

Design for Logistics: Development of a Process Model

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Abstract

Companies are confronted with increasing competitive pressure because customers demand cheaper products but at the same time want many high quality variants. Therefore, companies strive to increase their efficiency and effectivity. Companies realize that product development processes offer potential for improvement. The consideration of requirements coming from the logistics department present such an opportunity because parts are nowadays sourced from around the world and at the same time the number of parts required increases due to a higher number of variants. Researchers and practitioners state that considering the logistics processes during product development helps to increase efficiency. However, existing support for integrating a logistics perspective into product development is very abstract and does not support companies in mastering arising challenges. This paper addresses this need by taking stock of the existing approaches and collecting the requirements coming from industry. Based on those findings a process model is introduced, which supports the Design for Logistics. A case study at an automotive company was used to apply and evaluate the process model. The results show that the process model helps to integrate the logistics perspective into product development. The paper closes with further research suggestions and recommendations.

Keywords: Design for Logistics, Integrated Product Development, Design for X, Case Study

1 Introduction

Competitive pressure is a challenge for many companies stemming from higher customer demands and global competition (Schulz, 2014c). One option to deal with this situation is to increase efficiency and effectivity. Many companies optimized their shop floor to an extent so that further improvements are difficult (Neutschel & Vajna, 2014). Therefore, the focus shifts towards identifying potential for improvement in other areas. Logistics becomes increasingly important because companies often need to offer many variants of their product which leads, especially in the automotive industry, to higher process complexity and costs. Studies show that logistics is responsible for approximately 6 % of the cost (Göpfert, Schulz, & Wellbrock, 2013). However, it also becomes clear that up to 75 % of the cost is already determined during product development. Thus, the logistics department alone is not capable of decreasing logistics costs to a full extent because during product development many decisions are made that drive future logistics costs (Vajna & Burchardt, 2014). The objective is therefore to support product development by respecting the requirements from logistics early on in the product development process in order to increase efficiency and effectivity.

2 Theoretical Background

At the beginning of the research work a comprehensive literature review was conducted over the course of three months. Mainly scientific online search engines (ScienceDirect, Google Scholar, etc.) were used. The most important keywords which were used during the literature review were logistics, Design for Logistics, Design for X and (integrated) product development.

2.1 Tasks and the Importance of Logistics

Usually companies focus on specific activities in order to produce goods and therefore they often need to source materials from their suppliers (Heiserich, Helbig, & Ullmann, 2011). So essentially the main task of logistics is to provide the company with the resources needed for the production of goods by ensuring an efficient material flow from the respective suppliers to the company's production locations (Heiserich et al., 2011). However, besides an efficient material flow, a reliable information flow is also an essential part of a company's logistics system (Heiserich et al., 2011). Thus, an efficient and reliable logistics system is able to contribute to the success of an industrial company in a significant way (Heiserich et al., 2011).

2.2 Integrated Product Development

The classic approach for product development is characterized by a sequential process with a stepwise integration of involved departments (Schulz, 2014a). However, the complexity of products is continuously increasing and therefore new approaches are necessary to realize the efficient development of new products. To achieve that, Integrated Product Development strives for continuous collaboration of all involved departments at any time in the development process of new products (Vajna & Burchardt, 2014). As a result, this approach allows the reduction of development time and costs as well as the increase of product quality at the same time (Ehrlenspiel & Meerkamm, 2013).

2.3 Design for X

Integrated Product Development is a general approach to encourage all departments of a company to collaborate during the development process. Design for X goes one step further and aims to integrate requirements coming from a specific department into product development at an early stage (Stöber, Gruber, Krehmer, Stuppy, & Westphal, 2009). As a result, it is possible to develop products according to existing requirements in order to achieve efficient processes and to avoid unnecessary expenses because of decisions made during development (Dombrowski, Schmidt, & Schmidtchen, 2014).

