From functional to cross-functional management of product portfolio complexity

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Abstract

This paper explains a novel cross-functional evaluation concept for product portfolio complexity management. In a holistic approach it combines and connects four main evaluation dimensions which are integrated into a complexity index model. The validation of the concept will be explained along an industry project within a manufacturing company.

Keywords: Complexity management, complexity evaluation, product complexity

Introduction

Producing companies struggle to manage the increasing product portfolio complexity. Only few companies are able to master the complexity due to the inability to distinguish between the benefits and efforts of product portfolio complexity (Salvador et al. 2002). The first part of this paper explains problem and research relevance as well as the context of this study. Following this, a literature review with an overview and selection of the existing approaches in this research field is provided. The core of this paper lies in the explanation of the cross-functional evaluation concept. This paper closes with a conclusion and an outlook of research which remains unsolved.

Problem and research relevance

Product variety or complexity increase is a result of the differentiation strategy of companies to achieve higher revenues and market shares (Tang 2006). Beside the conquest of single customers and outperforming of competitors (Lancaster 1990), researchers as well as practitioner in various studies reveal that an increase of product complexity not equally leads to higher profitability (Ramdas & Sawhney 2001). On the contrary complexity often has various consequences which come along and is built up along years (Fisher et al. 1999, Kekre & Srinivasan 1990). Rathnow (1993) states the existing of an optimal level of product portfolio complexity, companies need to seek for. Fisher et al. (1999) argue that the optimal level of product complexity is difficult to appoint, because multiple factors need to be considered. Portfolio decisions affect all steps along the value-chain (e.g. development, production till service operations). This is also why decision-making processes around the product portfolio, such as decisions for new product development projects, product variants or product architectures are seen as one of the most critical tasks of management due to its uncertain and changing information, dynamic opportunities, multiple and strategic considerations from multiple functional and diverse stakeholders along the value-chain (Closs et al. 2008).

In this paper the definition of product portfolio complexity management is based on Closs et al. (2008), where "product portfolio complexity management is defined as the collective set of decisions, supporting processes, value systems and initiatives to determining and implementing the most effective product portfolio (i.e. mix of variants, feature sets, and component choices)."

Companies struggle to evaluate product portfolio complexity out of a broader multi-functional perspective due to lack of system interdependency knowledge and information asymmetries. Thus it results in decisions which are optimal for one functional perspective but not always optimal for the company along the product life cycle. Closs et al. (2008) state that there is a need to develop metrics that measure the relational and combinatorial dimensions of complexity that are predictive of various performance outcomes.

Context of the study

This problem is analyzed within a research project together with a manufacturing company. The company operates in a very price competitive market segment. Due to the market pressure the company follows a customer product individualization strategy to differentiate by fulfilling any customer requirements. In the last years the total number of stock keeping units (SKUs) has been exploded. More than 2000 new SKUs per year lead to a total number of 17000 SKUs in 2012. This development results in various problems which slinking appears on the surface of the company (e.g. loosing focus and overview about value adding complexity). Employees of different functional departments along the value-chain have to deal with additional efforts, especially in engineering, production planning, supply chain and data management. The employees have to operate with an increasing number of SKUs with the same quantity of workforce. Productivity loss as well as serious financial and operational performance issues revealed to be consequences of this strategy. Additionally, margin rate of SKUs are decreasing, order delivery time and response time as well as the employee workload is exponentially increasing. At the end of 2012 the company has a product portfolio where 3 % of the total number of SKUs generates 75 % of the companies' revenues. This company characteristic is similar to the description of companies fallen in a variant trap. The central question to be answered with the research project was to develop a tool to continuously keep the transparency about the values and efforts of the complexity induced by the product portfolio. The project is conducted along 18 months, in which 52 interviews and 14 workshops have been conducted to identify complexity drivers as well as to develop the concept.

Literature review

Several researchers carried out approaches on the management and measurement of product complexity. Table 1 shows an overview of core approaches in this specific field. The different approaches can be divided into two main groups. One group focuses on monetary evaluation concepts for the complexity costs of product variants like the resource-oriented process costs calculation by Schuh & Schwenk (2001). The other group of approaches develops non-monetary concepts to evaluate the product related complexity by building indices.

Table 1 – Overview about existing complexity evaluation approaches

Approaches	Author
Modular Balance Scorecard	Junge (2005)
Design for variety	Martin & Ishii (1997)
Product complexity efficiency	Nußbaum (2011)
Complexity index (GCI)	Jacobs (2013)
Complexity measurement methodology	Rennekamp (2013)
Product portfolio complexity measurement	Orfi et al. (2011) (2012)
Optimal variety	Rathnow (1993), p.42
Variant mode and effect analysis	Caesar (1991)
Resource-oriented process costs (RPK)	Schuh & Schwenk (2001)

Monetary approaches:

The major goals addressed by these concepts are to determine complexity costs for product variants as well as to generate transparency of hidden complexity costs caused by product variants. Approaches in this field help companies to continuously keep the overview about the margin rates of product variants and theirs right to exist as a SKU (Lechner 2011).

