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Validating a process model for future-robust product portfolios - two cases

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ABSTRACT: In this paper, two case studies are presented to validate a process model for the future robust advancement of product portfolios. In the first case study, the process model is implemented for a supplier in the automotive industry and evaluated by two company experts. In the second case study, the process model is implemented in a medical equipment company for 6 months. The evaluation shows that the investigated model can be applied and supports the process. The success evaluation is only assessed as expected added value, as the added value can only be observed when realizing the product portfolio. The evaluation in two case studies confirms the applicability and support potential of the model in corporate practice. At the same time, the need for improvement and multi-year implementation in the companies is identified.

KEYWORDS: new product development, innovation, multi- / cross- / trans-disciplinary processes, case study, product portfolio

1. Introduction

The future-robust advancement of products is a key activity in the long-term success of companies (Cooper, 2019). To support the advancement of product portfolios in the modern world, many different domains of strategy, product development and product management have to work synchronized as a team towards a common goal (Doorasamy, 2015; Meyer et al., 2021). Approaches such as scenario management (Siebe & Fink, 2011) as part of strategic product planning (Gausemeier et al., 2019) or the descriptive approaches for product family modularization (Krause & Heyden, 2022) form a helpful framework for advancing product portfolios. Fundamental strategies e.g. product line extension, vertical extension, or redesign according to Andersson (Andersson et al., 2021) show the directions for advancement in product portfolios. Interviews with companies have shown, however, that there is a lack of supportive approaches to model and synchronize the individual products in a portfolio in order to support the future robust advancement of product portfolios in practice (Meyer et al., 2021). Future robustness is understood as the prospect of being successful on the market with the product portfolio in most future scenarios (c.f. Siebe & Fink, 2011). As part of preliminary work, requirements from the view of companies (Schlegel, Just, Wiederkehr, Thümmel, et al., 2024) as well as existing approaches and requirements in the literature (Schlegel et al., 2023) were examined. Based on this investigation a process model for the advancement of product portfolios was developed (Schlegel, Pommer, et al., 2024). This process model was only initially validated in previous work (Schlegel, Pommer, et al., 2024), but when developing methods for corporate use, companies also have to be included in the design team for new approaches. In this article, the existing process model for the advancement of product portfolios according to Schlegel, Pommer, et al. (2024) is to be implemented in two case studies together with two companies and then evaluated. Based on the case studies, findings on the applicability of the support and success of the approach are to be gained to enhance the process model.

2. Theoretical framework

The present chapter takes up the previous work, which forms the theoretical framework for the validation study at hand. In line with the research methodology (chapter 3), the derivation of the requirements (chapter 2.1) and the initial process model for the advancement of product portfolios (chapter 2.2) are taken up as the object of research.

2.1. Analysis of theory and practice (descriptive study I)

A prior systematic literature review identified various requirements and considerations that have to be considered in the development of a supportive approach (Schlegel et al., 2023). From the literature, 114 requirements were extracted and subsequently organized into 14 requirement-clusters (Schlegel, Pommer, et al., 2024). To expand the theoretical perspective to include the requirements and practices of companies, two consecutive interview studies were conducted. In a first interview study, the basic principles of the advancement of product portfolios in companies were worked out (Meyer et al., 2021). In the subsequent interview study, the advancement process and the associated challenges were analyzed in more detail (Schlegel, Just, Wiederkehr, Kempf, et al., 2024). The findings of these studies represent the descriptive analysis to develop a supportive approach.

2.2. Developing a process model (prescriptive study)

Based on the derived requirements, a process model was developed in preliminary work (Schlegel, Pommer, et al., 2024), which represents the object of the present validation study. The process model was implemented in a guideline as shown in Figure 1.

