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# SUPPLIER INTEGRATION IN PRODUCT DEVELOPMENT: A SEARCH FOR EXISTING APPORACHES IN OTHER INDUSTRIES

J. Bock, J. Wilberg and U. Lindemann

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## 1. Introduction

Shorter product development cycles, higher quality, and at the same time lower prices. These are requirements companies need to fulfil in order to be successful. Therefore, companies are striving to increase their efficiency and effectivity. Applying Lean Thinking is option and it was already successfully implemented at the shop floor. Therefore, Lean Thinking was also applied to other business processes e.g. product development or administration [Warnecke and Hüser 1995]. The application of Lean Thinking to product development processes is called Lean Product Development System (LPDS). One of the main objectives of Lean Thinking is to increase the customer value and reduce non value adding activities (waste). Studies emphasize that high potential exists to eliminate waste (e.g., unnecessary information or waiting) in product development. Accordingly, applying LPDS presents a suitable approach to increase efficiency and effectivity. However, LPDS should not be seen as an easy path to shorter development cycles because developing new products involves creativity, which makes the application of Lean Thinking quite challenging [Karlsson and Åhlström 1996].

In general, the LPDS compromises many different principles like standardization, early supplier integration in product development, or continuous improvement [Liker and Morgan 2006]. A successful implementation of Lean Thinking requires that it is implemented in its entirety as a system. However, the authors decided to focus on early supplier integration in the product development. From an industry perspective supplier integration is an important topic because more and more companies are outsourcing parts of the product development to suppliers [Eppinger and Chitkara 2006]. Under such conditions the integration of suppliers becomes even more critical because the supplier often holds special product and process knowledge [Johnsen 2009]. Different case studies emphasized that better supplier integration is a key to success (e.g. [Dyer and Hatch 2004], [Song and Di Benedetto 2008]). The importance of this topic is not only underlined from a practitioner standpoint but also from researchers perspective because several questions remain unanswered [Johnsen 2009]. Supplier integration compromises of two aspects: the strategic and the operational management [van Echtelt et al. 2008]. Especially the operational management is of interest because the planning, management, and evaluation of current collaborations with suppliers is crucial for the performance and success.

The objective of the paper is to further contribute to the existing body of knowledge concerning the operational management of the supplier integration. Due to the fact that different industry sectors already apply Lean thinking to their business process, the research approach of this paper is to conduct an initial search in other industry sectors for best practice examples concerning the operational management of supplier integration. The research objective is to learn from other industries and eventually transfer the existing knowledge and insights into mechanical engineering context.

## 2. Theoretical background

### 2.1 Current situation within the mechanical engineering sector

A survey by Ehrlenspiel [2007] among 300 different companies in the mechanical engineering industry revealed that lack of time and production costs are named as the biggest future challenges. In particular, a growing competition from emerging countries puts the traditional western companies in the mechanical engineering industry under pressure. The new competitive situation also leads to a surplus of supply changes and the transition of the market from a seller's towards a buyer's market [Ehrlenspiel 2007]. In such a market, the price, timing, and extent of a product is defined by the customer. In order to continuously attract customers, the challenge for companies is to shorten development cycles, create innovative products, reduce product prices, improve quality, and align products flexible to the customers. One reason why the German industry is at the moment in a good competitive situation, is an intensive use of the Lean Philosophy for the Product Engineering Process (PEP) [VDMA and Mc Kinsey & Company 2014].

### 2.2 Lean philosophy

The Lean Philosophy is based on the principles and targets of the Toyota Production System (TPS). The main target of the TPS is to avoid waste (non value adding activities) and deliver value for the customer [Liker et al. 1996]. The core principles are a continuous improvement, standardization and stabilization of the processes, and the collaboration of all participants. The TPS seeks to achieve better quality, lower cost, shorter production times, better safety and higher morale among the workers [Liker et al. 1996]. The TPS helped companies to achieve very good results in production process performance.