Non-monetary approaches:

Non-monetary approaches attain the goal to build up a systematic level for characterizing and evaluating different dimensions of complexity. Most of these approaches are used to evaluate the implementation of the product architecture and to support the definition towards the optimal design. Hereto belong approaches by Nußbaum (2011) who developed a concept to measure the product complexity efficiency or the concept introduced by Orfi et al. (2011, 2012) which contains different indicators to evaluate the product-process design out of different perspectives in order to identify the optimal level of product complexity. For the evaluation of the technical implementation of a project based on the requirements, different indicators are introduced in the research community. The evaluation of the complexity of product architectures can be conducted with products per function (Fixson 2005), the commonality index (Martin & Ishii 1997), the dependency index (Kaski & Heikkila 2002) or the general complexity index (GCI) (Jacobs 2013) to assess the complexity of different product architecture designs and to enable a systematic and objective comparison.

The common idea behind these different approaches is to integrate different information into indices to make complexity transparent, comparable and usable for decision-making. Thus the major goal of it is to improve the information basis for decision-making. It builds the systematic bridge between system elements and information streams which are scattered along different functional departments. Thus complex problems become more tangible for decision-maker. All existing approaches lack the linkage of complexity values to financial and operational performance. Thus a determination of the usage and effort ratio of complexity is not possible. The next paragraph explains along the construction of the cross-functional evaluation concept a novel solution for quantifying complexity in terms of financial and operational usages and efforts.

Evaluation concept: complexity index model

The research process is divided into three main steps: Cause-effect model building by defining relationship families (RF) and relationship pairs (RP), operationalization by building and developing measures to describe the relationships and computing the complexity value level (CVL).

Cause-effect model and dimensions

Complexity is divided into two meta dimensions, external and internal complexity (Schuh & Schwenk 2001). External is everything which cannot be directly influenced by the company. Internal complexity contains all product and value stream process elements which can be determined. Based on that definition, eight core analysis units have been identified to describe or to evaluate the complexity of a product portfolio (see Figure 1).

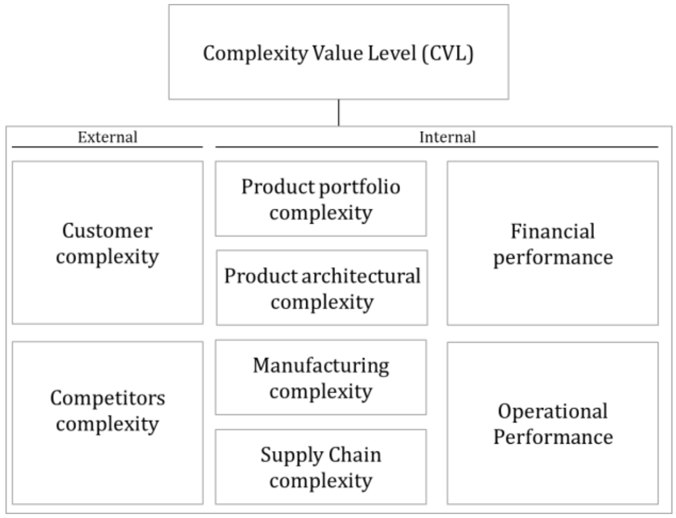

Figure 1 – Units of analysis

The goal of the index is to evaluate the usage and effort ratio complexity creates internally and externally, visual in financial indicators (e.g. product margin or companies growth rate) and in (e.g. market share) customer development rates. Its major task is to create a systematic connection of these eight evaluation dimensions which spread across functional departments and structural elements in and outside a company. In order to build up these connections, complexity drivers have been identified for each unit and their interdependencies have been analyzed and grouped to relationship families.

Relationship families

Based on this analysis four core relationship families (subsystems) have been defined (see Figure 2). A relationship family contains different relationship pairs along a process chain. RF is defined as a group of relationship pairs, necessary to describe the usage effort ratio of the complexity in a defined subsystem. Thus a relationship family maps the interfaces between different functional stakeholders. It is mandatory to define specific financial and operational performance indicators to enable a link between complexity values and certain performance characteristics. The first relationship family describes the interface characteristic between external and internal factors or stakeholders within processes around the companies' product portfolio. The goal of that family is to evaluate the product portfolio complexity out of the perspectives: market and customer, sales process and financial performance perspective.