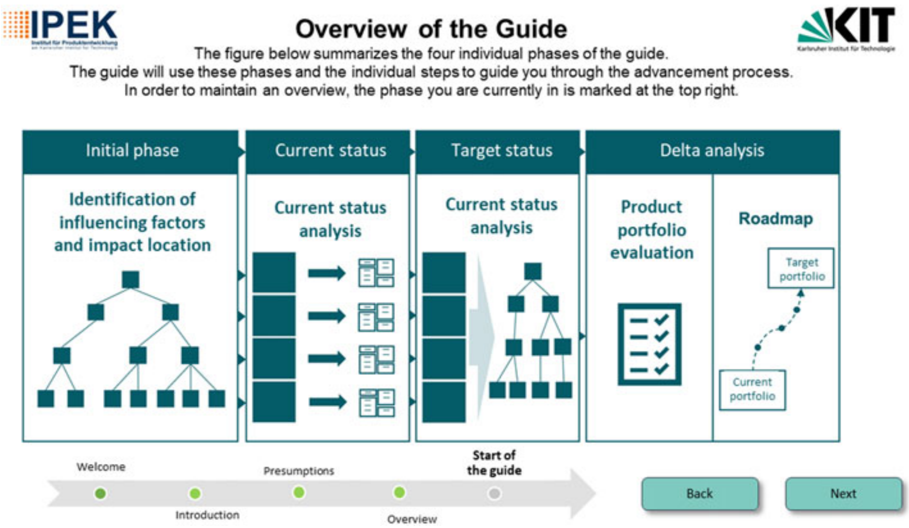

Figure 1. The guideline based on the process model according to Schlegel, Pommer, et al. (2024)

The **initial phase** starts with the identification and categorization of influences on the product portfolio. In the second step of the initial phase, the impact location is determined and the area of direct impact of the product portfolio is modeled. The influencing factors are then evaluated and checked for internal interactions. The interim steps are collected in an impact template, which is divided into the fields: Description of the influence, impact locations in the portfolio and structure, risk assessment, risk cube, interactions with other impacts, impact radar, further information and sources used. In the **current status**, the present state of the product portfolio is modeled with the help of level-specific product profiles (Schlegel, Just, Pfaff, et al., 2024). The aim is to obtain a uniform starting point focus on the benefits of the elements in the product portfolio for upcoming advancements. In the **target status**, future products are defined with the use of level-specific methods of foresight, such as scenario techniques at the higher portfolio levels like lines or families and trends or persona methods at lower levels (Siebe & Fink, 2011). In the **delta analysis**, the deviation from the current elements in the product portfolio is identified as a reference to the target state using a utility value analysis and then mapped in a cross-generational roadmap as a starting point for development projects. The model was initially validated in a simplified Workshop as shown in Schlegel, Pommer, et al. (2024). (Schlegel, Pommer, et al., 2024)

3. Methodology

The present work is part of an overarching research to develop a systematic approach for the future-robust advancement of product portfolios. The overall approach is structured along the design research methodology via the descriptive study I, prescriptive study and a descriptive study II (Blessing & Chakrabarti, 2009). In previous studies, requirements from theory and practice were collected and a process model for the advancement of product portfolios was created, but only initially validated (cf. section 2.1 and 2.2). Therefore, the focus of this study is on the Descriptive Study II. The overall structure can be seen in figure 2.

This paper aims to initially validate the process model for future-robust advancement of product portfolios regarding the application in corporate practice. To this end, the following research question is posed: *RQ1 - To what extent is the process model suitable for implementation in companies concerning the applicability, support and success of the process model?*

The present evaluation of the approach is based on the evaluation criteria support and application evaluation according to Blessing and Chakrabarti (2009). The success evaluation is only considered as expected added value, as the results from the process model application would have to be implemented in the company's product portfolio and the market success has to be awaited for verifiable findings, requiring several years. The Evaluation is therefore based on a qualitative study to observe and understand the challenges and potentials advancing product portfolios based on the process model. In a two-stage approach two case studies were carried out to achieve the research objective. In the first case study, the process model for the company Witzenmann GmbH, a manufacturer of flexible metal connecting elements for plant engineering or automotive, is implemented by the authors. The guideline and the company-related results are then reviewed by two company experts in an interview study with focus on the application, support and added value evaluation. The interviews were transcribed and coded. In case study II, the model is implemented, applied and evaluated by an employee in the company Henke-Sass, Wolf GmbH, a medical technology manufacturer for medical endoscopy, veterinary products and medical syringes & cannulas. The second case study focuses more than case study I on the results of the process model itself, as the process model was executed by an employee of the company.