Nevertheless, current the challenges also require an efficient and effective PEP. Therefore, Lean Think also makes sense for the PEP. However, the methods and principles of the TPS cannot simply be applied to a product development processes. One reason is that during the PEP the workflow consists of "ideas" not "products". It is therefore more difficult to standardize the PEP. For the product development field an adapted approach exists, which is called Lean Product Development System (LPDS). It shares common principles with the TPS but is more tailored to the challenges during PEP. Liker et al. [1996] divided the underlying management principles of the LPDS in the three categories: Process, People, and Technology & Techniques. Figure 1 summarises the underlying principles. Each one of the principles in Figure 1 represents an individual management framework. In a lot of projects, when it comes to Lean Thinking, especially the category process is considered and analysed. But only if all of the principles are implemented as a whole, the project performance can be significantly increased [Liker et al. 1996].

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|---|---|
| **People** | Includes the chief engineer, cross functional teams, balance of expertise and development of technical competence, continuous supplier integration, continuous learning environment, and the culture of excellence and continuous improvement. |
| **Process** | Comprises all tasks and sequence of tasks used to bring a product concept to SOP. Underlying principles include: Costumer-value oriented processes, front-loaded processes (exploration of multiple solutions while maximizing the design space), levelled process flow, process standardization and flexibility. |
| **Tools & Techniques** | Set of tools that enable people to execute and improve the PD process, which include adaption to people and processes, organization alignment trough visual Techniques communication, tools for standardization and organizational learning. |

**Figure 1. Summary of the three LPDS categories [León and Farris 2011]**

León and Farris [2011] conducted the most recent and comprehensive literature review on the LPDS. The review revealed multiple fields and research questions that require further effort. One of the suggested major directions for future research is the supplier integration in product development.

The way suppliers are integrated in product development has a large influence on the costs, development time, product quality, and innovativeness of OEMs [Ragatz et al. 2002], [Schiele 2010]. The integration of suppliers therefore plays an important role to increase the efficiency and effectivity. The demand is high for adequate solutions in this field. The objective is therefore to further discover the body of knowledge concerning supplier integration in order to identify unanswered research questions.

### 2.3 The importance of supplier integration in product development

A good and long-term integration of suppliers represents the basis for the standardization of processes [León and Farris 2011]. Therefore, sustainable and constructive supplier relations are an important component of the implementation and effectiveness of the LPDS [Schiele 2010].

In the German mechanical engineering industry, it is assumed that about 75 percent of the value is added in preceding and intermediate working steps [Weirich], [Schiele 2010]. In addition, the supplier industry is transforming from pure manufacturers of individual components to companies, which have more responsibilities and build whole components with their own development departments [Tang and Zimmermann 2009]. Accordingly supplier integration becomes more important, but also complex. OEMs depend on a large extent on suppliers as a source of innovation, know-how, and material.

The case of the Boeing’s 787 Dreamliner shows that supplier integration is also challenging because significant delays occurred due to supplier defaults [Tang and Zimmermann 2009]. The case also highlights that new forms of supplier integration in product development also require new operational management approaches and frameworks. Another case study in the Swedish automotive industry showed that organizational effort and willingness is required by every partner because both the OEM and suppliers need to adjust to a new positon [Corswant and Tunälv 2002].

In general, good supplier integration and operational management are very important, to avoid delays and to ensure that the problems which suppliers face, are detected and solved early on in the PEP [Ragatz et al. 2002], [Tang and Zimmermann 2009]. Cost, schedule, and quality of the final products are largely determined by suppliers due to the high real net output ratio.

Research findings show that supplier integrations helps to reduce cost and improve quality [Ragatz et al. 2002], [Staudenmayer and Hauptmann 2014]. A study conducted by Gupta and Souder [1998] showed that a stronger integration of suppliers leads to shorter development cycles. The innovation strength of companies also benefits from an integration of suppliers. With a good integration of suppliers in the PEP, OEMs can rely on the experience and the expertise of suppliers and thus benefit from their innovative strength and their complexity management [Ragatz et al. 2002], [Dyer and Hatch 2004]. The findings highlight that product development can strongly benefit from supplier input. However, research results also show that supplier integration does not per se improves product development because it requires additional coordination effort and also introduces new risks [Primo and Amundson 2002]. Johnsen [2009] identified three success factors for supplier integration: supplier selection, supplier relationship development and adaptation, and internal customer capabilities. The factors emphasize that successful supplier integration requires more than just a selection of suitable suppliers. The importance of relationship management (e.g., trust, risk and reward sharing) is high, but is often underestimated in industry. Nevertheless, it is also important to mention that also suppliers benefit from a stronger integration. Closely integrated suppliers gain insights into product- and process innovations of OEMs. A close relationship to the customers is important to align products closer with the market and to respond to trends or issues. Furthermore, when integrated successfully, suppliers can better respond to changes in the process planning [Dyer and Hatch 2004].

