Supply Chain Complexity

- A view from different perspectives

Markus Gerschberger
LOGISTIKUM Steyr – the logistics competence of the FH Upper Austria
markus.gerschberger@fh-steyr.at

Raimund Hohensinn
Alois Pöttinger Maschinenfabrik Ges.m.b.H.

Abstract

Purpose of this paper: Companies offered a broader range of product variants, to a larger range of customers (orders with a highly questionable contribution to financial key performance indicators were accepted as well) independent of whether those markets had been served before to master the economic crisis and to keep financial key performance indicators at an acceptable level. In the subsequent period of market growth/recovery companies were wondering why financial key performance indicators did not return to pre-crisis levels. One possible answer – the cost of growing supply chain complexity outweighs the benefits of additional orders. Therefore, the purpose of this paper is to analyse the development of supply chain complexity from different perspectives (market, process, product, and organisation) from 2008 up to now and to highlight possible attempts to reduce/manage supply chain complexity.
Methodology: Based on a longitudinal case study in the Austrian machine building industry the company under consideration is analysed according to the development of supply chain complexity within the four mentioned perspectives.
Findings: With respect to the company specific situations appropriate measures for the four analysed perspectives of supply chain complexity are defined and operationalised. This enables companies to easily and continuously monitor the development of the degree of complexity within the supply chain.

Keywords: supply chain complexity, case study

Introduction

No (significant) annual market growth was considered to be a retrograde step within the last decade. Company growth pledges to lead to success and in further consequence profit. One answer is heavy investment in organizational growth – investments in marketing, research and development, production and logistics capacities, new distribution sites have grown steadily in the past. But, several companies wondered about reasons for a collapse in earnings despite growth phases. Complexity can be one reason for this.

Larger numbers of product variants are offered globally and often in a market and customer specific set-up. The development of the variety of product variants is a dynamic process. The result is very often coexistence/an overlap of old and new products. Established market players are especially challenged by this development. Product adaptations and new product developments have to take place as fast as possible and lead to stress and uncertainty about the potential success of the new product (= an additional argument for keeping the previous product within the product range). The price of this: growing complexity.

The given example of growing variety is just one potential reason for increasing complexity (= a complexity driver). In this regard, various complexity drivers (e.g. the number of elements and interrelations, uncertainty, geographic remoteness, dynamics) are discussed in the relevant literature (Gerschberger et al. 2012, Manuj and Sahin 2011, Wycisk et al. 2008, Choi et al. 2001). The purpose of this paper is not an additional discussion of complexity drivers but a "holistic" complexity analysis from four different perspectives (market, product, process, organization) within a case company to highlight optimization potentials and to increase awareness of the importance of active complexity management within companies.

Complexity perspectives – the picture of a premium producer in the agricultural machine building industry

Summarizing, the main findings from literature related to complexity, the theoretical foundation is abstract, heterogeneous and often vague (Bozarth et al. 2009, Meyer 2007, Choi and Krause 2006). We support the opinion that the abstract construct "complexity" should be characterized and further operationalized indirectly using substantive complexity parameters (Kirchhof and Specht 2003), herewith accepting the fact that increasing, and especially company-specific concretization may be attended by a loss of generalisability. Attempts to understand and operationalize complexity are mentioned in all four perspectives described in this section.

The company under consideration is a premium producer in the agricultural machine building industry in Austria providing a wide variety of products in two different market segments – grassland and tillage. Grassland subsumes all products required for a careful mowing process (e.g., disc mowers, drum mowers, loading wagons/silage trailers). Tillage encompasses all products necessary for a sound ground/field preparation (e.g., ploughs, stubble cultivators, disc harrows, rotary harrows, drilling technology). High seasonality, a high number of product variants and a dealer based distribution system are some challenges that characterize the daily business of the company under consideration. Within the company under consideration 24 in-depth interviews (duration > 2 hours/interview) with key persons (managing directors, division managers, department managers) were conducted to get an idea about similarities/differences in the understanding of common business and organizational developments as well as the awareness of challenges related to complexity. Findings from single interviews were condensed to one big picture which highlights the main challenges and the current understanding of complexity within the company. Based on this big picture further steps and potential complexity measures were identified within a two-day workshop with the previously interviewed key persons.

