# Value chain profiling

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**Abstract**

This paper presents a framework for value chain profiling developed by researchers at Sintef and NTNU, within SMARTLOG, a research program funded by the Norwegian research council. The framework is a first step in an attempt to develop a value chain description scheme, and the purpose of the framework is to offer manufacturing companies a construct for value chain analysis, benchmarking and identification of improvement areas. A focal manufacturing company's value chain is defined as including all actors directly involved in activities adding value to its products.

The framework draws a value chain's characteristic profile. Other profiling frameworks being reviewed in this paper take narrower steps aiming at profiling only a limited range of aspects. This framework, however, takes a holistic view and aims at covering a wide range of logistics and operational aspects of the value chain and has thus become very comprehensive. The current version has been applied to several case companies and has also been used as a checklist for textual descriptions of case value chains. A sample profile is provided. The framework separates the value chain into seven categories, which content and purposes are explained. These categories might be considered individually, but for further analysis of collected data it is vital to recognize their reciprocity.

***Keywords: Profiling, value chain, normative frameworks, value chain analysis***

## 1. Introduction

Different kinds of frameworks, methods, models and tools for mapping and describing value chains exist, all aiming to increase one's understanding of a value chain, simplify value chain analyses and comparisons, provide decision support, identify areas for improvement or select benchmarking partners. Profiling is such a method. As the name suggests, it aims at describing the research object by drawing its characteristic profile. Profiling has been used in several normative frameworks in order to link different profiles to suitable value chain strategies. A drawback with these frameworks is that they only profile aspects that are relevant to a certain strategic choice, for example the customer order decoupling point, (e.g. Berry & Hill, 1992). This makes it difficult to use them for overall value chain analyses. A profiling framework is required that takes a comprehensive view of a value chain's operative characteristics. It should not only include aspects relevant to a certain strategic choice, but any aspect important to the optimization of the value chain as a whole. Such a value chain profiling framework will make it possible to identify mismatches between given features and chosen solutions. Earlier profiles used in normative frameworks should appear as extracts from the integral value chain profile. From a theoretical point of view, such a value chain profiling framework will provide a fundament for existing normative frameworks for value chain design and a starting point for development of further normative frameworks. Its practical interest will lie in its potential for complete and overall descriptions, analyses and comparisons of value chains.

This paper presents a first attempt to developing such a framework. It tries to ensure comprehensiveness by organizing a value chain's characteristics into 7 categories that together cover the important operative processes in value chains. Expert knowledge was used to identify relevant aspects within each category. Based on these aspects, profiles can be drawn.

In the following section, the scope of the framework is outlined by specifying the concept of value chain and defining its boundaries. Then, a literature review on normative frameworks using profiling is

provided, followed by the description of the profiling framework this paper proposes. An example is then outlined before the paper concludes with a discussion and suggestions for further research.

## 2. Scope

In logistic terms, value can be described as both value in place and value in time, hence all actors performing activities in order to get the right product to the right place at the right time are parts of a value chain, (e.g. Simchi-Levi et al 2000, Christopher 1998). The concept of the "value chain" introduced by Michael Porter (1985) encompassed the value adding activities taking place within the boundaries of a company, from inbound logistics through operations, outbound logistics, marketing and sales to after sales service. The efficient operation of these primary activities offered a competitive advantage. In recent years, however, the term has more and more often been used to encompass all actors adding value to a product on its way from raw material via manufacture to the final customer. Lambert et al. (1998) give a useful picture of a value chain by choosing a focal manufacturing company and defining the value chain as including all actors directly involved in activities adding value to its products. Our perspective of a value chain is in line with their picture of the supply chain network structure, see figure 1. A company could have several tiers of suppliers and/or customers.

