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Future-oriented product engineering through environment scenarios by using the example of future forms of mobility in urban living spaces

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Abstract

Foresight is crucial for companies, as the generated information will facilitate future positioning (Fink and Siebe, 2011). In addition, the early recognition of development opportunities and risks supports dealing with uncertainty in product engineering. The future of mobility is a topic that is characterized by such uncertainties while at the same time, it offers innovation potential through the current transformation process in mobility. The proposed systematic approach of Albers et al. (2018a) increases the chances of innovation by integrating future knowledge into the product engineering process while reducing the uncertainty for the product developer to a manageable level. This succeeds because of the direct connection of the future knowledge with the product development, which represents a guideline for the product development and at the same time carries out a prioritization and planning of development scopes. This supports the development of products on a long-term horizon.
The focus is on the application of the systematic approach to the subject of mobility in order to elaborate future relevant product characteristics and from there, product profiles for future mobility concepts and means of transportation in urban areas. This validates the system and at the same time reveals its optimization potential. Attention is particularly created to the environment-specific valuation in order to gain further insights into the developments of the respective product characteristics through the standard deviations of the evaluations. This allows to make statements on the continuity potential of product characteristics in order to identify particularly valuable product characteristics through the uniformity of their evaluations in the environment developments. This further investigation is to be used by its eminent importance as an extension of the system.
Mobility, the object of analysis confirms that the systematic approach facilitates the integration of future knowledge into the product engineering process while supporting the product developer in designing products on a long-term horizon. The product profile data shows that there is a great potential for the mobility of the future in the urban area. The consistency of these possibilities creates a thrust for the future. Current residual uncertainty exists as a given sub-element that companies can handle, as development opportunities and risks are known, and development scopes are prioritized and planned.

Keywords: PGE–Product Generation Engineering, systematic product engineering, future product characteristics, foresight, standard deviation

1 Introduction

More than 45 years ago, the future of mobility was reflected upon and the development of autonomous large cable cars as a means of transport in urban living space was investigated (Kalberlah and Heinzel, 1973). The visions for local transport, which is dominated by the automobile, did not prevail against the increasing need of the population for individuality. Today, the tense traffic situation in urban areas which is partially responsible for the current transformation process of mobility, opens new innovation potentials.

Methods and processes are used to predict the future so that companies recognize such innovation potentials in good time and thereby achieve a competitive advantage. In addition, a direct link between future knowledge and product engineering is necessary in order to define solution areas and to set a direction for product engineering. The interpretation of the information gained from foresight (Hirschter *et al.*, 2018) and the limited resources that companies can use in the area of development are of particular importance in this context. They make the prioritization and planning of development scopes indispensable (Albers *et al.*, 2018a). The systematic approach proposed by Albers *et al.* (2018a) is a contribution to close this gap of systematic product engineering (Albers *et al.*, 2018a; Marthaler *et al.*, 2019b). The systematic approach facilitates the development of products with a long-term time horizon and supports the product developer in the implementation of information from foresight into the product engineering process (Marthaler *et al.*, 2019b). The goal of this work is to apply the systematic approach and to create flexible and scalable concepts for future means of transport in urban space. The systematic approach will be validated by means of the mobility analysis. At the same time, optimization potentials for increasing the significance of the results will be revealed.

2 State of research

In the state of research, the model of PGE - Product Generation Engineering is first explained and the necessary overview of the subject area of foresight is given. Subsequently, the proposed systematic approach and the object of analysis are presented in detail.

