Dynamic Business Model Analysis for Strategic Foresight in Production Networks

Hans-Christian Haag and Meike Tilebein

Abstract In today's uncertain business environments, many small and medium-sized firms organize their production resources and processes within networks. As a consequence, these firms are increasingly connected through a complex and dynamic pattern of inter-organizational flows of material and information. Within such networks, approaches focusing on a single firm's perspective are inadequate strategic foresight. However, approaches, that explicitly consider the network perspective to enhance single firm perspectives, help firms to align flexibility with uncertainty to achieve greater robustness of their strategies. This chapter combines the introduction of a methodological approach with the practical experience from the application within a research project consisting of different application partners. Thereby, it shows an unconventional way of applying system dynamics within a strategic foresight approach in production networks. By demonstrating the application of the approach within an illustrative example, important modeling steps are shown and crucial tasks are evaluated.

Keywords Strategic foresight · System dynamics · Network modeling · Scenario development

H.-C. Haag (✉) · M. Tilebein
University of Stuttgart, Institute for Diversity Studies in Engineering, Stuttgart, Germany
e-mail: hans-christian.haag@ids.uni-stuttgart.de

M. Tilebein
e-mail: meike.tilebein@ids.uni-stuttgart.de

K. Windt (ed.), *Robust Manufacturing Control*, Lecture Notes in Production Engineering,
DOI: 10.1007/978-3-642-30749-2_37,

1 Introduction

Since the 1970s, different approaches have been developed to help single firms cope with environmental changes [1]. Ansoff's concept of weak signals marks the introduction of strategic foresight in literature, as a primary step in the strategic management process for firms [2]. In the past two decades a large amount of literature focusing on the performance of strategic foresight has been published [3–6]. Moreover, many firms adapted their strategies by cooperating within business networks [7, 8]. Firms within networks focus on their core competencies and build dynamic capabilities to address fast changing global market demands [9]. Networks, e.g. production networks are complex and dynamic structures which often evade a single firm's strategic perspective [10]. A firm can understand the influence of the business environment on its strategy through evaluation of dependencies between other network actors. This evaluation process, however, is difficult and requires a methodological sophisticated approach [11]. Over the past few years various ideas to successfully integrate different foresight methods e.g. the integration of scenario analysis with road mapping, have been explored [12]. Whereby, the role of doubting and learning in foresight activities is very important [13, 14]. Therefore, the research question of this sequel is, how strategic foresight for firms in production networks can be performed in a profound approach, systematically integrating existing methods e.g. system dynamics. In the following three sections, first a concept how to perform strategic foresight in production networks is introduces. Second, an example is given, illustrating the application of the approach. Third, results are discussed and an outlook given.

2 Concept of a Dynamic Business Model Analysis in Production Networks

2.1 Insights From a Single Firm Perspective

There are various foresight processes described in literature. Horton distinguishes between three steps to gain a profound output for corporate strategy development: Input generation, foresight activities and output generation for further activities [5]. Accordingly, Voros integrates these steps to a generic foresight process with three foresight tasks: Analysis, interpretation and prospection [15]. The strategic foresight time horizon is thereby fixed and much longer than in other approaches e.g. from the field of supply chain management. This chapter evaluates the three tasks in depth and identifies their contribution to the network perspective.

At the beginning of performing strategic foresight, environmental scanning helps to identify change drivers [6]. Thereby, change drivers from the political, economic, social, technological, legal and ecological field are identified [16]. PESTLE-Analysis is a rather well-known method and will therefore not be further

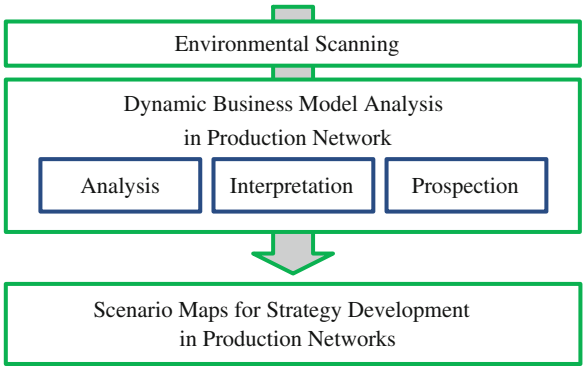

Fig. 1 Strategic foresight in production networks

explained. Based on the change drivers identified during environmental scanning, a dynamic business model analysis in production networks can be performed to transform change drivers to a profound prospection for future strategies (Fig. 1). This enables consideration of the prevailing complexity and dynamic interrelations within production networks.