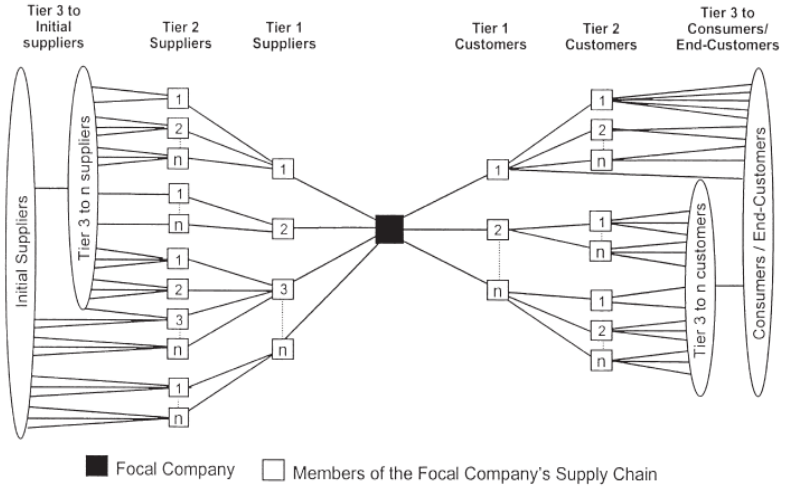


Figure 1: Supply chain network structure (Lambert et. al., 1998)

## 3. Literature review

Several normative frameworks have been developed that include profiling of mainly market and product related aspects of value chains. A few of them are outlined in this review.

Hill (1995) discusses product profiling as a way of mapping the fit between market requirements and manufacturing processes. He presents a framework based on a selection of aspects of products and markets, manufacturing, investments and infrastructure to be compared to manufacturing process choice. The framework is used to show how changes in market or manufacturing conditions require adjustment of process choice by highlighting mismatches between market requirements and process capabilities. The relationship between product aspects and process choice as well as the link between process choice and several manufacturing aspects, for example bottlenecks and set-ups, were first described by Hayes & Wheelwright (1979a, 1979b, 1984).

Berry and Hill (1992) underpin the importance of matching the market requirements, manufacturing processes and control strategy. They link a few aspects of the product, market and manufacturing to the Master scheduling approach, choice of shop floor system approach and material planning approach, thus offering a decision support framework for alignment of manufacturing capabilities to market strategy. Their framework is also described in Vollmann, Berry and Whybark (1997).

Pagh and Cooper (1998) present a framework for selection of distribution strategy with focus on postponement vs. speculation strategies. Based on aspects of product, market, manufacturing and logistics, called decision determinants by the authors, a profile is generated. This profile visualizes the degree of alignment between the selected aspects' values and the postponement/speculation strategies. The framework uses only a limited number of aspects and offers decision support on a generic basis on only a limited but still very important part of the value chain. Pagh and Cooper are aware that the complexity of the value chain may require an extended number of determinants, but their main emphasis has been on simplicity to avoid unnecessary details.

Schonberger (1996) presents a World Class Manufacturing (WCM) assessment tool. By working through the tool, a company profile is developed. This profile is assessed against WCM predefined measures turning it into a performance measure rather than relating relevant aspects to certain strategic choices. The predefined measures are aspects of product design, operations, market requirements and control principles, defined as management principles.

Finally, a number of frameworks for classification of value chains have been developed. While not explicitly stated, they can be considered as frameworks profiling a small number of aspects that crucially influence the way the value chain should be managed. For example, Fisher (1997) uses *demand uncertainty* to classify value chains and make managerial recommendations. Lee (2002) extends Fisher's work including *supply uncertainty* as a second crucial aspect. Lamming et. al (2000) use *product innovation*, *product uniqueness* and *product complexity* in their classification of value chains. Finally, Selldin & Olhager (2002) use *product variety*, *product life cycle* and *average forecast error* to characterize products and *manufacturing focus*, *inventory focus* and *lead-time focus* to characterize value chains.

## 4. The framework

One main objective of the work of developing this framework has been to make it comprehensive and generally applicable to companies involved in discrete manufacturing. Therefore, a wide variety of logistics and operations aspects of all areas of the value chain is included, although several of the authors reviewed emphasize simplicity because complexity might blur the picture.

The work was initiated by organizing the focal company into 7 categories of value chain aspects; *market, product, control strategy, procurement, manufacturing system, distribution and relations*. Based on a review of existing frameworks and case company findings, relevant aspects from the areas of logistics and operations management are listed for each category. Table 1 presents the complete collection of categories and aspects. Depending on the value chain considered, some aspects are given conditions while others are chosen solutions. They are however equally important to reveal. Next, each aspect is associated with one or several questions. In order to present responses as comparable profiles, 1-to-6 response scales are used for all the questions. Depending on the nature of the question, the 6 response options correspond to either percentage intervals, e.g. 0-10%, 10-30%, 30-50%, 50-70%, 70-90% and 90-100%, numbered intervals, representing e.g. time, piece or volume, and intervals along a continuum between two extremes, e.g. manual to fully automated. For several questions, it was difficult to define the optimal split of the continuum of possible answers into 6 intervals with similar consequences for value chain analysis, as a meaningful split will depend on the use of the information.