2.1 Model of PGE – Product Generation Engineering

The task and requirement of product engineering is to ensure that new products meet future market requirements and are as successful as possible in competition (Albers *et al.*, 2018a). In development practice, references and existing subsystem solutions are used in order to learn from gained experience and to fall back on existing knowledge. The phenomenon that all products exist based on modifications of other products, describes the model of PGE - Product Generation Engineering. At the same time, it is a further development of classical development methodology (Albers *et al.*, 2015). In the model of PGE, the development of a new technical product is always understood as a new product generation (Albers *et al.*, 2019). The goal in the development of a new product is the realization of sufficient differentiating characteristics to an already existing product, in order to guarantee the demand as well as the use and the enthusiasm for customers and users (Albers *et al.*, 2015). The reference system which serves as the basis for the new product generation, consists of elements from the previous generation as well as subsystems from competitors and other industries that enable cross-industry product development (Albers *et al.*, 2019). Three types of variation - principle variation, embodiment variation and carryover variation - must be differentiated as the sum of the new development share (Albers *et al.*, 2015). The model of PGE - Product Generation Engineering methodically supports development projects from the beginning in finding solutions. The PGE enables the developers to save resources and, by analyzing the consequences, reduces the risk involved in upcoming decisions (Albers *et al.*, 2017). The aim of the initial phase of PGE is to define a product profile that describes the requirements of future products in a solution-open way and contains solution-specific content from previous product generations. Thus, it is possible in the sense of strategic product engineering to make future-proof decisions that contain a lower development risk and offer potential for saving resources at the same time (Hirschter *et al.*, 2018). In order to anticipate customer requirements and thus make robust decisions, methods of foresight are applied.

2.2 Foresight

Development risks are based on the lack of knowledge and experience with technologies and insufficient market knowledge (Albers *et al.*, 2018a). As a result, sustainable and successful product development considers not only technical risks but also aspects that do not directly influence the performance of the function. This includes all influences from the environments that affect the future product as a result of customer and user wishes as well as politics and competition (Albers *et al.*, 2018a). In order to recognize these risks for today's business areas and to analyze future success potentials, methods of foresight are required (Albers *et al.*, 2018a; Gausemeier and Plass, 2014). The results from foresight are to be understood as a metaphorical image of a guard rail that supports product engineering in a targeted manner with regard to developments in the environment and contributes to the orientation of a company in the future (Hirschter *et al.*, 2018).In order to generate future knowledge, there are three instruments of foresight. Forecasts make it possible to make short-term statements about the future that are based on a linear projection of the past. Trends indicate medium-term changes in the future and describe isolated, potential one-dimensional developments. Scenarios are the most suitable instrument for forecasting beyond a period of ten years in order to provide the necessary impulses and approaches for product engineering. They describe several alternative and consistent visions of the future (Fink and Siebe, 2011). It should be noted that a scenario does not represent a single true future, but reveals the space of possibilities through the totality of scenarios (Fink and Siebe, 2016; Siebe, 2018).

2.3 Presenting the systematic approach

The model of PGE - Product Generation Engineering and foresight increase with a synergetic linkage the chances of generating products with a high innovation potential and thus achieving economic success (Albers *et al.*, 2018a). The success factor for the linkage is the integrative consideration of the areas in order to ensure an interdisciplinary communication on a common abstraction level (Gausemeier *et al.*, 2016, p. 20). The systematic approach presented by Albers *et al.* (2018a) forms a common level of abstraction through the analysis of future relevant product characteristics (Albers *et al.*, 2018a; Marthaler *et al.*, 2019b). The relevant product characteristics are derived from the requirements for the future product based on future knowledge (Marthaler *et al.*, 2019a), thus ensuring profitable interdisciplinary communication.

