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Systematic Evaluation of Knowledge Transfers in Product and Production Engineering

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1 Introduction

Interdepartmental collaboration is key in innovation processes (Cuijipers et al. 2011, Kahn 1996). In this process resources, skills and personnel from different departments are needed. Interdepartmental collaboration increases the exchange of information and knowledge across interdependent units (focus here: *product and production engineering*) (Troy et al. 2008, Albers et al. 2022). The knowledge transfer between product and production engineers takes place (consciously or unconsciously) in many different ways (e.g., discussing a product design in a meeting or sharing files) (Albers et al 2018). In a comprehensive study De Luca and Atuahene-Gima (2007) found, that knowledge integration increases innovation performance indirectly. To increase innovation performance, it is, therefore, necessary to increase the efficiency (relation between the quality of knowledge transfer and the transfer time) (Albers et al. 2019) and effectiveness (quality) (Klippert et al. 2023b) of those knowledge transfers. In literature, many different approaches and models are presented, that describe knowledge transfer in general as well as relevant influencing factors to consider when aiming to improve knowledge transfers (Grum et al. 2021, Klippert et al. 2022). Though, in practice, it is often not known where knowledge transfer in product and production engineering takes place and what successful

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knowledge transfer looks like. Furthermore, there is often a lack of transparency as to where there are improvement needs and which ones should be addressed first. Potential for improvement is therefore often not exploited.

Hence, this paper presents how to identify and explicate knowledge transfer situations in product and production engineering and how to systematically evaluate those to identify improvement needs. In the following the state of research in this research field is presented (Sec. 2) followed by the research aim and methodology (Sec. 3) as well as the research results (Sec. 4 to 6). Section 7 discusses the theoretical and practical implications of this research. The paper concludes by answering the research questions and giving an outlook on future research topics (Sec. 8).

2 State of Research

Product and Production Engineering

Each product life cycle starts with strategic product planning, is followed by the product and production system development as well as production, product distribution, and usage, and ends with the recycling or disposal of a product (VDI 2221, 2019; Vajna et al., 2009). In the following, this paper focuses on product and production engineering, which includes product and production system development as well as production.

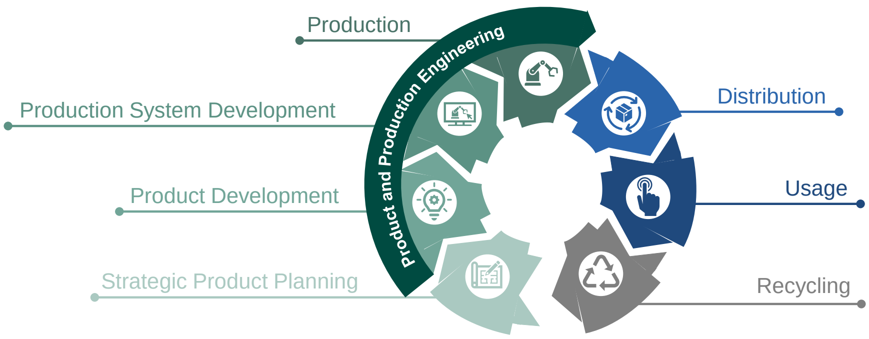

Figure 1 Product life cycle (own figure based on VDI 2221, 2019; Vajna et al., 2009)

Several approaches and models describe, how to design the collaboration in product and production engineering (e.g., Integrated Product Development (Lindemann and Lorenz 2008), simultaneous or concurrent engineering (Putnik and Putnik 2019)) to increase the efficiency and effectiveness of engineering processes and to contribute to the innovation performance. Based on a sample of 433 German manufacturing firms Cuijpers et al. (2011) showed, that interdepartmental innovation collaboration increases process innovation performance, but also produces costs in terms of project delay and project termination. Nevertheless, those costs do not affect innovation performance at the firm level. In addition, they highlighted a study by De Luca and Athuahene-Gima (2007), that describes an indirect increase in innovation performance through knowledge integration. Albers et al. (2022) emphasize the importance of using already existing knowledge while developing new products and production systems. How knowledge can be reused through several

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generations of products and evolutions of production systems is described in the approach of Product-Production-CoDesign (PPCD) (Albers et al. 2022).