1. **Analysis**: Input information gained from the previous step is analyzed. Specifically its relevance for the firm is evaluated. This evaluation identifies the impact of the external environment on a firm's business unit.
2. **Interpretation**: A deep understanding of the underlying system structure is important in strategic foresight. The correct interpretation of the impact of external effects on the corporate strategy is crucial for successful prospection.
3. **Prospection**: Creating coherent future scenarios based on the interpretation of changes on a corporate strategy is the last task to develop a profound future prospection for a firm. Thereby, different possible futures are developed based on the interpretation of the input signals as part of a distinct set of future values.

A concept to perform these three generic tasks during a dynamic business model analysis for firms operating in production networks is presented in the following three sections. Each section further describes one generic task of the dynamic business model analysis for production networks.

2.2 Analysis From a Network Perspective

A strategic network model is developed to perform an impact analysis within the network. Key factors are identified as a basis for interpretation. In order to deduce key factors with an important impact on a firm's business model, the structure of the production network is modeled. Network actors are identified and connected through information and product flows. A qualitative impact analysis is carried out based on the network model. Each change driver (d) has a chain of impacts through the network along the network relations (Fig. 2, following [11]). For

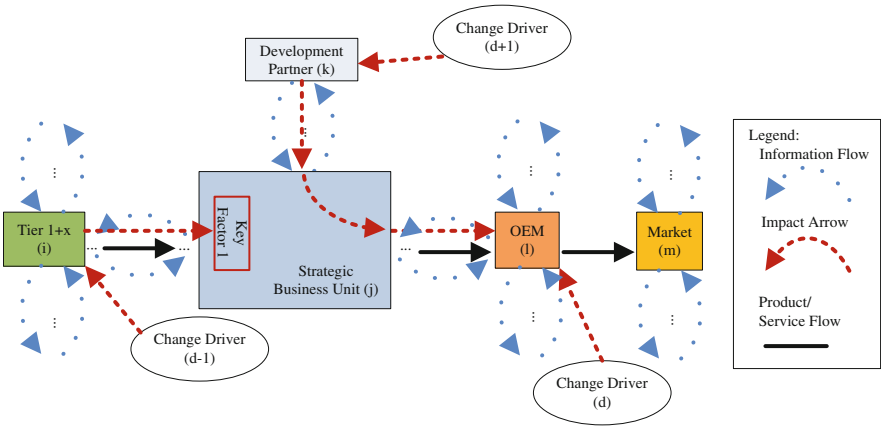

Fig. 2 Analysis from a network perspective

change drivers ending at the strategic business unit, a set of key factors is defined (represented by key factor 1 in Fig. 2).

This set of all key factors is compared to a generic business model to ensure that all relevant areas for the future course of a business unit are included. The generic business model from Johnson et al. includes the four elements (Fig. 3): Customer value proposition, profit formula, key resources and key processes [17].

The key factors are named according to the rules for variable naming which are well known from system dynamics literature [18]. At the end of the analysis task a set of key factors exist. These key factors are used as variables in the following step to set up a system dynamics model.

2.3 Interpretation by the Use of System Dynamic

Modeling the impact of the identified key factors on the business model of a firm helps to evaluate and interpret future scenarios. Therefore, appropriate assumptions on the business model need to be made. However, developing a model for such an uncertain and complex issue is rather challenging. This is especially true, since users often tend to question assumptions made during the modeling process. Therefore, the method system dynamics [18] is used in a group model building process [19] to ensure visualization of the underlying mental models. Here different representatives of the firm are integrated in a joint effort to learn about the future development of a business unit.

The development of a system dynamics model within a group model building process consists of two main steps. First, a qualitative model is built. This is done through the use of group model building concepts, such as those summarized in [19] e.g. group memories, workbooks etc. The model purpose is to visualize future

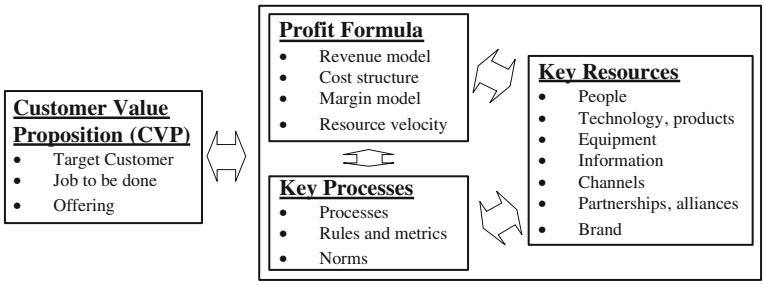

Fig. 3 Generic business model [17]