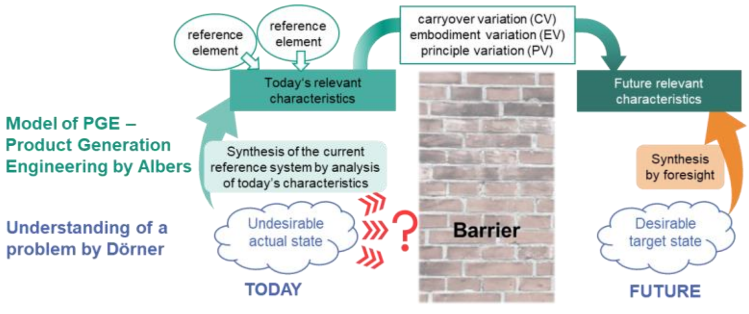

Figure 1. Modules of the systematic approach

The main modules of the systematic approach are based on two things (figure 1). On the one hand, according to Dörner's (1976) understanding of the problem, to transform a starting state into a target state and, on the other hand, the model of PGE, in order to support this unknown way of achieving the goal, by adding references (Dörner, 1976; Albers *et al.*, 2015). The three variants of the systematic approach (figure 2) that define the planning horizon are based on the levels of foresight presented by Fink and Siebe (2011). The steps and phases of the innovation process developed by Fink and Siebe (2016) have also been incorporated into the systematic approach as impulses. The systematic approach makes it possible to derive relevant product characteristics from future visions and to provide suitable recommendations for action directly, meaningfully and rule-based for the product developer. In addition, the scope of development is recognized and prioritized by considering several product generations (Albers *et al.*, 2018a).

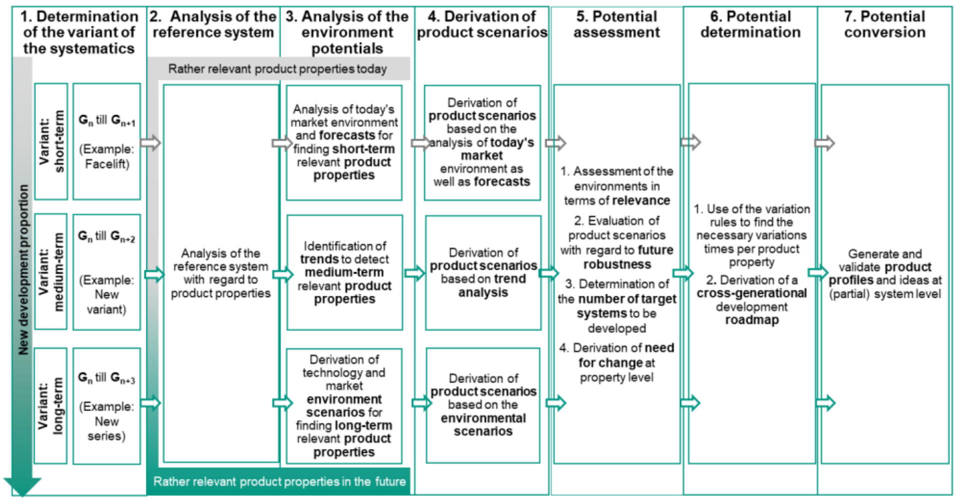

Figure 2. Methodic steps of the systematic approach according to Marthaler *et al.* (2019b)

The procedure of the developed systematic approach is divided into seven steps which are explained in detail below. Depending on the planning horizon of the product generation to be developed, the first step of the systematic approach determines one of the three possible variants of the procedure. For example, the goal is to develop a new product series based on the current product generation G_n, and to strive for a high planning horizon through the development with a high share of new development which calls the targeted product generation G_{n+3}.

