the players under a constant pressure: Ecological and social issues arise additionally to challenges like technology management and efficiency enhancement. Concurrently each of these holds incredible opportunities to separate from competitors, yet also increases chain complexity and risks.

This book addresses the hot spots of discussion for future supply chain solutions. It contains manuscripts by international authors providing comprehensive insights into topics like sustainability, supply chain risk management and provides future outlooks to the field of supply chain management. All manuscripts contribute to theory development and verification in their respective area of research.

We would like to thank the authors for their excellent contributions, which advance the logistics research progress. Without their support and hard work, the creation of this volume would not have been possible. We would also like to thank Sara Kheiravar, Tabea Tressin, Matthias Ehni and Niels Hackius for their efforts to prepare, structure and finalize this book.

Hamburg, August 2014

Prof. Dr. Dr. h. c. Wolfgang Kersten
Prof. Dr. Thorsten Blecker
Prof. Dr. Christian Ringle

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About HICL

Since 2006 the annual conference Hamburg International Conference of Logistics (HICL) at Hamburg University of Technology (TUHH) is dedicated to facilitate the exchange of ideas and contribute to the improved understanding and practice of Logistics and SCM. HICL creates a creative environment which attracts researchers, practitioners, and industry thinkers from all around the world.



Innovation is increasingly considered as an enabler of business competitive advantage. More and more organizations focus on satisfying their consumer's demand of innovative and qualitative products and services by applying both technology-supported and non technology-supported innovative methods in their supply chain practices. Due to its very characteristic i.e. novelty, innovation is double-edged sword; capturing value from innovative methods in supply chain practices has been one of the important topics among practitioners as well as researchers of the field.

This volume, edited by Thorsten Blecker, Wolfgang Kersten and Christian Ringle, provides valuable insights into:

- Innovative and technology-based solutions
- Supply chain security management
- Cooperation and performance practices in supply chain management

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