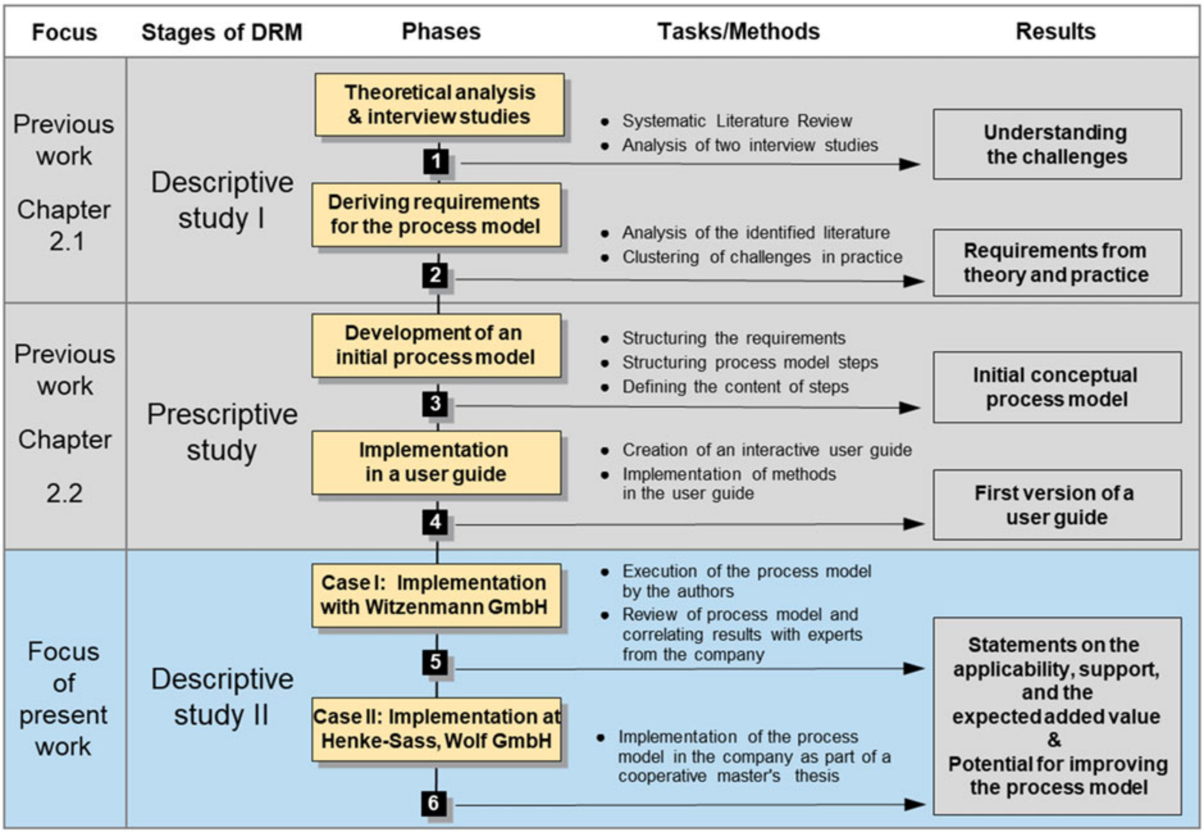

Figure 2. Methodological framework with focus on the descriptive study II (c.f. Schlegel, Pommer, et al. (2024))

4. First case study (Witzenmann GmbH)

In order to create an industrial relevance, while at the same time minimizing the effort in the company, the process model for portfolio advancement is applied by the authors as an example for the company Witzenmann GmbH within a bachelors thesis (Kunert, 2024). This was followed by two expert interviews with employees from Witzenmann's innovation management team in order to evaluate the process model together with the company-related results with regard to the criteria of applicability, support and expected added value. The interview with Innovation Manager 1 (IM1) lasted 71 minutes and with Innovation Manager 2 (IM2) 46 minutes. The structure of the interviews were identical. Each of the four process model phases was presented to the interview partners one at a time. An interim evaluation followed each presentation of a phase. The interviews concluded with an overall summary. Case study I focuses the evaluation statements rather than on the actual outcome of the process model.

4.1. Initiale phase

The initial phase results in the impact template following the steps for applying the process model (section 2.2). Figure 3 shows one of the impact templates and the evaluation questions asked.