The second step of the systematic approach analyzes and defines a reference system. This has to be done from the customer's and user's point of view so that product characteristics are the result of the step, but they describe the product openly and do not provide any concrete information on the technical implementation (Marthaler *et al.*, 2019b). In the third step, the environment is analyzed in order to find relevant product characteristics for the future. The three variants already mentioned differ in the instrument of foresight. Based on a comparison of the product characteristics found in the second step with the developments in the environment, obsolete product characteristics are identified and potential new product characteristics are derived by evaluating their significance (Marthaler *et al.*, 2019b). In order to derive innovation potentials in the fourth step of the systematic approach, a consistency analysis or a morphological box can be used. (Marthaler *et al.*, 2019b). This fourth step is omitted from the implementation, as the focus is on product profiles rather than product scenarios in order to identify innovation potentials. In the fifth step of the systematic approach, the product characteristics are to be analyzed with regard to their relevance and their need for change in the environments (Marthaler *et al.*, 2019b). The contribution of a product characteristic to customer satisfaction is decisive for its relevance. From the weighting of the relevance of a characteristic in the different environments, a total measure - the future robustness of a product characteristic - is composed. The need for change of a characteristic indicates the performance of a product developer which is necessary to change a characteristic starting from the defined reference product to a product in the respective scenario (Marthaler *et al.*, 2019b). In the sixth step of the systematic approach, four possible cases are derived from the combination of future robustness and the need for change based on variation rules, which determine the optimal time of variation for each product characteristic (Marthaler *et al.*, 2019b). This variation time represents a recommendation for action regarding the product generation in which the product characteristic should be realized in the required variant. The consistent derivation of the variation points on future product generations records the development roadmap to be created for this purpose. The last step includes the generation and validation of product profiles. These product profiles summarize the requirements for the future product. They bundle the benefits of the potential customer and user as well as those of the supplier. Through the product profiles, it is possible to validate the relevant advantages for suppliers, customers and users as well as to uncover synergy potentials and to identify conflicting objectives at an early stage (Albers *et al.*, 2018b).

2.4 Presenting the case: Mobility in urban living spaces

In order to investigate urban mobility, it is necessary to define the concepts of mobility and transport. Mobility makes it possible to combine life activities such as living, working and relaxing and to achieve this by changing places in terms of time and space (Bertram and Bongard, 2014; Zierer and Zierer, 2010). Transport is the realized mobility (Bertram and Bongard, 2014) and thus defined as a subset of mobility (Zierer and Zierer, 2010).
Mobility therefore does not only involve the use of a means of transport as a means to an end, but is also characterized by fundamental values and by individual habits and needs (Proff, 2019). Mobility decisions primarily have a specific purpose and serve to find an optimum for one's own needs (Flügge, 2018). Especially for the choice of public transport, the characteristics of the offer, speed, pace and fare are decisive (Schwedes, 2018). But the rational determinants for the choice of means of transport do not fully justify the decision. Several studies have shown that deeper motives which can be emotional, affective and symbolic, are of particular importance (Steg *et al.*, 2001). Klühspies (1999) postulates that mobility behavior is highly emotionalized. The interdisciplinarity of the topic and the symbolic aspects of the choice of transport are also confirmed by Sonnberger (2013) who sees the rational factors of the choice as speed and safety needs as well as the intention to demonstrate social status. The attributes examined by Proff *et al.* (2012) for the choice of means of transport and the attributes extended by Proff (2019) serve as the basis for the later determination of the characteristic product characteristics of means of transport. The factors influencing the choice of means of transport by Flügge (2018) are to be used as a basis to consider the interdisciplinary nature of the topic.

3 Research questions and research method

The above-mentioned state of research shows the importance of integrating future knowledge into the product engineering process. The systematic approach enables the integration of results from foresight into concrete, but solution-open product profiles. They thus provide development orders for pre-development. The interdisciplinarity of mobility behavior was also examined. The aim of this work is to apply the systematic approach to the complex case of mobility. The solution framework lies on future mobility concepts in urban space for the year 2040. Until this point in time, a transformation process in mobility and a multitude of technological developments is expected. The application should uncover optimization potentials in order to increase the significance of the results and thus further minimize the uncertainty in the product development process. This leads to two research questions:

- Which product profiles can be derived for the mobility concepts in urban space in the year 2040 by a methodical approach of advance engineering?
- How can the significance of the results of the systematic approach be further increased in order to be able to make safer decisions while dealing with uncertainty?