## 3. Research approach

### 3.1 Identified need for additional research

The wide range of identified challenges in the mechanical engineering sector present a risk and an opportunity at the same time. On the one hand, the changing situation endangers the viability of companies. On the other hand, finding new approaches to overcome challenges can lead to completive advantages and increased efficiency in product development.

The review of the body of knowledge revealed that supplier integration in product development proves to be of emerging importance for companies. However, the analysis of existing publications concerning this matter highlighted the need for new project handling approaches, which support managing integration of suppliers in product development [van Echtelt et al. 2008]. Therefore, the objective is to support industry with managing their supplier integration (e.g. fostering collaboration, setting a legal framework) because this an often underestimated success factor.

### 3.2 Developed research methodology

The research conducted for this paper followed the Design Research Methodology (DRM) [Blessing and Chakrabarti 2009]. The DRM consists of four consecutive stages: Research Clarification, Descriptive Study I, Prescriptive Study, and Descriptive Study II. The first stage provides the research goals. During the second stage (Descriptive Study I) the researcher obtains a detailed understanding of the existing situation that is addressed afterwards. In the Prescriptive Study stage insights of the previous stages are used to develop support for the identified situation. In the last stage, the developed support is evaluated concerning the usefulness and the applicability.

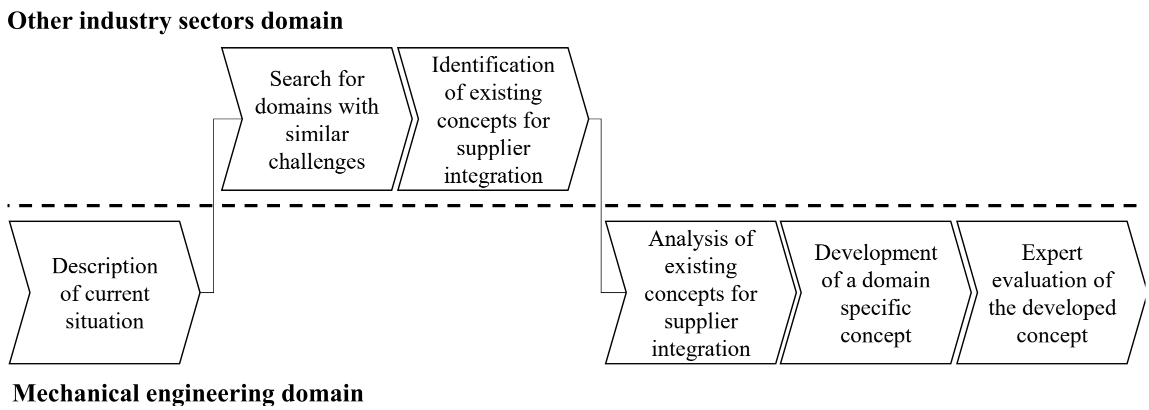


**Figure 2. Depiction of the applied research methodology**

The DRM served as blueprint for the research methodology of this work and all four stages were conducted. Figure 2 depicts the developed and applied research methodology of this paper. The overall research objective is to provide an approach for operational management of supplier integration that builds upon existing experience and knowledge from other industry sectors.

Lean Thinking has evolved in the past and has been applied to different industry sectors (e.g. health care, service sector, or construction) [Hines 2004]. Therefore, the research approach is to search in other industry sectors for successful approaches, which support the supplier integration in product development. The research question of this paper is: Do other industry sectors already apply approaches for supplier integration, which mechanical engineering can learn from?

