Management of processes in chains

A research framework

Jacques Trienekens

Stellingen

1. Het gedrag van een keten kan, ten behoeve van analyse en (her)ontwerp, worden bestudeerd door de keten te beschouwen als een netwerk van samenwerkende processen met precedentie relaties.
   Dit proefschrift.

2. Een ketenproces kan, ten behoeve van analyse en (her)ontwerp, worden gemodelleerd en geanalyseerd vanuit de beschrijving van zijn (structurele) gedrag en zijn interfaces naar het keten managementsysteem.
   Dit proefschrift.

3. Voor de analyse van de penetratie van klantorders in ketens is het concept van het ketenontkoppelpunt een belangrijke aanvulling op dat van het klantorderontkoppelpunt.
   Dit proefschrift.

4. Om als wetenschappelijke discipline te kunnen overleven en competitief te zijn dient Supply Chain Management een netwerk perspectief te ontwikkelen.
   Dit proefschrift.

5. "The network paradigm is not to be viewed as a substitute for any theory of the firm, of markets, or industrial organization but rather as a supplement, a viewpoint with both normative and positive implications" (Thorelli, 1986)
   Dit proefschrift.

6. Omdat bij het formuleren van een bedrijfsstrategie altijd naar een optimum tussen doel en middelen wordt gestreefd, moet informatietechnologie niet alleen worden beschouwd vanuit een 'pull' optiek maar ook vanuit een 'push' optiek. Dit betekent dat informatietechnologie ook als afzonderlijk onderzoeksgebied moet worden beschouwd.

7. Waarom?, Wat?, Hoe? en Wie?, Waar?, Wanneer? vormen de basisvragen die in het kader van theorie-ontwikkeling moeten worden beantwoord (Dit proefschrift). Ze vormen ook de basis-vragen die beantwoord moeten worden in het kader van kennisontwikkeling: inhoudende een kijk op de werkelijkheid (Waarom?), variabelen (Wat?), een methode (Hoe?) en ervaring (Wie?, Waar?, Wanneer?). Theorie-ontwikkeling is daarom synoniem met kennisontwikkeling.

8. Om een kwalitatief uitstekend product te leveren zijn in de versketen korte doorlooptijden van eminent belang. Doorlooptijd vormt daarom in de meeste van deze ketens het belangrijkste prestatiekengetal. Omdat het performance denken op milieugebied sterk in belang toeneemt, zal in de nabije toekomst een kengetal op dat terrein ("ketenmilieuprofiel") minstens zo belangrijk worden.

9. Er bestaat geen paradigma dat niet door onderzoekers geanalyseerd, begrepen en gesystematiseerd kan worden. Er is evenmin een wetenschap die niet door onderzoekers van andere wetenschappen op zinvolle wijze kan worden gebruikt.

10. De geboorte van een kind is een veel groter moment van creatie dan de afronding van een proefschrift. Immers de geboorte van een kind houdt vele beloftes in waarvan het schrijven van een proefschrift er maar één van velen is. Een bijzonder moment van creatie is het als geboorte (van het kind) en promotie (van de vader) vlak na elkaar plaatsvinden.

Jacques H. Trienekens
Management of processes in chains; a research framework
Wageningen, 15 october 1999

Management of processes in chains

A research framework

Promotoren: ir. A.J.M. Beulens
Hoogleraar in de Toegepaste Informatiekunde
dr. P. van Beek
Hoogleraar in de Operationele Research en Logistiek

Management of processes in chains
A research framework

Jacques H. Trienekens

Proefschrift

Ter verkrijging van de graad van doctor
op gezag van de rector magnificus
van de Wageningen Universiteit,
dr. C.M. Karssen,
in het openbaar te verdedigen
op vrijdag 15 oktober 1999
des namiddags te 16.00 uur in de Aula.

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Abstract

This study aims to contribute to the development of theory and a method for chain research. It defines and analyses major research perspectives on chains: process perspective, performance perspective and institutional perspective. From one of these perspectives, the process perspective, a research framework is designed. The framework consists of four elements: a process view of chains, definition of major variables to be taken into account in chain research, a method and tools to analyse and (re)design chains in practice, and practical applications in cases. The research focuses on logistics processes in food chains.

Voor Marie-Louise, Alex-Inès en Pepijn

Voorwoord

Het schrijven van dit voorwoord is de laatste stap in een promotietraject dat een jaar of zeven geleden begon. Werken aan een proefschrift als universitair docent betekent doorgaans onregelmatig werken aan een proefschrift. Dat gold ook voor mij. Immers er moesten (en mochten) vele andere interessante taken worden uitgevoerd (onderzoeksprojecten, samenwerking met andere instellingen, onderwijsvernieuwing, etc.), waardoor het promotietraject, naar het leek, een nogal grillig karakter kreeg. Dit maakte het overigens des te interessanter, door de diverse inbreng vanuit mijn verschillende taakgebieden. Ik hoop dat het voorliggende proefschrift iets van deze diversiteit uitademt.

Er zijn veel mensen die op enigerlei wijze aan de totstandkoming van dit proefschrift hebben bijgedragen. Enkelen wil ik hier noemen.

Mijn ouders.

Mijn broer Jos, werkzaam bij de Technische Universiteit van Eindhoven, inspireerde me om de overstap te maken van mijn baan in de gezondheidszorg naar de Universiteit van Wageningen.

De inspiratie en het enthousiasme van Adri Beulens en het overzicht van Paul van Beek, mijn beide promotoren, waren belangrijke input voor me, ook om 'bij de les te blijven'.

Een prima werksfeer werd geschapen door mijn collegas van de leerstoelgroep Bedrijfskunde, waarmee ik op bijzonder prettige wijze heb kunnen samenwerken.

De vele afstudeerders die ik heb mogen begeleiden en die in vele opzichten inspiratiebron waren en zijn, en de bedrijven en instellingen waar ik in tal van afstudeerprojecten of anderszins mee heb samengewerkt, zijn een voortdurende voedingsbodem geweest waarop ideëen konden groeien.

Tenslotte wil ik hier mijn gezin bedanken voor de tijd die ik ze met name het laatste jaar niet heb gegeven en voor de tijd dat ik door Marie-Louise werd 'vrijgehouden' voor mijn werk.

Contents

Chapter 1 Introduction

1.1 Introduction: collaboration in agribusiness and food chains.

Currently, many organizational changes are taking place and new strategic directions are emerging in the field of agricultural production. Because of technological developments, increased international competition, over-supply of food products and new consumer demands, food producing companies are being forced to a change over from push (supply) oriented production to pull (demand) oriented production. (Hughes, 1994).

The new demands are for high quality products, products in broad assortments that are available all year, short product life cycles, short lead times and competitive prices. Also, societal constraints and requirements are being imposed on economic activities to economize on the use of resources and to ensure, for instance, animal friendly and safe production, and restricted pollution. Combined with typical characteristics of the agricultural production process, e.g. perishability of products, varying quality of products and seasonal supply of raw materials (Trienekens and Trienekens, 1993), this creates new demands for businesses in the production of food.
For the businesses this implies listening more to the demands and expectations of customers, placing more emphasis on quality control and environmental issues and shifting from the production of bulk towards the production of specialities with high added value. These changes result in a larger product range, shorter product life-cycles, flexible production and distribution structures and a reduced throughput time of (fresh) products.

One strategy companies have deployed to cope with these developments, is that of forming alliances with important suppliers and customers. By making agreements about product characteristics and delivery conditions, companies try to comply more satisfactorily with the demands of customers (and other stakeholders) and to increase efficiency in the production process. In recent years there has been growing interest in extending these agreements to other parties in the production column, parties which are not direct suppliers or customers of the companies involved, resulting in so-called chains.
Especially in food chains there is a large degree of interdependence between links (Boehlje et al., 1995), which stresses the need for businesses to collaborate with other parties in the chain (Hughes, 1994; Downey, 1996).

To achieve chain collaboration themes like common strategies, cultural differences, trust and commitment, and contracting become key issues (Downey, 1996). Essential in this respect are open communication structures between chain participants, which underlines the importance of new information and communication technology for chains (Van Beek et al., 1998). During the last decades the opportunities offered by information technology have become an important vehicle to achieve new business structures (Hammer and Champy, 1993, Davenport, 1993). Important examples are Electronic Data Interchange (EDI) and the internet.

To support businesses in these developments, many chain research projects have been performed in the last few years, with objectives such as building new marketing strategies, lowering integral chain costs, developing chain quality systems, development of integral quality systems, etc.

1.2 Problem definition

Chain research, as it is strongly allied to management sciences, involves many interrelated aspect systems, such as economic, social, legal, logistics, and information systems. In any chain research, different aspect systems must be included to give the research empirical relevance (Van Beek et al., 1998).
However, no research is able to take into account the large diversity of aspects that are generally related to chain problems. The choice of what aspects to take into account in what situations is therefore a crucial one.

To be able to support these choices, an interdisciplinary and integrating view of chains is necessary, which would enable researchers to make the right demarcations and the right choices regarding empirical problems. Although several authors have developed methods in the last few years to approach specific chain problems (e.g. throughput time reduction, product quality improvement), no such integral view of chains has been developed so far.

- A literature search reveals (see chapter 2 of this thesis) that there are many different scientific approaches to coordination between companies. Not much finetuning between the approaches has been achieved so far.
- Methods and techniques of researchers in chain management often depend on the expertise available in businesses, consultancy agencies and research institutes involved in particular projects (see for example Beers et al., 1998). There is no accepted research methodology for chains.

This thesis has two goals:
- It aims to demarcate basic research areas on chains, which reflect basic research perspectives on chains. In relation to these areas, it aims to clarify the position and scope of various scientific approaches to chains (Transaction Cost Economics and Supply Chain Management amongst others).
- It aims to contribute to the development of theory and a method for chain research. Because of the broadness of chain research, this thesis focuses on one important area: analysis and (re)design of chain processes. (This research area is delineated in chapter 2).

1.3 Research approach

Theory building on chains is still immature. Exploration of a new field of research involves different methods than the more mature scientific fields do. The latter usually use the empirical cycle in which hypothesis testing is the motor of theory building (hypothetical-deductive method, Koningsveld, 1987).

According to Whetten (1989) a first step in (new) theory building is the constitution of propositions, which involves an initial exploration and formulation of concepts concerning an empirical domain: "The primary difference between propositions and hypotheses is that propositions involve concepts, whereas hypotheses require measures". Also Eisenhard (1989) stresses the importance of a priori specification of theory components in the first steps of theory building: "A priori specification of constructs can ... help to shape the initial design of theory building research".

This thesis takes two paths to arrive at the initial constructs of a chain theory:
- Definition of basic research areas on chains, reflected by different research perspectives on chains. This is achieved by a literature search.
- Development of theory and a method for chain research, with a focus on one important research area. This is achieved by developing a research framework.

A major part of the thesis is concerned with the design of the research framework.
The usability of frameworks in theory development is stressed, among others, by Porter (1991): "....... Frameworks identify the relevant variables and the questions which the user must answer to develop conclusions tailored to a particular industry and company. In a sense they can be seen almost as expert systems.... The theory embodied in frameworks is contained in the choices of included variables, the way variables are organized, the interactions among variables and the way in which alternative patterns of variables and company choices affect outcomes".

Whetten (1989) gives an overview of elements constituting scientific theories. A complete theory must contain four essential elements, which in this thesis are also considered to be the basic components of the research framework to be designed:
- Why?: what are the underlying psychological, economic, or social dynamics that justify the selection of factors and the proposed causal relationships? The Why? question is essential when it refers to the context in which the theory is developed and the view of the researcher. The view of the researcher again is embedded in the current scientific paradigm, which represents the perspective on empirical reality of the scientific community. A major element of the Why? question is the type of empirical problems a theory wants to tackle.
- What?: which factors (variables, constructs, concepts) should be considered as part of the explanation of the social or individual phenomena of interest. Choosing the right factors with the right scope is essential here.
- How?: how are these factors related?.
- Who?, Where?, When?: these questions concern how a theory can be validated.

Answers to the Why?, What?, How?, Who?/Where?/When? questions will form the basic components of the research framework to be developed. In line with Porter's definition, the framework includes a theory on chains, a method for chain research, and validation/testing of the method:
- the Why? question is answered by my view of chains and the scope of empirical problems to be tackled.
- the What? question is answered by the variables in the framework.
- the How? question is answered by the relationships between the variables and their application in a method for chain analysis and (re)design. The method includes tools/instruments to analyse and (re)design chains.
- the Who?, Where? and When? question are answered by application of the framework in the form of cases and by 'evidence' from literature.

Research cycle

The thesis research cycle consists of four steps:

The first step aims at definition of research perspectives on chains.
1. Three research perspectives on chains are defined. They are: process, institution and performance perspective. Various scientific approaches from literature are related to these perspectives.

The following 3 steps form the core of the thesis and are performed in an iterative way. Data collection in case studies and analysis of these data have overlapped frequently.

2. Focus on one research perspective: the process perspective. This is worked out by development of a research framework for analysis and (re)design of processes in chains.

> Although the process perspective on chains has been treated well so far in literature, see for example Cooper et al. (1997a) for an overview, most research projects are directed at problem solving (e.g. throughput time reduction or product quality improvement), without paying much attention to an integrated research method.

3. Specification of the variables (What?) of the framework for logistics processes in food chains (food chains are chosen as empirical domain in this research).

4. Framework application: case studies in food chains to test/validate the framework. Case studies are drawn from chain projects performed in practice.

The different phases in the research are depicted in figure 1.1.

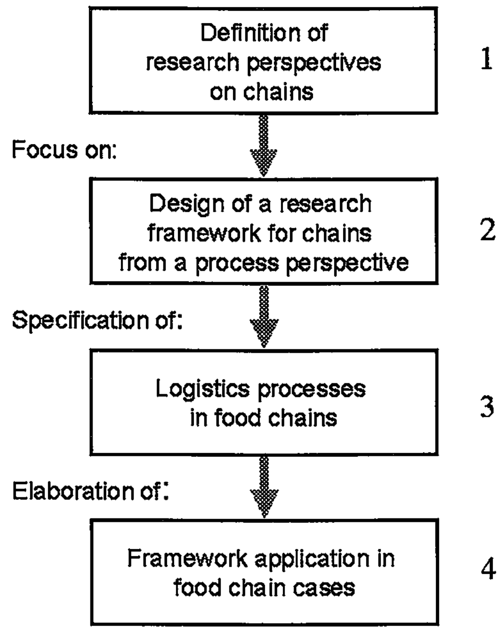


Figure 1.1 Research design

Figure 1.2 stresses the iterative character of the research by showing the cycles that form the core of the research (steps 2 to 4 in figure 1.1): framework design and framework application.

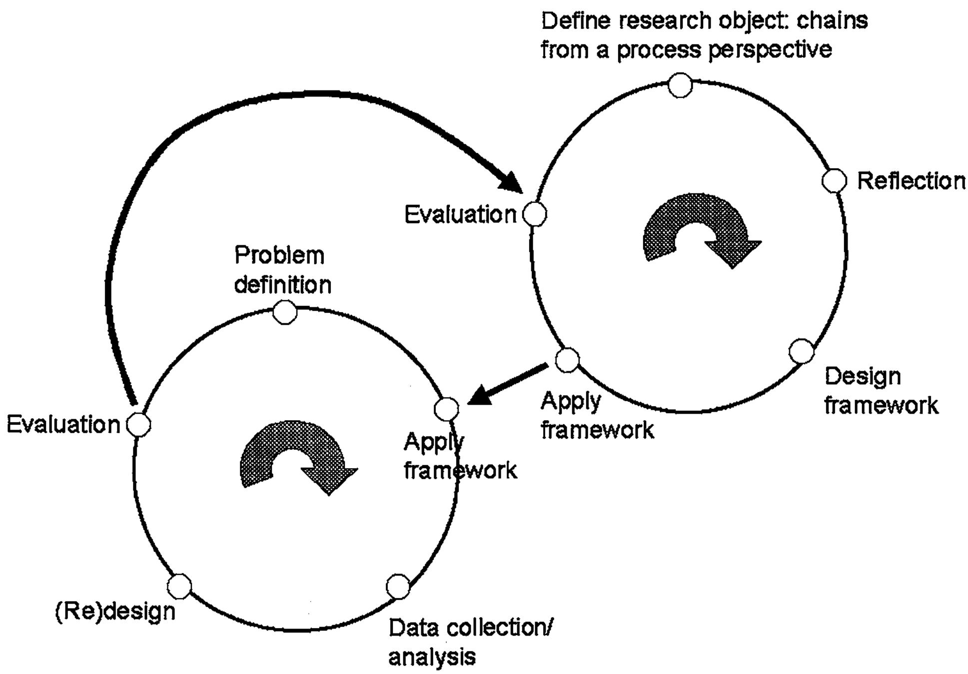


Figure 1.2 Cycles for framework design and application

Framework design cycle (right circle in figure): within the field of chain research the focus is on the process perspective on chains. Theoretical and practical reflection by literature analysis and case studies; lead to a research framework for analysis and (re)design of processes in chains. Subsequently, the framework is tested/applied in a regulative cycle.
Framework application (left circle in figure). Framework application resembles a regulative cycle (Van Strien, 1985; Hofstede, 1992): (re)design and changing of empirical reality. First, an empirical problem is defined. The framework (current status) is applied by choosing the relevant variables and their relations ('apply framework' in the figure). Data collection and analysis concerning the relevant variables and their relations takes place. A new situation is designed, followed by evaluation of the contribution to problem solving.

Evaluation in the regulative cycle coincides with evaluation in the framework design cycle and may be followed by a new cycle.

1.4 Validation

We recognize two validation tests that are of importance for our research (see for example Segers, 1983; Ellram, 1996):

Face validity reflects how accurately the results represent the phenomenon studied. It includes:
- theoretical reflection on meaning and content of the concepts used,
- specification of theoretical dimensions of the concept,
- reflected choice of indicators for each of the distinguished dimensions.

Construct validity can be measured by testing whether theoretical compositions are reflected by empirical evidence. It reflects how accurately variables, concepts and relationships are composed and how accurately they can be operationalized.

Validation in this research takes place with three instruments:
- Literature analysis, which aims to identify
  - scientific approaches to chains and relate these to the research perspectives recognized,
  - the elements of the research framework for chains from a process perspective.
- Case study research to apply the framework. Case studies are performed to make framework variables and their relations explicit in analysis and (re)design of chains (see regulative cycle). The case study method is qualitative in nature and focuses on a small number of cases. Cases in this respect are chosen for theoretical, not statistical reasons (Eisenhardt, 1989). In explorative research case study methods often provide a richness and depth of knowledge of the phenomenon studied, which is necessary to build theory. Mintzberg (1979) (cit. Eisenhardt, 1989) states: "For while systematic data create the foundation for our theories, it is the anecdotal data that enable us to do the building. Theory building seems to require rich description, the richness that comes from anecdote. We uncover all kinds of relationships in our hard data, but it is only through the use of this soft data that we are able to explain them".
- Expert testing. Framework elements are frequently discussed with experts, in and outside case studies.

1.5 Cases in this thesis

Since the beginning of the 1990s companies and research institutes have shown great interest in chain projects in the food sector in many countries. In this thesis cases originate from two groups of projects.

In 1995 and 1996 various projects on Efficient Consumer Response (ECR) were performed. In projects in which I was involved, several retail chains were analysed with the aim to improve logistics (lower throughput times, lower stock, lower costs), control structures and information architectures. Methods developed in these projects were further tested in several graduate student thesis projects in 1997 and 1998.

> In the period 1994-1998 the foundation for Agri Chain Competence, a governmental subsidized organization in the Netherlands that enables public-private partnerships, has supported more than 60 projects with subjects such as chain strategy, chain organization, chain care systems, chain logistics, chain information systems.

From 1996 to 1998 a large project in Dutch horticulture was performed with the aim to build new logistic structures for Dutch horticulture. Projects I was involved in were:
- design of a management model for a marketing organization of horticultural products (bridging supply and demand in the horticulture chain),
- design of a short term chain planning (and information) system for horticulture products,
- design of a supply planning/forecasting (and information) system.