For the first research question, the systematic approach by Albers et al. (2018a) is applied (Albers et al., 2018a; Marthaler et al., 2019b). Based on an initial literature research, which focuses on the fundamental influence and the determining aspects on the choice of transport, product characteristics can be derived and environment potentials are evaluated through environment scenarios initiated by Fink (2019). For the second research question, the focus is on the fifth step of the systematic approach in order to find appropriate optimization possibilities and to gain further insights for the development of product characteristics from the scenario-specific evaluations.

4 Implementing the systematic approach according to the mobility case

Since the application task provides for mobility concepts for the year 2040, the use of scenarios is necessary due to the time horizon. Thus, the long-term variant of the systematic approach is to be used. For the second step of the systematic approach, an analysis of the determinants of the choice of means of transport is necessary. Based on the state of research, 18 feature groups are derived, which are based on the needs of the users. Based on the cross-modal analysis of reference products, the derivation of product characteristics is possible. As the goal of the second step, the product characteristics are then explained in detail in a catalogue with explanations of the characteristics.

The aim of the third step is to analyze the future environment regarding the mobility in urban space and thus to detach the product developers' field of vision from the present. In order to derive future product profiles, the environment scenarios developed by Fink (2019) for the year 2040 will be used. For doing this, it is necessary to compare the product characteristics from the second step of the systematic approach with the projections consisting of the scenarios (figure 3).

	Low personal mobility for consumption: virtual experiences	Virtual experience shopping with real supply purchases	Radical change in consumer habits: declining mobility	Declining mobility needs - demand for sophisticated services	Strong demand for sophisticated mobility services	Strong demand for simple mobility services	Mobility is a scarce luxury commodity
Reliability	0	+	0	++	++	-	+
Punctuality	0	+	0	+	++	-	+
Autonomy	0	+	+	+	+	+	+
Spatial flexibility	0	0	0	0	+	-	+
Temporal flexibility	+	+	+	+	+	+	+
Usage costs	0	0	0	0	0	+	++
Speed	0	+	0	+	+	-	0
Transportation possibility	–	++	-	+	+	-	0

Legend:
++ Importance of characteristic increases strongly
+ Importance of characteristic increases
0 No correlation between characteristic and projection
- Importance of characteristic decreases
-- Importance of characteristic decreases strongly

Figure 3. Comparison at projection level

This is done by using a five-step rating scale for the significance of a particular characteristic in a particular projection. If there is no correlation between the characteristic and the projection and therefore an evaluation of the significance is not possible, a zero is entered. This evaluation allows to identify white spots in order to identify future product characteristics. A white spot can be identified by a high number of zero ratings in a column. An accumulation of the rating zero in a row means that in some projections the characteristic cannot be directly linked to the future and it is not significant for the future. The number of valuations with a zero in a row must be specified at the end of the row and forms the basis for deciding whether a characteristic should be integrated in future products. The newly found product characteristics are added to the catalog from step 2 of the systematic approach. As already announced in the state of research, the fourth step of the systematic approach was omitted in this application by focusing on product profiles and not on product scenarios to find potential. In the fifth step of the systematic approach, the parameters of relevance and the need for change of a characteristic are evaluated. The evaluation of the relevance and the need for change is carried out for each characteristic and each scenario. It is applied on a scale of zero, the lowest relevance or need for change, up to one hundred which is the assessment for the highest relevance or need for change. An interdisciplinary team of mobility experts (Fink, 2019) enables a differentiated assessment of the eight scenarios with regard to their consistency with the expected future. Based on the expectation that the developments in the environment will occur, a weighting of the scenarios can be carried out which leads to an overall statement of a characteristic on the parameters of relevance and need for change. The resulting variable, which has already been defined as future robustness, is referred to below as a weighted relevance through its mathematical calculation. The weighted calculation of the need for change of a characteristic is referred to in the following as the weighted need for change, analogous to relevance. The standard deviation of weighted relevance and weighted need for change for each characteristic is determined as a measure of the spread of the assessments of relevance and need for change across the scenarios. As the goal of the sixth step, search fields with the highest possible innovation potential are identified. For doing this, the calculated mean values of the weighted parameters must be examined. Subsequently, the scope of development is prioritized by using the variation rules. For the last sub-step, product profiles are now created at the characteristic level. These profiles contain concrete development orders as the overall goal of the systematic approach and thus limit the solution space for implementation without specifying specific solutions (Albers *et al.*, 2018b).