In principle, three different types of activities exist in an industrial environment: value-adding, non-value-adding but necessary and waste. The most important ones are value-adding activities, which the customer is willing to pay for because they are essential parts of the manufacturing process (Dombrowski et al., 2014). Furthermore, there are activities which are non-valued-adding, but necessary, as well as activities, which are just wasteful and have to be avoided (Dombrowski et al., 2014). The main focus of Design for X approaches is to influence the necessary but non-value-adding ones. This is done by influencing decisions made during the early product development stage. It is possible to avoid those non-value-adding activities, which are just necessary because of specific product attributes (Dombrowski et al., 2014). Ultimately, this can be done by every department which is involved in the

product development process, like logistics, or in an universal way, like Design for Recycling (Dombrowski et al., 2014). Nowadays several Design for X approaches, like Design for Assembly or Design for Quality, are widely-spread in industrial practice to realize efficient production processes and high product quality. However, in many cases logistics has a low significance compared to other departments (Schulze, 2013). As a result of that, the distribution of Design for Logistics approaches in practice is relatively little (Schulze, 2013).

2.4 Design for Logistics

Design for X is a general approach for influencing product development according to requirements stemming from different disciplines. To apply such an approach in practice, it is necessary to define the requirements of those respective disciplines. For instance, various structures and processes of a company's logistics system are influenced by product attributes (e.g., dimension, weight) and the design of a product. A Design for Logistics approach has to ensure that decisions made during development process are not conflicting with the implementation of efficient logistical processes (Pawellek, O'Shea, & Schramm, 2005).

However, there are several product attributes which may be part of the considerations in the context of Design for Logistics. One of the most important issues from a logistics point of view is the continuous increase in the diversity of variants (Thiebes & Plankert, 2014). For example, the automotive industry offers more and more possibilities to buy customized cars. This, however, leads to serious problems and complexity in production plants due to limited space (Klug, 2010). To encounter this problem, companies need to set up complex and expensive logistical processes (Göpfert & Schulz, 2013). According to Schulz (2014b) there are more attributes which influence the logistics system of a company in a significant way. For example, the dimension and weight of a product are very important attributes. Usually the complex shape of a product leads to small loading factors of the packaging and therefore the number of necessary transportations and handling steps increases. Similar to this, if a product needs a specific coating its surface has to be protected as well. This is usually realized by using special packaging, which is expensive too. Beside these examples, there are many attributes existing which are important to consider in a Design for Logistics approach. However, the relevance of each attribute may vary from case to case. So every company has to contemplate which attributes are important in order to ensure and reach efficient and effective processes.

3 Developed Research Approach

3.1 Findings of the Literature Review

The literature review revealed that logistics is closely linked to the other departments of a company. However, due to diverse tasks and goals, different perspectives exist. Integrated Product Development aims to foster an integral product development. Nevertheless, the findings reveal that logistics are often not considered during the product development processes. One reason why the importance of logistics is not realized is that logistics costs are often considered as overheads (Schulze, 2013). Accordingly, it is often difficult to relate decisions during product development to the resulting logistics costs. However, logistics costs will become more important in the future for gaining competitive advantages. The objective of this paper is therefore to support companies in integrating the logistics perspective into product development. The paper builds upon existing support for a Design for Logistics to provide a process model that can be applied in industry to integrate the requirements coming from the logistics department.