Knowledge Transfer in Product and Production Engineering

Involving several stakeholders is crucial in product and production engineering, e.g., the customer, who determines the product characteristics through requirements, and the employees, who work together to achieve common objectives (Cuijpers et al., 2011). In the engineering process, interdepartmental collaboration between product and production engineers is important (Marjanović et al., 2008). To ensure successful collaboration, the exchange of knowledge is necessary. Knowledge management plays an important role in facilitating the exchange of knowledge between different departments (Probst et al., 2012). The key here is knowledge transfer as part of knowledge management. To do so, it is necessary to identify the knowledge, transmit it from knowledge carrier to knowledge receiver and lastly apply it (Gronau and Grum, 2019).

Especially across departments, it is not always clear which knowledge is needed or needs to be provided. Often, knowledge relevant to product and production engineers are transferred via face-to-face conversations (non-formalized) or stored in document management systems (formalized) (Klippert et al., 2022). To create transparency, in how knowledge is transferred, Albers et al. (2018) introduced 21 knowledge transfer situations in product development, which not only include mechanical engineers but also people from other disciplines such as electrical engineering and manufacturing. Those are described by: *Title*, *Description*, *Number of people*, *Material*, *Time*, *Brisance*, *Hierarchies*, *Cultures/ Languages,* and *Disciplines*.

In addition to that, Grum et al. (2021) introduce eight dimensions with each two to three characteristics to describe knowledge transfer situations. By doing so, it is easier to compare different situations.

Table 1 Morphological box of transfer situations

Dimension	*Characteristics*		
Number of participants	single	Dyad	group
Power distance	hierarchical	collegial	equal
Directedness	directed	undirected	
Goal orientation	specific objective	no objective	
Duration	short-term	medium-term	long-term
Spatiality	local	distributed	
Process formalization	open	formalized	
Result formalization	open	formalized	

Source: Grum et al. (2021)

To improve the efficiency (relation between the quality of knowledge transfer and the transfer time) and/ or effectiveness (quality) of knowledge transfer the Knowledge Transfer Velocity Model (Grum et al. 2019) and Knowledge Transfer Quality Model (Klippert et al.

2023b) have been developed. Both models describe, that a situation analysis of the current knowledge transfer is necessary to identify improvement needs. Nonetheless, it is not described how to systematically evaluate knowledge transfer situations to identify those improvement needs.

Approaches and Models for the Analysis and Evaluation of Processes

To obtain a uniform understanding of the actual state of a process (here knowledge transfer in product and production engineering), it is necessary to precisely record and describe all hierarchical levels, sub-processes, steps, activities, participants, and interfaces. The process must be mapped completely and in sufficient detail (Davenport, 1993). If several processes are analyzed for comparability, a uniform description system, and language or illustrations are necessary. Biazzo (2000) identifies four approaches to the analysis of business processes:

1. Action analysis
2. Process mapping
3. Co-ordination analysis
4. Social grammar analysis

The four alternative approaches to business process analysis differ in strategy and focus of the analysis. The real complexity of a process can be made visible through the analysis of actions and social grammar. Focusing on the relationship between subjects' actions and structures allows for the exploration of important problems: the practical application of procedures, plans, and, more generally, organizational rules (Biazzo, 2000). Since the ability to describe and understand actions and sequences of actions is closely linked to the critical evaluation of processes the following approaches to process evaluation are presented.

In principle, process evaluation procedures are divided into quantitative and qualitative evaluations. A qualitative approach evaluates processes only based on clearly measurable variables and indicators. This approach is suitable for processes with quantifiable inputs and outputs. Examples of quantitative process evaluation methods are KPI analysis and internal and external benchmarking (Koch, S. (2015). If non-monetary process characteristics (e.g. quality or safety) are to be included in the process evaluation, qualitative evaluation methods are relevant (Koch, S. 2015). An example of a qualitative process evaluation is the 20-keys method (Kobayashi, I. 1990).

3 Research Aim and Methodology

Knowledge transfer is a common topic, which is researched by several authors already. Some findings are described in Sec. 2 but others are known from the fields of management science (Nonaka et al. 2000), agriculture (Westwood et al. 2023), or healthcare (Secundo et al. 2019; Buranarach et al. 2009), but rarely if ever consider the context of product and production engineering. While prior research presented approaches and models, that describe knowledge transfer, and the analysis and evaluation of processes in general or in other domains aside from product and production engineering several gaps remain. Some

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describe what to do to improve knowledge transfers, rather than how to do it exactly. Nevertheless, they serve as a basis for the investigation of knowledge transfer in product and production engineering.