5 Results and discussion

This chapter presents and interprets the results which are used to answer the two research questions. The chapter is divided into two sub-chapters, each relating to one research question.

5.1 Results for finding the product profiles

The result of the evaluation, the weighted relevance and the weighted need for change of individual product characteristics makes it possible to graphically present these variables in a portfolio and to develop a roadmap (figure 4). The developed roadmap provides an intergenerational opportunity to prioritize the development scope. An early variation is aimed at over the next five years, a medium-term variation over the next five to ten years and a late variation over ten to fifteen years.

		Characteristic	weighted relevance		weighted need for change		No variation	Early variation G_{n+1}	Mid-term variation G_{n+2}	Late variation G_{n+3}
			Total	Rank	Total	Rank				
Already existing characteristics	1	Degree of reliability	60	1	25	23				
	2	Compliance with departure and arrival time	58	3	19	31				
	3	Degree of autonomy	59	2	14	36				
	4	Spatial flexibility	53	9	16	34				
	5	Temporal flexibility	52	11	33	17				
	6	Usage cost	36	30	39	11				
	7	Speed	40	26	20	30				
	8	Transportation possibility	30	35	11	38				
	9	Whereabouts	50	17	33	18				
	10	Possibility for other activity	52	10	50	3				
	11	Charging options for devices	49	18	7	41				
	12	Control over driving	20	40	43	6				
	13	Choice of passengers	27	37	17	33				
	14	Weather protection	56	5	9	40				
	15	Guaranteed seating	47	22	12	37				
	16	Integrated lighting system	51	13	3	42				
	17	Rack and storage options	39	27	9	39				
	18	Door to door carriage	56	4	22	27				
	19	Privacy	50	15	31	19				
	20	Feeling of safety	46	23	23	26				
	21	Status symbol	14	42	49	4				
	22	Contest icon	15	41	41	9				
	23	Park space requirement	25	38	30	20				
	24	Intermodality	34	33	33	16				
	25	Emission of harmful substance	54	7	34	15				
	26	Noise emissions	36	31	18	32				
	27	Land use	34	34	27	21				
	28	Power consumption	50	16	43	7				
	29	Infotainment systems	48	20	36	13				
	30	Possible distance	24	39	16	35				
New Characteristics	31	Digital security	49	19	42	8				
	32	Active security elements	47	21	37	12				
	33	Systems with artifical intelligence	55	6	54	1				
	34	Interaction with other road users	45	24	52	2				
	35	Connectivity as a digital workplace	41	25	26	22				
	36	Autonomous travel of the means of transport to the user	51	12	44	5				
	37	Independent parking and parking space search	53	8	40	10				
	38	Possibility to sleep and rest	51	14	21	29				
	39	Customization options	35	32	35	14				
	40	Automatic loading	37	29	22	28				
	41	Crossing city boundaries	28	36	25	25				
	42	Connection of passenger and freight traffic	38	28	25	24				

Figure 4. Roadmap

From the product characteristics found, product profiles are created that provide a framework for product developers and thus stimulate their creativity. A critical question is whether the product profiles found have the level of detail required for further product development. In order to consider the boundary conditions such as the size of the urban space, the profiles found must be concretized. As a result, the profiles found are primarily search profiles that lead to detailed product profiles as a result of the systematic application of the approach to mobility in urban space.

5.2 Results to increase the significance of the systematic approach

The values of the weighted standard deviation of the parameters - generally between 21 and 23 - indicate an unevenness in the scenario-specific evaluation of the product characteristics. In order to illustrate this graphically for the relevance study, the weighted relevance and the standard deviation of the weighted relevance are plotted in a portfolio (figure 5).