Figure 2 illustrates how this research question was incorporated in the research methodology. Accordingly the first step (Research Clarification) was to gain a detailed understanding of the current situation and future challenges in mechanical engineering. This step was conducted literature based and the results are summarized in Chapter 2. The description of the initial situation and the required support for supplier integration drive the following steps of the research methodology. The second and third step aim to identify other industry sectors that also have demand for supplier integration. After such a sector is identified, existing and successful concepts for supplier integration are searched in within the corresponding sector. The objective of the fourth step is to obtain a detailed understanding of identified concepts and select a promising one (Descriptive Study II). The fifth step is then to transfer an existing approach into the mechanical engineering domain and to describe how such approach could be applied (Prescriptive Study). Due to the fact that this research does not include a case study the last step is then to discuss the developed concept with experts for industry in order evaluate the potential to overcome the identified challenges in managing the supplier integration (Descriptive Study II). The outcome of first step of the research methodology is presented in Chapter 2. The following Chapters will summarize the outcome of the following process steps.

## 4. Existing approaches for supplier integration

### 4.1 Search for other industry sectors requiring supplier integration

Other industry sectors were examined to identify existing approach for supplier integration. It is important that not only the structure, but also the problems and of the industry sectors are similar in order to be able to implement and apply an identified approach in the mechanical engineering sector. The analysis revealed that especially in the civil engineering industry similar challenges exists.

In the civil and mechanical engineering industry a very intensive competition and a high price pressure exist [Ehrlenspiel 2007], [O'Connor 2009]. Based on the real added value per worker [Eastman 2011], [Bureau of Economic Analysis (BEA) 2014] and the numbers of patent activities [European Patent Office (EPO) 2014] the areas productivity and innovative strength are languishing, respectively are, compared to developing countries, only slowly increasing in the western civil and mechanical engineering industry. Furthermore, the integration of suppliers as well as the relationship between customer and contractor is criticized and described as critical [American Institute of Architects California Council 2007], [O'Connor 2009], [Staudenmayer and Hauptmann 2014],.

Structurally the civil and mechanical sector have a lot in common. Companies of both branches are largely depending on suppliers in the development and production process due to a low real net output ratio [Smith et al. 2011]. Products of both sectors can be individual goods as for example rockets and skyscrapers but also mass produced products as cars or prefabricated houses. In some cases both disciplines closely work together or merge (e.g., wind turbines or oil platforms).

### 4.2 Identification of existing approaches for supplier integration in construction industry

Due to the similarity of both industries, the project handling approaches of the civil engineering sector were further examined. Traditionally project handling approaches that are applied in the civil engineering industry are Design-Bid-Build, Construction Management at Risk, and Design Build. These approaches use price auctions and the customer is promised to receive the best price and best product.

However, those traditional project handling approach seem to reach their limits and cause problems. Especially large projects struggle with rising budgets and are unable to meet the schedules [O'Connor 2009]. Expected and real output, as well as the customer and contractor relationship drift apart. O'Connor [2009] and Ashcraft [2014] see the traditional used project handling approaches, whose main selection criterion is the best price, as the cause for current problems in the civil engineering industry. To encounter this trend and as an alternative to current project handling approaches, the Integrated Project Delivery (IPD) has emerged in construction business.

With the IPD approach cost and construction time reduction, greater strength in innovation, better quality, higher productivity, and a good relationship between owner are supposed to be possible [Matthews and Howell 2005]. The integration of different responsibilities and suppliers into a homogeneous team is the most important part of the approach [Matthews and Howell 2005]. The IPD approach has emerged from Lean Construction, which is part of the Lean Philosophy. It combines characteristics of the TPS (construction phase) and LPDS (design phase), in terms of civil engineering [National Association of State Facilities Administrators 2010], [Heidemann 2011]. The methods and principles of the Lean Philosophy, as for example avoiding waste and the standardization of processes are considered as given [NASFA 2010].