Therefore, this research aims to explain how to identify and explicate knowledge transfers in product and production engineering to provide a basis for a systematic evaluation of knowledge transfer situations. The overall aim is to support product and production engineers to improve their knowledge transfer. Thus, the following research questions (RQ) will be answered:

1. How can knowledge transfer situations in product and production engineering be identified? (RQ1)
2. How can knowledge transfer situations in product and production engineering be explicated? (RQ2)
3. How can knowledge transfer situations in product and production engineering be systematically evaluated to identify improvement needs? (RQ3)

To answer the research questions, the research design follows research type 1 of the Design Research Methodology (Blessing and Chakrabarti, 2009). This research type entails a review-based research clarification (see Sec. 2) and a comprehensive descriptive study I (see Sec. 4, 5, and 6). The results of this research have been achieved in several iterations. They are implemented in two field studies to gain new insights from an industry point of view and continuously improve the results. The field studies are not part of this contribution (one study is presented in Klippert et al. 2023a).

To answer RQ1 an initial literature analysis (see Sec. 2) and observations in two different companies serve as a basis to identify, which knowledge transfer situations take place in product and production engineering and how to identify them. To answer RQ2 and to explicate knowledge transfer situations in product and production engineering literature research has been conducted to identify characteristics and their values as well as influencing and success factors. Those success factors were connected to each of the characteristics. The characteristics were then summarized in thematical categories and their values have been described. A logic with mathematical terms is developed to answer RQ3. This evaluation system forms the basis for decisions on the improvement needs in specific knowledge transfer situations.

To illustrate and clarify the results of this research, an example from practice is given. In this example, product and production engineers are supposed to develop and produce a protective plate for a vehicle underbody (see Fig. 2). During the engineering process several problems occur, such as different objectives and missing interdisciplinary knowledge. Those lead to late changes in the design of the protective plate and therefore high costs for the engineering process. The question arises: what is the cause of those problems and how to prevent this to happen in the future?

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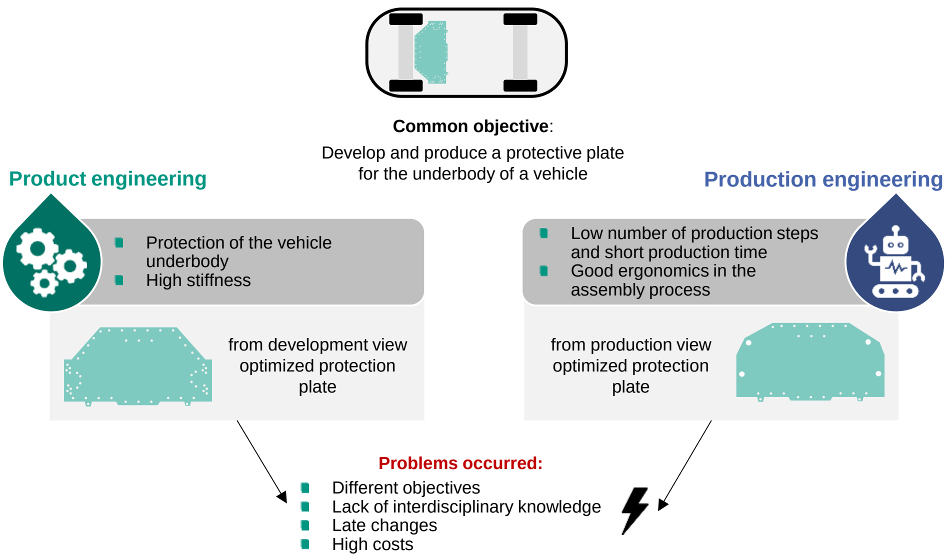

Figure 2 Example of the development and production of a protective plate for the underbody of a vehicle and problems that occur during the engineering process

4 Identification of Knowledge Transfer Situations in Product and Production Engineering

To answer the question, of what the cause for those problems is, it is first necessary to identify in which situations knowledge between product and production engineers are transferred.