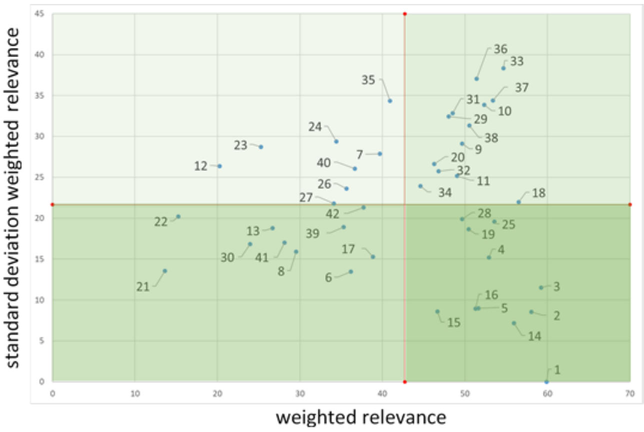

Figure 5. Weighted relevance and standard deviation of the weighted relevance

Product characteristics that have a high weighted relevance and a small standard deviation of the weighted relevance are to be assessed as particularly valuable. They have a high relevance and at the same time a continuity over the different future images. In contrast to this, product characteristics with a high weighted relevance and a high standard deviation of the weighted relevance are also important for the future, but they have little continuity over the different conceivable future developments. In order to summarize these findings and to link them with the previous parameters from earlier research work, the various parameters that are necessary for relevance studies must be redefined. The relevance required to evaluate a characteristic is also referred to as the *relevance of a product characteristic* which describes the influence of a characteristic on customer satisfaction in a particular environment. It is determined by the needs of customers and users and cannot be influenced by the product developer. The *weighted relevance* describes the influence of a product characteristic on customer satisfaction across the entirety of the considered and weighted product environments. The weighting is done by evaluating the likelihood of the environments considered. The *standard deviation of the weighted relevance* is the dispersion of the relevance of a characteristic over the considered and weighted environments. It provides a statement on the similarity of the relevance ratings of a product characteristic across the environments considered. A newly defined ***future robustness*** results from the combination of the weighted relevance of a product characteristic and its standard deviation. A high degree of future robustness indicates that the technical realization of a product characteristic makes a major contribution to customer satisfaction, even if various developments occur in the environment.
Analogously, the characteristic value of the weighted need for change can be examined.
Product characteristics with a high need for change and a low standard deviation of the weighted need for change are to be assessed as particularly valuable. They provide more stable statements on the development of the various scenarios than those with a high standard deviation. The results found must also be defined as variables. The current terms are to be given unambiguous names based on the new findings. Thus, the need for change of a characteristic is to be described as the *environment-specific invention potential* which defines the necessary creative performance for the realization of a product characteristic through a technical innovation in a considered environment. This service must be used by the product developer. The weighted need for change is more easily understood under the term of the *weighted invention potential*. It defines the necessary creative performance for the realization of a product characteristic by a technical invention over the totality of the considered and weighted environments. As with the relevance assessment, the weighting is carried out by evaluating the likelihood of the environments considered. Consequently, the standard deviation of the weighted need for change is introduced as the *standard deviation of the weighted, environment-specific invention*

potential. It thus describes the dispersion of the invention potential of a product characteristic across the considered and weighted environments. The ***invention potential*** results from the combination of the weighted, environment-specific invention potential of a product characteristic and its standard deviation. A high invention potential indicates that even when various developments in the environment occur, the creative performance required to realize a product characteristic through a technical innovation is high. A possibility to examine the original portfolio according to its standard deviation is shown in figure 6.