In the first group of projects key aspects were market orientation and customer service, and speed and efficiency of the product flow. In the second group of projects key aspects were coordination of demand and supply and design of logistics infrastructures. Together these projects offer a broad scope of analysis and the (re)design of chain processes.

In both groups of projects, multiple data sourcing was performed to identify variables and relations for the framework that was to be designed. Methods were discussed with researchers and key practitioners in the field. Further methods have been discussed and elaborated jointly with researchers from the international scientific community (Coll et al., 1998; Trienekens and Hvolby, 1999a) (the cases will be elaborated in chapter 5).

1.6 Contribution of this thesis

This thesis contributes to existing scientific knowledge of chains. It does so by:
- Defining basic research perspectives on chains and relating various scientific approaches to vertical coordination to these perspectives.
- Designing a research framework from the process perspective on chains, which entails the:
  - development of a process approach to chains including a view of chain processes and the scope of empirical problems to be tackled (answering the Why? question of theory/framework building),
  - definition of relevant variables for chains from a process perspective, which is further specified to logistics management in chains (answering the What? question of theory/framework building),
  - definition of relations between the variables and definition of a method to analyse and (re)design chains (answering the 'How?' question of theory/framework building).

Practical chain problems are tackled by choosing the relevant variables and relationships. The method (How?) includes supporting tools/instruments for analysis and (re)design of chains:
  - a modelling tool to analyse and (re)design chain infrastructures: aiming at throughput time reduction and efficiency improvement in chains,
  - a modelling tool to analyse and (re)design chain decision structures: aiming to improve the gearing of decisions in chains and to thereby improve efficiency,
  - a modelling tool to analyse and (re)design chain processes: aiming to optimize interfaces between chain links and chain management.

Application of the framework in cases reflects the 'Who?', 'Where?', 'When?' questions of theory building.

1.7 Structure of the thesis

- Chapter 1 gives an overview of the research approach.

- Chapter 2 defines three research perspectives on chains and relates various scientific approaches to vertical coordination to these perspectives, thereby demarcating areas of chain research.

- Chapter 3 focuses is on the process perspective on chains. From this perspective a research framework is designed for analysis and (re)design of processes in chains.

- Chapter 4 specifies elements of this framework for logistics in food chains. Typical characteristics of food chains play an essential role in this chapter.

- Chapter 5 presents four food chain cases to test/validate the research framework.

- Chapter 6 presents conclusions and identifies some major fields for further research.

Chapter 2 Research on vertical coordination

2.1 Introduction

This chapter provides an introduction to literature on vertical coordination. First, major perspectives on chains will be defined. In section 2.3 various scientific approaches (Transaction Cost Economics and Supply Chain Management amongst others) will be discussed. In section 2.4 these approaches will be related to the perspectives on chains. Finally, section 2.5 will give an overview of the broadness of chain research by summarizing a variety of views, variables and research approaches in chain research.

2.2 Perspectives on chains

Several definitions of chains are given in the literature, for example:
- The international center for competitive excellence of the university of North Florida considers supply chain management to be "the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers" (Lambert, 1994; cit. Cooper et al. 1997).
- Ellram and Cooper (1990) define supply chain management as "an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user".
- Christopher (1992) defines supply chain as "the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate customer".
- According to Beers et al. (1998) a chain can be defined as "... a network of connected organizations aimed at the fulfilment of specific consumer needs .... in conjunction with the fulfilment of needs of other stakeholders of such an entity",
- Zuurbier et al. (1996) consider a chain to be "a collaboration between two or more companies that take positions in successive stages of production" (translated from Dutch).

The first three definitions define supply chains, pointing at their logistic origin. The last two define chains from a broader perspective. In all these definitions three basic elements can be recognized:
- Chains are customer oriented, i.e. the relation between the entity chain and its market(s) is a basic issue in theories on chains.
- To meet customer demands a series of processes (with precedence relationships) must be executed.
- To coordinate these processes collaboration between organizational units is necessary.

In this thesis three distinct perspectives on chains are chosen as identified by Beers et al. (1998) and Trienekens et al. (1998) in the definition of chains:
1. Chains involve the relations between two or more organizational entities (organizations, departments, functions, processes),
2. insofar as these relations aim at a common (consumer determined) objective,
3. as this is created by a sequence of processes/activities of parties involved.

The first can be called the institution perspective, the second the performance perspective and the third the process perspective on chains.

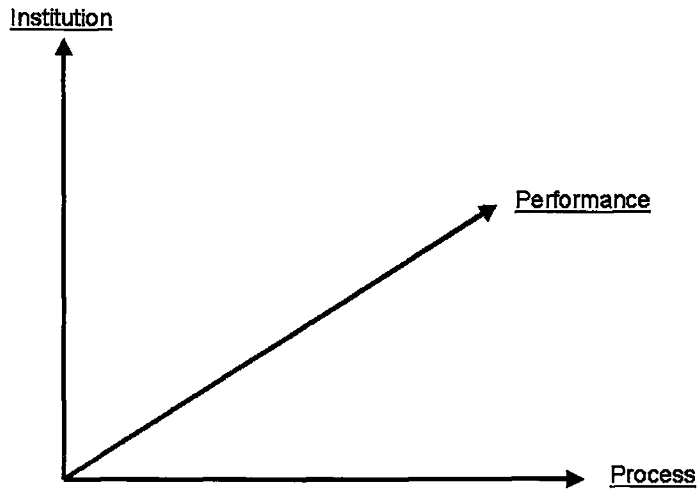


Figure 2.1 Research perspectives on chains

The institution perspective
focuses on the possible ways of linking chain participants together. A range of coordination options, varying from very rigid ways of coupling to very loose ones, belong to this focus. Another aspect of this perspective is the institutional environment that encompasses the political, legal, social, economic and cultural context of the companies at stake. Stakeholders other than the chain customer (governmental organizations, financial organizations, branch organizations, etc.) are also considered an important issue.

The process perspective
focuses on chain processes. A process is a set of related activities performed to achieve a certain goal. In a chain there are physical processes (production and distribution processes), administrative processes (supporting physical processes) and management processes (planning and control of physical and administrative processes).

The difference between the process perspective and the institution perspective can be clarified as follows. In the literature a rough distinction is made between two (opposing) approaches to organizational structuring: the functional approach and the process approach. Function oriented organizational approaches focus on grouping activities and tasks within an enterprise into functions. The aim is to structure the internal organization of the enterprise according to a (strict) division of labour and hierarchical structures. This is done to achieve efficient use of resources. In contrast, process oriented organizational approaches focus on grouping activities and tasks around processes that lead to the output required by customers. (Davenport, 1993; Hammer and Champy, 1993; Eijnatten, 1996).

Figure 2.2 depicts differences in focus between a functional and a process approach: integration on the level of similar tasks/functions versus integration on the level of product market combinations. (the functions in the figure are examples of business functions).

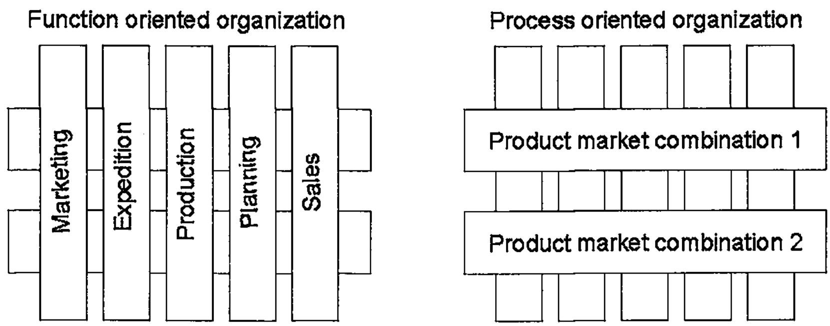


Figure 2.2 Function versus process orientation

The two approaches reflect distinct perspectives on organizations. Process approaches are rooted in the process perspective. Functional approaches are rooted in the institution perspective. Although the institution perspective as described above goes beyond a simple division in tasks/functions, its core is the relations between organizational units like tasks, functions, and organizations.

The performance perspective

Performance of a chain can be translated into the chain output as it is perceived by its stakeholders. The major stakeholder of a chain is its customer. Other stakeholders are the individual chain links, governmental organizations, financial organizations, social/political organizations, etc.

Performance concerns several dimensions. Browne & Jordan (1998) recognize quality, time, costs, flexibility and environment. In this thesis this division is followed and applied to chains:

- Quality reflects product quality and process quality as perceived by chain stakeholders (e.g. typical product chartacteristics like size, colour, composition and typical process characteristics like animal friendly production, handling of waste materials).
- Time reflects the duration between two activities as perceived by chain stakeholders (e.g. delivery time of orders, production time of products).
- Costs reflect the costs of any chain activity as perceived by chain stakeholders (e.g. costs of order processing, costs of transportation, overhead costs, investment costs).
- Flexibility reflects the degree to which changes in demands from chain stakeholders can be met (e.g. changes in demands related to quality, volume, product composition, delivery time).

- Environment reflects the environmental aspects as perceived by chain stakeholders (e.g. recycling of materials, animal friendly production).
The performance perspective encompasses important issues like the definition of performance demands, performance measurement systems, and the translation of performance demands throughout chains.

Although all three perspectives have a different focus, they are complementary. Indeed every business (or chain) has a division of labour and a form of hierarchy; it performs processes; and it wants to achieve a certain output performance.
Examples of overlap between the perspectives are:
- (output) performance (a cross between process and performance perspective),
- coordination between processes (a cross between process and institution perspective),
- organization of performance measurement (a cross between institution and performance perspective).
In the next section an overview of scientific approaches to vertical coordination will be given.

2.3 Literature overview

The description of scientific approaches is in random order and the structuring chosen here is the result of the author's assessment of the literature. The aim is not to provide a complete picture of all ways of thinking and theorizing about vertical coordination, but merely to provide a rich picture of the variety of views of and approaches to inter-company relationships.

The literature overview starts with a description of system thinking in science. System thinking as it emerged in the 1950s offered a solid basis for other post-World War II approaches and it still provides an important basis for the analysis of inter-company relationships. After describing the content and evolution of system thinking, this chapter will further explore scientific approaches that are related in one way or another to vertical coordination between organizations. Each sub-section will close with discussion of topics relevant to the approach involved. The literature overview ends with a discussion of motives, costs and benefits, and success or failure factors of vertical coordination.

2.3.1 The emergence of system thinking

Classic schools

The pre-World War II classic approaches to organizations considered organizations to be machine-like entities; organization models were mechanistic models. Organization science was primarily directed towards internal business processes. In this respect organizations were considered closed systems whose structure could be designed according to universal principles. Important works of organization science in that period were Weber's theory on bureaucracy, Taylor's scientific management and Fayol's analysis of management tasks.

After the 1950s a number of interdisciplinary sciences gained importance: management studies, information science, operations research, cybernetics, decision science, etc. The common feature of these sciences was that they considered reality from a system's behaviour perspective.

System thinking

Originating in biology and founded by Ludwig von Bertalanffy (e.g. Bertalanffy, 1955, 1968), system thinking leads to approaching the company as a 'whole' of interrelated elements, and to viewing it from the perspective of the company's environment.
In system thinking:
- reality is considered to be a construct of systems and their environments,
- systems can only be defined as objects of research; i.e. the researcher defines what is considered to be a system (Beer, 1959),
- every system is looked at as a 'whole' (a 'whole' being more then the sum of its parts),
- the behaviour of a system is goal-oriented.

Previous approaches focused on an analytic approach to organizational problems: every organizational problem can be unravelled into a number of basic components, which can be analysed separately. Results of this analysis can be assembled to form an overall picture of the organization under study. In contrast, system thinking is based on a synthetic approach to organizations. In this approach elements cannot be analysed on their own without taking into account how they relate to other system elements and to the environment. Also, the analysis should be founded in the goal oriented behaviour of the system (Ackoff and Emery, 1972).

System thinking, therefore, not only prescribes an integrated view of reality, it also aims at an interdisciplinary approach to organizational problems.

Management of systems

March and Simon (1958), among others of the Carnegie school, view management as a means to regulate and control decision making processes in organizations (in this view management is synonymous with decision making). They hereby underline the limitations in organizational control by the concept of 'bounded rationality', which identifies limits to (human) decision making processes. Decision making can only in part be programmed by rules and standardized procedures. Contrary to classical theories that focus on coordination by means of rules and hierarchical control, the Carnegie school emphasizes the role of information and communication in organizational coordination. In this respect it considers negotiation to be a key process. An important researcher who elaborated on the theories of March and Simon is Galbraith (1973).

An important issue in the management of systems is human relations management. In a dynamic environment, organizations proved to perform better when functioning as an organism (informal communications, flexible structure, autonomy, changing functions, etc.) rather than as a machine-like entity. This finding led to an emphasis on studies into human relationships and their relation to the organization's management, such as McGregor's theories X and Y (1960), Argyris' (1957) concept of job enlargement, and studies into participation.

System environment

Emery and Trist (1969) distinguished between the transactional and the contextual environment of organizations. To the transactional environment belong entities that are directly related to the system's entities; the contextual environment consists of entities in the environment of an organization that are indirectly related to the system's entities. Emery and Trist were also among the first to study the autonomous process of change within the system's environment.

Ackoff (1981) makes the following distinctions with respect to the relevant environment of an organization:
- Actors over whom the organization has complete control belong to the organization.
- The transactional environment consists of actors over whom the organization has partial control.
- The contextual environment consists of actors over whom the organization has no control.

Economic and societal developments in the 1950s and 1960s led to more dynamic environments for companies. This in turn led to a changeover in thinking from the idea of universally applicable management principles to the idea that every (type of) company has to find its own optimal relationships with its environment. One of the key management issues became the search for the right 'fit' between environmental characteristics (such as complexity, stability, turbulence) and characteristics of (the structure of) the organization. This 'open system approach' has been common since the 1960s.

Lawrence and Lorsch (1969) searched with their contingency theory for the right fit between system variables and context (environmental) variables. According to them, the environment can be defined by its diversity (in environmental sub-sectors) and interdependency (between these sub-sectors). The structure of companies can be defined by its differentiation (in functions/departments) and integration (between these functions/departments). For every organization there is a 'fit' between organizational structure and environment (e.g. differentiation in the environment means diversity in organizational functions; interdependency between sub-sectors in the environment may lead to integration between organizational functions).

Other important representatives of this approach were Trist of the Tavistock Institute of Human Relations and Woodward (1970), who described relationships between production environments and organizations.

2.3.2 Organizational economics: Transaction Cost Economics and Agency Theory

Two important schools of thought aiming at integration of economic and organizational theory are Transaction Cost Economics (Williamson, 1975, 1981, 1985) and Agency Theory (Eisenhardt, 1989).

Transaction Cost Economics

Williamson (1975) can be considered to be the most important pioneer in Transaction Cost Economics (TCE). In TCE the transaction between companies is the basic unit of analysis. Transactions are governed under conditions of bounded rationality and opportunism of the economic agents involved. The most efficient governance structure is determined by balancing production economics and transaction costs.

The starting point of the analysis is the make-or-buy decision. Stern et al. (1996) in their treatment of outsourcing decisions in Channel Marketing offer the following consideration: "Relying on market efficiencies buying is always preferred. Unfortunately, markets sometimes fail because the transaction costs associated with dealing across them elevate to such an extent that vertical integration by ownership (so-called hard vertical integration) becomes a more efficient and effective way of getting the job done."

In TCE the three major characteristics of transactions are frequency of the transaction, uncertainty in the transaction and asset specificity of the transaction. If the transaction has a high frequency, if uncertainties are involved and/or the transaction has a high asset specificity, vertical integration becomes the more efficient governance structure.

Williamson (1975) first distinguished between hierarchy and market as main governance structures. He later (1985) took a more differentiated view by also allowing hybrid forms of governance.

Discussion

According to Sauvee (1998): "... [Williamson's] concept of market or organization failures as the only determinant of vertical integration decisions is probably too restrictive".

And: "The classical Williamsonian analysis appears to be relevant in the particular case of a single firm's make-or-buy decision wherein the main (or exclusive) objective is the minimization of costs. But in many other cases, two firms involved in a transaction could also try to develop a common strategy of, for instance, product differentiation."

Other criticisms of TCE have to do with its limited attention to power issues, transaction costs within organizations, and social issues.

Agency Theory

Agency Theory is directed at the ubiquitous agency relationship, in which one party (the principal) delegates work to another (the agent), who performs that work.

Eisenhardt (1989) in her article on Agency Theory states: "the focus of the theory is on determining the most efficient contract governing the principal-agent relationship given assumptions about people (e.g., self-interest, bounded rationality, risk aversion), organizations (e.g., goal conflict among members), and information (e.g., information is a

commodity which can be purchased)".
And: "Agency Theory is concerned with resolving two problems that can occur in agency relationships. The first is the agency problem that arises when (a) the desires or goals of the principal and the agent conflict and (b) it is difficult or expensive for the principal to verify what the agent is actually doing. The problem here is that the principal cannot verify that the agent has behaved appropriately. The second is the problem of risk sharing that arises when the principal and agent have different attitudes towards risk. The problem here is that the principal and the agent may prefer different actions because of different risk preferences."

Eisenhardt (1989) describes a series of propositions of Agency Theory, the most important of which are listed here.
- Proposition 1: When the contract between principal and agent is outcome based, the agent is more likely to behave in the interests of the principal.
- Proposition 2: When the principal has information to verify agent behaviour, the agent is more likely to behave in the interests of the principal.
- Proposition 3: Information systems are positively related to behaviour-based contracts and negatively related to outcome-based contracts.
- Proposition 4: Outcome uncertainty is positively related to behaviour-based contracts and negatively related to outcome-based contracts.

Eisenhardt further states that "the heart of principal-agent theory is the trade-off between (a) the cost of measuring behaviour and (b) the cost of measuring outcomes and transferring risk to the agent".

Discussion

Agency Theory seems to be most relevant in situations with goal divergence and incomplete information.

Larson (1992) and Uzzi (1997) point out that Agency Theory has difficulties in explaining organizational forms in which the roles of principal and agent cannot easily be recognized.

2.3.3 Strategic Management: positioning the company

Although Strategic Management for most scholars encompasses many of the other schools of thought described here, we try to limit its field in this chapter to two basic issues:
- the position of the business within its environement, and
- competitive advantage.

For Porter (1980) "the essence of strategy is relating a company to its environment." The market position of a firm is the main focus of strategy building. Porter recognizes five forces that determine the competitive position and strength of a company: its suppliers, substitutes, new entrants, rivals and customers. He defines three generic strategies for companies: cost leadership, differentiation and focus.
Another of Porter's important contributions is the value chain concept (Porter, 1985; Porter and Millar, 1985). A company can achieve competitive advantage by improving the links between the value adding processes in its value chain.

Mintzberg (1990) categorizes strategy literature and recognizes ten schools of thought. Business strategy concerns many divers aspects, and every school of thought focuses on certain ones of these aspects. He recognizes three groups of schools:
-The prescriptive group consists of the design, planning and positioning schools. These "are more concerned with how strategies should be formulated than how they actually do form". (Porter is considered a representative of the positioning school.)
-The descriptive group consists of the entrepreneurial school, the cognitive school, the learning school, the political school, the cultural school and the environmental school. These "focus on specific aspects of the process of strategy formation and are concerned less with prescribing ideal strategic behaviour than with describing how strategies do, in fact, get made".
-The configuration school combines the others into a single perspective. Mintzberg considers himself to be a member of the configuration school.

The most important schools of thought, measured by the number of publications, are the prescriptive schools. However, some others, like the configuration school, have been given increased attention in various journals in recent years (Mintzberg, 1990).