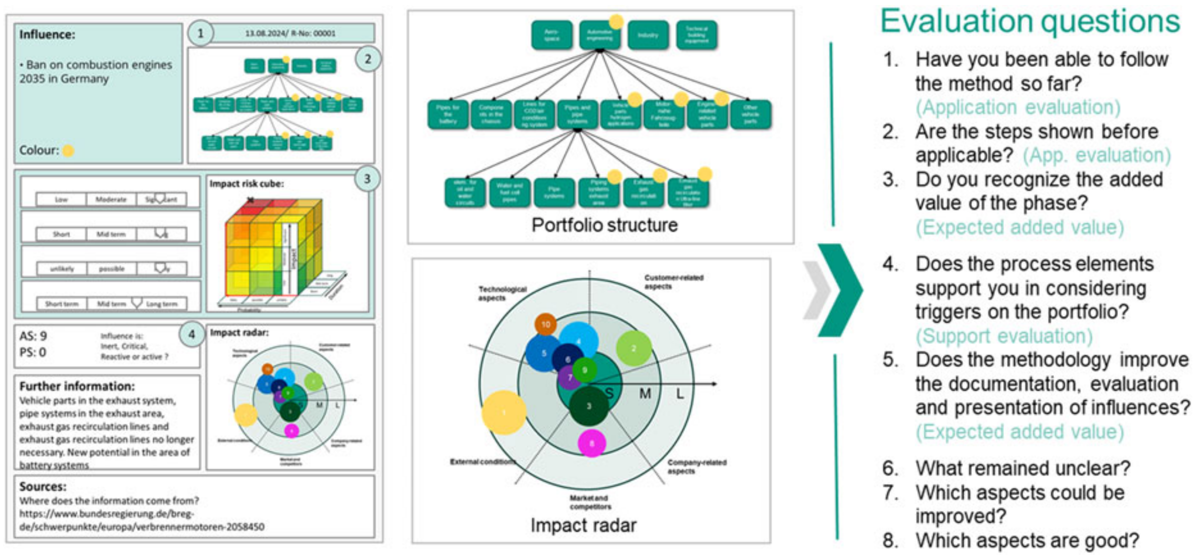

Figure 3. The illustration shows one of ten impact templates as a key result of the initial phase as well as the evaluation question posed (Kunert, 2024)

Innovation manager 1 (IM1) can imagine that the initial phase is **applicable,** but expresses concerns about the complexity and time required for the initial phase. "If it becomes too detailed, it can also be a deterrent." The process model could be too complicated for companies without a high affinity for methods. IM2 also considers the phase to be applicable. He points out that the effort involved could be too high and emphasizes that the individual steps had to be implemented consistently and efficiently. **Support:** The process model could be useful for companies that work methodically. The identification of influencing factors as a collective process is positively emphasized. Involving several people in the process is mentioned as a challenge. According to IM2 in particular the documentation in influence templates can help to gain an overview of influencing factors. The categorization of influencing factors can help to systematically consider the advancement of the product portfolio and link it to future fields. The structured approach is recognized as an **added value** by IM1. However, a simple and comprehensible explanation of the individual sub-steps is relevant to demand broad acceptance of the process model within the company. IM2 recognizes added value in the documentation options as well as the long-term and systematic consideration of influencing factors. The process model is particularly relevant concerning strategic decisions on future fields. The systematic approach and detailed documentation can lead to a clear and focused discussion in the development process. Both interviewees highlighted the structured approach positively and emphasized the possibility of support in creating an overview of influencing factors but were critical regarding the high level of effort and acceptance required within the company to implement the process model.

4.2. Current status phase

In this phase, the portfolio structure and the elements using level-specific product profiles are considered (Schlegel, Just, Pfaff, et al., 2024). The evaluation questions are similar to those in the initial phase.
In terms of **applicability**, the phase is relevant for the advancement, but IM1 emphasizes that companies should already have a sufficiently good understanding of their product portfolio. IM2 considers the actual phase to be principally applicable as far as an assessment is possible without applying it oneself. To provide a basis for future decisions, the actual phase appears to provide **support** according to IM1. The basic assumption of the hierarchical structure of the product portfolio and the resulting inheritance from a high level to a low level are rated as helpful by IM2. In particular, this requires a comparable view of different products. The creation of product profiles also helps in the development process, provided the right level of detail is selected to keep the effort to a minimum.
IM 1 questions the **added value** of the actual phase if the analyses carried out are too detailed and time-consuming. The added value of the actual phase is primarily seen in the preparation of the target phase. According to IM2, the added value of the actual phase is to gain a systematic overview and to create the opportunity to identify critical points from the past. Proper implementation in the development process is necessary to create direct added value. Both IM emphasize that companies should ideally know their product portfolio and that the effort involved in the current status phase should be kept to a minimum. According to both interview partners, the phase can serve as a basis for future decisions.