The questions and corresponding response options are organized in tables by category, and are used to draw value chain profiles. See figure 2 for illustration. The purposes of each category are briefly described below.

**Market**
The purpose of the questions in this category is to identify aspects of the company's market situation and customers. Number of customers, customer requirements, what customers value, seasonal variation, and competition are important aspects. The importance of knowing the market requirements and variations before selecting a logistics strategy is vital, and this issue has also been recognized by several authors, e.g. Fisher (1997), Lee (2002), Pagh and Cooper (1998) and Christopher and Towill (2002). The presence of different market aspects may indicate opportunities inherent in specific logistics strategies and as recognized by several of the mentioned authors, the issue of market requirements must be considered jointly with information represented in the product category.

**Product**
This category is developed for the purpose of identifying market and handling aspects of the product. Important factors to consider are level of customization, commodities or fashion products, special handling equipment requirements (hygiene or temperature) etc. The function of the product is not dealt with and the framework is applicable to any product. One important aspect of this category is product modularity. Modularity enables both manufacturing and logistics postponement and offers great opportunities to take advantage of less traditional logistics strategies. Considered jointly with the market information discussed in the previous category, this information will be used extensively for identification of recommended logistics strategies.

**Control strategy**
This category describes customer order handling and management. The purpose of this category is to identify how customer orders are received and handled, how they are integrated with manufacturing initiation and how and what information is shared further upstream the value chain. Identification of the customer order decoupling point (CODP) sets the starting position for the discussion of manufacturing management strategies. Findings in this category should be in line with certain product aspects, for example will high volumes and frequent orders require more efficient order handling routines. Findings may identify opportunities for customer integration.

**Procurement**
This category illuminates the company's inbound logistics with respect to supplier relations, number of suppliers, geographical distance to suppliers, inbound transport frequency, mode and terms. The purpose of this category is to identify opportunities of supplier collaboration or integration and strategic sourcing. With respect to transaction cost theory the pros and cons regarding single sourcing can be discussed, likewise the risks and benefits of global sourcing including cheap but distant far east suppliers.

**Manufacturing system**
The purpose of this category is to map the manufacturing structure and performance with respect to capacities, capabilities, limitations, shop floor layout, WIP inventory levels, equipment specificity, bottlenecks, level of automation etc. These aspects indicate opportunities to increase operation efficiency and findings should be in line with findings from both market and product categories, (ref. Hayes and Wheelwright, 1979a, 1979b, 1984). Mismatch indicates a major area for improvements. Discussions on procurement and distribution strategies should also be supported by data from this category.

**Distribution**
This category illuminates the company's outbound logistics by mapping the distribution channel with respect to number of customer tiers, warehouse and terminal structure, inventory costs and turnover, transport mode, frequency and ownership. One purpose of this category is a parallel to the procurement category on integration opportunities. Distribution strategies, including third party logistics agreements and just in time deliveries, are mapped. Findings may indicate opportunities to extend existing strategies or introduce new ones. For example, product modularization will necessitate a discussion on warehouse centralization and postponement.

**Relations**
The last category highlights the managerial relations in the value chain. The aspects are vertical integration and ownership, profit sharing, level of collaboration, power relations and company's bargaining position within the chain. This category represents one of the main purposes of this analysis as this is where the company's overall possibilities to make changes are identified.