First, a **list of knowledge transfer situations in product and production engineering** provides an overview. Table 2 shows exemplary knowledge transfer situations, which are the result of an initial literature analysis (see Sec. 2) and observations in two companies.

Table 2 List of Knowledge Transfer Situations in Product and Production Engineering (PPE)

Title	*Description*	*No. of people*	*Format*	*Time*
Agreements	Agreements in PPE regarding development, prototyping, and modifications	5-10	Meeting	1 h
Business Unit Meeting	Meeting in which business units exchange ideas	50	Congress	2 h
Calls	Short personal inquiries via call	2	Phone, MS Teams	10-60 min
Channel of Department	Exchange and information on the latest topics; storage of files	< 5	MS Teams	Continuous
Construction-Manuals	Manual containing all technical requirements and drawings of products	< 2	Wiki	Continuous

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Creative Software	Software for creating mind-maps and other creative methods	approx. 5-10	Software	1-2 h
Customer-Meetings	Consultation with customers; Involvement of product and production engineers	10-20	Meeting	1-2 h
Daily Meetings	Regular meetings of units or project groups	approx. 10	Online Meeting	2 h
Document Management Software	Management and storage location for technical documents	entire company	Software	Continuous
E-Mails	Exchange via emails; Forwarding of customer requests and files	< 2	Mail	10 min
Information circle	Detailed introduction to new findings/processes or methods	10-20	Workshop	2 h
Layout Planning	An exchange between product and production engineers on available capacities, processes, and plants	approx. 5	Meeting	2 h
Lessons Learned	Exchange of experience on insights	Departments	Mail/Wiki/ Meeting	10-20 min
Newsletter	Information and notifications on the latest topics	Departments	Mail/Docu ment	10 min
Personal Chat	Exchange via chat in communication software	< 2	MS Teams	Continuous
Personal Conversations	Personal conversations (in person) on the company premises or in production	2	Talk	5-10 min
Project Kick-Off	Kick-Off at the beginning of a project in which all parties are informed about the project	approx. 20	Hybrid Meeting	2-3 h
Project-Channel	Information and file storage of all topics relevant to a project	up to 20	MS Teams	1-2 years
Project Management Tool	Software for project management; Information on dates and milestones	< 10	Software	1-2 years
Review of Specifications	Meeting on the specifications; Exchange, planning, and management of tasks	10	Meeting	3 h
Sharing and Agreeing on Drawings	Agreements between product and production engineering; Acceptance/release of drawings	approx. 5	Online Meeting	1-2 h
Steering Committee	A committee that supports with expertise and decision-making	approx.. 5-10	Meeting	-
Training	Qualification program for employees	approx. 10	Training	3-5 days
Update Meeting	Meeting in which each project gives updates on the current status and challenges	approx. 15-20	Hybrid Meeting	2h

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Wiki	Company's wiki as a storage location for knowledge	entire company	HTML-Website	Continuous
Workshops	Workshops for the development of new ideas and solutions	> 10	Workshop	2-3 h

Secondly, it is necessary to check, whether the list of exemplary knowledge transfer situations suits the own engineering context or if some situations are missing. To identify further knowledge transfer situations **guiding questions** are given, some of which are stated in the following:

- How often or in what rhythm and time frame does knowledge transfer take place?
- In which setting does knowledge transfer take place? (e.g., face-to-face meeting, virtual meeting, regular meeting, break)
- Is knowledge tacit (non-formalized) or explicit (formalized)?
- In which manner is the knowledge transferred? (e.g., use of meta boards in brainstorming; complex content shared explicitly and formally)
- What tools or media are used to generate, present, and transfer knowledge? (e.g. MS Teams, Excel list, databases, PowerPoint, projectors, whiteboards)
- Which people are actively and directly/passively and indirectly involved in knowledge transfer? (incl. roles/position, area of expertise, education, competencies, tasks)
- Where and in what form is the knowledge stored? Can the knowledge be easily retrieved after the knowledge transfer? (e.g., filing, standardized designation)

To answer those guiding questions, it is possible to search the organization's website or databases for information (e.g. organigramme or process documentation). Furthermore, it is possible to observe employees in their daily business, interview them or send out questionnaires to get more insights on how knowledge is being transferred between product and production engineers (e.g., in regular meetings or during lunch breaks). A visualization of the identified knowledge transfer situations might also help to get an overview of the current knowledge transfer. An example is given in Figure 3.