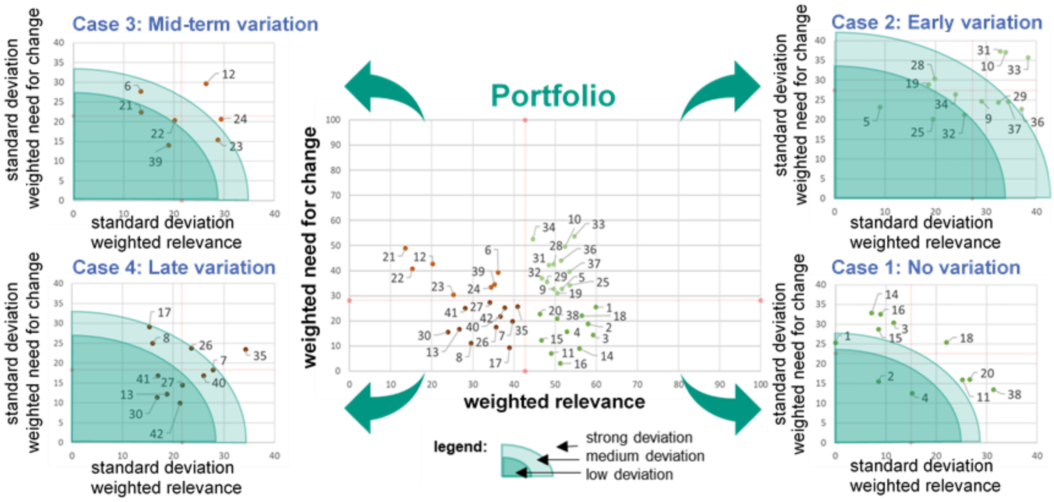

Figure 6. Extended portfolio for examining the total deviation

Starting from the original four quadrants of the portfolio, each characteristic in its quadrant must be examined for the standard deviation of its parameters. Looking at the total deviation as a Euclidean standard from the weighted standard deviations of relevance and need for change, the product characteristics can be divided by the maximum and minimum total deviation, into a small, a medium and a large total deviation. The different development directions of the product characteristics and thus the deviations, are triggered by the occurrence of different scenarios. A high total deviation due to different development directions has an influence on the strategy to be applied. Due to the dissimilar evaluations in the different scenarios, it is necessary to pay attention to the different development directions when considering the product characteristics with a high total deviation. By means of indicators, the expectation for the occurrence of the scenarios could be used to pay more attention to product characteristics with a high total deviation and to derive concrete control measures for product developers. These control measures take place at previously defined milestones if the product in its current version only fits the environment developments to a limited extent.

6 Summary and outlook

In order to investigate the developments and challenges of urban mobility in 2040, the use of methods of environment foresight is essential. The future needs of users are anticipated and can be transferred into future product characteristics. The product profiles of future means of transport, which were derived from the product characteristics, offer an innovation potential for the product developer and a directed stimulation of creativity. The investigations on the standard deviation of the parameters of the weighted relevance and the weighted invention potential offer new possibilities for the extension of the systematic approach. These parameters allow making a statement on the continuity potential of characteristics and to recognize particularly valuable product characteristics through the uniformity of their environment developments. The newly found and defined variables of future robustness and invention potential result from these findings. Further research work is needed to confirm the implementation potential found for optimizing the systematic approach and to validate adjustments in the methodological approach. Especially important for future applications is the adaptation of the systematic approach to complex and multi-layered application cases. The application case of urban mobility confirms that the systematic approach supports the development of products with a long-term time horizon over several generations and that the results of foresight are systematically integrated into the model of the PGE - Product Generation Engineering. The development roadmap ensures a prioritization of development scopes that support the product development process across generations. The newly found variables supplement the advantages of the systematic approach by increasing the decision-making reliability of a product developer and providing information that is important for strategy development and the strategic early recognition process. Thus, the systematic approach offers the predestined opportunity to stimulate the dialogue about future needs and to minimize the uncertainty of decisions in the product engineering process through a systematic integration of future knowledge.

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