3.2 Research Methodology

The developed research methodology of this paper is based on the Design Research Methodology (DRM) (Blessing & Chakrabarti, 2009). All four phases of the DRM were conducted during the course of this research project: Research Clarification, Descriptive Study I, Prescriptive Study, and Descriptive Study II. Figure 1 illustrates the developed research methodology. The literature review (Chapter 2) was the basis for the Research Clarification and highlighted the importance of integrating the logistics perspective into product development. The next phase is the Descriptive Study. In order to come up with a process model that supports industry a literature search was conducted for the identification of existing support. Afterwards, a case study at an automotive company was used to formulate the requirements for a process model bridging product development and logistics. The case study was conducted at a company in the automotive sector over the course of six months because logistics processes play an important role in this sector due to many product variants and global sourcing. One of the authors was present daily at the company during the six months. After comparing insights coming from literature and industry, the objective was to identify reasons why existing support is not used in industry and to formulate a need to improve the current situation. During the Prescriptive Study a process model was developed building upon existing work and the requirements collected during the case study. During the last phase (Descriptive study II) the developed process model was applied at a case study in the automotive company. Afterwards, different experts were asked to evaluate the developed support with regards to usefulness and applicability. The feedback from the experts was used to identify potential for improvement and to formulate future research questions. The research results of this research methodology are summarized in the following.

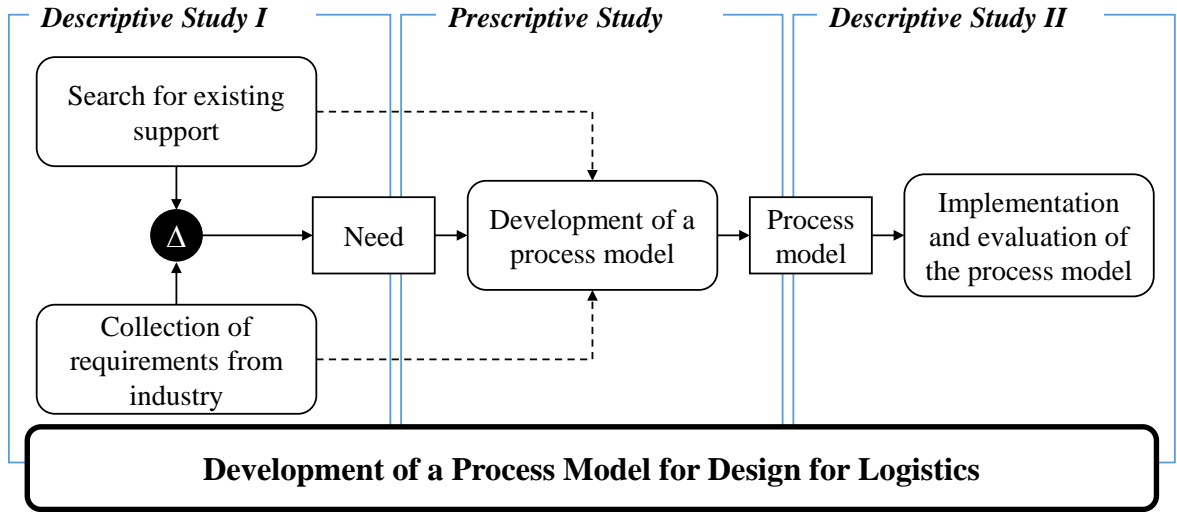


Figure 1. Developed research methodology to derive a process model.

4 Evaluation of Existing Approaches for a Design for Logistics

4.1 Existing Support in Literature

The literature review revealed that the importance of Design for Logistics has already been recognized. Various researchers highlight the importance of such an approach (Pawellek et al., 2005). However, many publications do not make any concrete suggestions as to how to implement Design for Logistics in practice. Nevertheless, many researchers agree that the

application of an effective Design for Logistics approach is capable to save both time and money (Klug, 2010; Pawellek et al., 2005; Schulz, 2014a).

However, a simplified, theoretical process for the realization of a Design for Logistics approach was developed by Schulze (2013). This process is shown in Figure 2. In principle it is a simple regulation process which compares actual values to target values and evaluates if any deviation is existing. Indeed, the potential analysis step is not shown in detail. Furthermore, the process does not show any responsibilities for the tasks which are stated. However, the process represents a fundamental approach for the realization of Design for Logistics and therefore presents a first starting point for the development of a process, which should better address the needs coming from industry.