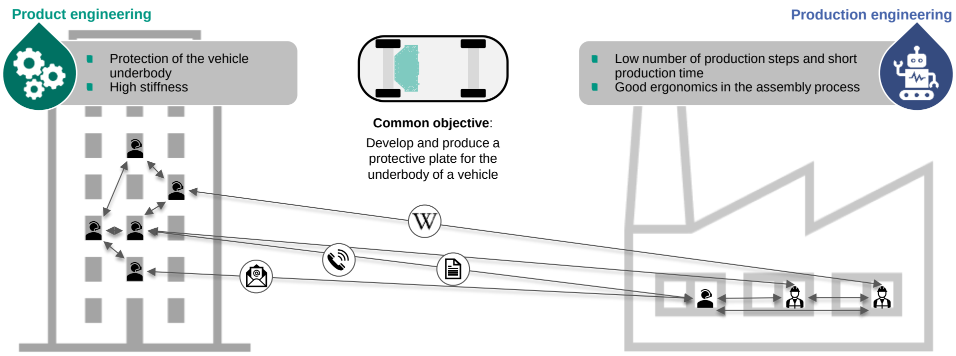

Figure 3 Example of the visualization of the identified knowledge transfer situations in the development and production of a protective plate for the underbody of a vehicle

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The provided list of exemplary knowledge transfer situations can be extended by an initial description of the identified knowledge transfer situations. In this example the list is extended by *Regular Meetings, an exchange between product and production engineers on project updates* with *approx. 5-10 people* in an *Online-Meeting* with a duration of *1 hour*.

Two knowledge transfer situations are identified: *Regular Meetings* (here 7 people are involved) and *Document Management Software* for sharing documents. Those are investigated further in Sec. 5 and 6.

5 Explication of Knowledge Transfer Situations in Product and Production Engineering

Once interdepartmental knowledge transfer situations in product and production engineering have been identified, they must be explicated in detail. A systematic explication by product and production engineers involved in the knowledge transfer serves to gain a deeper understanding of the situation and as a basis for later evaluations (Sec. 6). This is necessary to be able to transparently assess whether and where there is a need for improvement. Through a literature review and expert interviews, five factors were identified that influence the success of a knowledge transfer situation. These five factors are *willingness*, *competence*, *standards*, *networking,* and *knowledge culture*. Table 3 describes the success factors of knowledge transfer in more detail. Each success factor is assigned a success criterion that defines the objective and/or purpose of improving the knowledge transfer.

Table 3 Success Factors of Knowledge Transfer in Product and Production Engineering

Success Factor	*Success Criteria*	*Description*
Willingness	Increasing Willingness	Personal willingness as well as the promotion of general willingness to transfer knowledge by the management level through ensuring necessary framework conditions and incentive systems
Competence	Enhancing Competence	Individual, person-related competencies that are required for a knowledge transfer
Standards	Consistent Standards	Consistent standards regarding knowledge, tools, technology, and documentation within the organization or knowledge transfer
Networking	Increasing Networking	(Personal) networking among the persons involved and higher-level organizational units. Included are organizational factors that enable the networking of the participants in the first place
Knowledge Culture	Consistent Knowledge Culture	Behavioral and working patterns as well as mindsets as components of the corporate and leadership culture have an impact on knowledge management

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These success factors are affected by 84 influencing factors. The influencing factors are unequally distributed among the success factors and are all equally weighted. Figure 4 shows an example of the success factor readiness with the three associated influencing factors. To make knowledge transfer describable, the interaction of success and influencing factors is not sufficient. Among other things, company characteristics and framework conditions of knowledge transfer must be identified to be able to properly define knowledge transfer in product and production engineering in practice. Therefore, characteristics of knowledge transfer were assigned to the influencing factors. The characteristics of knowledge transfer in product and production engineering can be divided into two levels, the dynamic part of the knowledge transfer situation and the static entrepreneurial part.