4.3. Target status phase

In the target phase, the ideal future product portfolio is built up as described in section 2.
The target phase is **applicable** for IM1, provided that the forecasting methods (e.g. scenario technique, forecasting by trends or persona method) are understandable. IM2 emphasizes that the number of foresight methods in the guidelines should be reduced and the possibility of company-specific adaptation should be given. A focus on essential methods is also recognized as useful to keep the effort low and thus the acceptance of the process model in the company high. According to IM1, the target phase has a high potential for **support**, as it accompanies the starting point for future development, in particular the derivation of new ideas and future product profiles.
The **added value** of the target phase is recognizable for IM1 due to the possibility of designing future profiles based on multiple methods. However, the benefits must be communicated more clearly and proven by practical examples to be accepted by the developers e.g., with success stories. According to IM2, the development of scenarios and the creation of a basis for strategic discussion represent a potential added value. The possibility of finding new paths for the company is considered relevant. Both IM assign great importance to the target phase within the process model. They emphasize the methodical structure as a useful approach for identifying new product profiles and areas of improvement.

4.4. Delta analysis phase

The Delta analysis is carried out following the guideline in chapter 2.2.
According to IM1, the delta phase is well structured in terms of **applicability**. However, the level of detail should not be set too high in order to avoid unnecessary discussions within the company regarding individual assessments. According to IM2, the applicability depends heavily on a suitable balance between effort and benefit. In order to be able to fully evaluate the benefits of the delta phase, a practical application of the delta phase as a test is necessary.
In order to ensure that the delta phase can **support** the development process, according to IM1, the effort must be in proportion to the benefit. According to IM2, the delta phase can support the selection of strategic decisions on the basis of clear analyses (e.g. utility value analyses). The included prioritization of changes can reduce risks in the development process. The cross-generational product map can support discussions, for example to identify possible partnerships.
IM1 recognizes the **added value** of the delta phase in the fact that it enables a systematic evaluation of the individual changes and subsequent prioritization of these changes. IM1 points out that the scope of the delta phase should be limited in order to maintain a suitable detail level for advancements. IM1 highlights the possibility of a structured approach to complex changes and clear prioritization of risks and opportunities as an added value of the delta phase. In particular, IM2 emphasizes that the identification of gaps in past development steps can enable strategic decisions to be made for the future.

4.5. Overall evaluation of the process model

Applicability: According to IM1, simpler explanations are necessary to ensure acceptance of the process model within a company. There must be a commitment within the company to engage intensively with the process model. IM1 expresses concern that constant support from experts may be necessary for the long-term application of the process model due to its high level of complexity. According to IM2, the process model has a barrier in the form of a large initial effort. As soon as this effort has been overcome, the model can be used, but must be tested and refined over several years and focused on the most important aspects. Both see the process model as fundamentally applicable.

IM1 states that the specification of clear structures **supports** the advancement of the product portfolio. The process model can improve the development process if the model is well implemented in the company. According to IM2, the structure of the development process provided by the process model and the associated systematic approach support product portfolio development. As a challenge, IM2 mentions that the employees involved in the development process must accept the process model. If acceptance is given, the process model supports coherent collaboration within the company.

According to IM1, the **added value** of the process model is recognizable. To make this clear to everyone involved in the company, clear communication of the benefits of the individual phases is necessary. A successful example project would also be helpful to demonstrate the added value of the process model to employees. IM2 states that the process model makes it possible to identify aspects and topics not previously considered in the company. The ability to make well-founded strategic decisions based on systematic analyses is seen by IM2 as a key added value of the process model. Furthermore, the necessity of a prototypical application of the process model over several years is emphasized in order to optimize the efficiency of the model and ensure acceptance within the company.

5. Second case study (Henke-Sass, Wolf Gmbh)

The second cast study was carried out as part of a cooperative master's thesis for 6 months at Henke-Sass, Wolf GmbH (HSW). Therefore the results of the process model are referred to more closely in the following than in case study I. (Kaiser, 2024) For each step, the results generated by the applicant are discussed by the author and consolidated into interim results.

5.1. Initial phase

The first step of the initial phase is aimed at **identifying potential impact factors** influencing the product portfolio. An internal company interview study was conducted for this purpose. The influencing factors were documented using influence templates, which were completed following the guideline in the initial phase. A total of 23 different influencing factors were identified through the five expert interviews.

The second sub-step, the **description of the product portfolio**, focuses on the area of arthroscopy with shaft diameters of four millimeters, as these have the largest market share, see figure 4.