Strategy dynamics

Hamel and Prahalad (1994) underline the importance for businesses to continuously base their strategy on future developments. Porter (1990) stresses that competitive advantage is achieved through acts of innovation. Drucker (1994) underlines the changing fit between the company and its environment. Changes may/must lead to new theories of the firm. Fisher et al. (1994), among others, underline the importance of environmental dynamics in this respect. Hayes and Pisano (1994) state that "in a turbulent environment, the goal of strategy should be strategic flexibility". And finally, Hamel (1998) states: "The question today is not whether you can reengineer your process; the question is whether you can reinvent the entire industry model..."

Stakeholders

An important approach that relates the company to its environment is the stakeholder approach (e.g. Ackoff, 1981; Freeman, 1984). Stakeholders are the parties within and outside the organization that can directly influence, and be influenced by, the organization's actions. Ackoff recognizes six clusters of stakeholders: employees, suppliers, customers, creditors, debtors, and the government.

According to Pouloudi and Whitley (1997), the stakeholder concept is primarily used "as a tool for examining the external environment of a given organization". They suggest the use of stakeholder analysis in combination with other analytical approaches: "similarly, in soft systems methodology (Checkland and Scholes, 1990) the perceptions of a wider range of parties, not just users, are recorded and form the basis for the description of the new system. The resulting 'rich picture' that describes the problem situation is then used as the basis for system requirements."

Convention theory

In his analysis of convention theory, Sauvee (1998) refers to an article of Eymard-Duvernay (1989) focused on the central role of quality uncertainty in structuring inter-firm relationships. "In this theory, conventions are a set of mechanisms and rules that involve private agents as well as public institutions. Therefore, the analysis focuses on the way quality uncertainty is solved. The content of product specification, the nature and genesis of third parties involved, the strategy of product differentiation or labeling, or other empirical observations about quality, clarify the conventions. Convention theory shows that quality conventions are a strong factor structuring industrial organization." (Sauvee, 1998)

In convention theory "prices do not constitute a determinant variable anymore to ensure coordination, but one of the links of industrial organization subject to conventional rules". Quality conventions are needed in the analysis when the price alone cannot evaluate quality. "..convention theorists do not consider nonprice exchanges between firms as market failure or imperfections. Instead ... they integrate the diversity and complexity of the quality issue and build their analysis on it." (Sauvee, 1998)

Discussion

According to Mintzberg (1994b), the strategic planning movement of the 1970s and 1980s is at its end. Strategy cannot be planned; planning is about analysis and strategy is about synthesis: "the most successful strategies are visions, not plans" (Mintzberg, 1994b).

Hamel and Prahalad (1994) underline the importance for businesses to continuously base their strategy on future developments. Contrary to Mintzberg, they stress the importance of "foresight" (which is also based on quantitative figures) of a company's management more than just "vision".

Sauvee (1998): "the convention theory approach shows that the definition of contracts cannot be understood exclusively at a micro-economic level, i.e., between two single parts. A convention is also a mode of regulation found at a collective level, for instance, a region or an industry."

Strategic Management according to Thorelli (1986) is as much concerned with network positioning as with market positioning: "positioning of the firm in the network becomes a matter of as great strategic significance as positioning its product in the marketplace".

2.3.4 Network Theory

The network approach (Hakansson, 1982) views the organization as a node in a network of organizations. Networks of organizations emerge because of the necessity to exchange resources (see, for example, MacBeth and Ferguson, 1994; Hines, 1995).

Thorelli (1986): "the entire economy may be viewed as a network of organizations with a vast hierarchy of subordinate, criss-crossing networks. Our focal network is the one intermediary between the single firm and the market, i.e. two or more firms which, due to the intensity of their interaction, constitute a subset of one (or several) market(s)."

Thorelli (1986) describes a number of strategic issues that can be positioned in a network context, thereby stressing the broad scope of Network Theory:
- positioning of the firm and its product
- marketing channels and franchising
- patent and trademark licensing
- turnkey contracts and 'systems' selling
- barter and reciprocal trading
- make-lease-or-buy decisions
- split versus unified sourcing
- transactions between divisions of a company
- cartels
- interlocking directorates
- joint ventures, mergers and acquisitions
- diversification
- internationalization
- vertical integration.

According to Thorelli (1986) power is the central concept in network analysis. He recognizes at least five sources of power of a network participant:
-economic base (e.g. liquidity, access to suppliers)
-technology (systems and product and process technology)
-expertise (personnel and equipment capabilities)
-trust (reputation, past performance)
-legitimacy (e.g. ownership relationships, contracts).

Uzzi (1997) mentions trust as the primary governance factor:
"...in an embedded logic of exchange, trust acts as the primary governance factor. Calculated risks and monitoring systems play a secondary role. Information transfer is more fine-grained, tacit, and holistic than the typical price data of pure market exchanges, and joint problem solving arrangements promote voice rather than exit. On a microbehavioral level, actors follow heuristic and qualitative decision rules, rather than intensely calculative ones, and they cultivate long-term cooperative ties rather than narrowly pursue self-interest."

Larson (1992) highlights "the importance of reputation, trust, reciprocity, and mutual interdependence. The network form is proposed as an alternative to vertical integration for high-growth entrepreneurial firms".

Discussion

Compared to other approaches, such as Transaction Cost Economics, the network approach can be positioned between the two governance extremes of the transaction cost approach: market and hierarchy.

Thorelli (1986): "The network paradigm is not to be viewed as a substitute for any theory of the firm, of markets, or industrial organization but rather as a supplement, a viewpoint with both normative and positive implications."

2.3.5 Resource Dependency Theory

The resource dependency approach (e.g. Pfeffer and Salancik, 1978) is complementary to the network approach. Its starting point is that the source of interdependency between organizations is the restricted availability of resources (materials, capacities, customers,...). Organizations structure their external relationships in response to these restrictions, i.e. uncertain availability of resources.

Davis et al. (1990): "The typical solution to problems of interdependence and uncertainty involves increasing coordination, which means increasing the mutual control over each other's activities."

Capabilities/core competencies

Many authors have stressed the importance of capabilities and competencies in Strategic Management (Porter, 1980; Wernerfelt, 1984; Prahalad and Hamel, 1990; Drucker, 1991; Mahoney and Pandian, 1992; Schoemaker, 1992; Stalk et al., 1993; Hayes and Pisano, 1994; Argyris, 1996; Davenport et al., 1998).

Capabilities and competencies play a major role in the resource based school of thought. Its central tenet is that every company has unique capabilities and competencies. An organization's strategy should be based on its strengths, especially the capabilities and competencies that distinguish it from other companies.

Monash et al. (1996): "... a company's capabilities are more than its physical assets. In fact, they are largely embodied in the collective skills and knowledge of its people and the organizational procedures that shape the way employees interact."

Outsourcing of non-core activities is an important tenet of the core-competence approach. In decisions concerning outsourcing, buying or making, some risks must be considered (Walker 1988):
- the appropriation of the advantage by the supplier of the work outsourced,
- the distribution caused by unwanted imitation by the supplier,
- the degradation of the product because less attention is paied to it by the supplier.

Argyris (1996): "The capabilities approach to the firm postulates that firms vertically integrate activities for which they posses capabilities that are superior to potential suppliers."

Choosing the right capabilities to compete with seems to be the essence of strategy (e.g. Venkatasan, 1991).

Discussion

Eisenhardt (1989): "institutional and resource dependency theories were developed primarily in large, public bureaucracies in which efficiency may not have been a pressing concern".

Prahalad and Hamel (1990) state that "only if the company is conceived of as a hierarchy of core competencies, core products, and market-focused business units will it be fit to fight" (See also Hamel and Prahalad, 1994).

Hayes and Pisano (1994): "If managers pin their competitive hopes on the implementation of a few best-practice approaches, they implicitly abandon the central concept of a strategy in favor of a generic approach to competitive success. How can a company expect to achieve any sort of competitive advantage if its only goal is to be "as good as" its toughest competitors?"
And: "... a company should think of itself as a collection of evolving capabilities, not just as a collection of products and businesses, which provide the flexibility needed to embark in new directions. Corporate strategy must provide a framework for guiding the selection, development, and exploitation of these capabilities."

Monash et al. (1996) distinguish between supply chain oriented and demand chain oriented capabilities. They find that demand chain oriented capabilities have a greater impact on firm profitability.

2.3.6 Supply Chain Management

The concept of Supply Chain Management (SCM) has received a great deal of attention. It originated in logistics literature, specifically in purchasing literature (as the term suggests). Cooper and Ellram (1993): "The term Supply Chain Management first appears in the logistics literature as an inventory management approach. Houlihan (1985) ... describes excess inventory building as akin to snowdrifts against a fence. The more independent entities, the more fences with snowdrifts."

Cooper et al. (1997a) state that "there is definitely a need for the integration of business operations in the supply chain that goes beyond logistics". In this sense, Supply Chain Management extends to processes concerning product development, marketing, etc. Giunipero and Brand (1996) add: "in its most advanced form SCM is not a subset of logistics but is a broad strategy which cuts across business processes both within the firm and through the channels required to reach the customer and involves the firm's suppliers".

Cooper et al. (1997a) recognize important points of agreement among definitions of SCM.
- It evolves through several stages of increasing intra- and inter-organizational integration and coordination; and, in its broadest sense and implementation, it spans the entire chain from initial source (supplier's supplier, etc.) to ultimate consumer (customer's customer, etc.).
- It potentially involves many independent organizations. Thus, managing intra- and inter-organizational relationships is of essential importance.
- It includes the bidirectional flow of products (materials and services) and information, the

associated managerial and operational activities.
- It seeks to fulfil the goals of providing high customer value with an appropriate use of resources, and building competitive chain advantages.

Discussion

Ellram and Cooper (1993) state that "the movement toward SCM is evolutionary, rather than revolutionary".

According to Christopher (1992), "leading-edge companies have realized that the real competition is not company against company, but rather supply chain against supply chain".

2.3.7 Information technology

Information technology is often viewed as merely an instrument used by various scientific approaches, with which collaboration between companies can be achieved. However, in this thesis information technology is considered to be a separate approach. Collaboration between companies can easily be studied/ approached through the glasses of information exchange. Information technology thereby is not just a "follower" of a strategy chosen in a certain scientific approach, it is also an enabler of strategies.

The potential for inter-organizational systems (IOS) to improve firm performance and change industrial structure has been described by many authors (a.o. Barret and Konsynski, 1982; McFarlan, 1984; Cash and Konsynski, 1985; Clemons and Row, 1992; O'Callaghan et al., 1992; Beulens, 1992, 1996; Bowersox et al., 1995; Boehlje et al., 1995; Kilmer, 1996; Stern, 1996; Premkumar et al., 1997).

For Clemons and Row (1992), IT can support the following effects:
- Vertical quasi-integration. Existing relationships with customers and suppliers can become more tightly coupled.
- Outsourcing. Activities previously performed within the firm due to high transaction risk may be shifted to third-party providers, allowing the firm to benefit from the providers' higher production economics, such as scale and specialization.
- Quasi-diversification. Firms may co-operate across markets and across industries in order to leverage their key resources in new areas, exploiting increased economics of scale and scope in those resources. Relationships with other firms that were previously not possible due to high coordination costs or high transaction risks may become feasible.

They argue "that IT has the potential to reduce coordination costs while also reducing the transaction risk created from closer integration of decisions, leading to an increase in explicit coordination and co-operation among firms... IT can reduce transaction risk by reducing the level of transaction-specific capital and by reducing the cost of monitoring and control among separate firms."

Mason-Jones and Towill (1997) exploit "the concept of the 'seamless supply chain', by encouraging marketplace information to move through the supply chain with as little distortion as possible".

Gustin et al. (1995) underline the importance of information availability for logistics integration; e.g. fast costing can enable service based differentiation.

Venkatraman (1994) describes the scope and benefits of business network redesign using information technology:
- transaction processing (seamless interconnection for exchanging structured data on transactions)
- inventory movement (triggered across organizations based on predefined conditions without human intervention)
- process linkage (interdependent process linkages for unstructured tasks (for example, design and manufacturing)
- knowledge leverage (creation of a network for leveraging skills and expertise).

Models for decision support

The role of modelling and information technology in process rationalization was already emphasized by Simon in 1960, but several other examples can also be found in the literature. For example, mathematical models to support decision making for chain multi-echelon replenishment environments are described by Silver et al. (1998) and others (see e.g. Van Beek 1981, 1985). Also of importance are simulation tools, etc. Towill et al. (1992), Berry and Towill (1992), Towill (1996b) and Van der Vorst et al. (1998), among others, stress the importance of dynamic modelling in supply chain analysis and design.

Discussion

Konsynski and McFarlan (1990) state that: "through an information partnership, diverse companies can offer novel incentives and services or participate in joint marketing programs. They can take advantage of new channels of distribution...." They consider intensive exchange of information to be an alternative for vertical integration.

2.3.8 Cost approaches

Most cost approaches are closely linked to the primary processes in the supply chain. Much has been published (especially in journals on logistics) on costing in supply chains (Tyndal, 1988; Cavinato, 1992; Shank and Govindarajan, 1992; Ellram 1993, 1995a, 1995b; Lalonde and Pohlen, 1996; Davies and Brito, 1997; Ellram and Maltz, 1995).

Lalonde and Pohlen (1996) give an overview of the pros and cons of several cost approaches for Supply Chain Management.

DPP

An approach that is often used in supply chain perspective is Direct Product Profitability (DPP). We use Stern's (1996) description: "DPP creates an individual profit and loss statement for each product carrier. The system measures product performance by:
- adjusting the gross margin for each item to reflect deals, allowances, forward-buy income, cash discounts, etc.;

- identifying and measuring costs that are directly attributable to that product (e.g. labor, space, inventory, transportation)".

ABC

Activity Based Costing, or ABC, refers to a method of allocating costs to products via the activities necessary to produce those products. The concept was first introduced by Cooper and Kaplan (1988).

TCO

Total Cost of Ownership (TCO) (e.g. Ellram 1993, 1995a, 1995b) recognizes that the purchase price represents only a portion of the total cost of acquiring an item. Other costs like ordering, expediting and receiving are often obscured by being buried in overhead or general expenses. "TCO attempts to identify the total acquisition price by including the costs of purchasing, holding, poor quality, and delivery failure." In another article Ellram and Maltz (1995) developed a generalized version of TCO in which they propose a framework for logistics outsourcing decisions.

In answer to the shortcomings of existing approaches, Lalonde and Pohlen (1996) introduced Supply Chain Costing. "Supply chain costing provides a mechanism for developing cost-based performance measures for the activities comprising the key processes within a supply chain. The capabilities provided by supply chain costing include the ability to determine the overall effectiveness of the supply chain, identify opportunities for further improvement or reengineering, measure performance of individual activities or processes, evaluate alternative supply chain structures or select supply chain partners, and evaluate effects of technology improvements. While supply chain costing employs many of the techniques embedded in DPP, ABC, TCO,....it differs by costing activities across the entire supply chain. The approach overcomes the obstacles regarding the availability of cost information by making use of standard or engineered times and existing rate information."

Lalonde and Pohlen's methods in general employ six steps:
-analysing supply chain processes
-breaking processes down into subprocesses/activities
-identifying the resources required to perform an activity
-costing the activities
-tracing activity costs to supply chain outputs
-analysis and simulation.

Discussion

Lalonde and Pohlens (1996) comments on DPP: "DPP excludes fixed overhead costs such as supervision, facilities, management, detention, demurrage, purchasing, and inventory carrying costs; it fails to recognize overhead and administrative expenses; and therefore cannot be used for total company costing purposes. A major factor contributing to the limited use of DPP stemmed from the requirement to maintain an extensive database of physical characteristics and to continually update the database."

Lalonde and Pohlen's (1996) comments on ABC: "Despite the advantages provided by ABC, the methodology does not provide a satisfactory solution to Supply Chain Management. ABC applications have concentrated on determining how other supply chain partners affect the firm's costs and profitability...These internal applications do not enable the supply chain participants to determine where non-value-added activities may exist in the supply chain, what high cost activities or processes to target for continuous improvement or reengineering, ... to strategically position logistics activities in the channel where the function can be best performed in terms of cost, time, or quality."

Lalonde and Pohlen's (1996) comment on TCO: "When coupled with activity based costing, TCO can provide a more accurate depiction of the activities and resources consumed in dealing with specific vendors. However TCO does not provide total supply chain costs. TCO may miss opportunities for making inter-firm cost trade-offs."

2.3.9 Collaboration between organizations: motives, success and failure factors, social aspects

In this closing sub-section of the literature search an overview is given of issues that are referred to in most scientific approaches.

Motives for collaboration

Considerations for vertical integration are given by a number of approaches (Transaction Cost Theory, Agency Theory, Resource Dependency Theory, Network Theory, etc.). Many authors have written about the advantages, disadvantages, and success and failure factors of strategic alliances (Harrigan, 1986; Mahoney, 1992; Ellram and Hendrick, 1995, Stern et al., 1996; Lambert et al., 1996; Bowersox and Closs, 1996).

Mahoney (1992) mentions the following motives for vertical coordination:
- uncertainty concerning costs and/or prices
- transaction cost considerations
- output and/or input price advantages
- strategic considerations.

Cooper and Ellram (1993) recognize from a logistics point of view three reasons for building supply chains:

-to reduce inventory investments
-to increase customer service
-to help build a competitive advantage for the channel.

Giunipero and Brand (1996) researched purchasers' perceptions of the benefits of SCM. The greatest benefits were considered to be: improved coordination, reduced lead time, greater productivity, lower inventories, increased reliability of delivery, lower costs of products, and shorter order cycle time.

Success and failure factors for vertical collaboration

Success and failure factors for vertical collaboration are described by Bowersox (1992) and Hughes (1994), among others. Bowersox (1992) outlines five factors that are critical to the success of a logistic partnership:
-selective matching - partners have compatible corporate cultures and values;
-information sharing - partners openly share strategic/operational information;
-role specification - each party in the partnership knows
specifically what its role is;
-ground rules - procedures and policies are clearly spelled out;
-exit provision - a method for terminating the partnership is defined.

The importance of the application of modern information technology has been underlined earlier in this chapter (2.3.7).

Bowersox (1992) also examines reasons why alliances fail, including lack of senior management support, lack of trust, fuzzy goals, lack of commitment and lack of control.

Social aspects: trust, commitment and power relationships

Many researchers from different approaches suggest that trust and relationship commitment are important elements in successful alliances.

Carter and Berry (1995): "Recently, the traditional posture taken by supply chain members, that of adversaries, is being replaced by a much different stance, one in which the firms position themselves as partners". They stress the importance of openness and trust.

Williamson (1985) states that trust reduces transaction costs. Stern et al.(1996) also stress the importance of power relationships in marketing channels. Ellram and Cooper (1990) state that long term alliances require trust, loyalty, sharing of information, risks and rewards. Downey (1996) stresses the importance of commitment and trust in food supply chains.

Morgan and Anderson (1990) underline the importance of trust and commitment in relationship marketing:
"We posit that relationship commitment and trust develop when firms attend to relationships by

1 providing resources, opportunities, and benefits that are superior to the offerings of alternative partners;
2 maintaining high standards of corporate values and allying themselves with exchange partners having similar values;
3 communicating valuable information, including expectations, market intelligence, and evaluations of the partner's performance; and
4 avoiding malevolently taking advantage of their exchange partners."

Larson (1992) on seller-buyer relationships: "The integrity of participants, their honesty, and their continued efforts to improve the exchange process became important ingredients of the process as firms took incremental risks and invested more in the relationship."

Cotterill (1997) and Wrigley (1997) compare power relationships in the US retail chain to those in the UK retail chain. They conclude that the two groups have very different power relationships: in the UK the retailer is "in charge" of chain management and in the US the food manufacturer is.

2.4 Relative position of scientific approaches

In the previous section (2.3) an overview was given of a number of scientific approaches to vertical coordination. In section 2.2 three research perspectives on chains were defined: institution, process and performance. In the following sub-sections these scientific approaches will be related to the three perspectives on chains, with the aim of structuring the range of scientific approaches to chains.