Static characteristics are considered in the *framework conditions* of a knowledge transfer situation and enable conclusions to be drawn about the company's positioning regarding knowledge transfer. The framework conditions of knowledge transfer result from the interaction of the framework conditions in product and production engineering and those of knowledge transfer. 18 characteristics could be assigned to the framework conditions. These in turn could be divided into four categories: *organizational structure (1), goals and knowledge culture (2), knowledge management (3),* and *operational structure (4).* Dynamic characteristics are considered in the *transfer situation* and enable the specification of a certain knowledge transfer situation in product and production engineering. The level of the knowledge transfer situation could be worked out from the interface between knowledge transfer and product development and production. 47 characteristics could be assigned and classified into six categories: *Conditions of the transfer situation (5), communication (6), technology and tools (7), interpersonal (8), properties of knowledge (9),* and *personal competencies (10).*

In total, 65 characteristics in ten categories were identified from the literature research (Fig. 4). Characteristics can take on two to five different values.

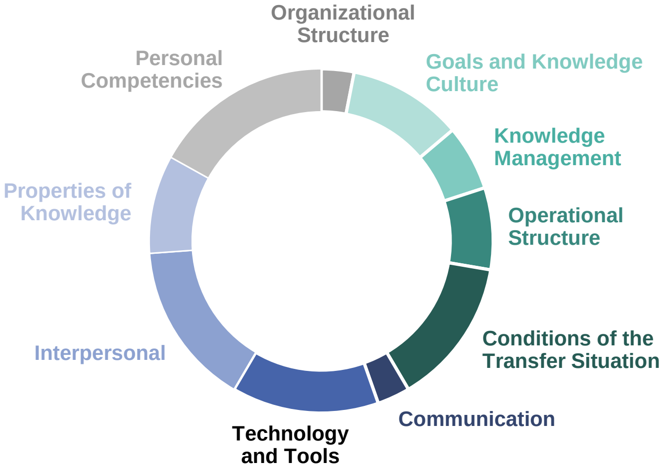

Figure 4 Visualization of the distribution of characteristics of knowledge transfer in product and production engineering among ten categories

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In the example in Fig. 5, the characteristic *knowledge sharing* from the category *interpersonal* is assigned to the influencing factors of the success factor *willingness*. Sharing knowledge can take three possible values: unrestricted sharing, partially restricted sharing, and no willingness to share knowledge.

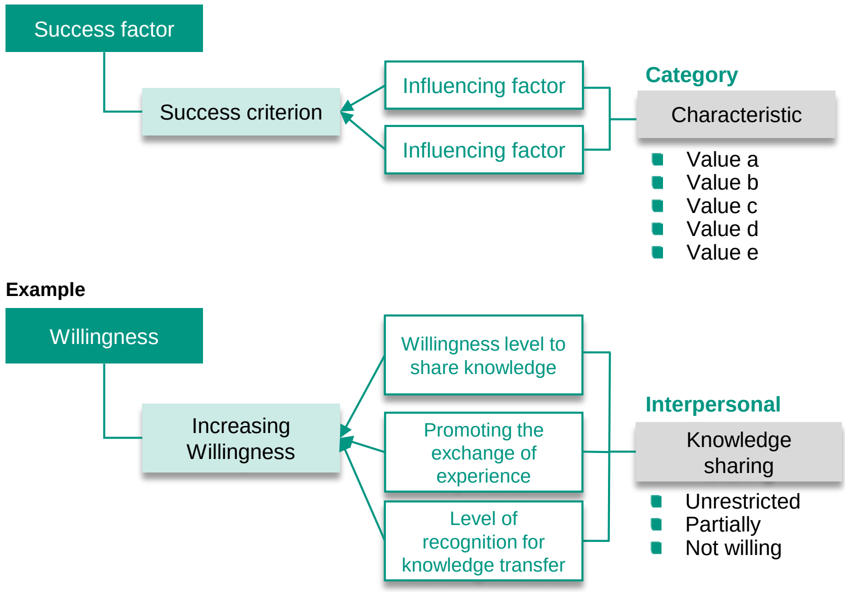

Figure 5 Connection between success factor, success criterion, influencing factor and characteristic of knowledge transfer in product and production engineering including an example

Knowledge transfer situations in product and production engineering can be explicated by the combination of characteristics and the assigned value. This makes it possible to distinguish or compare knowledge transfer situations. In the following section, explication by participants in the transfer situation serves as a base for evaluating the transfer situation.