changes of the business model resulting from the impact of change drivers transformed by the network or directly affecting the business unit of the firm. Dynamic system analysis makes the various mental models of strategists and decision makers on the future course of the firm available. Therefore, it contributes to a firm-wide discussion about it. To ensure an efficient model building process, a so called preliminary model can be used. A possible preliminary model for setting up a qualitative system dynamics might be given by the spreading fixed cost model [18]. In the model the share from spreading fix costs is a reinforcing loop. This is true for a market, where an increase of product attractiveness is automatically followed by an increase of market share. Second, a quantitative model is built. Every relation between two variables needs to be considered and evaluated. For qualitative relations table functions are considered, where simple pairs of values can be inter- or extrapolated.

2.4 Prospection with Respect to Future Scenarios

Prospection aims at building and evaluating different future scenarios. This is accomplished through scenario development based on the given key factors, and through simulation of discrete value sets of the impact factors within a scenario.

There are different approaches available within literature on how to develop future scenarios for single firms [20], including quantitative scenarios. Since, developing quantitative scenarios is well-known from literature, no further explanation is given at this point.

Simulation of scenarios within the system dynamics model visualizes the mental model of the group. Thereby, assumptions on the future course can be interpreted, while discussing the simulation runs of the different scenarios.

By the use of the network models and the simulation models, verbal scenario descriptions and interpretations are completed to a comprehensive view on the meaning for the organization. These network scenario maps enable a firm to use the resulting scenarios of the approach and to consider the underlying models of the network structure during strategy making.

3 An Illustrative Example

3.1 Analysis From a Network Perspective

The following example illustrates the application of the approach for a firm producing machine tools. As explained in Sect. 2.2, a network model was developed (Fig. 4). The model consists of two strategic business units belonging to the firm. On the upstream part of the production network different suppliers are connected over a complex pattern of material and information flows [10]. On the downstream part of the production network, three different classes of direct customers are serving various end customer markets.

In addition to the network structure, the impacts of four selected change drivers on the network are shown in Fig. 4. These change drivers were identified as relevant for the firm. For a later interpretation, business unit II was selected, although the same approach could also be applied to another business unit of the firm.

Table 1 shows the mapping of these four selected change drivers to key factors within the business model of business unit II which can be explained as follows: A possible increase of consolidations and joint ventures activities of suppliers could increase the market power of these suppliers over the firm. A possible increase of technological improvements by the suppliers could directly increase the product attractiveness of specific product features and is therefore relevant for the business unit. The further integration of customers in the product development process is directly represented in the model by a ratio key factor. The demand for system solutions is represented by a key factor representing the share between system solutions and 'normal' product features. The interpretation of the identified key factors follows in next section.

3.2 Interpretation by the Use of System Dynamics

A qualitative system dynamics model has been developed for the selected business unit based on the preliminary model referred to in Sect. 2.3. Figure 5 depicts a simplified version of the original model developed with the firm in a group model building process. In the centre of the model, an improved version of the preliminary model can be seen. At the outer edge of the model the key factors are connected. The corresponding change drivers are visualized by dotted arrows (which are not part of the system dynamics syntax given within literature). The model shows that an increase of market power of the suppliers (first key factor) will lead to an increase in purchasing costs for the firm.

The second key factor, attractiveness of product features, positively correlates with the overall product attractiveness. While an increase of the third key factor, ratio of cooperative development projects with customers, leads to an increase of the product portfolio attractiveness. While the product attractiveness only affects the market share, the portfolio attractiveness affects the market size as well. This