Due to the very close connection to the Lean Philosophy [NASFA 2010], which was applied successfully in the mechanical engineering industry and good results. The application of IPD approach led to improvements concerning the budget, schedule, quality, and supplier integration in the construction industry (e. g. [American Institute of Architects 2012]). The approach seems promising and was selected for further research. Other approaches were not analysed at this stage of the research project because the IPD approach is also used for large construction projects. A detailed analysis of the IPD approach is necessary in order to conclude if the approach can be helpful in the mechanical engineering domain.

### 4.3 Detailed analysis of the Integrated Project Delivery (IPD) approach

The IPD approach provides a framework for the management to integrate all key project participants, as for example suppliers, designers, and engineers into a legal connection, an integrated team on the same level.
The IPD approach was first defined by the American Institute of Architects: „Integrated Project Delivery (IPD) is a project delivery approach that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all phases of design, fabrication, and construction.“ [American Institute of Architects 2007]
Between all participants so called „multi-party-“ or „relational-contracts“ are installed [NASFA 2010]. In these contracts not only rights, responsibilities, and services between the participants are established but also the relationships between the different parties are defined.
Participants are bound to communication and teamwork [American Institute of Architects 2007]. For this purpose, a core team is formed at the beginning of the project. It consists of the best qualified representatives of each individually important area for the project, the so called "Primary Team Member (PTM)" and the customer [Matthews and Howell 2005]. Interdisciplinary decisions are taken in this team together and at an early stage of the project [NASFA 2010].
Essential for the kind of teamwork is, that the interdisciplinary flow of information is facilitated and the project status as well as problem areas are transparent throughout the project for all participants [Raisbeck et al. 2010]. To provide this transparency, electronic project status, and information systems, as Building Information Modeling (BIM) and Project Management Information Systems (PMIS) are intensively utilized [Thomsen et al. 2009].

### 4.4 Methods and principles of the Integrated Project Delivery (IPD) approach

Based on this analysis, the supreme objective of IPD is the maximization of collaboration and coordination throughout the whole project [Kent and Becerik-Gerber 2010]. Hereby synergies in the areas of development, administration, infrastructure and a higher overall project performance shall be achieved [Matthews and Howell 2005], [Ghassemi and Becerik-Gerber 2011]. Thus, teamwork and collaboration cannot be achieved by contractual obligations. They are built on trust and mutual respect between the project participants [American Institute of Architects 2007]. In an IPD project these characteristics must be challenged and provided.
This process is supported by an important tool of the IPD, a shared motivation- and incentive structure, in form of a payment- and reward pool. In a simple variant, the risk- and contingency pool, all participants agree on a target price and characteristics, as quality, extent, and schedule for the project [Thomsen et al. 2009]. The customer pays the target price into a fund. Ongoing costs such as materials, labor, etc. are paid therefrom. If the overall costs at the end of the project are lower, or higher than the target price, all team members and the customer - depending on the contractual agreements - share the loss or profit [Thomsen et al. 2009]. The payment of the risk- and reward pool is not completely individual but bound to the project success. Therefore, all team members have aligned goals, to achieve the common agreed targets. This creates trust and causes all project participants to work together for the project and nor for own goals [Thomsen et al. 2009]. Other ways, to promote cooperation and trust are e.g., a local consolidation of the teams, so called „collocation in a ‚Big Room‘” [Raisbeck et al. 2010] or the implementation of a "no blame culture" in the company [O’Connor 2009].
Another important principle of the IPD is early and intensive involvement of suppliers. Teamwork can be supported in an early stage of the project, changes, mistakes and problems can be implemented or remedied with lower costs. The methods and principles can be supported by a shared IT-system for all participants. It ensures a transparent status overview and information flow for the management.

## 5. Concept for applying the IPD approach in mechanical engineering

The analysis of the IPD approach revealed the positive results in the construction sector. Therefore, the objective is to build upon the existing experience with the IPD approach and to develop a theoretical concept how the approach could be used in the mechanical engineering industry. The concept is until now only an idea because the IPD approach has not been applied outside the construction industry.