The axes in figure 2.3 below represent the three perspectives on chains. They are not intended to be viewed as scales (indicating, for example, a strong or weak relation to a perspective). Future research might indicate more precise positions for the approaches in relation to the perspectives. In this thesis every scientific approach will be positioned in the middle of one or more axes. If a scientific approach has a combined perspective on chains, the major perspective will be indicated by placing the name of the approach next to the axis corresponding to that perspective in the figure.

Two or three approaches will be treated in each of the following sub-sections. All sub-sections will start with a graphic representation of where each approach fits on the three perspective axes, followed by a description of each approach and an explanation of its positioning on the graph.

2.4.1 Transaction Cost Economics and Agency Theory

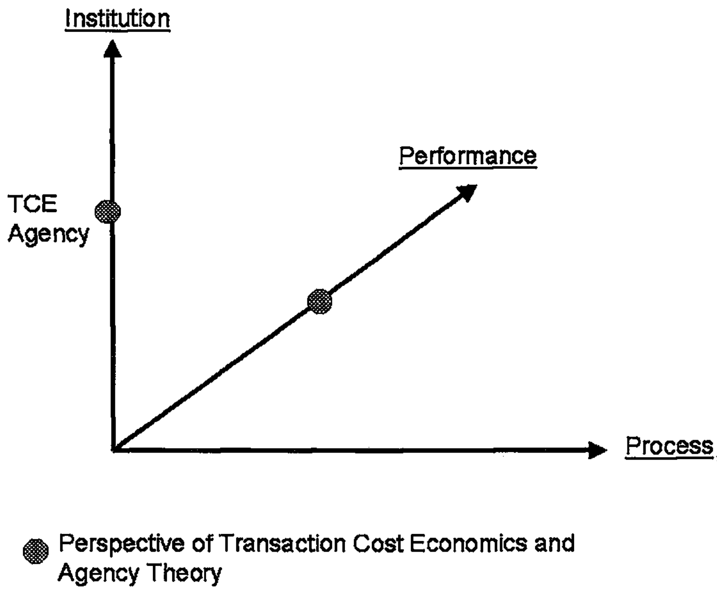


Figure 2.3 Perspectives of transaction Cost Economics and Agency Theory

Descriptive elements:
-The transaction is the basic unit of analysis.
-Starting point of the analysis is the make-or-buy decision.
-The governance choice is determined by the frequency of the transaction, uncertainty with the transaction and asset specificity of the transaction.

TCE focuses on transactions between organizations. It therefore has a strong position on the institutional axis. However, because of its focus on costs (as a major performance indicator) it also has a position on the performance axis.

Agency Theory

Descriptive elements:
-Agency Theory is directed at the ubiquitous agency relationship, in which one party (the principal) delegates work to another (the agent).
-The heart of principal-agent theory is the trade-off between the cost of measuring behaviour and the cost of measuring outcomes and transferring risk to the agent (Eisenhardt, 1989).

Agency Theory focuses on the contractual arrangements between two organizations. It therefore has (just as TCE) a strong position on the institutional axis of the framework. Because of the attention to trade-offs of several cost factors, it also deserves a position on the performance axis.

2.4.2 Network Theory, Resource Dependency Theory and Strategic Management

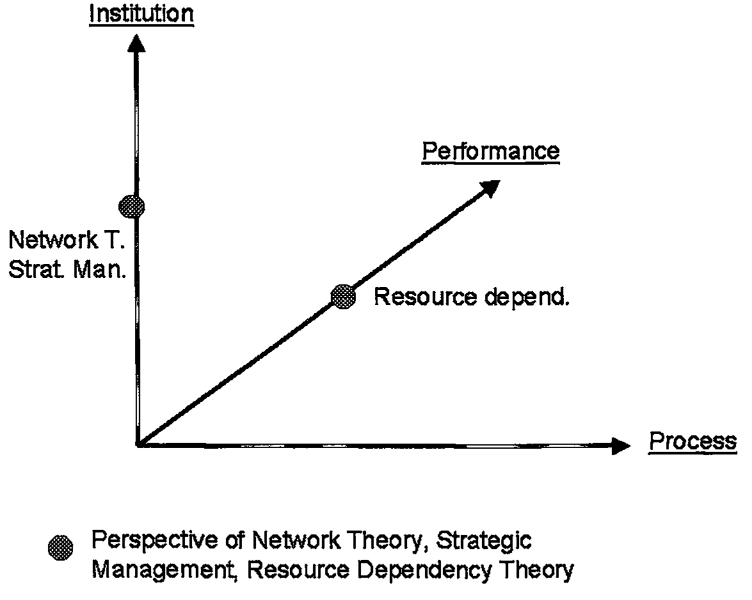


Figure 2.4 Perspectives of Network Theory, Resource Dependency Theory, Strategic Management

Network Theory

Descriptive elements:
-Network Theory views the organization as a node in a network of organizations.
-The necessity to exchange resources brings organizations together and enables networks to emerge.
-Forms of collaboration are not only based on economic motivations; power and trust are key concepts in Network Theory.

Network Theory focuses on institutionalisation processes in a broad sense, therefore it has a strong position on the institutional axis. It also has a position on the performance axis.

Resource Dependency Theory

Descriptive elements:
-Uncertainty concerning resource availability and interdependency are the key issues of resource dependency approaches.
-Much attention is paid to control structures in relation to dependency relationships.
-A firm's capabilities and competencies form the base from which it can achieve a competitive advantage.

Resource dependency approaches focus on relationships with other organizations and their environment. They therefore have a position on the institutional axis. Much attention is also given to performances (capabilities etc.), which gives the approach a strong position on the performance axis.

Strategic Management

Descriptive elements:
As stated before we limit the field of Strategic Management in this thesis to two basic issues:
- the positions of the business within its environment, and
- competitive advantage.

Strategic Management, because of its focus on the position of the company in its environment, has a strong position on the institutional axis of our framework. It also has a (strong) position on the performance axis because of its attention to competitive advantage.

2.4.3 Supply Chain Management and Information Technology.

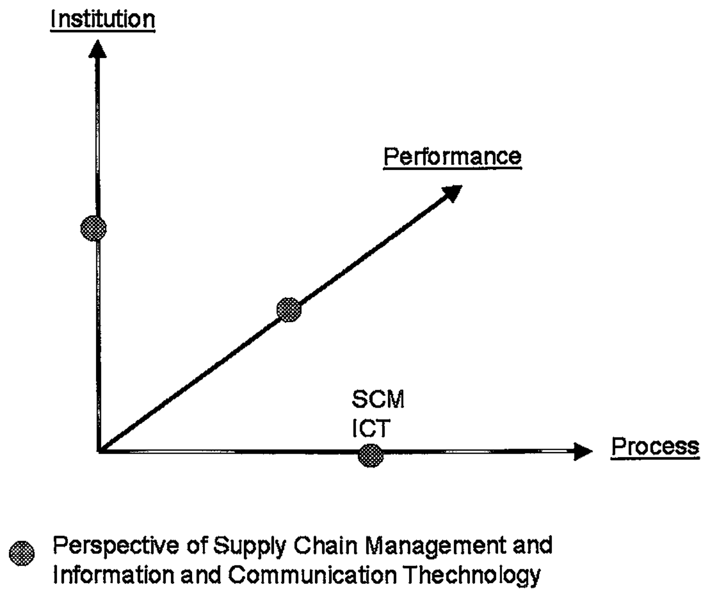


Figure 2.5 Perspectives of SCM and ICT

Supply Chain Management

Descriptive elements:
-Supply Chain Management is "an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user" (Ellram and Cooper, 1990).
-Customer demands lead and initiate the major flows of goods, information, and capital.
-(Customer-)value adding processes are the key object for analysis.

Supply Chain Management has a very strong position on the process axis because of its orientation towards processes. It also focuses on performance of the chain in terms of both customer value and internal performance (quantitative measurements). Recently, it has started to pay (still minor) attention to inter-company relationships.

Information Technology

Descriptive elements:
Information Technology literature has paid major attention to chain processes (e.g. BPR). In a more limited sense it has paid attention to performance (improvement with information technology) and institutional arrangements (e.g. Electronic Data Interchange

literature).

2.4.4 Cost approaches

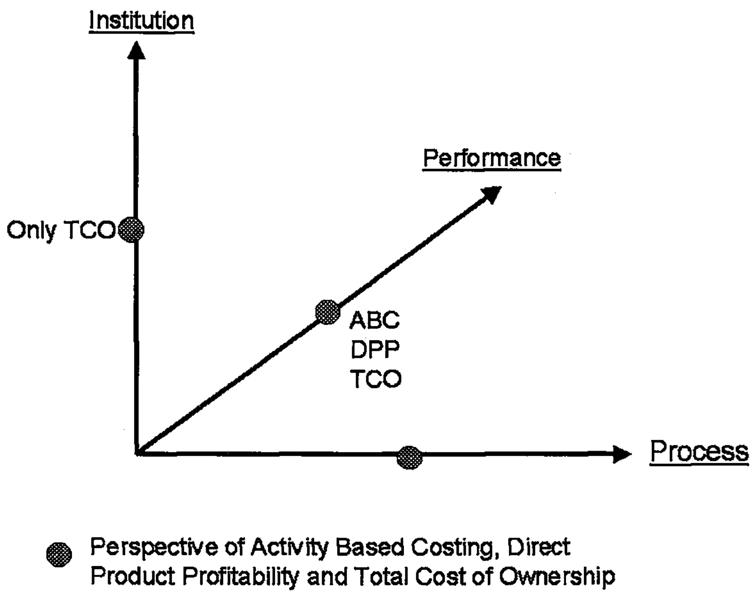


Figure 2.6 Perspectives of ABC, DPP and TCO

Cost approaches

Descriptive elements:
The cost approaches (Direct Product Profitability, Activity Based Costing, Total Cost of Ownership) are all linked to processes in the supply chain (ABC/DPP are stronger than TCO).
This gives them a position on the process axis. Their major attention to performance is (of course) related to costs. This gives them a strong place on the performance axis. Minimal attention is paid to organizational issues in DPP and ABC, although TCO pays attention to inter-organizational relationships.

2.5 Overview and discussion

The scientific approaches presented here all have different purposes and different views of vertical coordination. This also holds true for approaches with the same perspective(s) on chains.

Transaction Cost Economics focuses on how organizational boundaries should be drawn. Agency Theory is concerned with risk assessment and contracts between parties. Both theories are especially useful in studying inter-company relationships.
Strategic Management (as defined in this thesis) is more concerned with the (competitive) position of the company in its environment, which is a far broader view.

A middle position seems to be taken by Network Theory, which is about relations between companies and about positioning the company within a broader (network) reality. A similar approach is taken by the resource based school.

The above mentioned approaches are all grounded in the institution and performance perspectives on chains. Whilst these approaches focus on questions concerning the position of the company in relation to other companies and its environment, Supply Chain Management is more about how a chosen position should be filled in with management structures.

Information Technology approaches are used by, and for the support of, various approaches.

Finally, the cost approaches comprise methods of cost definition.

The table below, gives an overview of the broadness of chain research by depicting the variety of views of chains (and objectives), variables chosen and approaches to practical chain problems, according to Whetten's division (chapter 1).
The Why? question is answered by the view of reality of the approach and, related to this, its general objective. The What? question includes the aspects (of reality) that are considered to be important. The How? question includes the approach to empirical problems.

Table 2.1 Examples of theory elements of various scientific approaches to vertical coordination.

Approach	**Why? (view of reality)**	**What? (aspects/variables)**	**How? (problem approach)**
Transaction Cost Economics	Goal: search for the most appropriate organizational form to govern transactions. Elements in view: -nexus of contracts -bounded rationality -opportunism	Frequency Uncertainty Asset specificity (of transactions)	Make/buy decision
Agency Theory	Goal: contract optimalization. Elements in view: -self interest -bounded rationality -risk aversion	Principal Agent Information	Trade-off between risks and costs of measurement
Strategic Management	Goal: competitive advantage. Elements in view: -market -strategic position	Stakeholders Competitors Market	Strategy building (e.g. cost/ differentiation)
Network Theory	Goal: best network position. Elements in view: - dynamic relationships - power - trust	Nodes Links Market	Building network relationships
Resource Dependency Theory	Goal: resource securement/control. Elements in view: - resource dependency - core competencies	Resources: - information - capital - labour - capabilities	Building supply networks Outsourcing

Approach	Why? (view of reality)	What? (aspects/variables)	How? (problem approach)
Supply Chain Management	Goal: efficient and effective replenishment. Elements in view: - customer orientation - efficiency of processes	Product flow Information flow Processes Coordination	Throughput time reduction Gearing processes
Information Technology	Goal: enable coordination between parties Elements in view: - reduce costs and risks of coordination	Data Process Event Object	Information modelling Sytem building Information technology in products
Cost approaches	Goal: cost minimization. Elements in view: - activity based costing - direct product profitability - total costs of ownership	Process Costs Product Ownership	Define processes as cost centres Assign processes to products Define ownership relationships

It must be stressed that the table only depicts examples and is not exclusive.

In this chapter an overview was given of a variety of scientific approaches to vertical coordination.
Although each of the approaches has a different view of reality, they all have also important elements in common (drawn from the discussion items in section 2.3):
- All approaches mentioned here have roots in (open) system thinking.
- The way organizations collaborate is defined by a complex of factors: economic, social, technical, (network) environmental, etc.
- This makes the relations between organizations often diffuse.
- Environmental dynamics (should) play a role in any analysis on vertical coordination relations.
- Vertical coordination can take many forms, from arm's length to vertical integration.

In the next chapters, theory elements concerning chain processes (process perspective) are elaborated, covering parts of several scientific approaches depicted in the table, especially Supply Chain Management and Information Technology, that have a strong process perspective (figure 2.5). A research framework for analysis and (re)design of chains will be

designed.
Because of the large coherence and interdependence of the three perspectives, elements of the institution and performance perspective will play an important part in elucidating elements of the process perspective. Institutional and performance aspects often constrain aspects of processes and vice versa. For example contract forms (institution perspective) may constrain the way processes are managed (process perspective); performance demands (performance perspective) may constrain the way processes are designed).

Chapter 3 A research framework for chains from a process perspective

3.1 Introduction

This chapter focuses on chains from a process perspective.
In chapter 1 four basic components of the framework were distinguished. In this chapter the following three components are worked out:

- The Why? question in framework building is answered by defining a view of chain processes (section 3.2);
- The What? question in framework building is answered by defining the relevant variables of the framework (section 3.3);
- The How? question in framework building is answered by presenting a method to approach practical chain problems (section 3.4).

The fourth component, which answers the Who?, Where?, and When? questions in framework building, is developed in chapter five by applying the framework to cases.

3.2 A view of chain processes

This section describes major process approaches to business analysis found in the literature. Based on these approaches a view of chain processes is developed.

Modern process approaches originated in the 1980s and were an answer to organizations' search for a dynamic adjustment to increasing market demands: faster deliveries, higher quality and broader assortments of products, safe and animal friendly origin of products, and lower costs. Companies had to change their method of production from supply oriented, in which the technical production processes were in the focus of production management, towards demand oriented in which the marketing orientation becomes the focus.

An important foundation of modern process approaches was laid by Porter and Millar (1985), who introduced the term 'value chain'. A firm's value chain is a system of interlinked processes. Every activity in the value chain adds value to the product or service. (The total value of the product or service a company creates is measured by the amount that buyers are willing to pay for its product or service.)

The value activities of a company fall into nine generic categories, divided into two groups (Porter and Millar, 1985):
-primary activities: inbound logistics, operations, outbound logistics, marketing and sales, service;
-support activities: firm infrastructure, human resource management, technology development, procurement.

"Primary activities are those involved in the physical creation of the product, its marketing and delivery to buyers, and its support and servicing after sales. Support activities provide the inputs and infrastructure that allows the primary activities to take place." (Porter and Millar, 1985). A support activity supports (all) primary processes in the value chain.

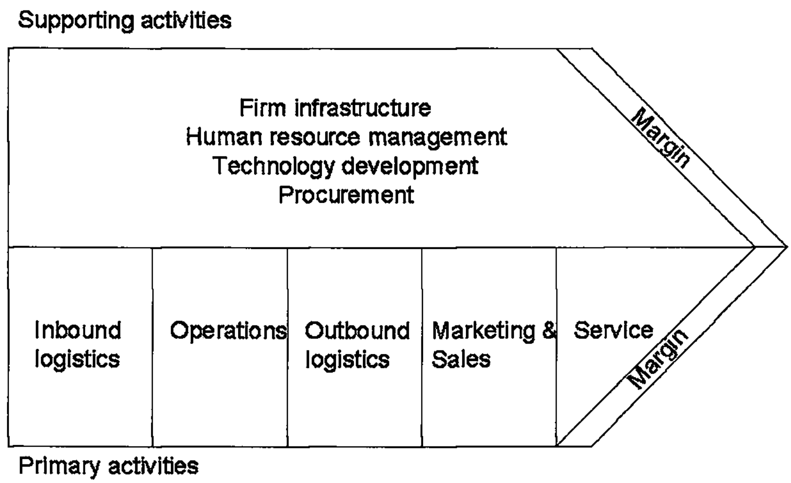


Figure 3.1 Porter's Value Chain

In line with the value chain of a single company, several companies can form a 'value system' in which the value chains of individual companies are linked.

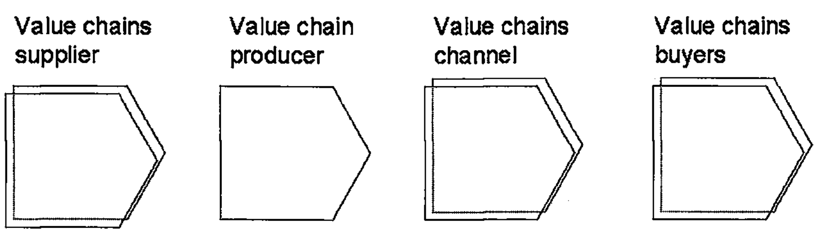


Figure 3.2 Porter's Value System

In the literature, several process oriented approaches for redesign or improvement of organizations can be recognized. The most significant are Business Process Redesign (BPR), Total Quality Management (TQM) and sociotechnics. These approaches have a broad, interdisciplinary concept of business processes. An approach in production management literature, which has several important similarities to these three approaches, although it is not recognized as a process approach, is Group Technology (GT).

Several other process approaches can be found in the literature, which are used by particular disciplines as a means for analysing the companies' processes: e.g. Activity Based Costing in the business economics discipline, Quality Function Deployment in the quality management discipline and a number of methodologies in the information systems discipline.

3.2.1 Business Process Redesign (BPR)

BPR was introduced in the early 1990s by Hammer (1990), Davenport and Short (1990) and others. BPR aims at drastic improvement of the performance of organizations through fundamental redesign of business processes. Hammer and Champy (1993) define (Business Process) Reengineering as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed".
'Fundamental' in this respect means that BPR incorporates a critical view of all existing activities of the company in order to design new activities that are better in line with market/customer demands. BPR therefore aims at finding the right activities for an organization instead of improving existing activities. BPR does not aim at a one-time business redesign operation, but it seeks to create organizations that have the ability to improve continuously.

Process definition in BPR

Davenport(1993) defines ".. business process as a set of logically related tasks performed to achieve a defined business outcome" in support of the organization's objectives.

Processes, according to Davenport, have two important characteristics (Davenport, 1993):
- They have customers; processes have defined business outcomes, and there are recipients of the outcomes. Customers may be either internal or external to the firm.
- They cross organizational boundaries; they normally occur across or between organizational subunits. Processes are generally independent of formal organizational structure.

Hammer and Champy (1993) emphasize, in line with Porter, the value adding character of processes: "... by process, we simply mean a set of activities that, taken together, produce a result of value to a customer".

Harrison & Pratt (1993) state that "The underlying premise of business reengineering is that work should be broken down not by functions, but by value-added processes that cut across traditional functions such as marketing, sales and manufacturing. One of the main aims of BPR is in fact to get rid of the traditional borders between departments".

Cypress (1994), in line with these thoughts, defines a process as "a cross functional set of activities".

Processes in BPR thus have customers, are cross-functional and can go beyond the borders of departments and companies.

