Integration of Strategic Flexibility into the Platform Development Process

Fatos Elezi, Rita Tschaut, Wolfgang Bauer, Nepomuk Chucholowski and Maik Maurer

Abstract Platform systems are used for obtaining and sustaining competitive advantage, as they make possible derivation of a variant-rich product portfolio and at the same time provide cost advantages in development, production and assembly. In this paper, a methodology for conception of a platform system that is robust to internal and external dynamic changes, and which at the same time supports flexibility with respect to these dynamic influences is proposed. The proposed methodology is evaluated in a real industrial setting and has shown much better results as an unstructured method for incorporation of planed flexibility. In addition, the methodology is to date incorporated into the platform design process of the industrial partner and is used on day-to-day basis.

Keywords Strategic flexibility · Product flexibility · Platform system · Modularity

1 Introduction

Manufacturing firms are operating in an environment where market power has shifted from producers to consumers. This is due to globalized markets, which have fractured from mass markets into heterogeneous niche markets [1]. The fractured market requires high quality, favorable, customized products in shorter product life cycles [2] while competitors are introducing new products in shorter intervals. As a consequence, typical market conditions have become extremely dynamic and turbulent. Companies have to respond quickly to these changing market demands for providing a versatile product portfolio for rapidly segmenting markets [3]. In order to do so, companies are seeking to incorporate strategic flexibility as an approach to deal with these dynamic and turbulent changes [4]. Strategic flexibility refers to the ability of companies to plan, adapt and respond to external changes. The first author

F. Elezi (✉) · R. Tschaut · W. Bauer · N. Chucholowski · M. Maurer
Institute of Product Development, Technische Universität München, Munich, Germany
e-mail: elezi@pe.mw.tum.de

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to extend the flexibility concept into strategy was Sanchez [5]. He states that strategic flexibility depends not only in the inherent flexibility of the firm's resources but also on firm's flexibility in applying those resources to different alternatives. This means that it is not enough just to have flexible resources but there need to be adequate processes that help operationalize these flexible resources. These processes, that according to Eisenhardt and Martin [6] are also called dynamic capabilities, are strategic decision-making, alliancing, and product development. In relation to product development, Buganza and Verganti [7] outline product flexibility and development process flexibility as two important perspectives of flexibility. In literature, however, the dynamic capabilities in relation to flexibility—strategic decision-making and product development [6]—are not treated in an integrative way, although in industry settings these two processes are highly interrelated and exactly in their interfaces most of the value in relation to product flexibility is generated. Strategic decision-making in relation to product flexibility is concerned more with deciding about the necessary functional flexibility in the products for achieving the sustainable competitive advantage, whereas product development in relation to flexibility is concerned about how to technically make possible this flexibility in an efficient and cost-sensitive manner. It is obvious that the stakeholders of these processes need to communicate in an efficient and pragmatic way so that the company incorporates fully the notion of product flexibility.

As a conclusion, the product flexibility can be implemented in an industrial setting only by having appropriate strategic decision-making processes and appropriate product development processes. In addition, these two approaches need to be synchronized and come together with a coherent result which is accepted and agreed upon in both levels—strategic and architectural (design) level. In the research project "SFB 768 transfer subproject", a methodology for integrating these two important processes for strategic flexibility is being developed. However, in this paper we focus only on the strategic decision-making in flexibility planning.

2 Theoretical Background

2.1 Modular Products and Platform Strategies

Modularization is described by Schuh [8] as a reduction of dependencies between product elements (modules) as well as a reduction of element interfaces. Therefore, modules can be understood as subsystems with different functions, but with standardized interfaces, that are both functionally and physically relatively independent of each other and allow diverse combinability [9–13].

According to the understanding of [12], a *platform system* constitutes of standardized and individualized elements. The standardized elements form a stable, uniform basis for all final products. The individualized elements use this uniform basis to form a number of variants of the product range. Accordingly, the modular product system within a platform strategy comprises a robust part and a flexible part, both clearly separated.