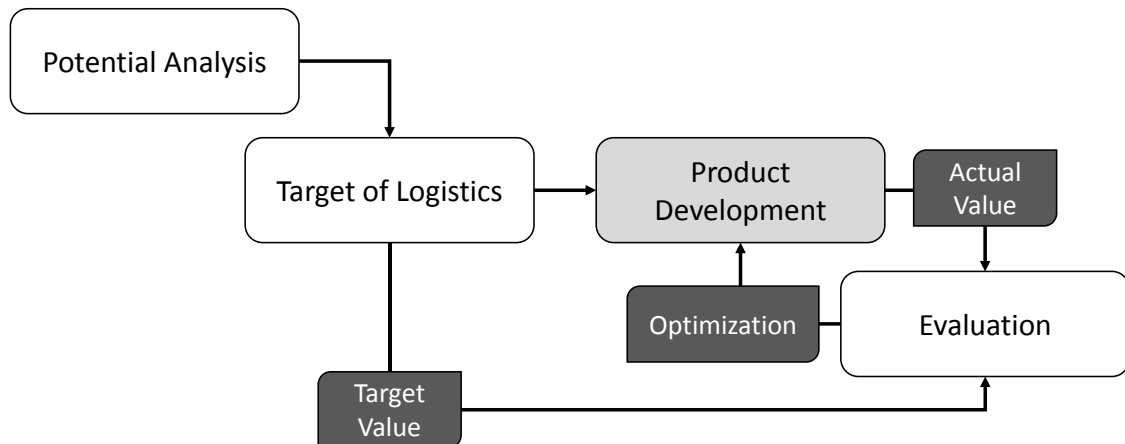


Figure 2. Process model for a Design for Logistics approach based on Schulze (2013).

4.2 Industry Requirements to Support the Design for Logistics

An essential part of this work is a case study at a company from the automotive sector. The industry sector is characterized by products with many variants and complex supply chains due to global sourcing and distribution. Based on the insights gained during the case study the objective was to develop and evaluate a practical process for Design for Logistics. In order to increase the application of a Design for Logistics approach, the requirements for a successful implementation in practice were determined through expert interviews at the beginning.

One of the most important requirements for the implementation of a Design for Logistics process is an early integration of the logistics departments into the developments process. The earlier logistics is able to contribute its specifications in the development process, the likelier it is that they will be considered. Furthermore, it is integral to realizing a continuous collaboration of all involved departments, according to the approach of Integrated Product Development. By ensuring a continuous collaboration, the acceptance of all involved departments can be increased and therefore more dominant departments like development or purchasing obtain a better understanding of typical challenges for departments like logistics. Indeed, to achieve that, logistics has to show its potential whenever possible to highlight its significance for the overall success of a product or the company. To support the analysis of potential it can be very helpful to use specific tools, which enable the documentation and assessment of ideas. These ideas can be used as part of a Design for Logistics approach for new product development projects.

Additionally, necessary contact persons to implement the Design for Logistics approach have to be determined so that definite responsibilities are defined. That is very important for the successful implementation of such a complex process in established company structures.

4.3 Need for the Development of new Process Model

Existing suggestions for process models, like the approach mentioned by Schulze (2013), emphasize the importance of the implementation of a Design for Logistics approach in industry. However, existing process models are too theoretical to implement them in practice without extensive adaptations in many cases. For example, they disregard the fact that it is very important to define responsibilities for a successful realization in industrial practice. Although the mentioned process describes the step of potential analysis at the beginning, it does not show how to identify these potentials in detail. The case study revealed that it is very important to address this step in depth because often most potentials are not obvious. Focusing on an effective potential analysis supported by a well prepared standardized process helps to increase the acceptance of Design for Logistics. If logistics is able to highlight great potentials, it will not be too difficult to convince other involved departments of the implementation.