BPR, however, has a broader view on 'process', in the sense that it views a process not merely as a set of activities aimed at an expected output. 'Process' also means an organizational unit with resources (human and others) that aim at a certain goal. Redesign of the business processes therefore always takes place concurrent with restructuring the organization, human resources management, technical resource management, use of information technology, etc.

A major instrument in Business Process Redesign is the use of information technology (e.g. Davenport, 1993; Earl, 1989). In the past, IT was often only used to speed up existing activities and to make them cheaper by exchanging labour force for IT (Hammer, 1990; Earl, 1989). In BPR, IT is used to restructure business processes. However, IT is not the only instrument with which BPR can be performed. Examples of other important instruments are restructuring the organization, new process and product technology, and restructuring of management systems (e.g. integral quality management).

In recent years BPR has also made use of the gains of other management approaches. For example, Kettinger et al.(1995) also consider step-by-step improvement as a form of business process reengineering. They define Business Process Reengineering as "an organizational initiative to accomplish strategy-driven (re)design of business processes to achieve competitive breakthroughs in quality, responsiveness, cost, flexibility, and satisfaction. These initiatives may differ in scope from process improvement to radical new process design". By doing this they in fact incorporate characteristics from other management approaches into BPR.

One management approach that aims at step-by-step (and continuous) improvement of business processes is Total Quality Management (TQM).

3.2.2 Total Quality Management (TQM)

Total Quality Management emerged in the 1980s out of several quality improvement theories and techniques that had been developed since World War II. Well-known names in this respect are Deming, Juran and Feigenbaum.

"Total Quality Management (TQM) is the integration of all functions and processes within an organization in order to achieve continuous improvement of the quality of goods and services. The goal is customer satisfaction" (Ross, 1994).

TQM aims at major improvement, and at a lower organization level like BPR also at redesign, of existing processes. Once this has been achieved, it aims further at continuous improvement of customer value, productivity, reduced cycle times etc. In TQM quality is a result of the quality characteristics of the product; but it is also equally a result of the quality of the production processes that lead to the product (from design to final assembly). Product quality must therefore not be accomplished by regulation and control of materials characteristics only, but also by enabling high quality process management with the right resources. This requires a strong focus on the measurement of processes and the efforts to make them manageable. A basic element is also the notion that quality applies to all functions of the business, not just manufacturing.

> In the Dutch pork chain an integral quality management (IQC) project has been carried out. Through IQC, a system of integral quality assurance and environmental assurance has been developed for the biggest part of the chain. Emphasis is put on sustainable production, environmental and animal welfare issues (matters of hygiene, residues in meat products, the use of medicines, animal food characteristics, etc.). Major elements of IQC are the adjustment of the production processes of the chain participants and the exchange of identification and registration data, recording source, production characteristics and process characteristics of the meat products. The system regulations are designed by the Dutch Product Board for Livestock, Meat and Eggs (PVE) and controlled mainly by the slaughterhouses. It was implemented by the Dutch Board of Livestock and Meat in 1992 (PVV, 1995) and has lead to less use of medicines and to fewer losses during the slaughtering process. This system reflects the significance of an integral product and process quality control system.

Aspects of human resource management play a significant role in TQM. Concepts like 'empowerment' and 'teamwork' are key issues. Empowerment aims at reduction of hierarchical structures and increased autonomy on the work floor. Teamwork must enable process flexibility and a highly motivated workforce to improve customer satisfaction. Several quality control approaches in the literature stress the importance of teamwork on the work floor. An often-heard term in this respect is quality circle (Dean and Evans, 1994), which concerns a group of workers on the work floor who are working jointly, as a team, at continuous improvement of product and processes.

Although TQM is in part a bottom-up approach (an important share of quality improvements finds its origin on the work floor), an essential part of TQM concerns top-down translation of the company's strategy on quality issues (Zuurbier et al., 1996):
- Policy deployment; management must translate company goals into quality care activities at several management levels in the organization.
- Process management aims at the translation of customer demands throughout the chain of processes within the company.

Just like in BPR theory, the customer plays a central role in TQM. In TQM literature a distinction is made between internal (within the company) and external customers. Also, direct customers can be recognized as well as indirect customers (e.g. staff departments, governmental organizations). Quality output should be provided to internal as well as external customers, and to direct as well as indirect customers.

Similar to BPR, TQM has a broad process concept. In modern quality management literature this comprehensive view of processes is underlined, for example by Juran and Gryna (1993): "We define a business process as any goods or non-goods-related cross-functional process of critical importance which will be managed by a permanent team. [...] Like all processes, a business process involves an organization of people, material, energy, equipment and procedures designed into work activities to produce a specific output".

The third process oriented management approach described here originates from both social sciences and engineering.

3.2.3 Sociotechnics

Sociotechnics is an applied science that aims at joint improvement or redesign of contents and composition of technology and human tasks. It originated in the 1950s at the Tavistock Institute of Human Relations in England. The approach was further developed in the Netherlands and has similar elaborations in some Scandinavian countries. Its most well-known representative in the Netherlands is De Sitter (Eijnatten, 1996).

In the sociotechnics approach, process control is a key issue. Control in this respect means interfering with the process when a deviation occurs in the (expected) output. An important distinction can be made between routine and non-routine control. Routine control means that existing control steps and regulations must be performed in which the intellect and creativity of the controller are of no importance. On the other hand, during non-routine control the controller is confronted with a new situation in which knowledge, insight and creativity become of main importance. The larger the variability of processes, the larger non-routine control usually becomes (De Sitter, 1982; Kuipers and Van Amelsfoort, 1990).

From an organizational point of view, sociotechnics aims at simple structures with complex tasks (De Sitter et al., 1990). A major notion in this respect is that variances must be dealt with at the level at which they occur to reduce complexity and enhance control. This means that on the level of the process enough control capacity must be available to handle variance. Control, therefore, must be integrated in the processes themselves and must be incorporated in the responsibilities and authority of associates involved. It is especially at the level of non-routine control that the social science aspect of sociotechnics comes in.

Four basic principles of self-organization can be recognized (Kuipers and Van Amelsfoort, 1990; derived from Morgan, 1986):
- Redundancy of functions: multi-deployability of human resources (minimal division of labor) makes the group more flexible in its actions.
- Requisite variety: diversity in control capacity must conform variety in tasks and the uncertainties the group has to cope with.
- Minimal critical specification: only critical tasks will be specified, to maintain maximal space for self-control.
- Double loop learning: single loop learning aims at perfecting routines in relation to a given set of norms. Double loop learning aims at discussing these norms themselves.

Organizational learning is considered a key area of attention in relation to organizational redesign. In this respect sociotechnics leans on literature about learning organizations. Garvin (1993) states that "a learning organization is an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behaviour to reflect new knowledge and insight".

Senge (1990) recognizes five 'component technologies' that are of importance for the learning process in organizations:
- Systems thinking, which means seeing the whole as an interrelated set of elements rather then looking at each element individually.
- Personal mastery, which is "the discipline of continually clarifying and deepening our personal vision, of focusing our energies, of developing patience, and of seeing reality

objectively".
- Mental models, i.e. "... deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action". Mental models in organizations are very powerful in preserving current situations. Questioning these models is a pre-condition to organizational learning.
- Building shared vision: "When there is a genuine vision (....), people excel and learn, not because they are told to, but because they want to".
- Team learning. Senge states that a team, and not an individual, is the fundamental learning unit in organizations.

Of these five disciplines systems thinking is the one that integrates them "into a coherent body of theory and practice".

3.2.4 Group Technology

Group Technology is a method of factory organization in which organizational units known as groups complete all the products or parts they make and are equipped with all the processing facilities and knowledge they need to do so (Burbidge, 1991).

Although not recognized as a process approach the organizational unit of Group Technology (the "group") is similar to "process" as used by BPR, TQM and sociotechnics:
- people in a group work as a multifunctional team,
- groups work autonomously on finished products or parts.

Major advantages of GT are (Burbidge, 1991):
- short throughput times (because groups complete parts and machines are close together under one foreman),
- better quality (teamwork, one foreman),
- lower materials handling costs (less materials flows),
- better delegation and accountability (machines are close together, a group works like an autonomous entity),
- training for promotion (the team consists of generalists with a broad range of opportunities),
- preparation for automation (GT is the first evolutionary step in automation),
- increased capacities (reduced set-up times due to easier sequencing),
- increased job satisfaction (working as a multifunctional team).

3.2.5 Overview

The three process approaches described here all have a comprehensive process concept in which customer orientation is essential. Their main aim is organizational improvement.

BPR has a top-down approach and aims at drastic improvements. The organization's structure has to be deduced from the processes to be (re)designed. BPR has been most successful in administrative business environments like the insurance and banking businesses. Related to this, information technology is considered a major enabler of BPR.

TQM incorporates both a bottom-up and a top-down approach: quality improvement must come from both the shop floor and from management regulations and support. A change of the organization's culture is regarded to be of great importance by TQM. Because of the step-by-step improvement approach, existing company structures often remain unchanged.

In sociotechnics improvement of the organization has to come from both a top-down approach (redesign) and a bottom-up approach. In the past, sociotechnical redesign projects started with the technical subsystem; changes in the social subsystem were deduced from this. In more recent approaches, however, redesign of the social and technical subsystems are executed jointly. In several points modern sociotechnics combines aspects of BPR and TQM. Just like TQM, sociotechnics has been applied mostly in industrial business environments (Eijnatten, 1996; Ross, 1994).

Group Technology is starting to have a wide range of applications in which several advantages of working in groups as described above are recognized (Burbidge, 1991).

3.2.6 Other process approaches

Besides BPR, TQM and sociotechnics, there are a number of methods in management sciences that use a process oriented approach. Most of these, however, have a narrower concept of process, i.e. they pay attention to a limited number of process aspects.

Olle et al. (1991) distinguish three different perspectives used by information systems methodologies:
- data oriented perspective (starting at the analysis of real-world entities),
- process oriented perspective (starting at the analysis of business activities),
- behaviour oriented perspective (starting at the analysis of time-dependent events).

In many methodologies a combination of the process and data perspective is applied.
The process oriented perspective was the first to appear during the evolution of information systems (Olle et al., 1991). Olle et al. give a number of examples of process oriented information system methodologies:
-IEM: Information Engineering Methodology. IEM covers several stages of information systems development, and combines process and data orientation at each stage.
-ISAC: Information Systems Work and Analysis of Change is a process oriented methodology concerned primarily with information systems planning, business analysis and system design.
-JSD: Jackson System Development models the business application as a network of communication processes.
-SADT: Structured Analysis and Design Technique combines a process orientation with a data orientation. The method is mainly applicable for business analysis.

QFD (Quality Function Deployment) aims at the translation of customer requirements into demands towards product development and production process characteristics throughout the chain (Ross, 1994). The following steps are recognized:
- Customer attributes are compared to product characteristics.
- The most important product characteristics in this respect are translated to demands towards raw materials and process characteristics.
- Critical points in the production process are identified and control characteristics (e.g. options, frequency) are defined.

- Critical points are translated into working instructions along the process.
Major attention in QFD is paid to product and process technological parameters.

ABC (see also chapter 2) is a cost accounting approach in which costs are accounted to processes. From then on, product costs can be relatively easily computed. ABC can be used to get a clear picture of the costs of activities, materials and end products in companies. In most companies, many of the costs are treated as indirect costs and accounted equally along the activities and products.

3.2.7 View of chain processes in this thesis

In the view developed here, a chain consists of processes that are considered to be the links in the chain. The focus of this thesis is therefore on processes, not on the functional organization of chains.

The process view is summarized in the table below.

Table 3.1 View of chain processes

Answers to the Why? Question of framework building: a view of chain processes
This thesis follows the broad process approach of BRP, TQM and sociotechnics. Applying this approach to chains gives us the following view of chain processes: a chain consists of a network of processes with precedence relationships that are linked by the flow of products, information and/or money. Chain processes have the following characteristics: - they transform input to output, - they are output/customer oriented, - they are cross-functional (and may cross organizational borders), - they are considered to be units with resources, - in (chain) processes human resources can play an important role in process management (e.g. teamwork in semi-autonomous units), - they posses internal management mechanisms tuned to external management mechanisms.

3.3 Variables in the research framework

In the previous section a view of chain processes was delineated, answering the Why? question with regard to the research framework to be developed. In this section relevant variables of the framework are defined. Attention is paid not only to physical aspects of processes, but also to the way they are managed. For the identification of the variables, a division is made between the part of the chain that has a management function and the part that is being managed.

Several authors make this distinction between managing system and managed system. Ansoff (1969) and Keuning and Epping (1979), for example, make a distinction between management processes and transformation processes. And according to Brevoord (1991) "The transformation processes are designed, structured and managed by the management processes". In this thesis the management paradigm of De Leeuw (1982) is followed (figure 3.3).

De Leeuw makes a distinction between management processes (executed by a 'managing system') and managed processes (in a so-called 'managed system').

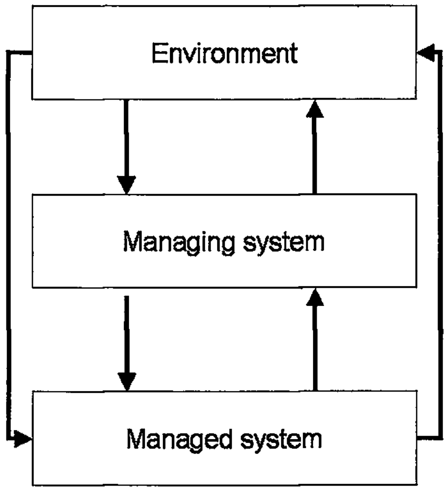


Figure 3.3 The management paradigm

Management processes are processes that plan and control managed processes. Both have relationships to the environment, i.e. by means of exchange of products and/or information.

The paradigm can be used to model any management situation to be defined by a researcher. This means, for example, that a managing system recognized as such in one perspective, can be modelled according to the management paradigm in another perspective. For example, decisions taken within the borders of a production system in an organization can be regarded as part of the managed system as far as higher management levels are involved, however, they could be part of the managing system from the viewpoint of the production manager. An important implication of this view is that (management) decisions can be taken at the level of the managing system and the level of the managed system. We will elaborate on this further in the next section.

3.3.1 Managed system variables

In the literature, several authors make a distinction between design/structure of a system and operation of a system. Kampfraath and Marcelis (1981) make a distinction between creation of capacities (design management) and use of capacities (management of operations). Silver et al. (1998) and Van Beek (1987) make the distinction between operation and design of a system. Beulens (1996) makes a distinction between configuration/infrastructure and operations.

In this thesis the distinction of Beulens between infrastructure and operations of a system is followed. The infrastructure defines the chain structure through which products, information, and/or money flow. The flow of products, information, and/or money constitutes the operations of a chain. Besides these two elements a third is defined: the object system. The object system decribes the intrinsic characteristics of the object under study. By including the object system as a separate element, it is possible to make a specific identification of the constraints put on the infrastructure and operations by specific product and process characteristics.

The object system

The chain object system is defined by typical (intrinsic) characteristics of product (e.g. perishability) and process (e.g. throughput times). Depending on the research area, these characteristics can be further specified (in chapter 4 the characteristics will be specified for logistics).

The infrastructure

Depending on the research area, typical chain infrastructures can be defined: the logistics infrastructure for logistics, the marketing infrastructure for marketing, the information infrastructure for information systems, etc. An important element of any chain infrastructure is the configuration of processes and resources (in a network with precedence, time and place relationships). Another important element is the product flow (e.g. choices with regard to the location of a stock point in the logistics infrastructure).

Operations

At this level chain operations take place. Operations are performed using the relevant infrastructure(s), within object system constraints. The aim is to bring goods, services, information, etc. to the customer given a certain demand. Process performance issues are directly related to chain operations. Performance can be expressed in (chapter 2): quality, time, costs, flexibility and environment. The operations element of the framework forms an important link to the performance perspective on chains (chapter 2). As will be described in section 3.3, demanded performance is the starting point of any chain analysis.

3.3.2 Managing system variables

In this thesis, management is regarded as synonymous with decision making (following Simon, 1960). Three aspects of management are distinguished: decision levels, type of decision making, and coordination mechanisms. Coordination mechanisms facilitate coordination between decisions.

Decision levels

Many authors have underlined the importance of a hierarchically structured decision function (Anthony, 1988; Wild, 1979; Meal, 1984; Burbidge, 1990; Bertrand et al., 1990; Slomp ,1993).

According to Slomp (1993), several arguments can be given to justify a hierarchical approach to the analysis and design of a management function:
- reduction of complexity,
- separation of short, medium and long term aspects,
- improved stability and controllability.
He states that "without hierarchical decision structure all (interrelated) (...) control problems are affected by any disturbance".

Reduction of control complexity is achieved by separating various decision levels, thus reducing the span of control of management on these levels and making the several parts of the system less sensitive to disturbances in other parts. Aggregate planning on the higher levels also provides consistency in control for various stages in the process, which in turn improves stability.

Higher level decisions have longer planning horizons and are concerned with aggregates such as total demand, total resource requirements, and investment decisions. Lower level decisions have shorter planning horizons and are concerned with individual items. Meal (1984) states that "this hierarchy arises from differences in the lead times needed to execute decisions, the planning horizons for analysing and evaluating choices, and the magnitude of the costs affected by the decisions. The hierarchy is natural in the sense that long lead-time decisions necessarily constrain short lead-time choices."

Anthony (1988) distinguishes three types of planning and control activities (decision levels):
- Strategic planning "is the process of deciding on the goals of the organization and the strategies for attaining these goals".
- Management control "is the process by which managers influence other members of the organization to implement the organization's strategies".
- Operational control: "task control is the process of ensuring that specific tasks are carried out effectively and efficiently".
The boundaries between these three levels of decisions are often not sharp when they have to do with time, organizational level, goal of the decision, and characteristics of information used.

With respect to the goal of decisions, the following translation of the three levels is made:
- Strategic planning issues concern, among other areas, choices with regard to product/market combinations and the processes involved in producing the output and investments necessary.
- Management control concerns deployment of the available resources to processes.
- Operational control concerns product flow management.
Keen and Scott Morton (1978) elaborate on Anthony's division. They distinguish between decision levels based on the characteristics of the information used:

Table 3.2 Information characteristics by area of decision.

Task (decision) Variables	Strategic planning	Management control	Operational Control
Accuracy	Low	<---------->	High
Level of Detail	Aggregated	<---------->	Detailed
Time-horizon	Future	<---------->	Present
Frequency of use	Infrequent	<---------->	Frequent
Source	External	<---------->	Internal
Scope of Information	Wide	<---------->	Narrow
Type of Information	Qualitative	<---------->	Quantitative
Age of Information	Older	<---------->	Current

<u>Type of decision making</u>

The second element of the managing system is type of decision making. Decisions can be the result of various types of decision making processes.

According to Simon (1960) rational decision making presupposes complete information availability and the tools/intelligence necessary to choose the decision that offers maximum profit/returns. Most problems, however, are too complex and too much surrounded by uncertainties to make a rational decision possible. In practice, usually limited information is available and decision makers do not have the proper tools to find the maximum return decision.
Simon in this regard makes a distinction between 'bounded rationality' (limited information and tools availability), as opposed to 'objective rationality' (complete availability of information and tools). Because of this 'bounded rationality' the choice in most decision making situations is for so-called 'satisficing' decisions: "most human decision-making, whether individual or organizational, is concerned with the discovery and selection of satisfactory alternatives; only in exceptional cases is it concerned with the discovery and selection of optimal alternatives".
Bounded rationality implies in practice that ('satisficing') decisions are often made on the basis of relatively simple models of real systems. By using simplified models, the decision maker tries to decrease the complexity of the decision problem.

Simon distinguishes between two types of decisions: programmed and non-programmed decisions. The distinction is related to the type of problem to be handled:
- Programmed decisions can be made when the problem under consideration is structured: it has a repetitive or routine character or a procedure is available. Techniques for programmed decisions are related to existing procedures. An example is an ordering system in which ordering decisions depend on stock levels.
- Unprogrammed decisions apply to problems that are unstructured in the sense that they are new or no procedure is available. The techniques to make this kind of decisions are related to terms like vision, intuition, and especially creativity. An example is decisions related to unexpected situations a business is confronted with.