The automotive industry strongly depends on suppliers. Staudenmayer and Hauptmann [2014] conducted a study with approximately 100 participants from the supplier industry (automotive sector) and analyzed the collaboration and the role and responsibility of suppliers in the product engineering process. The results emphasize that the current situation and the relationship between OEMs and suppliers is seen as critical. Therefore, there is a particularly high demand for new approaches in supplier integration.
A possible practical implementation in the automotive industry will be described in the following: After selecting the process partners at the beginning of the project, a project team, consisting of the project spokesmen of the various suppliers and the car manufacturer, will be set up. In the regular meetings of this project team problems can be addressed early, suppliers can be involved and interdisciplinary issues can be addressed and clarified. In the context of local consolidation, e.g., in automotive clusters this form of cooperation and the formation of the project team could be further facilitated.
With team events and external coaching at the beginning of the project start a good cooperation and a "no-blame-culture" could be introduced and implemented. This also includes the risk- and reward pool, which could be implemented practical by the OEM, by storing the project's budget in an escrow account. The running costs could be covered by this account. After completion of the project, the remaining amount or a possible balance would be proportionately shared by all project participating suppliers and stakeholders according to the working interests in the project. The monitoring of the account and the project milestones could be done by an independent, by both sides designated arbitration.
Conceivable for large projects is the formation of a joint venture in which both, OEM as well as the various supplier companies would share responsibility. With a joint commitment to the project's success expertise and synergies can be traded and shared easily among themselves. Through the implementation of a common IT-system or a cloud solution, the within the project obtained findings and the project status can be open available for all the project participants. With the cooperation of all involved project participants, skilled workers, or special IT-licenses can be shared to increase the product performance.

## 6. Preliminary expert evaluation of the developed concept

The authors conducted two semi structure expert interviews to evaluate to what extent the project performance can actually be increased by using IPD. The former director of the purchase department of a major OEMs and the head of the development department of a large supplying company for the automotive industry participated in the interviews. Both interviews were conducted in German and lasted approximately 45 minutes. The transcripts of the interviews are available upon request.
The interview covered three topics: current practice in supplier integration, future vision and needs, and evaluation of the applicability of the IPD approach for the automotive industry.
Concerning the current practice in supplier integration, the core statements of the study by Staudenmayer and Hauptmann [2014] were validated. The opinions of the OEM and the first-tier are contradictory. From the supplier’s perspective, the involvement does not happen early enough. In contrast, the OEM stated that the involvement takes place early enough. However, both sides agree that an early and intensive integration is an important aspect for the future, in order to enhance project performance. The study emphasized, that the relationship between the OEM and the suppliers is evaluated as critical. This statement was verified by both interviewees. They highlighted, that teamwork and trust are decreasing due to the current cost pressure. The psychological model, which states that people in teams act as homo economicus and therefore aim to optimize their one outcome [Rademacher 2014]. Especially in situations with high cost pressure, decision makers try to optimize processes and resources so that they reach the best personal result [Matthews and Howell 2005]. The effect is that results and trust among the team member are getting worse, which leads to even higher cost pressure and additional problems.
Afterwards, the IPD approach was introduced as a possible framework for the supplier integration. Both interviewees agreed that the IPD approach could be a possible solution to improve the current situation. Partial aspects of the IPD approach, as for example Simultaneous Engineering (SE) or collocation in form of clusters as well as shared IT-solutions are already in use.
But in particular an external reward system as the risk- and reward pool is currently not used. The supplier company anticipates, that the application of an IPD approach could be prevented by human egoism or by the company's internal controlling departments. The experts from the supplier company

believes that it is not yet conclusively how unpredictable long-term costs can be represented in an overall calculation and a risk- and reward pool.
Therefore, a simplified approach was presented to the interviewees, in which savings, that were worked out together through intensive cooperation of OEM and supplier within the project are shared fifty-fifty. Both believe that with this method it is possible, to achieve better results in the project performance. Nevertheless, due to unforeseeable risks, they see a need for further analysis and practical experience.