The term *platform strategy* describes the coordination of product portfolio- (internal) and market-oriented (external) strategic focus concerning product platforms with the objective of applying cost reduction potentials while offering a large and rapidly changeable product variety [12]. The platform strategy thus is a hybrid competitive strategy combining aspects of cost leadership- and differentiation strategies.

For the *implementation of a platform strategy* and its objectives modular product design is necessary. The cost-optimizing aspect of the platform strategy requires operative measures at the level of product architecture. The relatively large amount of standardized components within the platform system enable cost-effective production. The remaining flexible part serves the differentiating part of the strategy. Ley and Hofer [14] also point out that the platforms should be standardized across the entire product family and also should be stable in time. Besides product components also technologies, processes, knowledge and organizations are considered part of a platform system [15–17].

In summary, platform systems as a type of modular product systems provide two main benefits. For once, they allow quick response to dynamic markets by eased generation of new variants. Furthermore, cost efficiency can be raised due to realization of standardization and economies of scale in the stable platform components. To ensure long-term robustness of such a platform system, however, it is required to anticipate future changes relevant to platform system and in addition assess the required flexibility from the strategic perspective. Basic definitions for these notions are given in the following section.

2.2 Product Changeability, Anticipation and Planned Flexibility

Over time, i.e. during development phases, technologies applied in products evolve, market- and other external conditions vary, overall leading to altered requirements to a product [2]. To achieve long term value robustness for a platform system, it needs to have the ability to change, i.e. show *changeability* [18]. The more options for change a system has as a reaction to the effects of external change, the higher its changeability [18].

As a prerequisite to incorporating changeability in product system design, *anticipation* of future external and internal environmental changes needs to be performed. Anticipation is a future-oriented action, decision or behavior, which is based on predictions about the future [19]. According to Rosen [20]—founder of anticipation theory—an anticipatory system is defined as a system that contains predictive models of itself and/or the environment that allow the system state to change immediately on the basis of the predictions of the models. The focus of this work lies on anticipation of platform development activities.

For successful application of both anticipation and design for product changeability, these approaches need to be combined with the definition of *planned flexibility* according to [21]. Planned flexibility includes (1) anticipation of and (2) consideration of responsiveness to future changes in terms of flexibility of resources, flexible communication, parallel developments, redundancies and flexible production technologies, and modular product architecture [21]. Through a case study, Verganti [21] could prove that companies that anticipate in the early development stages and thereby plan responsiveness of the product system to later changes, generate shorter time to market and ensure higher product quality.

From the discussion above, it can be deduced that design for changeability is a form of implementing planned flexibility and thus must be a foundation for the development of platform systems. However, in existing procedures and methodologies suggested to support design of platform systems, neither planned flexibility, anticipation nor design for changeability in early development stages are explicitly included [22]. Therefore, a novel approach is required to incorporate planned flexibility into platform system conceptualization. The development of such a novel approach is the objective of this paper and is described in the next chapter.

3 Developed Methodology

3.1 Assumptions and Approach

As a basis for the presented approach it is assumed that incorporating dynamic, internal and external, predictable as well as unpredictable influence factors into conceptual design of platform systems increases value robustness of such systems during their whole lifecycle [23]. These dynamic influencing factors (DIF) thus represent the initiation of planning for flexibility in the presented approach. DIFs are part of superordinate trends. They originate in the designed system itself or in external environments such as the market. DIFs influence inputs and resources on which determining parameters of conceptual platform design is based. To enable transparent identification of said influence, the so-called change priority indicator (CPI) is proposed. The concept of CPIs is a variation of the FMEA method with the difference that for CPIs the degree of required product flexibility is assessed rather than risk of failure. Determination of DIFs and CPI is embedded in one of standard procedures for platform development [12] shown in Fig. 1 to incorporate planned flexibility into the development process of product platform systems.