5 Development and Application of a Process Model

5.1 Development

Based on literature findings and existing challenges at the observed company, a process model was derived to implement a Design for Logistics approach in practice. Many interviews and discussions with experts in logistics and product development were conducted over the course of the entire research project. The most important requirement for the process model is to support an effective potential analysis because in an environment of complex company structures and also products it is very important to derive a process model for Design for Logistics that is applicable in industry. A supporting tool, which accompanies the whole process, is an idea database. It is a basis for the analysis of ideas and documents the progress of Design for Logistics for a specific product. Furthermore, so called briefing documents allow for the summarization of the results of the Design for Logistics process which are stored in the idea database and for their provision to the development department of the company.

Essentially the process model, which was developed over the course of this research project, can be divided into the four stages: preparation, idea generation, evaluation of potentials and application. Figure 3 depicts the process model for the Design for Logistics approach, which was developed during the case study. In the following, each of the four stages is described in more detail in order to reach a clear and detailed understanding of the developed process model.

The **preparation** contains every activity, which is necessary to establish the requirements of an efficient Design for Logistics process in the company. However, this stage has to be performed and adopted to the present situation. Especially during the first implementation of the process it is crucial that all necessary requirements for a process supporting Design for Logistics exist.

The next stage, the **idea generation** is the core element of this Design for Logistics process. Supported by the idea database, existing ideas concerning possible potentials for specific product components can be evaluated and examined. However, the content of the database is

dependent on previous applications of Design for Logistics approaches. Following the analysis of ideas and possible potentials, suitable product components for the Design for Logistics application must be selected. Afterwards, an important decision needs to be made. For complex products especially, or in the case that there are a limited number of existing ideas for improvement, it might be useful to perform Design for Logistics workshops. Therefore, it is recommended that experts from different departments involved in the product development process participate. Besides, the workshop should consist of experts from the logistics department, which can be for example a responsible persons from development or purchasing. The next step is to document the potentials for improved product design from a logistics perspective, which were found during the idea generation stage. For that, the idea database can be used as a supporting tool. In the developed process model the results of the idea generation can, for example, be summarized into a briefing document, which is stored in the idea database.