6 Systematic Evaluation of Knowledge Transfer Situations in Product and Production Engineering

To answer research question 3, the improvement needs of knowledge transfer situations in product and production engineering are derived from the combination of characteristics and expression using mathematical logic. The evaluation is based on a qualitative process evaluation method to systematically assess process characteristics of interdepartmental knowledge transfer. Based on the explication of the transfer situation (Sec. 5), it can be concluded from the value of a characteristic whether the state of the characteristic has a positive, neutral, or negative influence on the success of the knowledge transfer situation. To make this usable for the evaluation, the characteristics were coded. The coding can assume integer values between -2 and +2, depending on whether they have a positive (+) or negative (-) influence on knowledge transfer (Fig. 6). Since characteristics have two to five values, this coding can be flexibly adapted.

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Value	Impact on success	Coding
a	Very positive impact	2
b	Positive impact	1
c	Neutral relation	0
d	Negative impact	-1
e	Very negative impact	-2

Example

Value	Impact on Success	Coding
Unrestricted	Very positive impact	2
Partially	Positive impact	1
Not willing	Very negative impact	-2

Figure 6 Connection between knowledge transfer characteristic's values, their impact on success, and the coding

The evaluation logic is explained below using the initial example. The seven product and production engineers assign a coded value to all characteristics in both knowledge transfer situations (*Regular Meetings* and *Document Management Software*). The evaluation then takes place in two levels. One is the median of the characteristic value and the other is the variance of the distribution of the characteristic values (Fig. 7). These two levels were chosen because the median is more robust against statistical outliers and the variance accounts for the dispersion of different opinions on the state of a characteristic. With a median of 2 and little variance among the respondents, there is no need for improvement in the characteristic. The need for improvement increases with decreasing median to barely need for improvement (1), little need for improvement (0), medium need for improvement (-1), and high need for improvement (-2). However, since a knowledge transfer situation can be perceived differently by different people, a variance in the distribution of the values of a characteristic is possible. In this example, the variance was used as a second basis for decision-making. The greater the variance, the greater the improvement needed. This assumes that ambiguities regarding a characteristic also have a negative impact on the overall knowledge transfer situation.

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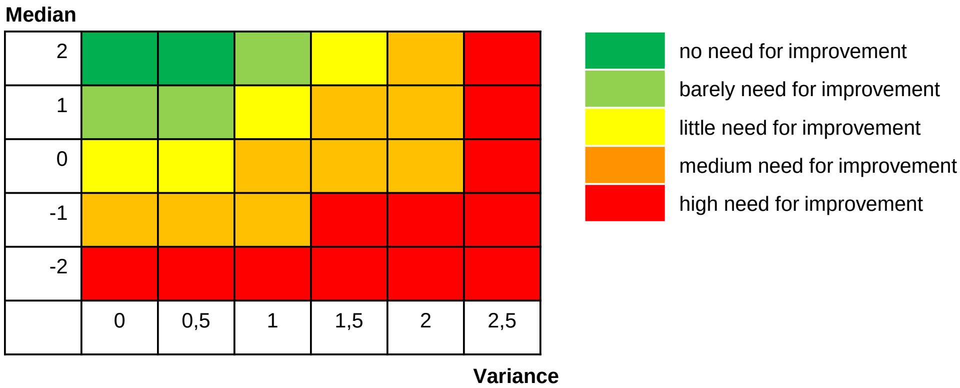

Figure 7 Evaluation matrix for the improvement need

The improvement need of the individual characteristics can be summarised into areas of improvement based on the ten categories of characteristics presented earlier. If the vast majority of the characteristics within a category show a need for improvement, action should be taken.