| ***Categories and corresponding aspects*** | | |
|---|---|---|
| **Market** | Info sharing with customer | Level of automation |
| No. of customers | Customer order frequency and volume | Capability |
| Type of customer | Order variation and change | Data acquisition |
| Type of contract | Customer order handling | Dedicated equipment |
| Price elasticity | Customer order integration | Capacity utilization |
| Market requirements | Shop floor system approach | Bottlenecks |
| Competitive strategy | Control techniques | No. of work shifts |
| Market location | Supplier orders means of comm. | Set-up time |
| Demand variation | Suppliers info sharing | Operational time |
| Demand uncertainty | Replenishment order frequency, volume | Throughput time |
| Competitive situation | Replenishment order changes and variations | Production lot sizes |
| Demand volume | Replenishment order integration | Transfer quantity |
| **Product** | Decision level | Waste/wreckage |
| Product variety | Workforce structure | Preventative maintenance |
| New product development | **Procurement** | Training |
| Product launching | Share of total turnover | **Distribution** |
| Customization | Sourcing strategy | No. of drop points |
| Market relation | Components customization | No of distribution echelons |
| Added value Service | Number of suppliers | Actors in distribution channel |
| Monetary density | Supplier location | No. of actors at each echelon |
| Product life | Replenishment principles | No. centralization and locations of warehouses |
| Transportation and handling requirements | Inbound Transport pattern | Terminal operations |
| Hygiene requirements | Supply frequency | Inventory turnover rate |
| No. of BOM components | Terms of delivery | Inventory costs |
| Modularity | Type of contract | Delivery principles |
| Levels in BOM | Inbound transportation mode | Transport frequency |
| I V A X structure | **Manufacturing system** | Transport mode |
| Environmental considerations | Shop floor layout | Outbound transport pattern |
| Life cycle | Process choice | Term of delivery |
| **Control strategy** | Redundancy | 3pl service provision |
| CODP | Parallel/serial assembly | 3pl Contract period |
| Material planning approach | WIP centralization | **Relations** |
| Customer orders means of communication | Buffer levels | Vertical integration |
| | Tool store centralization | Dominance |
| | Operative vs. administrative workforce | Level of collaboration |
| | | Stability in value chain |
| | | Profit distribution |

Table 1: Categories and corresponding aspects.

## 5. Discussion and example

A framework for value chain profiling can form a template for systematic and comprehensive descriptions of value chains. This framework has been applied to several case companies and also been used as a checklist for textual descriptions of case value chains. Value chain profiles can be used as a starting point for value chain analyses and comparisons aiming at the identification of improvement areas. The framework is supposed to stimulate discussions between managers and researchers when answering the questions associated with each aspect. It can be wise to limit an analysis to one or two categories, in order to allow more time to discuss each aspect.

Figure 2 shows how two company profiles can be compared. The main feature of the profile is however the single company analysis and data interpretation. A case company's profile could for example characterize the manufacturing system as being a highly automated manufacturing line with serial

operations, short throughput time (few hours) and a certain degree of dedicated equipment. Batch sizes are large, bottlenecks are not identified and they run on 60% - 70% capacity utilization due to a fairly high level of downtime. Data acquisition is highly automated.

Like referred to in the description of the categories this analysis of the manufacturing system should be compared to the market requirements and product characteristics to identify mismatches, (ref. the product/process matrix, Hill). The analysis should also be an input to discussions around the other categories. For example, company A's highly automated production line, combined with a short throughput time, makes detailed planning and control of the individual production processes unnecessary (control strategy).

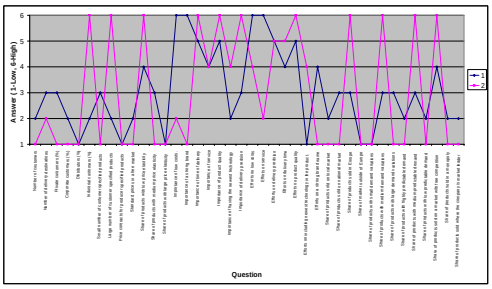


Figure 2: Illustration of two different value chains' profiles in same category.

From a theoretical perspective, a framework for value chain profiling can constitute a classification scheme for normative frameworks for value chain design. The need for such frameworks has been stated in literature (Beamon, 1998). Basically, such normative frameworks provide strategic decision support by identifying recommended correlations between different value chain aspects. Often, aspects from the market or product category are linked to strategies described by aspects from the 5 other categories. For example, Berry and Hill (1992) link customization, product variety, product volume, market requirements and process choice to customer order decoupling point. Fisher (1997) links demand predictability to capacity utilization, safety stock, lead times and customer order decoupling point.

## 6. Conclusions and suggestions for further research

This paper presents a framework for value chain profiling including a wide range of aspects from logistics and operations management. It can be used as a template for a systematic value chain description, a starting point for value chain analyses and comparisons, and a classification scheme of normative frameworks for value chain design.