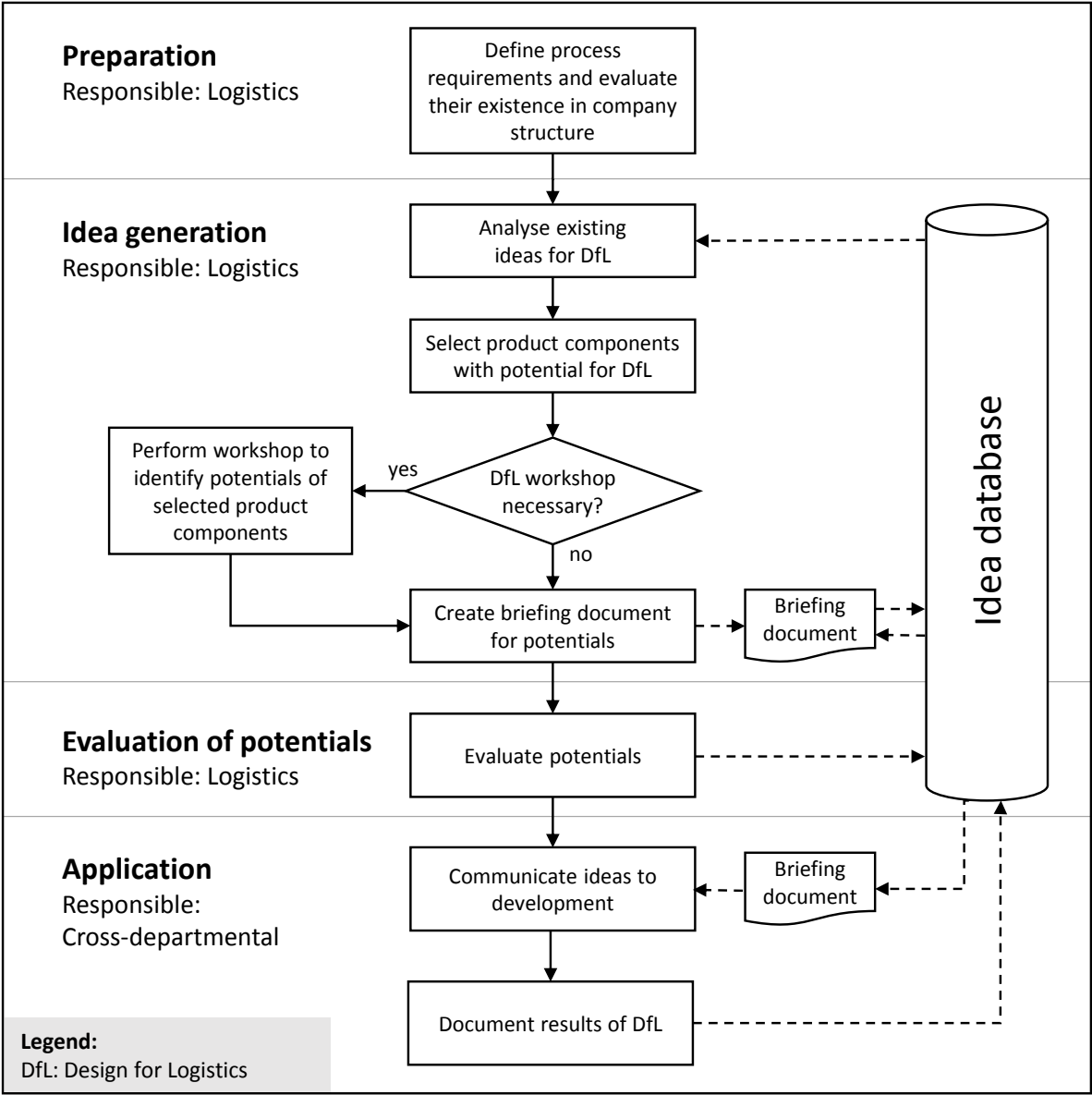


Figure 3. Process model for an implementation of the Design for Logistics in practice.

The next stage is the **evaluation of potentials**. Once the results of the idea generation stage are documented, they must be evaluated. Of course, it does not make sense to claim or implement engineering changes to specific product components or parts if they do not lead to significant savings from a logistics perspective. At the same time, the cost of an engineering change should not exceed the potential savings, which means that the benefit-cost should be greater than 1.

The **application** is the last stage of the developed process model. This stage contains the communication of ideas to the responsible departments involved in product development and the final documentation of the results of the Design for Logistics process. It is important to document the success or refusal of ideas at the end because this again serves as useful input for further applications of the Design for Logistics approach. The last step is of great importance for a sustainable integration of the Design for Logistics approach because it requires time and maybe multiple iterations to anchor the extended product development mindset into the heads of the involved stakeholders.

5.2 Application

An essential part of this work was a six months long case study at a company of the automotive industry to evaluate the practicability of the process model (Descriptive study II). Unstructured expert interviews served as the major input during the case study. The Design for Logistics process model was applied during a current product development project at the company.

At the beginning the availability of the necessary requirements, which have already been described in Section 4.2, had to be ensured. So the most important issue which had to be addressed was an earlier integration of the logistics department into the product development process in order to integrate the logistics perspective into the product design decisions. This was necessary because it is much easier to demand changes relating to product components in the early product development phase. So, by coordinating with the development department the early integration of logistics from the beginning was realized.

For the next step, ideas for Design for Logistics had to be created. First, existing problems in the company's logistics were analyzed and collected in an initial database. Based on these problems and suggestions for solving them, a few product components were selected for further analysis. After that, workshops were performed to find as many ideas and improvement potentials as possible. Experts from different areas of logistics as well as experts from the development department participated in these workshops. The results of these workshops were comprehensive. On the one hand, everybody who participated at the workshops learned much about the existing problems regarding the product components which had been observed. On the other hand, many ideas for solving existing problems with specific components were created and were collected into the idea database.