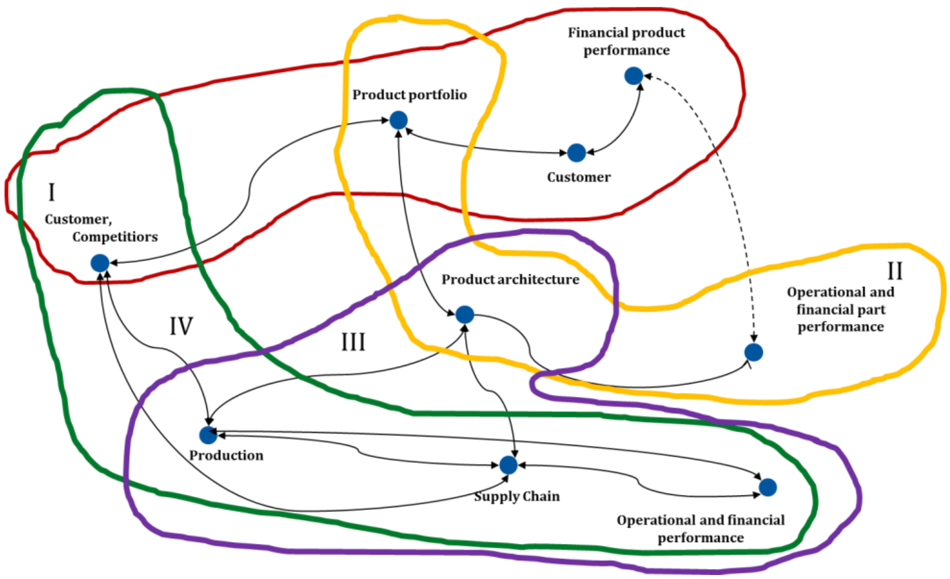

Figure 2 – Relationship families

The second relationship family is focused on an internal perspective by evaluating the interfaces between product portfolio and product architecture. This view enables product management as well as product development to evaluate the product portfolio complexity out of an “under the skin” perspective while considering an external context. It creates the possibility to systematically evaluate the fit between product variety and the degree of intelligence implemented in the product architecture to fulfil and react on customer requirements. The third relationship family is defined to describe the interface set-up between product architecture design and production and supply chain design elements. This family evaluates product portfolio complexity out of the value-stream perspective including product development, manufacturing and supply chain functions. The fourth relationship family assesses product portfolio complexity by analyzing the fit between external and internal elements of the values-stream.

In the case relationship family one, customer, sales as well as product management and marketing are involved in this subsystem. Figure 3 shows an example how to describe a relationship family with different relationship pairs.

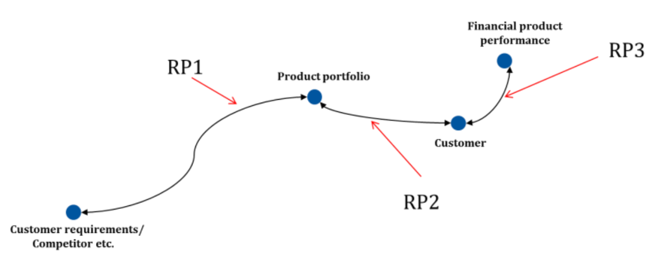

Figure 3 – Relationship pairs of RF1

Measures to describe the relationship pairs and families

Relationship pairs embody the linkages between different system elements. The system elements can be stakeholders (e.g. customer) or structural elements like product portfolio or production processes. They act as the measure instruments to catch the different driver of complexity influencing the fit between different system elements. As more measure points are taken to describe the fit between two or more system elements the higher the accuracy of the evaluation. Table 2 shows an excerpt of the indicators which have been defined in the project to describe relationship pair one.

Table 2 – Measures for relationship pair one

Dimension	RF	RP	Measures/ Indicators
Customer requirements fit Product portfolio	1	1.1	Offered product feature attributes/Requested product feature attributes
Customer requirements fit Product portfolio	1	1.2	Offered product feature combinations/ Requested product feature combinations
Competition fit	1	1.3	Offered product feature combinations/ Offered product feature combinations by competitors
Innovation fit	1	1.4	Product technology innovation level/ Product technology innovation level competitors
Individualization degree	1	1.5	Number of standard SKUs/ total number of SKUs
…	…	…	…

CVL-calculation

Having defined measures for all relationship pairs, the connection of the different measures in a relationship family has to be conducted. Therefore it is mandatory to choose measure pairs which reflect interdependencies. Each pair consists of a “performance” and a “complexity” component measure. The complexity value level (CVL-RFi) for a relationship family describes the usage effort ratio of complexity for this subsystem. Mathematical functions based on the research knowledge base or longitudinal data analysis are used to describe the respective behavior. In the project case the CVL for relationship family one is calculated along a sigmoid function, whereas x is the difference of the values RP2 and RP1 and k the slope. In the case RP 1 measures the product individualization degree and RP 2 the financial performance rate.