The profiling framework presented is merely a first attempt and there exist opportunities for further research in different directions. It was intended to include as many relevant aspects from logistics and operations management as possible into the framework. Since these two disciplines are very broad, the number of aspects has become large. Nevertheless, some aspects are missing. This opens two research opportunities: on the one hand, one might try to complete the framework; on the other hand, one may reduce the number of aspects by identifying a few key aspects that are particularly relevant. Some work done in the second direction has been done in order to classify value chains (see literature review for references).

On the basis of the present or a more complete profiling framework, one could try to classify a large number of existing normative frameworks as explained in section 6. Moreover, new normative frameworks can be developed by recommending correlations between aspects. For example, standardization could be linked to automation by stating that highly standardized products should be produced using highly automated manufacturing processes and vice versa. Such recommended correlations could then be empirically tested. For example, several authors have carried out empirical

analysis of the correlation between product volume and process choice. See Selldin & Olhager (2003) for an example and further references.

## 7. Acknowledgements

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## 8. References


- Beamon, B.M. (1998). "*Supply Chain Design and Analysis: Models and Methods. International Journal of Production Economics"*, vol. 55, no. 3, pp. 281-294.
- Berry W. L. & Hill T. (1992). *"*Linking Systems to Strategy*". International Journal of Operations and Production Management,* Vol. 12, No. 10, pp. 3-15.
- Browne, J., Harhen, J. & Shivnan, J. (1996), "*Production Management Systems, an integrated perspective",* Addison-Wesley.
- Christopher, M. (1998), "*Logistics and Supply chain management*", 2nd ed. Prentice Hall.
- Christopher, M. and Towill, D. (2002) "Developing market specific supply chain strategies", *International Journal of Logistics Management*, Vol. 13, No. 1.
- Fisher, M. L. (1997) "What is the right supply chain for your product?" *Harvard business review*, Vol. 75, No. 2,pp. 105-116.
- Hayes, R. H., Wheelwright, S. C. (1979a) "Link manufacturing process and product life cycles", *Harvard Business Review*, Vol. 57, No.1, pp. 133-140.
- Hayes, R. H., Wheelwright, S. C. (1979b) "The dynamics of process-product life cycles", *Harvard Business Review*, Vol. 57, No. 2, pp. 127-136.
- Hayes, R. H., Wheelwright, S. C. (1984) *Restoring our Competitive Edge: Competing Through Manufacturing*, John Wiley & Sons, New York.
- Hill, T. (2000) *Operations Management: Strategic Context and Managerial Analysis.* Basingstoke, UK. Macmillan.
- Lambert, D. M. Cooper, M. C. & Pagh, J. D. (1998) "Supply chain management: implementation issues and research opportunities" *International journal of Logistics management*, Vol. 9, No. 2.
- Lamming, R., Johnsen, T., Zheng, J. & Harland, C. (2000) "An initial classification of supply networks", International Journal of Operations & Production Management, Vol. 20, No. 6, pp. 675 – 691.
- Lee, H. L. (2002) "Aligning supply chain strategies with product uncertainties", *California management review*, Vol. 44, No. 3, spring 2002
- Pagh, J. D. & Cooper, M. C. (1998) "Supply chain postponement and speculation strategies, how to choose the right strategy", *Journal of business logistics*, Vol. 19, No. 2.
- Porter, M. E., (1985) "*Competitive advantage"* Free Press, New York.
- Schonberger, R. J.(1996) "*World Class Manufacturing: the next decade*", The Free Press, New York.
- Selldin, E. & Olhager, J. (2003),"Testing the relationship between product, process, and supply chain design" in Spina, G., Vinelli, A., Cagliano, R., Kalschmidt, M. and Salvador, F. (Eds.): *One world? One view of OM? The challenges of integrating research and practice*, Servizi Grafici Editoriali, 2003, Vol 2, pp. 281-290, Padova, Italy.
- Simchi-Levi, D. Kaminsky, P. & Simchi-Levi, E. (2000), "*Designing and managing the supply chain*", McGraw Hill
- Vollmann, T. E., Berry, W. L., & Whybark, D. C. (1992). "*Manufacturing Planning and Control Systems"*. 3rd ed., Richard D. Irwin, Homewood, IL.