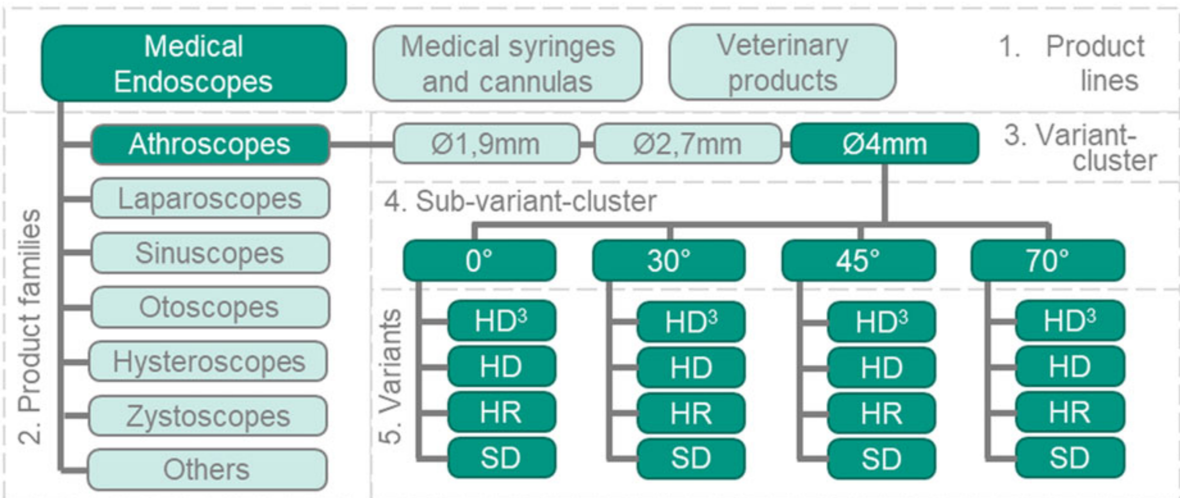

Figure 4. Section of the product portfolio under consideration (Kaiser, 2024)

The **line level** determines which industry sector the product is assigned to. At the **family level**, the product is categorized by medical application, which has an impact on dimensions and geometry. The **variant cluster** defines which joint examinations the devices are suitable for: larger diameters for shoulder examinations and smaller diameters for wrist examinations. The 4 mm arthroscope variant cluster is subdivided according to the image exit angle. At the **variant level**, a further distinction is made according to the generation of optics used, with four generations currently in use that produce different image qualities. Regardless of the variant, the devices are divided into seven subsystems, including the light guiding system, main section, funnel and eyepiece holder, which are largely independent of the viewing angle. The viewing angle mainly affects the distal end of the envelope tube and the optical system. In the third step of the initial phase, the focus is now exclusively on **identifying the impact area** in the product portfolio.
The fourth step was to **evaluate the impact factors**. The visualization using a risk cube primarily facilitated the direct comparison of individual factors. The influences were collected and clustered in the impact radar in descending order of relevance in figure 5.
In the fifth step of the initial phase, the core factors are selected based on the **internal interactions between influencing factors**. The impact factors: manufacturing costs, standardization, repairs and technology decline can be derived as core factors from the analysis of the interactions. The factors repairs and technology decline were only identified as core factors through the application of the systematic approach. In addition, other factors were assessed by the methodology as tending to be relevant: The user requirements factor is in the area of leverage forces and can also be considered as a core factor. With the help of the system grid analysis (Siebe & Fink, 2011) proposed in the guideline, the following core factors were defined for further consideration in the subsequent phases: Manufacturing costs, standardization, repairs, technology decline and user requirements.