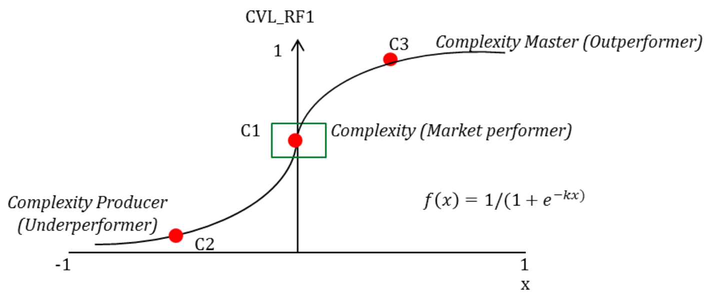

Figure 4 – CVL

Three core cases have to be differentiated (see Figure 4). Case 1 (Complexity market performer): The product portfolio is characterized as a market performer out of marketing, sales and finance perspective. Two sub cases have to be differentiated: low level balance and high level balance. Low level balance means that external opportunities have not been fulfilled and used. It is an indication for the company changing the product portfolio configuration to increase revenues. High level balance means, that the company achieves a high external fulfillment degree, while having good or excellent performance values at the same time. The company has to be careful not sliding into the complexity underperformer status due to the high complexity of the product portfolio. Case 2 (Complexity producer-underperformer): “Complexity producer” reflect profiles in which the generated complexity delivers no or only a very low contribution to internal usages. This can be for example, a high individualization degree of SKUs which generates only low revenues and profit shares. Case 3 (Complexity master-outperformer): Profiles with the status “Complexity Master” stands for companies which are able to use the complexity to generate over proportional benefits.

This evaluation is done for all relevant relationship pairs in each relationship family. CVL-total is calculated by the arithmetic mean of the CVL of the different subsystems. Figure 5 shows the results of the different evaluations in the company relationship family one.

Application of the evaluation model

The project results of relationship family 1 show a high external performance fit meaning the company is providing a high level of customer product individualization. But this individualization is dearly bought by lower margin rates for the products and higher efforts to communicate the product variety to the customer.

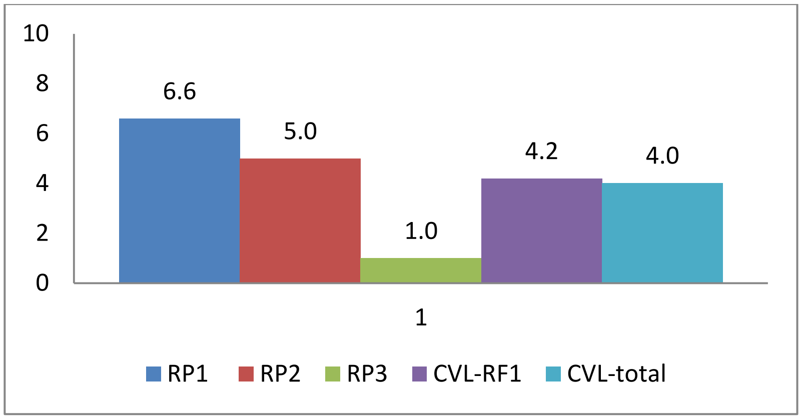

Figure 5 – Company results for relationship family one

The CVL-rating for this family is "underperform". The company should rethink the product strategy, product variety and pricing. This is somehow confirming the development described in the introduction. The CVL calculations of the other relationship families also reveal that the internal process configurations along the value chain, specifically in production planning, supply chain and data management are not configured for this increasing product variety. The complexity of the product variety flows directly into the processes, which lead to productivity losses and an underperformance of customer requirements in terms of delivery lead time.

The total CVL-value of the company shows an underperformance, meaning a high level of unnecessary complexity. The strategy and actions derived out of that analysis contain the reduction of the internal complexity around the product architecture combined with production and supply chain processes. At the same time product variety will be stronger controlled and transferred into a continuous process with phase-out and phase-in SKUs. In order to increase the accuracy of the evaluation model it is recommended to weight the different relationship pairs along the set goals and strategies. Longitudinal studies should be conducted to analyze the behavior of different indicators towards other connected elements in the system to improve the evaluation model accuracy.

Conclusion

The paper introduces a novel concept to evaluate product portfolio complexity out of a multi-functional perspective. By delivering a standardized approach different functional departments can be systematically connected. The cross-functional collaboration productivity can be measured and continuously improved. It helps to quickly identify the major causes. Future research should focus on identifying further relationship pairs and measures to improve the measurement and accuracy of the evaluation model.

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