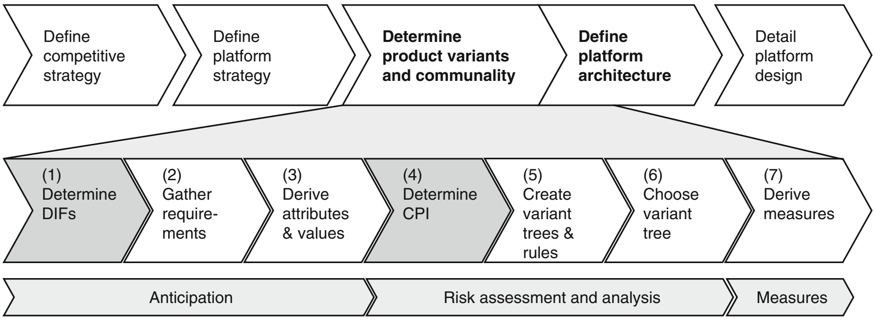

Fig. 1 Planned flexibility (*highlighted grey*) incorporated into standard procedure for platform system design

3.2 Methodology Steps

In the following, all seven suggested steps (see Fig. 1) of the methodology are briefly described regarding their purpose and content.

Step (1) is concerned with determining the DIFs for the investigated platform system based on the abovementioned assumption that dynamic influence factors are crucial for a platform system's economic robustness over time. It is suggested to collect DIFs based on e.g. marketing- and benchmarking data. The DIFs should be described concerning their dynamics, source, relevance and fields of impact.

Step (2) covers gathering of all internal and external requirements to the platform system. Based on the identified DIFs from step (1), additional future requirements or future changes to current requirements are to be anticipated in addition to common requirements analysis techniques.

In *step* (3), the platform system's products' attributes and their respective values are derived from the previously defined requirements. At this point, realized product variance and (part-/module-) communality of the platform system are determined.

Step (4) includes the CPI into the platform development process and thereby allows for quantitative assessment of required changeability. Subject to this assessment are the product attributes identified in step (3). Each attribute is rated in three categories on a defined scale from 1 to 10: probability of change (P), dynamics of change (D) and customer perception of change (C). These three factors are multiplied, resulting in the CPI as shown in Eq. 1.

$$\mathrm{CPI} = \mathrm{P} \cdot \mathrm{D} \cdot \mathrm{C} \tag{1}$$

Differentiation into stable, invariant functions which represent the platform itself, and flexible product functions, later producing product variance, is

Table 1 CPI threshold values for stable and flexible platform components

Feature/function type	Factor values or	CPI value
Stable	C < 3	CPI ≤ 175
Flexible	P > 6, D > 8, C > 8	CPI > 175

realized by threshold values as listed in Table 1. These values are derived from scale definitions for the individual factors.

Step (5) is concerned with deriving alternative variant trees from the gathered product attributes, their necessary values and classification into stable and flexible components. Creating several alternatives ensures objective and transparent design decisions.

In *step* (6), the most suitable alternative created in the previous step is chosen in reference to the whole set of requirements, the determined CPI values and to costs for realization of the alternatives.

Step (7) concludes the herein presented procedure by deriving measures for further development. Management decisions, resource planning and design consequences are to be made referring to the CPI and thereby to risk assessment and anticipation of future developments. Categorization of DIFs concerning their fields of impact (cf. step 1) can be a useful source for decision making.

4 Case Study

The 2 steps for incorporating strategic flexibility into platform design processes described in the section above were applied in an industrial environment. At an international home appliances company, experts from departments of product management, product development, and design were engaged in moderated workshops to apply the method and subsequently evaluate applicability and quality of results.

4.1 Case Study Objective, Data Acquisition and Procedure

Initial identification of DIFs was performed with seven workshops, each involving two or three company experts. A list of known trends within the addressed industry served as a basis for DIF determination. Therefore, all categories of the context model [24] (politics, legislation, socioeconomics, technology, resources, knowledge, manpower and organization) had been considered at the levels of market, consumer, company, development system and development project. The list was filled with influencing factors utilizing the brainstorming technique. DIFs first were described by their time of initial occurrence, their dynamic characteristics and then