Complexity perspective – market

Companies try to keep pace with changing market and customer requirements. The heterogeneity of market and customer segments, different distribution channels, geographical remoteness of customers and markets, the cyclicality and seasonality of markets and logistical requirements

(e.g. expected lead times, the composition of orders) are some drivers that influence the degree of complexity from the market perspective. Especially growth is a driver of market complexity. Growth mainly originates from entry in new markets, new customer segments and new distribution channels. (Suter 2009)

An increase in marketing and sales efforts, a reduced ratio of enquiries to orders, an increase in customer complaints or the ratio of items added and removed from the price list can be potential indicators to gain a better awareness of the development of the degree of complexity that enters the company from the market.

Due to restrictive and country-specific legislative conditions the continuous monitoring of the number of served markets is a sound indicator for the company under consideration. The entrance into an additional market is directly related to a number of additional signs and plaques, safety conditions and warning notices relevant for all product groups (e.g. tedders, mowers, ploughs). Beyond that it is of vital importance whether the market is served with an independent importer or directly through a sales subsidiary of the case company. In the latter case, investments in premises, the monitoring and management of on-site stock, sales and after-sales services as well as efficient transport management to the final customer are some additional tasks which have to be handled by the company under consideration. Therefore the number of served markets in total in combination with the number of markets served by independent importers is a good indicator for the company under consideration to get an idea about the complexity entering the company from the market. The development of the number of variants and price list positions are additional indicators which are described in the subsequent section as these can be seen as connections between the two complexity perspectives – market and product.

Complexity perspective – product

Market and product complexity are directly related to each other. In general, product complexity is influenced by the complexity of markets in all cases when a standardized product cannot be sold in a similar manner to all markets. The main product is frequently accomplished by a large number of additional services – standardized catalogue products are no longer sufficient. Companies compete on customer specific solutions. If the common product range is insufficient it is adapted. Growing complexity from the product perspective is the consequence. Product complexity demands greater efforts for product development, maintenance and documentation as well as greater efforts in the offer and order processing phase. Beyond that higher material and processing costs have to be managed as volume and learning curve effects are reduced. Besides the degree of standardization, product design, the number and similarity/commonality of components and materials used in different products can drive the degree of complexity the company has to handle from a product perspective. (Suter 2009)

The development of the number of sold items per product variant can be used to identify unpopular product segments within the price list. The feature tree described by Schuh et al. (2004) displays the number of variants of existing and potentially new product groups and can be used to identify low running variants which do not contribute to operating profit. In the company under consideration the feature tree is used to evaluate existing product groups and to highlight low running variants. Low running variants are defined in the company under considerations as variants which are sold less than a specified amount per year. The low running variants are the basis for discussion in the sales/supply chain meeting regarding whether they are removed from the product catalogue or not.

The developments of the total number of items or price list items and consequently product type groups are potential indicators to get a better idea about the development of the degree of complexity that enters the company from the market and the product perspective. The company under consideration tries to internally monitor the development of product type groups and in-house production parts on a continuous basis and on a group level. Up to now the development was monitored at a main plant level and in relation to the major competitors. (Gerschberger and Traxler 2013) Therefore, in-house production parts monitored at the main plant level are inappropriate for a longitudinal comparison as they were shifted between production plants influencing the number manufactured at the main plant. In future, the overall development can be monitored on a longitudinal basis due to the increased aggregation level.

Complexity perspective – process

The product range drives process and production complexity. The number of different process steps and procedures, the number of storage levels and the number of sequence controls and disruptions grow parallel to the number of product variants offered. Besides the offered product range, new technologies, new production techniques or a closer synchronization of cross-company activities with suppliers and dealers can lead to an increase in the degree of process complexity. A defined standard of how single activities have to be processed can be an initial step to reduce process complexity. Process performance has to be consistently monitored and evaluated with a focus on those processes which are not well managed as this uncertainty can influence the entire company performance and a larger amount of buffer stock is required too. (Suter 2009)

A consequent monitoring and tightening of process flows, clear and logically bundled responsibilities and simplified and regularly monitored interfaces to customers and suppliers are some levers which can help to keep process complexity at a manageable level.

Within the company under consideration a decision model to identify those suppliers that contribute most to the degree of process complexity was developed (Gerschberger et al. 2012) and applied (Gerschberger 2012). More than 250 serial suppliers were evaluated according to the degree of process complexity that enters the system (= the supply chain of the focal company) because of cooperating with this single supplier. Complexity was measured according to a set of case-specifically determined parameters (delivery reliability, the number of SKUs delivered by a single supplier, the specificity of the SKUs delivered, the geographical distance from the supply site to the premises of the focal company and the logistics performance index of the country where the supplier is situated). The result is a ranking of suppliers. Suppliers with a very high complexity ratio are invited to jointly discuss and identify optimization potentials.