## 7. Discussion

The IPD approach is yet not applied in the mechanical engineering sector and therefore no experience is available. The objective was an initial evaluation concerning the applicability of the IPD approach.
The expert interviews confirmed, that there is a need for an improved supplier integration in the automotive industry and the current situation is not ideal. An interesting finding of the interview is that the employee of the supplier believed that an earlier integration would be beneficial. This might be an indicator that the supplier has additional knowledge or ideas, which the OEM is not aware of.
The main objective was to evaluate the applicability of the IPD approach. Both interviewees agreed that the IPD approach could lead to a better target achievement and an increased project performance. However, they also see a need for future research especially in terms of risk and reward sharing. Important are the organizational and administrative costs, which arise in administering the risk- and reward pool and during the intensive collaboration with the automotive supplier. Ehrlenspiel [2007] assumes that for achieving opportunities and benefits in integrated product development, time-consuming tasks occur on both sides. A key challenge is the implementation of cohesion and trust in the team. It is equally difficult to create a good communication basis from the beginning of the project. These increments of social relationships need time and the right environment. The positive experience with the IPD approach in construction shows that these efforts can be significantly reduced. The problems occur mainly during the first projects. As far as project experience exists and both sides meet regularly, long- term experience in collaborate can be exploited. With the emerging synergies administrative expenses are significantly reduced [Office of Government Commerce (OGC) 2007].
Also discord and mistrust in the team are also expected rather rare, since the trust is defined as a key criterion of the IPD process from the outset in the project. Ashcraft [2014] refers in this context to the fact that IPD follows the principal of mutual cohesion and is not a "blank check". Optionally, team members must resign. This cannot be avoided even with traditional project management approaches.
The encountered risks and challenges of the IPD approach need to be addressed and dealt with in further research. Nevertheless, especially with long-term project experienced teams, the problems can potentially be reduced. In this context the positive aspects of the IPD, an increasing project performance and a good OEM and supplier relationship exceed the challenges.

## 8. Summary and outlook

The integration of suppliers in the product development is one important cornerstone of Lean Thinking. The literature review revealed that researchers and practitioners both see supplier integration as a key to reduce costs, development time, and quality problems but at the same time unanswered questions exist. In the future suppliers will become an even more important source for innovation because their portion of the R&D activities will increase. Especially the operational management of supplier integration appeared to be challenging. The authors decided to search for best practice examples for supplier integration in other industry sector. The motivation behind this research approach is the wide application of Lean Thinking in other sectors and therefore also the issue of supplier integration.
The analysis revealed that construction industry and mechanical engineering have many characteristics in common. Within the construction sector the IPD approach appeared to be quite promising because different publications report about success stories. The IPD approach aims to integrate many different stakeholders into a team. A central element of IPD is the risk and reward pool, which aims to align the different objectives and to avoid local optimization. Based on the experiences made in construction, a theoretical concept for the application of the IPD approach in the automotive sector was developed.
To evaluate the applicability of IPD, the two expert interviews were conducted. The interviews confirmed that supplier integration will become even more important in the future and that the current

situation between OEMs and suppliers in the automotive industry is not fostering innovation but rather leads to mistrust. Both interview partners emphasized that they could not imagine that the IPD approach with its complex legal framework for the risk and reward pool would be used in the near future due to the legal challenges. However, both experts stated that a simpler version of the risk and reward sharing of the IPD approach could increase the project performance. The results clearly emphasize supporting tools are available and in use. Establishing an environment that promotes the collaboration between OEM and suppliers seems to be a key challenge for supplier integration. The risk and reward sharing of the IPD approach could help to reach a more collaborative environment that avoids local optimization of the partners.

The overall results show that supplier integration in the product development will become a more important topic in the future. However, more research is needed to evaluate if the IPD approach could be helpful in the mechanical engineering domain. The next step should be to test the application of the IPD in the mechanical engineering domain. Furthermore, further research is required to analyse how an incentive system can be integrated in engineering projects in order to avoid local optimisation. The development of a concept for a risk and reward pool within mechanical engineering sector would be an important step to further improve the current situation. Additional, emphasis should be put on an in depth analysis to which extend exiting approaches for supplier integration are already applied.

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Julian Wilberg, Research Assistant
Technical University of Munich, Institute of Product Development
Boltzmannstr. 15, 85748 Garching, Germany
Email: wilberg@pe.mw.tum.de