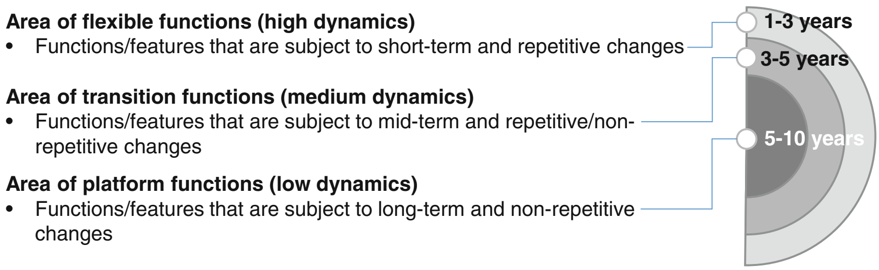

Fig. 2 The shell-model, *Source* adapted from industry partner's internal document

mapped to their fields of impact. This information served as input to the CPI workshops which represent the major focus of this case study.

Assessing the CPIs was undertaken within a workshop of seven product managers with experience ranging from 1 to 6 years. A second group of six specialists from comparable disciplines used the company's own, previously used shell-model (Fig. 2) to serve as a comparison group. Both groups used the same database of 41 consumer-relevant functions from eight strategic topics. Each function was separately discussed and rated during the workshops, both for the CPI-method and the shell-model. In addition, defining the CPIs was based on the previously collected DIFs as background information especially for assessment of the CPI-factors P and D (see Sect. 3.2, step 4).

To enhance comparability between the CPI and the shell-model approach, the CPI was normalized to CPI_N. It was decided by the workshop participants, that the areas for assessing flexibility are divided equivalent as in the shell-model (transition area was added in the middle of flexible and platform areas) and the CPI thresholds for these areas were set as following:

- Area of flexible functions: $70 \leq CPI_N < 100$.
- Area of transition functions: $40 \leq CPI_N < 70$
- Area of platform functions: $CPI_N < 40$

4.2 Results

In the initial DIF workshops, 233 different influencing factors were identified. From this number, 45 % of the DIFs could be characterized in terms of their dynamic properties. The time of initial occurrence could be determined for 25 % of DIFs. Mapping the DIFs to their respective fields of impact showed that about two thirds of all DIFs affect external fields such as market, customer requirements, technology and product definition, while one third impact internal topics such as finance, organization, production and strategy. The definition of DIF fields of impact was rated as adequate by seven of the eleven participants and the mapping results were

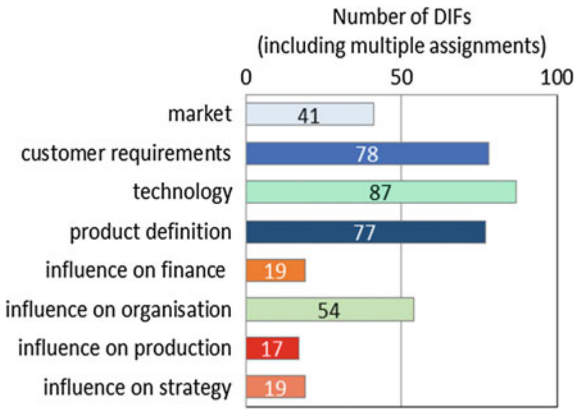

Fig. 3 Distribution of DIFs by fields of impact

rated as good. Figure 3 shows the defined fields of impact and the number of assigned DIFs.

In the CPI-assessment-workshops, a total of 41 product functions were considered. As a result of the CPI-method, 17 of those functions were assessed as platform functions whereas only six were rated as such using the conventional shell-model-method. The highest fraction of functions following the shell-model-method is the area of transition functions with 51 % (21 functions), compared to a fraction of 36.5 % (15 functions) resulting from the CPI-method. The area of flexible functions contained 14 functions using the shell-model method and nine using the CPI-method. Overall, there is an increase in platform functions and a decrease in flexible- and transition functions by applying the CPI-methodology instead of the conventional shell-model. The results of the CPI- and shell-model-workshop are presented in Fig. 4.