Following this, the ideas, which had been discovered in the workshops, had to be assessed by experts in order to highlight possible savings and process improvements. The results of the assessment were recorded in the idea database also. In the end, the database contained specific ideas relating to the product components and their potentials for the company, which were derived during the workshops.

Finally, the results of the application of the Design for Logistics approach had to be communicated to the responsible product development departments. However, this last step takes much time due to the complex process structure of a company. Especially in the development project of an automotive manufacturer's new care model the visibility of the results of Design for Logistics will take some time.

6 Evaluation of the Developed Process Model

Various experts from specific company departments were involved during the initial application of the developed process model. After the application they were asked about their feedback for the suggested process model for Design for Logistics. The three dimensions of the DRM: applicability, usability and usefulness were used for the evaluation of the developed process model (Blessing & Chakrabarti, 2009). Most of the interviews involved experts from various logistics areas because they were the main participants during the implementation of the process. However, a few experts from other departments, like development, were involved too. Altogether, the feedback from all involved experts revealed that the developed process model is suitable for application in practice. The fact that the cross-departmental communication had increased due to the mutual potential analysis was described as very positive. Associated with that, the experts emphasized that the acceptance and understanding of problems stemming from other departments was raised and therefore future collaboration is expected to become easier. But experts also mentioned that the Design for Logistics initiative would have benefited if more departments had been involved in the process. This finding will be considered during the further development and application of the suggested process model. Furthermore, the supporting idea database will get further improvements to make it more efficient and to realize a cross-departmental integration into the existing supporting toolbox of the company. Ultimately, suitable key performance indicators have to be created to measure the results of the Design for Logistics approach. It will be important for future applications to highlight the significance and potential of logistics in decisions regarding product development. Especially in large companies a successful evaluation of the approach is very important in order to raise managerial awareness that a change in the current product development mind-set is needed and, more importantly, financially attractive.

7 Summary and Outlook

Companies are striving to increase efficiency and effectivity in order gain a competitive edge. Currently product development is the focus for identifying potential for improvement because development does not only cause costs but also determines the costs of many downstream processes. Logistics becomes increasingly important because many companies need to offer an increasing number of variants, which requires efficient logistical processes. Furthermore, globalization leads to larger transport distances. The decisions during product development impact to a large extent the logistical processes and often decrease their efficiency because the logistics department can often only react to decisions made during product development rather than proactively influence them. Therefore, the objective is to integrate the logistics perspective into product development earlier. The findings of the literature review revealed the importance of an early involvement of logistics. However, the comparison between the existing support and the requirements collected during a case study at an automotive company disclosed a need for further research.

Therefore, the objective of this paper was to develop a process model that supports a Design for Logistics in practice. The developed process model aims to reduce logistics costs and increase the performance of the logistical processes. Due to the fact that not all parts or components of a product can be optimized, an important piece of the process is to identify those parts that cause high logistics costs. Afterwards, ideas are collected as to how the design of a part can be improved from a logistics perspective, followed by a discussion with the product development department to evaluate possibilities of implementing the ideas. The developed process model for a Design for Logistics was implemented and evaluated at a company from the automotive sector. The results showed the applicability of the process model. At the same time the application of the Design for Logistics approach increased the involved stakeholders' awareness of the benefit of early involvement of the logistics department in product development.

The results of the case study show that the developed process model is a step in the right direction. However, additional research is required to define how the Design for Logistics approach can be integrated into product development in a sustainable way. The development of a comprehensive goal system would be an appropriate tool to increase awareness of the requirements coming from the logistics departments. Furthermore, it would be possible with such a goal system to evaluate the target achievement.

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