Regular Meetings

	Characteristic								
Interpersopnal	Knowledge sharing	1	1	0	-1	0	0	-1	
	Language	0	0	2	1	1	2	1	
	Thematic interest of participants	1	0	-2	0	-1	0	1	

Document Management Software

	Characteristic								
Interpersopnal	Knowledge sharing	2	-1	-1	-2	-1	-2	-1	
	Language	1	2	2	2	1	2	2	
	Thematic interest of participants	0	0	1	0	2	0	1	

Figure 8 Example evaluation of the knowledge transfer characteristics in the category interpersonal for the knowledge transfer situations Regular Meetings and Document Management Software

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Referring to the initial example and comparing the two transfer situations, all seven participants explicated those and the coded evaluations were compiled. The median and variance are used to identify the need for action in the three characteristics of the interpersonal category. The characteristic *sharing of knowledge* shows a strong need for improvement in the case of *Document Management Software*, and only a little need for improvement in the case of *Regular Meetings*. It, therefore, follows that action should be taken to increase the sharing of knowledge in the documentation of knowledge in software.

This procedure provides a process for the systematic description, analysis, and evaluation of a knowledge transfer situation in product and production engineering. Actions for the targeted improvement of knowledge transfer can be derived from the results of the systematic evaluation. The contribution to research and practice and the limitations of this procedure will be addressed in the discussion.

7 Discussion

Through a first field study, the explication and evaluation procedure could be applied in practice. Limitations were derived from the practical application and feedback from the participants in the two departments product and production engineering. The effort of explicating the individual knowledge transfer situations can initially be perceived as too high, as there are no reference values for the required processing time, for example. For this reason, the motivation of the users is necessary to achieve a minimum number of participants. To guarantee a reasonable effort-benefit ratio of the process, a minimum of five participants in a knowledge transfer situation should explicate and evaluate it. In the logic itself, the coding of the values has a great influence on the later results of the evaluation. For this reason, they should be carefully checked and, if necessary, adapted to the situation. If the number of participants is small, statistical outliers are very significant and the interval limits must be adjusted. In summary, the evaluation serves as a decision-making aid; in the case of medium values, individual situations must be considered in detail.

The main scientific contribution achieved is the developed procedure to make the knowledge transfer in product and production engineering accurately describable and evaluable. Merging success factors, success criteria, influencing factors, and characteristics make it possible to evaluate a specific knowledge transfer situation in its degree of success. The systematic procedure of explicating and evaluating the characteristics of a situation creates a transparent basis on which improvement measures for transfer can be taken.

The results of this research provide a basis for a method, which supports the improvement of knowledge transfers in product and production engineering. The immediate inclusion of the people directly involved in the knowledge transfer makes the process very accessible to product and production engineers. The focus is on a fast and simple capture of the real situation. Transparency is systematically created which serves as a basis for further decisions in improving the daily interdepartmental knowledge transfer. Due to the generic and adaptable character of the procedure, it is easily transferable to other companies.

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8 Conclusion and Outlook

Successfully transferring knowledge between product and production engineers is essential in interdepartmental collaboration, since this might lead to an increase in the innovation performance of a company. Several approaches and models already exist, that describe knowledge transfer and give examples where knowledge is being transferred in product development. In addition, dimensions are presented on how to describe those knowledge transfer situations to enable a comparison. Nonetheless, the current state of research revealed a research gap in the improvement of knowledge transfers in product and production engineering.

To fill the research gap, this research explains how to identify as well as systematically explicate and evaluate knowledge transfer situations in product and production engineering. A list of knowledge transfer situations in product and production engineering as well as guiding questions are presented to identify where knowledge is being transferred (answer to RQ1). This list can be added by an initial description of the identified knowledge transfer situations. RQ2 is being answered by providing a procedure to explicate knowledge transfer situations. It contains five success factors, 84 influencing factors, and 65 characteristics (with each two to five values) of knowledge transfers. This serves as a basis to systematically evaluate knowledge transfer situations. Building on a unified explication scheme based on success factors, success criteria, influencing factors, and characteristics of knowledge transfer, a logic with mathematical terms was developed to answer RQ3. Coded values of the characteristics are evaluated according to their median and variance and needs for improvement are assigned.

In conclusion, product and production engineers can identify and systematically evaluate their knowledge transfer situations. This helps to gain transparency in the interdepartmental collaboration in product and production engineering and at the same time provides a basis to decide, which improvement needs to address first.

Following this research, it is necessary to support product and production engineers in addressing their improvement needs to exploit the potential of successful knowledge transfer. This could be done by defining and implementing knowledge transfer interventions, which are already known in the literature (Albers et al., 2019; Klippert et al., 2023b). This procedure needs to be validated in different environments to continuously improve the research results presented here.

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