Beyond the assessment of the supply side flows, internal process flows are evaluated based on logistically relevant criteria (= logistical drivers). The logistically relevant criteria were identified on a company specific basis within internal cross-departmental workshops. The repetitive comparison of ‘good’ and ‘poor’ processes enabled the step by step identification of logistical drivers, which are seen as the root of the main differences between ‘good’ and ‘poor’ processes. Depending on the product, type of business or customer base, the logistical drivers will differ in each company or corporate network and therefore have to be defined individually. In the considered focal company, for example, the number of plants involved in production has a major impact on the logistical costs of material flows. In contrast, for other companies, highly customized engineering efforts or the number of companies involved in the supply network might be more important. Based on the identified drivers (external processing, producing plants

involved, lead time, number of parts list level, relocations/number of in-house production parts, number of productions steps) 'logistical crash barriers' were categorized. The term 'crash barrier' was chosen to indicate the attempt to determine boundary values for each relevant driver which must not be exceeded. Due to the restriction of length the deduction process of the individual crash barriers as well as the individual underlying logistical drivers are not described in detail. For an in depth description see Traxler et al. (2011) and Traxler et al. (2012). The prototypic implementation of the logistical crash barriers resulted in 1,400 (out of more than 20,000) in-house production parts violating the determined boundaries. These 1,400 parts are the primary subject of analysis as high optimization potentials are subsumed within these process flows. If the number of identified material flows is too high/too low the determined crash barriers have to be adjusted accordingly.

Customer side flows will be monitored based on an adaptive product-configurator. Adaptive in this context means that this product-configurator is able to analyse logistical impacts as early as during the tender-stage, depending on the required product-variant. The current result is a working prototype with semi-automated product-configuration that was successfully applied in the case company and will be tested and modified on an ongoing basis. (Traxler and Engelhardt-Nowitzki 2013)

Complexity perspective – organization

The result of market, product and process complexity is the degree of complexity within the organization. BUT, in many cases the opposite direction is valid. Uncertain responsibilities and reporting lines, unclear strategic directions, overload of decision makers and key persons or an overly centralized decision making process are common observations in companies. Motivated department and division managers use this vacuum to optimize locally. Unwelcome firefighting exercises shape daily business. (Suter 2009)

Despite those positive aspects of lean management which made companies more flexible and successful, the flattening of the organization by elimination of hierarchy levels results in tremendously reduced managerial resources. Division and department managers or key persons do not have the time to push strategically relevant and long lasting projects into the right direction. Furthermore in many cases they have to occupy more than one managerial position on an interim basis due to a lack of appropriate applicants. The result is full capacity utilization for daily business and no time for important long term decisions. Full capacity utilization often results in long lead times to come to decisions – a harsh contrast to the continuously increasing speed and uncertainty in market developments. Uncertain responsibilities and reporting lines can result in serious over- and underemployment of individual workers. Both directions negatively influence staff satisfaction and increase fluctuation, sickness or serious stress-related illnesses.

In the focal company the ratio of blue to white collar workers, the number of ongoing projects as well as their status and indicators of employee satisfaction will be collected and continuously monitored in future to get a better insight into the organizational development. The identification and operationalisation of indicators for the average lead time for decision making is a desirable but challenging future goal.

Concluding remarks

As the theoretical foundation of complexity is abstract, heterogeneous and often vague it is even much more difficult for companies to get an idea about what the term means and how to handle it. Complexity or the phrase "it gets more and more complex" is often used to justify

unsatisfactory developments and outcomes. Therefore, this paper highlights the case of a premium producer in the Austrian agricultural machine building industry that identified the successful handling of complexity in its supply chain as a key driver. Complexity is analyzed from four different perspectives and ideas on how to operationalize them (to monitor the development of complexity on a continuous basis) are developed in a very pragmatic manner. Measures within the four perspectives were critically selected according to the effort needed for data collection and whether information can be automatically generated based on existing systems and reports.

The result is a traceable and applicable example of how an individual company develops its own and internally accepted understanding of complexity and what measures are needed to continuously monitor developments related to complexity and the effectiveness of specific activities to handle it more successfully.

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