Cyert and March (1963) extend Simon's view by viewing the firm as an 'adaptively rational' system. The firm responds to a variety of internal and external constraints in arriving at decisions. Organizational aspects are of key importance here. Keen and Scott Morton (1978) interprete this idea as follows. "Cyert and March focus -as organizational theory would suggest- on the effect of organizational structure and conventional practice on the development of goals, the formulation of expectations and the execution of choice."

Keen and Scott Morton (1978) (Benders et al., 1983; Brevoord, 1991) conclude that there are five approaches to decision making:
- the 'rational' way of decision making, in which the manager is completely informed, knows all the decision alternatives and can make an optimal choice,
- the 'satisficing' way of decision making, in which a decision alternative is sought that satisfies all participants (in the following the term 'satisfying'will be used instead of 'satisfycing'),
- the 'organizational procedures' way of decision making, which sees "decisions as the output of standard operating procedures invoked by organizational subunits",
- the 'political' way of decision making, in which a decision is seen as a result of negotiations between actors; power and influence determine the outcome of any given decision,
- the 'individual differences' way of decision making, which presupposes a very important role for the character of the individual, and in which personality and style are of great importance.

"These five conceptions of the decision process range from the entirely normative to the entirely descriptive."

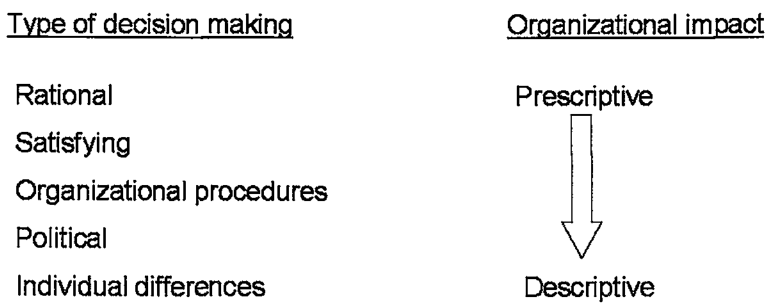


Figure 3.4 Relation between type of decision making and organizational impact

In most decision making situations aspects of several approaches will play a role.

Coordination mechanisms of Galbraith

The third element of the managing system is comprised of coordination mechanisms. Coordination mechanisms reflect an important link between the process perspective and the institution perspective on chains. They make coordination between decisions possible. Coordination mechanisms will be described in a general sense, as supporting elements in decision making. Organizational, legal, social, etc. impacts of coordination mechanisms belong to the institution perspective on chains.

Galbraith (1973) sees organizations as information processing systems. The more complex the tasks of an organization are, i.e. the more exceptions to the rule that exist, the more loaded the information channels in the organization are. Galbraith (1973) describes several organizational strategies to handle complexity of management in organizations. He distinguishes between 'mechanistic' solutions and 'organic' solutions to complexity.

Mechanistic solutions:
- Primary coordination mechanisms are made up of rules, procedures and programmes. These are satisfactory if the organization is able to anticipate different work situations it is confronted with.
- If an organization that depends on rules is confronted with new, unknown situations, no suited reaction can be given. If the organization wants, however, to develop proper reactions to unknown situations it is necessary to introduce new levels of decisions that have an overview of all the tasks/processes that can be influenced by these reactions. Hierarchy is then chosen as a coordination mechanism (as a supplement to rules).
- If, however, because of an increase in exceptional situations, an information overload occurs in bureaucracies, a third solution can be to delegate decision making as much as possible to lower levels in the organization by way of terms of reference (task-setting). Task setting leaves room for freedom of acting on the level of sub tasks. Task setting

includes product specification, lead times, resources, etc. Adaptation of tasks to be set is done through hierarchic channels in the organization.

However, also in this last situation, an overload of hierarchic channels can occur. Galbraith therefore defines basic strategies to handle complexity in organizations, strategies with an organic character:

- Reduce the amount of information that flows through the hierarchic channels:
    - Build in slack: enlarge capacities (for the same tasks) or decrease output (qualitative/quantitative).
    - Create autonomous tasks: rebuild the organization by grouping tasks into autonomous units that have sufficient control over the means needed (e.g. to produce a certain product, or to serve a certain market). The organization structure in that case is no longer based on inputs, means, competencies or professional categories, but is based on output or market categories (compare the process approach in section 3.2). Creation of autonomous tasks leads to less information processing because of less output diversity per capacity group and less division of labour.
- Increase the information processing capacity:
    - Invest in vertical information systems.
    - Create lateral relationships: let decision making in organizations take place where information is already available. Decision making is improved by allowing communication between people at the same hierarchical level in the organization (in different departments or organizations).

An organization can choose one strategy or a combination of these.

<u>Overview of managing system components</u>

Table 3.4 gives an overview of the different components of the managing system recognized. No specific relationships between elements are depicted. Roughly, relationships between the elements are strongest at the same horizontal level in the figure (e.g. rules as a coordination mechanism are often related to rational decision making, which again is often related to operational decisions).

Table 3.4 Relations between decision level, type of decision making and coordination mechanism

Decision level	Decision type	Coordination mechanism
Operational control	Rational	Rules/procedures
		Hierarchy
	Procedural	
		Information systems
Management control	Satisfying	Slack
		Task setting
	Political	
		Autonomous tasks
Strategic planning	Individual differences	Lateral relations

Importance of enabling technologies

Characteristics of the managed system (object system, infrastructure) constrain in large part decisions and coordination mechanisms. On the other hand, strategic decisions may alter the object system (e.g. investment in product and process technology) as well as the infrastructure (e.g. choice of a stock point). In this respect, Beulens (1996) stresses the importance of Enabling Technologies for any management system. Enabling technologies can change typical characteristics of the object system (e.g. shorten throughput time of administrative processes), can enable (new) configuration/infrastructures (e.g. decoupling the flow of goods from the flow of information by information technology), can support decision structures (e.g. rationalize decision making) and can enable coordination mechanisms (e.g. lateral relations by intensive information exchange between parties).

3.3.3 Overview framework variables

Table 3.5 depicts the variables used in the research framework.

Table 3.5 Managing and managed system variables

Managing system	Managed system
Decision levels	Operations
Type of decision making	Infrastructure
Coordination mechanism	Object system

These variables answer the What? question of framework building in this thesis.

3.4 Development of a method for chain research

In the previous sections the Why? and the What? questions with regard to the research framework were answered. In this section the How? question will be answered.
To analyse chains from a process perspective the following steps are proposed:

- definition of the research objective (section 3.4.1),
- demarcation of the chain (section 3.4.2),
- definition of chain processes (section 3.4.3),
- decomposition into chain process units (section 3.4.4),
- design of a chain managing system and chain process interfaces (section 3.4.5).

3.4.1 Definition of the research objective

Any research on chains should start with a goal. The general goal in this research is chain improvement, i.e. chain performance improvement. Given a performance problem or a performance demand, a strategy can be chosen which is the basis for analysis and (re)design.

The precise contents of performance demands and how these arise are not subjects of this thesis. They are considered to be given entities. (In chapter 2 the following dimensions of performance were defined: quality, time, costs, flexibility and environment). This thesis deals with how to translate performance demands into (re)design options for chains.

3.4.2 Demarcation of chains

In this step the chain (end)customer is defined as well as processes that belong to the chain. Depending on the chain demarcation, the end-customer in a chain can be the end-consumer or a chain process.

3.4.3 Definition of chain processes

Relevant activities are grouped into processes that can be linked to a chain (compare Porter's Value System, section 3.1.2).

Important issues that arise are
- type of processes the analysis focuses on, primary or supporting,
- scope of analysis, i.e. what processes are considered to be involved in producing the output of the chain.

<u>Primary and support processes</u>

Processes can be divided into (Porter, 1985)
- primary processes: which are directly focused on the product flow (e.g. Davenport, 1993; Hammer and Champy, 1993),
- support processes: which support the primary processes. Examples of supporting processes are the business organization, its financial and information systems and its human resource management (see e.g. Beers et al., 1994).

A primary process in this thesis is considered to be a process that is directly linked to (producing) the output of the chain. For example, primary processes in production chains concern activities like receiving raw materials, producing the product, storing and conditioning the product, selling, delivery and service.

Figure 3.5 shows an example of the apple chain

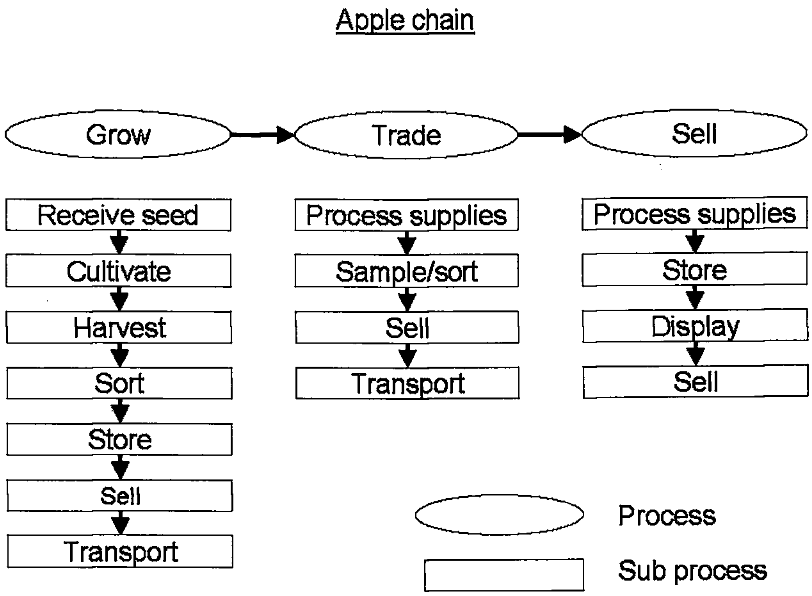


Figure 3.5 Processes in the apple chain

Chains with the same object system will generally have similar primary processes. However, most chain object systems allow various solutions concerning the supporting processes.

For example, figure 3.6 depicts two chains with the same chain object system, but with different organizational structures.

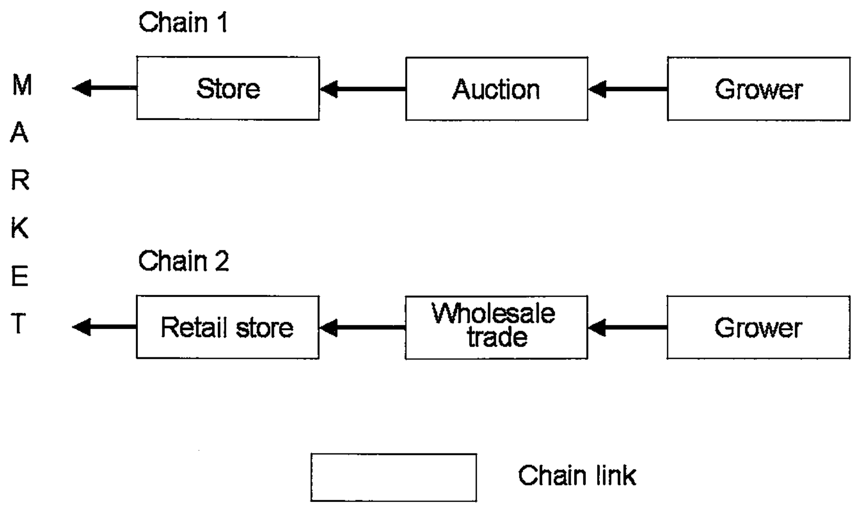


Figure 3.6 Two apple chains with different organizational structures

In relation to the different organizational structures a chain can take, Stern et al. (1996) recognizes three important principles in the structure of marketing channels:
- One can eliminate or substitute institutions in the channel arrangement.
- The functions ('primary processes' in our terms) these institutions perform, however, cannot be eliminated.
- When institutions are eliminated, their functions are shifted either forward or backward in the channel and, therefore, are adopted by other members.

In this thesis primary processes in chains form the basis for chain analysis and (re)design. Non-primary processes (financial, human resources, a.o.) play a secondary role. They are/should be constructed to support primary processes.

In line with the process approach in this thesis, a primary process
- transforms input to output
- is output oriented
- is cross functional
- is considered to be a unit with resources
- posseses internal management mechanisms tuned to external management mechanisms.

Primary processes in chains can be studied on various abstraction levels. The abstraction level can vary from activities, to groups of activities, to organizations, to groups of organizations (for example: an activity can be considered a primary process, a production unit can be considered a primary process, a trading company can be considered a primary process, a multi-plant production company can be considered a primary process, etc.).

Scope of analysis

A chain is considered as an output oriented entity. Essential in the research approach taken here is that the product of the chain (as demanded by the customer) is the starting point of any analysis. From this demand the primary processes involved in producing the chain product can be traced upstream through the chain.
Vermunt (1996) makes a distinction between supply chain management and demand chain management. In supply chain management the chain is managed starting with the availability of raw materials, semi-finished and finished products. In demand chain management the chain is managed starting with market demand.
Here this difference is translated to a difference in a demand chain and a supply chain approach in analysis. In a 'supply' chain approach the analysis starts at primary producers and ends at the market. In a 'demand' chain approach the analysis starts with the requested output (in terms of market demands). The processes linked to the chain output should be traced upstream and subsequently downstream through the chain. For example, in logistics this reflects the upstream flow of orders and the downstream flow of products.

3.4.4 Decomposition of chain processes

The fourth step in the method for chain analysis and (re)design is decomposition of chain processes.
An important goal of decomposition is to reduce complexity of the object of analysis (Bemelmans, 1994; Bertrand, 1990). In chain (re)design, besides reduction of complexity, another goal of decomposition is to achieve a process configuration that is responsive to the market (Beulens, 1997). Responsiveness can be defined as the ability to respond to (changes in) the demands of the customers: the demanded product/service in the demanded quantity, quality, within narrow time limits, and at the right costs within certain margins.

Decomposition for chain analysis and (re)design purposes therefore has two goals:
- Reduction of complexity. Decomposition aims to reach a structure of decomposed, though interrelated, processes with maximal internal cohesion and minimal external cohesion. This is done to arrive at a simple analysable process configuration.
- Achievement of a market/output oriented structure of chain process units. On the one hand, this is related to reduction of complexity, to achieve a process configuration with manageable complexity. On the other hand, its goal is to achieve a responsive (output oriented) chain infrastructure (Beulens, 1997).

Decomposition types

In this thesis, three forms of decomposition are proposed:
1. Vertical decomposition (segmentation): processes can be divided in sub-processes with precedence relationships.
2. Horizontal decomposition (parallelization) (e.g. Van Eijnatten, 1996): complex flows of goods can be separated in several simpler flows, e.g. products in a chain can be grouped into logistic product categories with the same demands regarding ordering, transportation, and delivery. These again can be assigned to process units.

In addition to vertical and horizontal decomposition (well known in the literature) there is also management decomposition:
3. Management decomposition: type and contents of a managing system can be of (great) influence on the process configuration to be designed. Decision levels, type of decision making or coordination mechanisms can all lead to decomposition choices. (Consider, for example, processes that are split up in process units in which more or less rationalized decision making takes place; or processes that are split up by organizational borders).

The three types of decomposition can be performed with the help of the framework variables: object system, infrastructure, levels of decisions, type of decisions, and coordination mechanisms. Operations characteristics (performances) are not taken into account in the decomposition process. On the contrary, they might initiate the improvement strategies that lead to chain analysis and (re)design.

<u>Examples of decomposition criteria</u>

Criteria related to object system:
- product characteristics: e.g. processes can be decomposed according to the products they produce (parallellization),
- process characteristics: e.g processes can be decomposed according to similarity in lead times.

Criteria related to infrastructure:
- time relationships between processes: e.g. processes, such as order picking and transportation, that are performed in different time frames could be split up,
- precedence relationships: e.g. two processes preceding another process, such as order picking from different product groups for the same market, could be merged to enable integral control,
- place relationships: e.g. activities in the same location might be regarded as one chain process,
- economies of scale considerations (shared usage of resources).

Criteria related to coordination mechanisms:
In a dynamic (process) environment with high demands towards process responsiveness, the following coordination mechanisms could be chosen:
- Building in slack: e.g. merging of processes to create units with larger capacity that can handle demand deviations better.
- Autonomous tasks. Responsiveness of processes can be increased by (see earlier this chapter):
    - interdisciplinarity
    - cross functionality
    - enough control capacity to handle demand dynamics
    - minimal critical specification of tasks
    - organizational learning and team building.
- Information systems and lateral relationships (which can increase interprocess responsiveness): e.g. building processes with their own data processing facilities and with enough capabilities to build lateral relationships.
In a more static (process) environment the following coordination mechanisms could be

chosen:
- Procedures, hierarchy and task setting. Consider, for example, the formalization possibilities of processes, management span of control issues, and the possibilities of creating task groups.

Criteria related to decision level:
- Dependence on decisions: e.g. processes covered by the same decisions with respect to goal, time horizon, organizational level, and information input or output could be merged into one process.

Criteria related to type of decision:
- Separation of processes according to type of decision: e.g. processes that focus on rationalized decision making can be separated from processes that focus on political decision making.

How to perform decomposition

Just as with chain analysis in general, the starting point in a decomposition process should be the chain customer. From this point, the primary processes related to customer demand can be traced upstream through the chain (e.g. the order flow).

The variables that must be included in decomposition depend on the research objective chosen. Any research will focus on certain variables of the framework. Decomposition will start with these variables, for example
- if the improvement strategy is throughput time reduction of primary processes, the focus is on the object system variables,
- if the improvement strategy is cost efficient production locations, the focus is on the infrastructure variables,
- if the improvement strategy is enhancing autonomy of processes (thereby aiming e.g. at improvement of process flexibility), the focus is on coordination mechanisms,
- if the improvement strategy is better tuned decision structures (to achieve e.g. reduction of throughput times), the focus can be on decisions.

However, although the focus may be on one specific group of criteria, the other criteria should be evaluated as well to investigate their constraining characteristics with respect to the decomposition.

Figure 3.7 depicts the cohesion between the various variables of the research framework with regard to decomposition of processes.

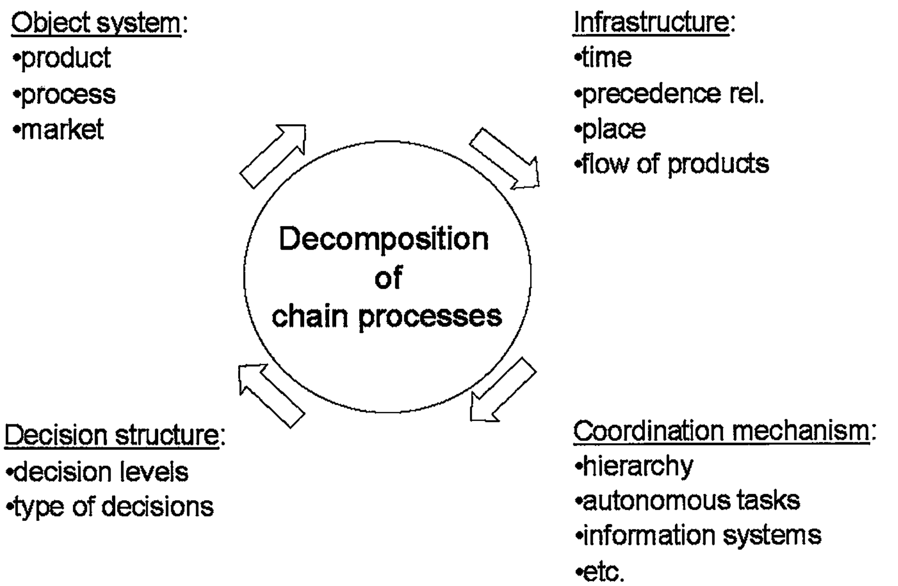


Figure 3.7 Decomposition criteria

Decomposition of businesses into processes is often a procedure performed by analysts in strong collaboration with business representatives. Therefore, the correct choice of decomposition criteria is, at least in part, in the eyes of the beholder.