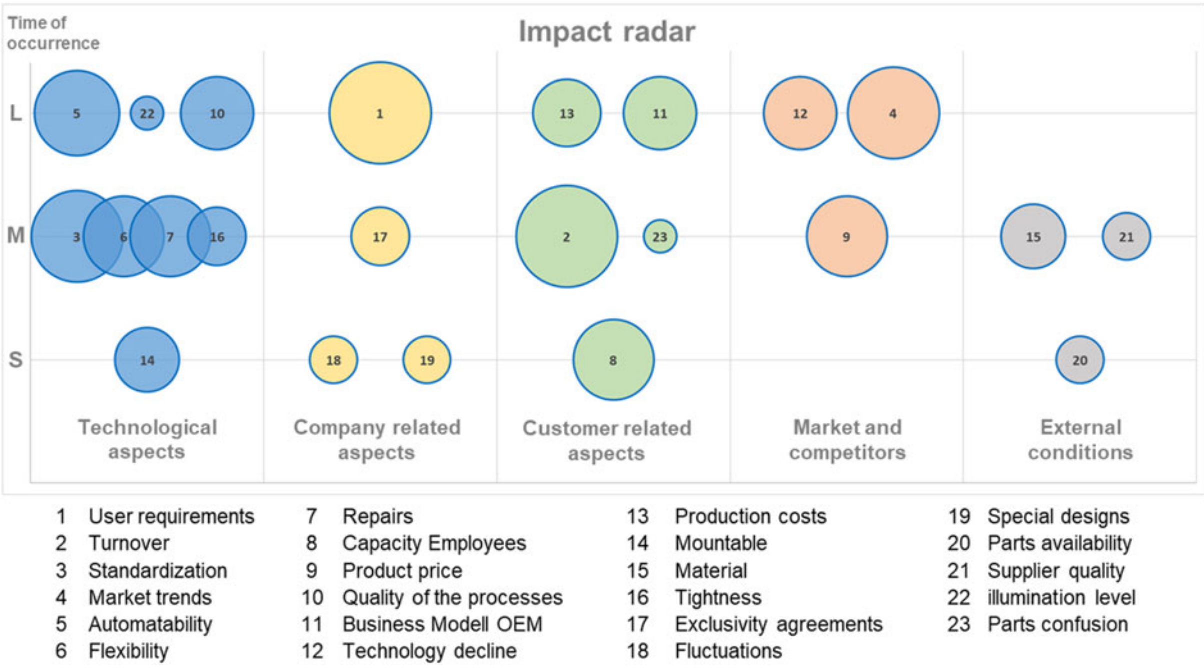

Figure 5. Adapted impact radar of all impact factors mentioned in expert interviews. The Y-axis shows the time of occurrence of the impact factors S: short-term, M: medium-term and L: long term, while the X-axis subdivides the different aspect areas. The diameter of the individual points in the diagram represents the relevance of the impact. (Kaiser, 2024)

As an **interim conclusion of the initial phase**, it can be stated that core factors were identified through the application of the guideline. The implementation of the initial phase was based closely on the methods proposed in the guidelines. By applying the proces modell, influencing factors were identified and evaluated using the proposed methods. This in turn allowed core factors with individual impact locations to be defined and various development levels of the portfolio to be derived.

5.2. Current status phase

The main objective of the current status phase is to create detailed level-specific current product profiles. As the focus is on the variant level, a product variant profile specifically for arthroscopes is developed for this phase. The following analyses are recommended to support the creation of profiles at variant level. The **competitive analysis** recommended in the guide revealed four competing OEM and their portfolios.
Portfolio comparison: By comparing the portfolios, it is possible to identify areas in which HSW is weaker or stronger than its competitors. HSW's strengths lie particularly in the area of 4mm arthroscopes, where the common viewing options of the major manufacturers are fully covered. HSW also acts as a system provider and offers comprehensive supplementary material such as trocars, obturators and other accessories.
Customer and User survey: A customer and user survey was not carried out at the request of HSW.
Program structure analysis: The variant field of Ø4 arthroscopes with their subsystems was examined according to the viewing direction and the installed optics generation (SD, HR, HD and HD^3). An almost non-existent proportion of devices of the first generation of optics (SD) can be seen. The proportion of HR devices will fall to around 20% in 2023, compared with around 30% of the total number of units in 2015 and 2020. At the same time, the share of the more modern optical generations HD and HD^3 devices will increase continuously.
Interim conclusion: While the implementation of the process model described in the guidelines was carried out for the most part, the customer and user survey was not used due to objections from HSW. To clarify customer needs, the method should nevertheless continue to be part of the process model according to the applicant. The application of the strategic product map was perceived as challenging due to the high level of abstraction of the product profiles under consideration and the large scope of the portfolio. In the opinion of the applicant, the process model is described with a high level of detail in the current status phase and provides the user with sufficient relevant methods for the target analysis.

5.3. Target status phase

As part of the target phase, five future product profiles were derived for the advancement of the product portfolio. (I) Product line profile - technical endoscopes, (II) product family profile - flexible endoscopes, (III) product subfamily profile - 2.4 mm arthroscopes, (IV) product life cycle and (V) standardization system relating to the entire portfolio.
Interim conclusion: The application of the guidelines made it possible to derive potentials and create a total of five future product profiles. According to the applicant, these profiles provide a structured basis for possible further developments in the company's portfolio. While the portfolio level for the flexible, technical and 2.4 endoscope profiles could be clearly assigned to one level, it was not possible to define the two profiles product life cycle and standard modular system at a single level, but rather encompassed the entire product portfolio.