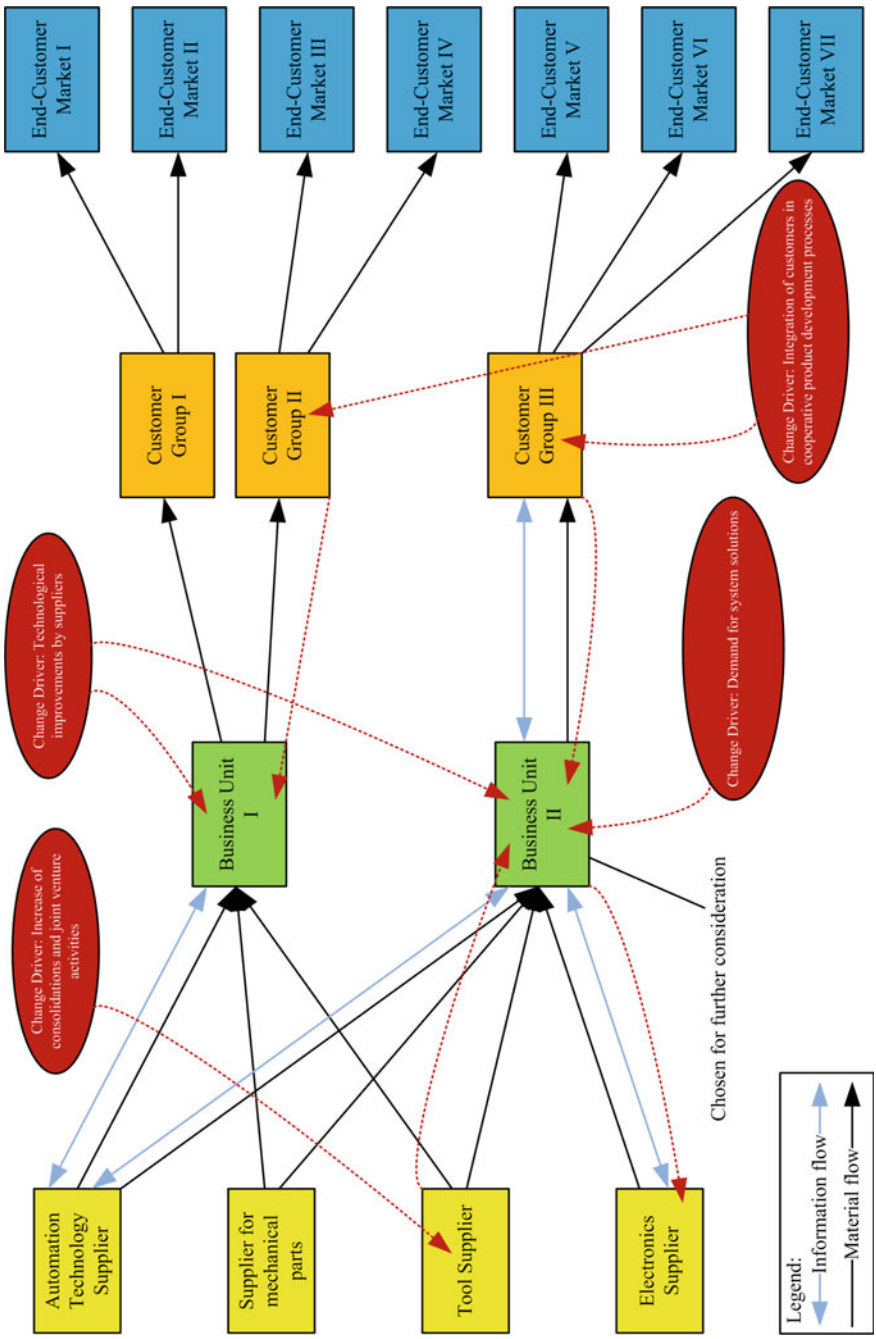

Fig. 4 Illustrative example for performing an analysis from a network perspective

Table 1 Mapping of change drivers on key factors relevant for business unit II

Change driver	Key factor
Increase of consolidations and joint venture activities	Market power of suppliers
Technological improvements by suppliers	Attractiveness of product features
Integration of customers in cooperative product development processes	Ratio of cooperative development projects with customers
Demand for system solutions	Share of demand for system solutions