3.4.5 Analysis and (re)design of a chain managing and managed system and chain process interfaces

The last step of the method for chain analysis and (re)design concerns the management of process linkages in chains.
In Porter's view (1985), careful management of linkages in the value chain is often a powerful source of competitive advantage. Management of linkages should lead to higher responsiveness of the company towards the market and more efficiency in the chain: higher product and process quality, shorter lead times, lower costs, flexible reaction to demand changes and attention to environmental issues. Management of linkages is the major task of the chain managing system.

Figure 3.8 depicts relations between a managing system and a managed system in chain perspective. The chain managed system has typical object system characteristics (e.g. intrinsic product characteristics), typical infrastructural characteristics (e.g. process precedence relationships) and typical operations characteristics (e.g. product quality performance).

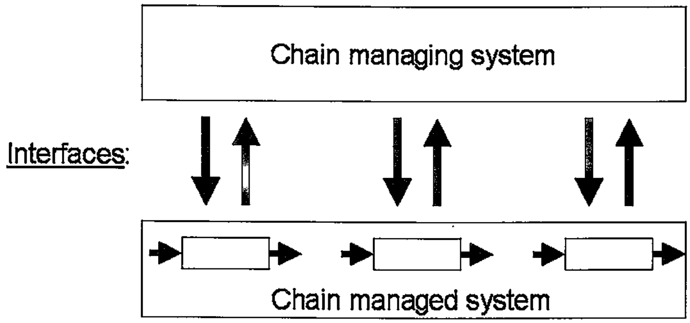


Figure 3.8 Relation between managing system and managed system in chain perspective

The chain managing system can be covered by an organizational entity, e.g. an umbrella organization. However, also planning departments of various organizations belonging to the chain can be seen as the chain managing system. It can, however, also just be an abstract composition of information flows between the chain processes. Besides the coordination mechanism of the chain, this depends to a high degree on the abstraction level chosen by the chain researcher.

As has been described before, the framework allows for autonomous decision making within processes. From a process perspective this means that management decisions in a chain can be made at two levels, by the integral chain managing system and by the processes. Depending on the abstraction level of the researcher, a chain might consist of independent organizations that are regarded as chain processes, or a chain might consist to a high degree of physical processes with hardly any internal management. In the first example, chain decisions are made within chain processes; coordination is via information exchange between processes. In the second example, decisions are made by organizational units outside the chain processes.

Process interfaces

Of huge importance in analysing the management structure in chains is the analysis of process interfaces. These define how chain processes are managed by the chain managing system.

An important guild in describing processes by their interfaces with the outer world can be found in system theory. In system theory (De Leeuw, 1982; In 't Veld, 1993), every system can be described as a black box with input and output. In the literature several process models for analysing businesses have been developed. Two examples are the SADT model

(Structured Analysis and Design Technique; Marca and McGowan, 1988) and the DFD (Data Flow Diagram) model (De Marco, 1978).

Below a chain process model will be developed in which management interfaces between a chain process and its (chain) environment can be described (and analysed).

Design of a chain process model

The chain process modelling method (CPM) developed here is derived from the so-called 'minimal model' approach (Beers, Beulens and Trienekens, 1994) in which the aim is to be able to analyse a process from a basic description of its behaviour (within margins) and its management interfaces. A division is made between the managed system and managing system parts of the process. The managing system part is made up of the interfaces between process and chain.

Managed system part

A process transforms input into output. Every transformation process is constrained by characteristics of the object system. These object system constraints define the margins for the (future) behaviour of the process and set the scope for what can be structurally expected from the process by its stakeholders. Object system constraints can change over time, e.g. due to the development of capabilities/competencies (the learning organization) or investments in new technology.

A process is structured around the primary flow of products. Input and output are restricted to the product flow with its intrinsic (status independent) product characteristics. In this sense input and output are abstract entities: information concerning operational characteristics (quality, quantity, etc.) are not considered to be part of process input and output. (N.B. information concerning operational characteristics, accompanying the flow of goods, is not considered to be part of the primary product flow; all 'operational' information inputs and outputs are regarded as part of the chain managing system.)

It is important to note that a process can have multiple inputs and multiple outputs.

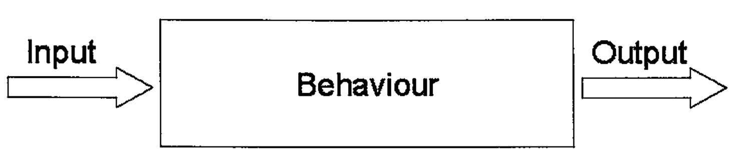


Figure 3.9 Process model

Managing system part

For the managing system part/process interfaces three types of information input/output are recognized: constraints, control and decision support information.
Indeed, from a chain point of view it has to be clear how a process can be managed, i.e. what external constraints can be put on the process from the managing system and what control and decision support information the process needs to perform its tasks. Also, it is important to know what constraints, control and decision information output can be expected from the process.

These interfaces define the margins within which the process can operate. It is important to note further that interfaces can also enable processes to develop new behaviour (e.g. stimulation of learning behaviour, product development).

> An interesting parallel can be drawn between the relationship of managing to managed system and the Dantzig-Wolfe decomposition principle (Lasdon, 1970), in which a mathematical programming problem is split up in one or more independent subproblems.
> The subproblems receive a set of parameters from a master program and send their solutions to the master program, which combines these with previous solutions in an optimal way. Iteration proceeds until an optimal solution has been found.

(External) constraints

External process constraints originate from decisions taken by the chain managing system: strategic planning decisions, management control decisions and/or operational control decisions. Depending on the coordination mechanisms chosen, the process has more or less autonomy to adjust its actions on the basis of this input. Of importance here is that
- every process has its degrees of freedom within which it can perform, and
- if allowed by the management structure, a process can act like an autonomous production unit in the sense that it decides by itself when and how activities necessary to fulfil its tasks will take place.

Chain managing system decisions may lead to several types of process constraints, reflecting strategic planning, management control, and operational planning decisions:
-constraints put on structural process behaviour, e.g. regulations with regard to animal healthcare, use of pesticides, technology investments, etc.,
-constraints with regard to deployment of resources, e.g. human resource management, materials management, etc.
-constraints with regard to operations, e.g. performance of a process.

Control

Control is seen as a way to initiate, continue or stop execution of the process. Control input in the process originates from decisions taken by the managing system of the process, especially operational control decisions. A major example of process control is the customer order. Just as was described for constraints, control depends to a large degree on the (external) coordination mechanism chosen. Control in this respect does not necessarily mean that starting time and contents of process activities are prescribed by a customer order or by an external control system.

Decision support information

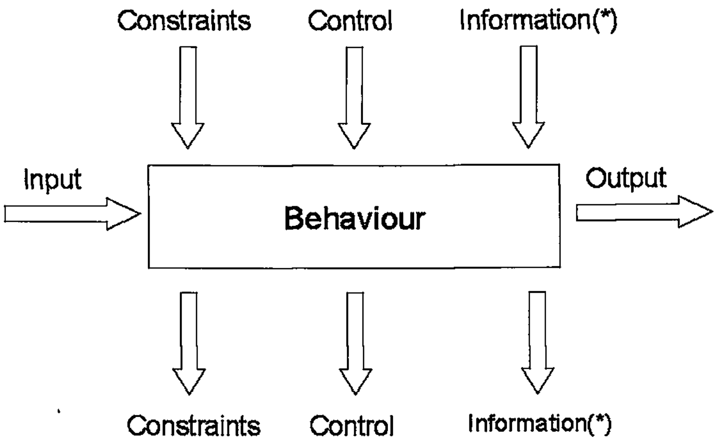
This is information to support decision making by the process (of a non-constraining type). Examples are information concerning the performance of the process experienced by its environment, and market information.

Output information of processes: constraints, control, decision support information

A process can in its turn make decisions that constrain or control other processes (e.g. a strategic decision taken by one process unit can constrain another). Also, it can give information output that can be used for decision support by other processes. Constraints and control are of the same type as described above.

Examples of decision support information as output of the process are
- information regarding the process as far as it occurs outside the limits put on it by the constraint or control input, e.g. exceeding of delivery time,
- information about the (changing) status of the process: the materials used in the process, the process steps, the production means, and also legal/environmental information, tax reporting, etc.

This brings us to the chain process model as described in figure 3.10



(*) Information for decision support

Figure 3.10 Chain Process model

These process interfaces form a major part of the chain managing system.

In the following section an overview of the research framework is given.

3.5 Overview of research framework

The table below depicts three components of the research framework. The fourth component (answers to the Who?, Where?, When? questions) is delineated in chapter 5.

Table 3.3 Overview research framework

Why? (general research objective and view of chains):
The goal of chain research from a process perspective is chain performance improvement. A chain consists of a network of customer oriented and cross-functional processes with precedence relationships. In chain analysis the focus is on primary processes that are the closest linked to the product flow in the chain. Non-primary processes support, and in this sense can be or should be deduced from, primary processes. A chain process can be seen as a link in a chain that is managed through its interfaces by the chain managing system (constraints, control and decision support information). It also has its own managing system, however, which allows for autonomous decision making up to a certain degree.
What? (variables):
The variables of the framework can be divided in two groups: managed system variables and managing system variables. (The chain managing system manages the chain managed system.) Managed system -Object system: product and process characteristics. -Infrastructure: process and resources configuration with location, time and precedence relationships. Product flow structure (e.g. stock points). -Operations: performance in quality, time, costs, flexibility, environment. Managing system -Decision levels: levels according to period and horizon of decision making. -Type of decision: rational, procedural, satisficing, political, individual differences. -Coordination mechanism: rules, hierarchy, task setting, slack, autonomous tasks, information systems, lateral relations.
How? (method):
Steps are performed iteratively to move from the current situation to a future one: - Step 1: definition of research objective, based on chain improvement strategy - Step 2: definition of chain customer and links involved - Step 3: definition of primary chain processes (e.g. the order flow for logistics management) - Step 4: decomposition into chain processes (iteratively focusing on the relevant variables of managed and managing system) - Step 5: analysis and (re)design of chain managed and managing system and interfaces to chain processes (iteratively focusing on the relevant variables of managed and managing system) Also, a modelling tool (CPM) for analysis and (re)design of process interfaces is developed, to support the method. (In chapter 4 two modelling tools, especially suited for logistics processes, will also be developed).

Elements of the other two dimensions of chain analysis (institution and process dimensions) can also play a major role in analysis or (re)design of chain process management. Besides coordination mechanisms and output performance elements, which are incorporated in the framework, other elements could also be included as constrains to (re)design options (e.g. political decisions concerning investments, trust relationships, and commitment for the institutional perspective; structure of performance measurement systems, origin of performance demands, etc. for the performance perspective).

The framework is general in character. It can be used not only to analyse chains of processes linked to the flow of goods, but also to analyse other processes (like product development). However, this thesis focuses on managing the flow of goods. In chapter 4 the variables of the framework (What?) will be further specified for logistics processes in food chains and the method of framework application (How?) will be further delineated.

Chapter 4 Logistics management in food chains

4.1 Introduction

In this chapter the variables in the framework developed in chapter 3 will be specified for logistics processes in food chains. Some of the major points are derived from the Supply Chain Management approach, which has a strong process perspective on logistics processes (chapter 2). Sections 4.2 and 4.3 elaborate on Supply Chain Management approaches and define key points of attention for chain analysis. Sections 4.4 to 4.8 focus on the object system, infrastructure, operations and managing system of food chains. Section 4.9 will introduce two modelling tools that can be applied in analysis and (re)design.

4.2 Supply Chain Management approaches

This section elaborates on the description of Supply Chain Management (SCM) approaches given in chapter 2.

Some definitions

Houlihan (1985) stated that the objective of SCM is to "lower the total amount of resources required to provide the necessary level of customer service to a specific segment" (cit. Cooper et al., 1997a). Ellram and Cooper (1990) define Supply Chain Management as "an integrative philosophy to manage the total flow of a distribution channel from the supplier to the ultimate user". Scott and Westbrook (1991) suggest that the driving force behind the emergence of Supply Chain Management is pressure from the customer for improved service. To Lambert (1994), "Supply Chain Management is the integration of business processes from end user through original suppliers that provides products, services and information that add value for customers."

Efficient Consumer Response

An important Supply Chain Management concept originating from the USA is the concept of Efficient Consumer Response (ECR, Kurt Salmon, 1993): it aims at more efficient collaboration in the supply chain to improve the flow of goods (lower stocks and shorter throughput times) and to improve customer satisfaction. The concept focuses on four goals to be achieved by intensive collaboration between chain participants:
- efficient assortments,
- efficient product introduction,
- efficient promotion,
- efficient replenishment.

Since the beginning of the 1990s many ECR projects have been performed in chains in which retailers have had the lead in translating customer orders to upstream links of the chain.

In all Supply Chain Management definitions the role of the end-customer is stressed: the wishes of the end-consumer have to be fulfilled as efficiently (fast, at low cost) as possible.

Key elements of SCM

Ellram and Cooper (1993) choose (in a comparison between Keiretsu and SCM) a number of elements to describe SCM relationships between companies:
-a long term time horizon,
-information sharing and monitoring,
-coordination of multiple levels for inventory reduction,
-other synergies in the channel,
-joint planning on different management levels,
-compatible corporate philosophies,
-reduced supplier base for better coordination,
-channel leadership must exist for coordination and direction,
-sharing of risks and rewards, which implies trust and commitment,
-speed of operations, information and inventory flows, which
is the major goal of the system!

The next section gives an overview of framework variables that are further specified for logistics processes. Special attention will be given to the key issues in Supply Chain Management described above.

4.3 Logistics variables

Typical managed system variables

Object system:
The chain object system is defined by typical (intrinsic) characteristics of product and process. Specification in terms of logistics can be made to:
- intrinsic characteristics of product and product flow,
- intrinsic characteristics of production and distribution processes.

Infrastructure:
For the infrastructure the following specifications can be made:
- Configuration of production and distribution processes. Precedence, time and location relationships are key characteristics of a process configuration. Also, the type of resources used by various processes belongs to the process configuration (compare e.g. Cohen and Lee, 1989).
- Product and product flow: product assembly characteristics, stock points, order penetration points. Order penetration points constitute the way customer demand is translated into the chain. The importance of order penetration points is stressed by several authors (e.g. Wild, 1977; Bertrand, 1990; Hoekstra and Romme, 1992). Hoekstra and Romme - introduced the term customer order decoupling point (A customer order decoupling point is the point in the production cycle up to where the customer order penetrates).
Because customer demand is regarded as the starting point of any chain analysis, order penetration points are regarded as the key element in chain infrastructures.

Operations:
With regard to operations, five dimensions of performance were recognized in chapters 2 and 3: quality, time, costs, flexibility, environment. These can be applied easily to logistics processes:
- quality of products and processes,
- lead times (order, production, distribution, etc.),
- costs of processes are related to stock levels, resource deployment, throughput times, etc.
- flexibility of deliveries, production processes, etc.
- environmental impact of processes (e.g. waste materials).

An important variable in most SCM approaches is the speed of operations. In this respect lead times are regarded as a major performance indicator in chain logistics.

Typical managing system variables

Typical managing system aspects in the summary of Ellram and Cooper (see above) are
-joint planning on different management levels,
-coordination of multiple levels,
-information sharing and monitoring.

A translation can be made to
-decision levels: integrated planning on different management levels (strategic planning, management control, and operational control),
-coordination mechanisms: coordination of planning levels and use of information systems.

Although most definitions pay attention to these first two components of the managing system, only little attention is paid to the third component: type of decisions. A presupposition seems to be that processes can in principle be rationalized (which is a quite common approach in logistics literature). This also explains the abundant attention paid in this literature to the more rationalized forms of coordination (rationalized planning methods, information systems).

Other aspects mentioned by Ellram and Cooper, like corporate philosophies, channel leadership, partnershipping, trust/ commitment, etc. will be left out in this analysis because they belong to the institutional perspective on chains. Descriptions of relationships between logistics systems and the institutional or performance dimension will be restricted to coordination mechanisms and process performance respectively (which are part of the framework).

In the following sections food chains are chosen as the empirical domain of research. First section 4.4. will describe the object system. Section 4.5 will then analyse infrastructure and section 4.6 operations. Section 4.7 will elaborate on the managing system.

4.4 Food chain object system variables

4.4.1 Intrinsic characteristics of product and product flow in food chains

Food products have several intrinsic characteristics (Den Ouden et al., 1996; Trienekens and Trienekens, 1993):
- unpredictable supply of produce due, for example, to weather conditions,
- quality variation between different producers and between different lots of produce (which leads, for example, to variable recipes),
- perishability of produce and fresh products, which limits the possibility of using stock as a tool to balance supply and demand),
- unpredictable production yields (due to quality variation within and between lots).

Product characteristics (can) differ at different links in the chain starting with raw materials (which in food chains are often highly perishable, and subject to quality variations within and between lots), to semi-finished products (less perishable, homogenized products), to end-products (non-perishable to little perishable, and diversified in packaging).

4.4.2 Intrinsic characteristics of production and distribution processes in food chains

Two examples of typical food chains are given to identify the most important food chain processes:
- a chain of processed products,
- a chain of fresh products.

In a chain of fresh products (e.g. vegetables, fruit, flowers) no, or only limited, changes are implemented on the product. The intrinsic characteristics of the consumer product are equal to those of the primary produce. Changes made to the product concern, for example, change in packaging units, cutting of products, and combination/assembly of products in assortments. Important characteristics related to logistics in this chain are (Zuurbier et al. 1996):
- short throughput times (essential),
- long production throughput times (e.g. growing vegetables, fattening pigs),
- distance to market (a limiting factor with respect to transportation time),
- special demands for the means of transportation (e.g. hygienic measurements, cooling facilities),
- a dominant role for chilling technology (in many food chains).

In a chain of processed products (e.g. dairy products, meat products, snacks, desserts), produce is processed by food industries. Shelf-life is strongly improved by adding preservatives and/or canning products. Zuurbier et al. (1996) identified important characteristics related to logistics in this chain:
- complex production processes at food processors (this will be discussed further in this section),
- increasing environmental demands with regard to production processes.

Figures 4.1 and 4.2 depict both chains.

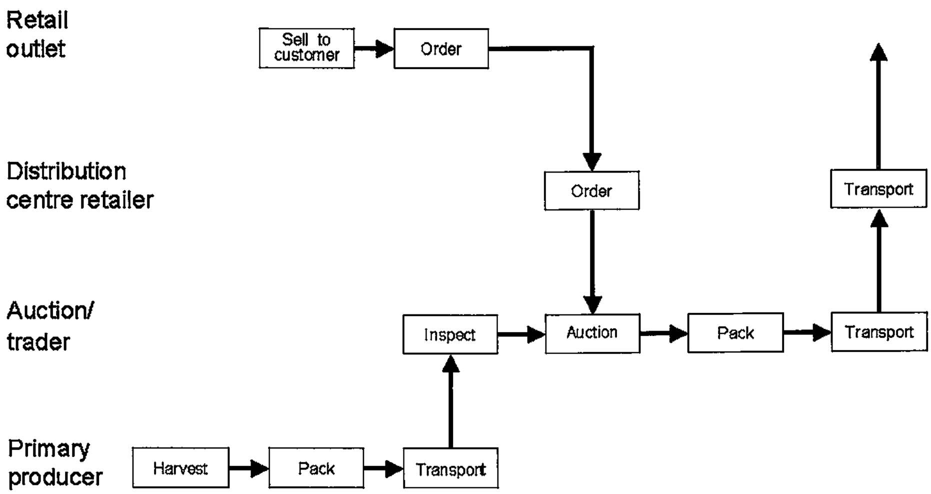


Figure 4.1 Typical chain for fresh products

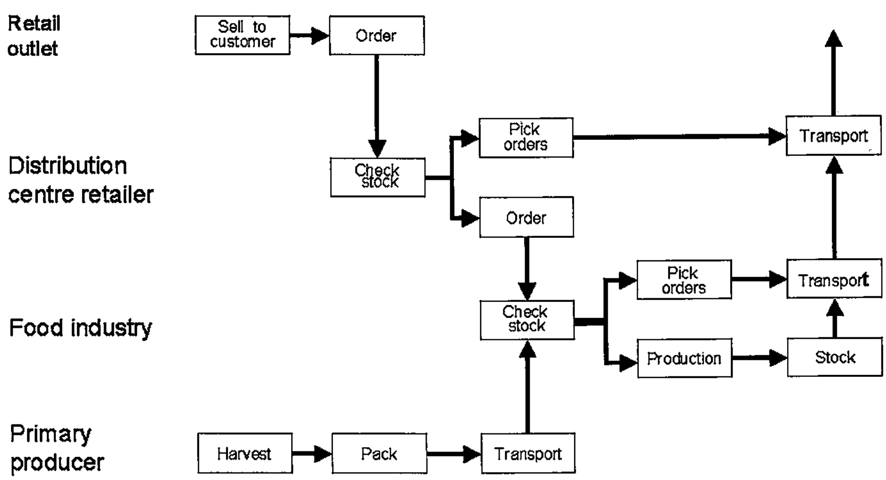


Figure 4.2 Typical chain for processed products

The two examples are generic chains in the sense that in practice many varieties can be found. In chapter five the examples will be elaborated further in cases.