5.4. Delta analysis phase

In the delta analysis phase, the feasibility of the five product profiles developed in the target status phase is evaluated. This results in the following prioritization:

- **Product life cycle**: Highly rated feasibility with high potential business success puts this product profile in first place.
- **Standardization system:** High potential business success, combined with challenges in realization, especially from a design perspective.
- **Technical endoscopes:** A high assessment of feasibility with moderate business success.
- **2.4 mm arthroscopes:** A high feasibility rating with medium potential business success explains why the profile was abandoned with the first product generation due to a possible lack of customer inquiries.
- **Flexible endoscopes:** The analysis of the product structure shows that only a few components from the existing portfolio are inheritable and that there is little expertise and related elements in the portfolio. This results in low feasibility and risks that should not be underestimated.

According to the process model, a roadmap is to be drawn up for the implementation of the advancements, to manage the changes to the portfolio. The roadmap aims to process large portfolio changes in several small intermediate steps. This should make it possible to prioritize changes with high benefits and low costs.

Interim conclusion: In the delta phase, the profiles were evaluated by applying the guidelines and prioritized by means of a utility value analysis, allowing the application of the guidelines to provide insights for decision-making. The delta phase was implemented along the lines of the guideline. Only when creating the roadmap did the challenge arise that the prioritized profiles bring extensive changes to the product portfolio, which must be reviewed by the various internal company stakeholders before the roadmap can be created. This could not be carried out within the extend of the case study at hand.

5.5. Overall conclusion on the application of the system at HSW

The implementation in the company was very close to the proposed guidelines and thus demonstrates the **applicability** of the process model. Except for the customer survey and the roadmap for specific products all recommended methods were applied. The creation of decision bases and documentation also provides **support** in the advancement of product portfolios. The application of the methodology resulted in the following **added values** in particular:

- It was possible to identify 23 influencing factors, their impact locations and the central core factors, which were not seen without the methodology.
- It was possible to map the current status of the product portfolio.
- Three future product profiles were developed at different levels of the portfolio with assessed risks and opportunities.
- Two future product profiles were prioritized as strategic approaches with a high utility value.

Overall, the applicability of the process model due to the guideline for use in an industrial environment could be shown. A limitation concerning the objectivity of the results is the link between the Master's thesis and the researcher. To increase the support and added value an industry-specific extension of methods within the guideline in the field of medical technology is considered helpful.

6. Conclusion and outlook

Two case studies in a two-stage approach were conducted in line with the paper's aim to initially evaluate the process model for the advancement of product portfolios with regard to the applicability, the support and added value and answer the research question posed in chapter 3.

The first case study in collaboration with Witzenmann GmbH is assigned a limited validity, as the experts themselves did not fully implement the process model. The detailed presentation of the phases of the process model and the company-related results form a foundation for a realistic evaluation of the process model by the company experts. According to the experts, the process model can be applied across all phases. The experts stated that the process model provides support in development. The effort involved must be considered in relation to the added value, as the process model is very complex and time consuming. Both interview partners also assess that the process model can provide potential added value through the structured and systematic approach. However, according to Innovation Manager 2, the process model would have to be applied and monitored in a company over several years for it to be fully validated.

A step in this direction was taken with case study two, in which the process model was implemented in the company Henke-Sass, Wolf GmbH for 6 months. Therefore, the outcomes of the process model itself are considered to be more valid in the second case study and are more in focus than in the first case study. The process model could be applied by an employee in the company, except for adjustments in the delta phase and the customer and user survey, which was explicit not desired by HSW. The process model supported advancement and it was possible to derive new influences and profiles. The extent to which these will lead to success for Henke-Sass, Wolf GmbH in terms of innovation can only be determined after the market launch.

In conclusion, concerning the research question posed, it can be said that the process model could be applied in the corporate context based on the two case studies and can offer developers support in product portfolio advancement. Statements on the success of the process model can only be formulated based on expected added value. The expected added value is seen in both cases, but for a more comprehensive evaluation, a study covering several years of practical application of the process model is recommended.

Based on the results of the evaluation by the two case studies and the feedback of the experts, the process model is to be improved in future iterations in order to increase the applicability, support and added value. For example, a lean version of the process model is to be developed to reduce the high cost of implementation and execution. Not all methods and steps offered within the process model need to be executed, several intermediate results are generated that can already be used independently. In addition, to emphasize the added value compared to the effort involved, parts of the case studies presented in this work could be integrated into the guideline as examples, as suggested in the evaluation of Case Study I. Further validation studies with the improved process model are planned in order to develop a broader basis for different companies and sectors. The expanded evaluation basis enables conclusions to be drawn about the methods required, depending on the company type and the industry in which the company operates, as well as a more profound and specific evaluation of applicability, support potential and expected added value.

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