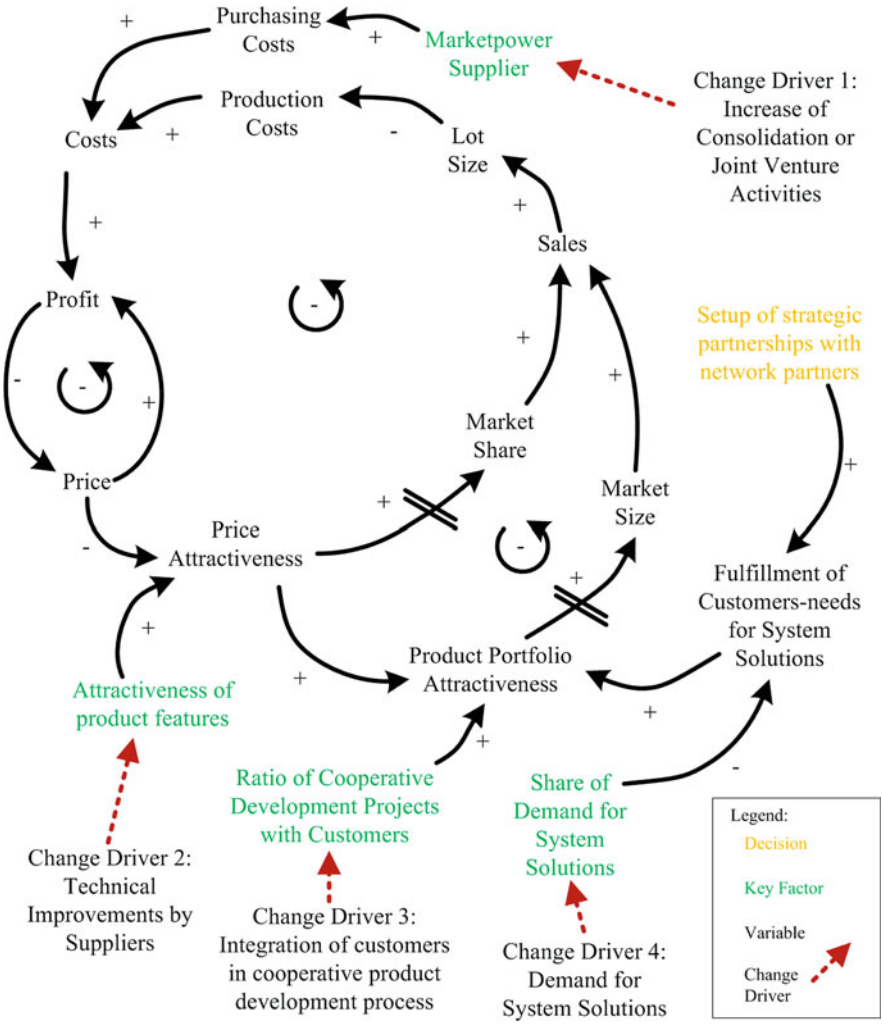

Fig. 5 Illustrative example for a system dynamics model to simulate dynamic changes of a business model

results, because innovative products may address new market areas. The fourth key factor, share of demand for system solutions, decreases the fulfillment of customers' needs for system solutions. This decrease may, however, be diminished by setting up strategic partnerships with other network partners, which would increase the overall system solutions performance of the products of the business unit.

Using a recursive modeling process, a quantitative model was developed based on the previously explained qualitative model. Every relation was quantified, and its value ranges and dimensions defined. The resulting simulation model evaluates the impact of different sets of future values of key factors on the business model. The simulation model can be used to evaluate the future course of the business unit developed in the following section.

3.3 Prospection with Respect to Future Scenarios

In order to develop an appropriate prospection of the business unit's future, two steps need to be fulfilled. First, scenarios based on the key factors identified during analysis with the corresponding value sets defined during interpretation have been developed. Second, these scenarios have been interpreted by the use of the system dynamics model developed during interpretation.

For the given example a consistency matrix combining each possible value of a key factor with each other has been developed. Based on the results, commercial scenario development software selected five different value sets. Simulation of the scenarios showed the impact of the scenarios on the business model of a firm. Different variables, like the profit or the market share, were chosen for a direct comparison of the scenarios. As reference a pre-defined base run was simulated from today's input values.

By simulating the future scenarios, the mental model of the group has been explicitly visualized. Future assumption could be challenged and a profound knowledge base for strategy development has been set up. The greater benefit of applying the approach was rather the participatory group model process itself, than the resulting simulation model whose accuracy stayed short due to high uncertainty and complexity.

4 Results and Discussion

The chapter presents a strategic foresight approach for firms in production networks. This approach builds on earlier published generic foresight processes by addressing the dynamic complexity firm are facing within production networks. Network analysis enables firms to focus on the network perspective. In addition the development of a system dynamics model contributes to a comprehensive interpretation of the interaction between network changes and corporate strategy. This aids in determining the robustness of strategies for different future scenarios.

Finally, the chapter provides an illustrative example of the application of the approach and demonstrates the contribution to the strategy process of a single firm operating in production networks.

The introduced approach has been applied in four different firms within a research project over a period of one and a half years. Feedback from the application partners reveals that the approach is still too complicated for being applied without external advise. Therefore, further research is needed to make the application more intuitive. Developing a simple system dynamics reference model might be an appropriate step, to improve practicability. Also part of further research should be a larger case study in order to examine the limitation of the presented approach. Limitation might be for example the size of a firm, the industrial sector or special attributes of the network like the degree of complexity. Combining the results of the case study with a detailed guide to apply the approach might help to further spread the application of the approach.

Acknowledgments This research is supported by the German Federal Ministry of Education and Research (BMBF) within the framework "Research for the Production of Tomorrow" and coordinated by the Project Management Agency Karlsruhe (PTKA) from the Karlsruhe Institute of Technology.

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