All functions rated as platform functions using the shell-model were ranked equivalently using the CPI-method. This consistency serves as an indicator for both the reliability of results from the CPI-method and the absence of a systematic error in the definition of the area of platform functions. Divergence of the results comparing both approaches can be explained as an effect of inadequate feature discussion as part of the shell-model-method and lack of knowledge about DIFs related to functions. Namely, when shell-model-method was applied, the workshop participants tended to be subject of group thinking. This can be observed in the

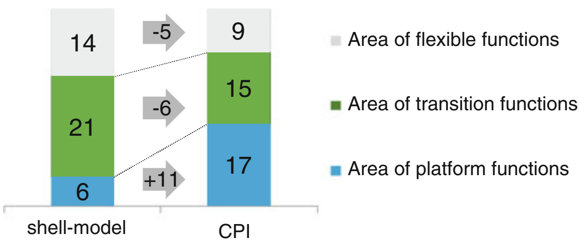

Fig. 4 Results of shell model and CPI—workshops

functions that belong to a strategic topic (for example, freshness functions were clustered together instead of discussing separately each of them). As a result, all functions within one function group (strategic topic) were rated equally when using the shell-model as opposed to more differentiated ratings for each function resulting from the CPI-method. This is observed especially in the area of platform functions, where the higher amount of platform functions as a result of the CPI-method supports the notion of developing a modular system that includes a robust platform.

4.3 Evaluation

Evaluation was conducted using standardized questionnaires with additional open questions. The rating scale ranged from 1 (very good) to 6 (unsatisfactory). Seven workshop participants were engaged in answering the questionnaire immediately after the workshops.

The results from the questionnaire showed that the participants were satisfied with the results of both the CPI- and the shell-method. The overall rating of the CPI-method in the categories consumer orientation, trust in results, definition of thresholds for the functions, and differentiation of functional areas was satisfactory (3) to sufficient (4) but inferior to the shell-model-method. Reasons might be time pressure during the CPI-workshop and uncertainty in handling a new method. Some participants conceived a lack of knowledge in the field of operational marketing as a potentially profound input concerning consumer orientation as beneficial to CPI-method. The participants of the shell-model-workshop on the contrary missed a differentiation between the importance of a function and the dynamics of a function. This shows that whereas the shell-model was conceived as more trustworthy procedure, its output lacks the clear input definitions and differentiation in terms of discussion (as can be taken from the previously compared results and from observing workshop discussions). Also, the quality of result documentation and thus transparency within the CPI-method was rated as very good and thereby superior to the shell-model-method.

Furthermore, participants rated the support offered by DIFs, their quantity and thematic mapping to the functions as good (2) in the workshop. This indicates that DIFs were used as background information for determining CPIs.

In general, the concept of using the factors P, D and C for determination of the CPI instead of using the simpler shell-model showed to be suitable for the industrial setting. This can be taken from replies of shell-model-workshop participants to the question which criteria they would subsequently use to determine necessary changeability. All of the factors named in the answers are covered by the suggested approach of determining feature CPIs based on initially identified DIFs.

5 Conclusions

The methodology presented in this paper is anchored between platform strategy definition and platform architecture design and enables systematic identification of the product variant structure under consideration of future developments.

Key elements of this methodology are two new steps: the method of determining dynamic influencing factors (DIFs) that supports the identification of dynamic influences acting on the platform system. To describe this level of awareness, the frequency of occurrence as well as the dynamic behavior of the dynamic influence factors are anticipated. Along with the importance of changes for the consumer, the so-called change priority indicator (CPI) method is used in order to quantify the effect of these influence factors on platform system. CPI is used as a quantitative measure of the necessary capacity for platform system flexibility and robust trade-off.

At the end of this paper we presented the case study, where it could be shown that the proposed methodology provides a concrete support for development of a platform system in an industrial setting. The methodology could be evaluated by the means of a survey among participants confirming successful integration of the proposed flexibility in a real platform system design process by adding transparency and objectivity to the strategic aspects of planning flexibility. It is worth noting that strategic flexibility alone may not be sufficient to address the needs for change caused by external and internal factors. The platform system itself may have to be updated or replaced by a new one, since there is always possibility that unanticipated influences occur. This means that for having always up-to-date platform system, the organization needs to embed a controller mechanisms that continuously monitors the "health" of the platform system. Therefore, as part of a SFB 768—transfer project 1, a lifecycle platform management controller that in a continuous manner monitors the platform system and has all the processes needed for platform-related decision-making is being developed.

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