Explanation of the chain of fresh products

The retail outlet sends products, on the basis of customer sales orders, to the distribution centre of the retailer. Orders are received at the distribution centre and passed through to the commission agent at the auction. Products are bought at the auction, packaged as requested by the retailer and transported to the retail distribution centre. From there they are distributed to the retail outlets. Before products are sold at auction, they are inspected and given a quality grading.

Explanation of the chain of processed products

The retail outlet sends products, on the basis of customer sales orders, to the distribution centre of the retailer. Stock levels are checked. If stock levels are sufficient, orders are picked and transported to the retail outlets. Orders of the retail distribution centres are sent to the food industry. Here stocks are checked. If stock levels are sufficient, orders are picked and transported to the retail distribution centre. If stock levels are low, production takes place. Most food industries have contracts with suppliers of agricultural produce.

To provide a broader picture of characteristics of food chain processes, we will concentrate on the most complex link in the chain with regard to logistics.

4.4.3 Characteristics of product and production processes in food industries

Production processes in food industries have special characteristics (van Rijn et al., 1993; Trienekens and Trienekens, 1993):
- Production processes usually consist of divergent processes combined with convergent processes (e.g. milk is composed of more than one product; after division other ingredients are added).
- Production yields are often uncertain. This can be explained by variations in composition, form, colour, etc. of raw materials and semi-manufactures. Materials often have dynamic characteristics (e.g. changes in composition of dairy products, shrinking of meat products). This implies that slack in produce or in time must be incorporated in the process.
- Production often involves by-products (not taken into account in planning) and co-products (taken into account in planning). These have to be sold as well (e.g. cheese as an end-product with whey as a by-product, butter as an end-product with buttermilk as a co-product). Also, waste products have to be accounted for, because of environmental regulations, among other reasons.
- Recipes are often variable (one product can be based on more than one recipee: different raw materials can lead to similar products) and multi-level (one recipe can lead to more than one product: for example products in different packaging).
- Recycling of products or semi-finished products is common in food processing industries. In many cases end-products that do not meet quality standards and, in part, waste or by-products can be recycled.
- Production control and inventory control must deal with the variety and dynamic quality of raw produce and semi-manufactures. Registration of process and product characteristics (e.g. composition, storage time, history of products) is essential for these industries. A related issue is lot registration. Because of quality differences between lots and tracing

issues, it is important to know from which lots produce and/or semi-finished products have been selected during the production process. Another reason that traceability and lot registration are so important for food industries is that they are needed to comply with governmental regulations (safety and health regulations).

- Exact timing and sequencing of processes plays an important role:
    - Produce has to be processed soon after it is harvested.
    - Output of intermediate processes (e.g. the output of production of semi-finished products) must be processed further within certain time limits. Generally in food industries a division can be made between recipe production processes and packaging processes. The packaging process is becoming more important, which is related to the increasing number of final products in food processing industries. Recipe production is in most cases continuous whilst the packaging process is discrete. Tuning of both processes is complex in many food industries.
    - Many final products are perishable (although to a lesser extent than produce), and therefore have a limited shelf-life.

In the next section food chain infrastructures will be described.

4.5 Food chain infrastructure

As stated before, the transmission of customer demand to the upstream part of the chain is regarded as a major issue in chain logistics. In discussing chain infrastructure and the chain managing system, therefore, major attention will be paid to customer order decoupling points in chains.

4.5.1 The customer order decoupling point

In the 1970s several authors stressed the relationships between organization environment and production organization in companies (e.g. Woodward, 1970; see also chapter 2 of this thesis). Wild (1979), for example, developed a typology on relationships between a company's customer approach and its manufacturing system. He identifies four basic structures for manufacturing systems:

-make from stock (of raw materials) to stock (of finished products), i.e. all input resources are stored and the customer is served from a stock of finished goods,

-make from source (supplier of raw materials) to stock, i.e. no input resource stocks are held, but goods are produced to stock,

-make from stock (of raw materials) direct to customer, i.e. all input resources are stored but goods are made only against and on receipt of customer orders,

-make from source (of raw materials) direct to customer, i.e. no input resource stocks are held and all goods are made on receipt of customer orders.

Hoekstra and Romme (1992) developed in this respect the concept of the customer order decoupling point (CODP). The customer order decoupling point is the point 'that indicates how deep the customer order penetrates into the goods flow'. They regard the customer order decoupling point as important for the following reasons:

- It separates order-driven activities from forecast-driven activities.
- It is the place where 'independent demand' is converted into 'dependent demand'.

- It generally coincides with the last major stock point in the goods flow: deliveries to customers are made from there.
- It creates the opportunity for upstream activities to optimize independently from irregularities in market demand.
- It separates two areas in which the nature of decision making is very different: upstream from the CODP the risk of more than normal investment in stocks is dominant; downstream the risk of missed orders is dominant. The main business decisions are, respectively, the acceptance of plans and the acceptance of orders (Hoekstra and Romme, 1992).

Downstream of the CODP no stock is held, while upstream stock is kept only for business economic considerations. Downstream of the CODP the supply chain is managed/controlled by customer orders.

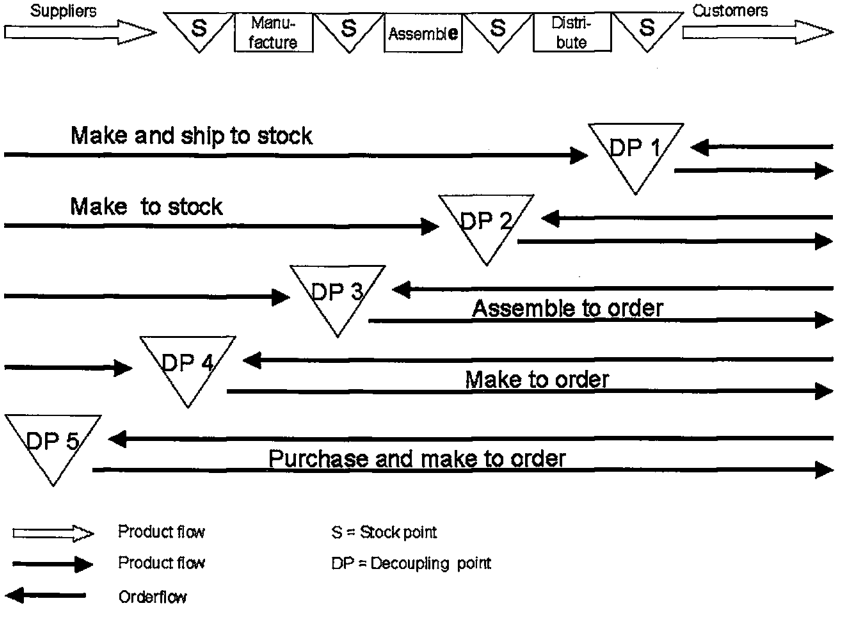


Figure 4.3 Customer order decoupling points

In figure 4.3 five generic decoupling points are described:

1. 'Make and ship to stock'. Products are manufactured and distributed to stock points spread out and located close to the customer (e.g. retail stores deliver to their outlets from central distribution centres).
2. 'Make to stock' (central stock). End-products are held in stock at the end of the production process and from there they are sent directly to many customers who are scattered geographically.
3. 'Assemble to order' (assembly for one specific customer).

Only system elements or subsystems are held in stock in the manufacturing centre, and the final assembly takes place on the basis of a specific customer order. (e.g. packaging to order in the food industry).

4. 'Make to order'. Only raw materials and components are kept in stock: each order concerns a specific project.
5. 'Purchase and make to order' (for a specific customer). No stocks are kept at all: purchasing takes place on the basis of the specific customer order; furthermore, the whole project is carried out for the one specific customer.

The position of the customer order decoupling point often varies with different products within the same company (e.g. in meat processing industries some recipes of sausages are specified by customer order, other recipes are standard).

Considerations with regard to the position of the CODP

The choice of where to position the customer order decoupling point is made by weighing efficiency against delivery performance. The following table depicts specific delivery demands and process constraints, which tend to move the CODP downstream in a production chain, and product-market constraints and inventory cost considerations, which tend to move the CODP upstream in a production chain.

Table 4.1 Business characteristics and their influence on the decoupling point (adapted from Hoekstra and Romme, 1992):

Reasons to move CODP downstream
Delivery service requirements: - short delivery time expected - high delivery reliability Process constraints: - long lead times - bad process control
Reasons to move CODP upstream
Product-market constraints: - irregular market demand - specific, high value products Inventory cost considerations: - low stock levels (avoid investment risk) - reduce risk of obsolescence

An example of downstream movement of CODPs is postponed production, in which the last production processes are performed at a chain link close to the market. For example flowers can be transported after harvesting to a central distribution centre where flower bouquets are made to customer order.
An example of upstream movement of CODPs is the tendency of producers to centralize their production processes for reason of cost efficiency. Many large companies now opt for centralization of production units. From these central units customer demand is satisfied and products are distributed.

Opportunities for positioning the customer order decoupling point depend to a large degree on order, production and distribution lead times.

Customer order lead time and customer order penetration

Figure 4.4 illustrates the relationship between order leadtime and order penetration (order lead time is defined here as the time between the moment that the customer orders and the moment of delivery).

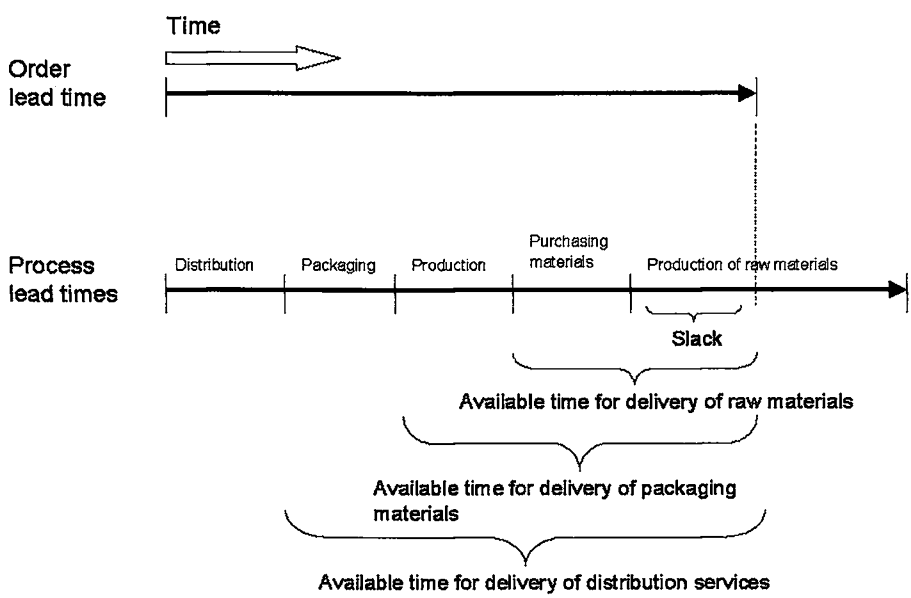


Figure 4.4 Example of the relation between order lead time and process throughput times

In the example, the customer order can, according to the order lead time, theoretically penetrate the production cycle until halfway the production of raw materials. Within the order lead time range the processes distribution, packaging, production, and purchasing materials can be executed). Production of raw materials is not included in the lead time range. The figure also shows the theoretical time available for various processes to be completed and the theoretical slack. (In the example it is assumed that all processes are linked without waiting time and delivery is planned exactly at order due date).

A customer order decoupling point is not always fixed on a certain production phase. Depending on the specific demands of the customer, the position of the CODP can change over time, sometimes even between one order and another (e.g. if production to stock is common, for rush orders one might decide to produce to order. In this case, extra capacity might be transferred to production to decrease lead times).

4.5.2 Customer order decoupling point in chain perspective

To translate the concept of the customer order decoupling point to chains, several considerations require attention:
1. Definition of chain customer and chain links/processes involved: a chain consist of two or more processes, which raises the question of what process is considered to be the chain customer and what processes are considered to be links in the chain (see also chapter 3).
2. Relation between production phase and chain process: a customer order penetrates up to a certain production phase. However in a chain, a production phase can be performed by more than one chain process, e.g. packaging of products.
3. Penetration depth of customer orders in chains: upstream movement of the CODP means that links upstream in the chain will have a direct, 'widened', vision of chain customer demands. It also means, however, that links downstream of the CODP have to collaborate optimally to bring the product to the customer.
4. Diffusion of customer order decoupling points in chains: usually a customer order consists of many articles/products. Within every order, groups of products can be recognized with similar CODPs. Between these groups differences exist however (theoretically even every single article could have its own customer order decoupling point).

<u>1. Definition of the customer in the chain and the links/ processes involved</u>

The definition of the chain customer and of chain processes depends on the research scope chosen. For example, a retail store outlet can be a customer in a supply chain with links/processes: retail outlet - retail distribution centre - food industry. However, a food company can also be a customer in the chain: seed producer - grower - food company. The chain customer is the link that places demands on the chain.

<u>2. Production phase and chain link/process</u>

The CODP defines the production or distribution phase up to where the customer order penetrates. However, in a chain, a production phase is not necessarily performed by just one process, it can be performed by more processes, e.g. packaging of products. As an example, packaging of vegetables to order can take place at the grower, at the auction, or at the trader (figure 4.5).

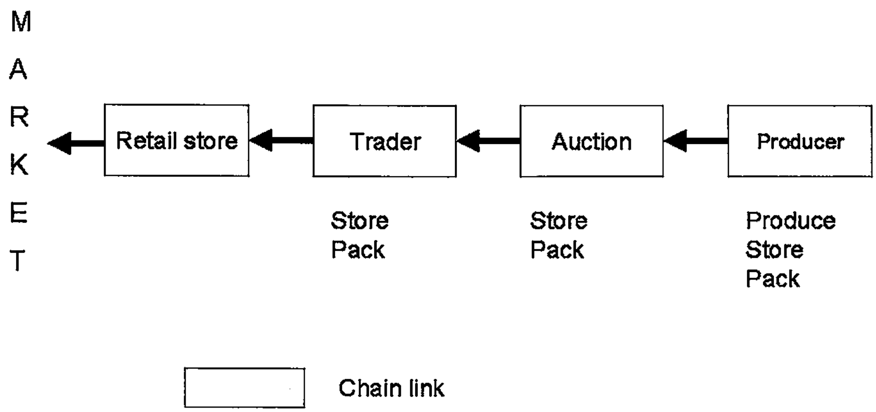


Figure 4.5 Similar activities at different links in the horticulture supply chain.

(For the customers this is of less importance. For them it does not matter at which link the product is made customer- specific, at which link the product gets its final composition or at which link the product is packed; as long as they get the right product with the right specifications).

> Repacking is one of the major problems in Dutch horticulture. Products are often packed right after harvesting without regard to specific customer wishes. At the auction, sales take place, after which the product is often repacked by the trader or exporter, who does not have a clear view of his customers' orders either. Often the retail store repacks the product again. This phenomenon leads to a loss of quality due to extra handling, long throughput times and additional logistic costs. In the last few years, however, it has become much more common for growers to pack their products in the packages wanted by retailers. This means that the customer order decoupling point moves from the 'production to stock' phase to the 'production (packing) to order' phase.

Because a specific CODP (e.g. packing to order in the example above) can be positioned at several links/processes in the same chain, the term chain decoupling point (CDP) is introduced here as the chain link/process up to where the customer order penetrates.

In practice the chain decoupling point in the horticulture chain can move from auction/trader (delivery from stock or packing to order) to grower (production or packing to order). A similar development can be seen in fruit and flowers (Zuurbier et al., 1996).

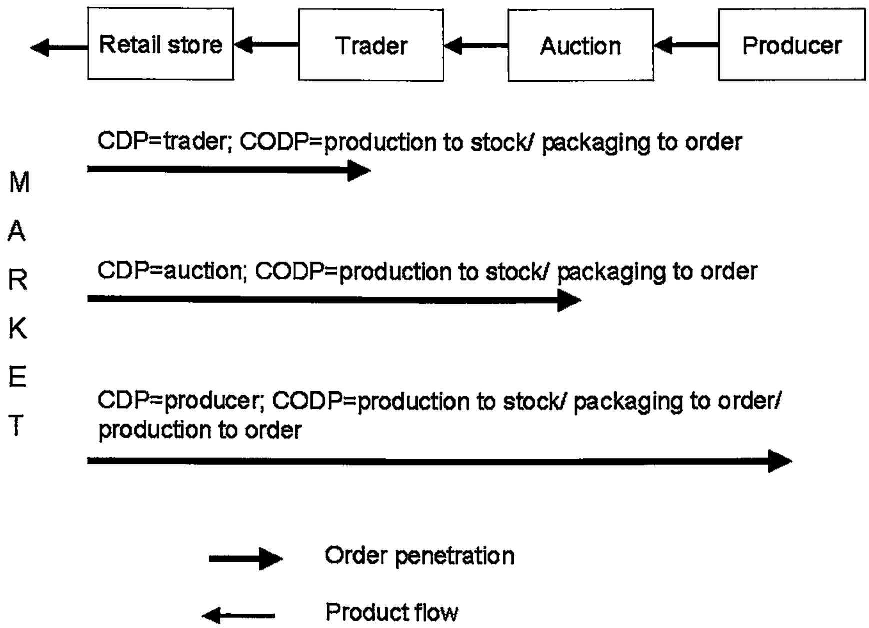


Figure 4.6 Three different chain decoupling points (CDP) in the horticulture chain and corresponding customer order decoupling points (CODP)

Further upstream movement of the CDP in horticulture chains could mean fewer losses in handling and transportation; products are packed only one time and delivered in some cases directly from primary producer to customer.

3. Penetration depth of customer orders in chains

In most chains, customer orders only penetrate the chain up to the link/process closest to the market. On the basis of aggregated sales, orders from this process go to the next process upstream in the chain, where new orders are made for the next process upstream, etc.
For example, in a chain for processed food products, orders from the retail outlet penetrate up to the distribution centre of the retailer. From there, new orders are composed and go to the food industries, etc. This means that, besides the retail outlet, every party has only a 'second-hand' view of customer demands.

Moving the CDP upstream in the chain can provide various chain processes with a broader view of the customers' wishes. Naturally, this means that all processes downstream of the CDP must collaborate efficiently to meet the demands of the end-customers (e.g. with regard to delivery time, quality and costs). Every chain process which can be performed within the lead time of the order and which can actually contribute to fulfilling the customer order can be started on the basis of the same customer order information. This implies that order information must be available at all these processes. If, for example, production to order takes place, this means that order information must also be available to packing and distribution activities. These may start simultaneously with production processes.

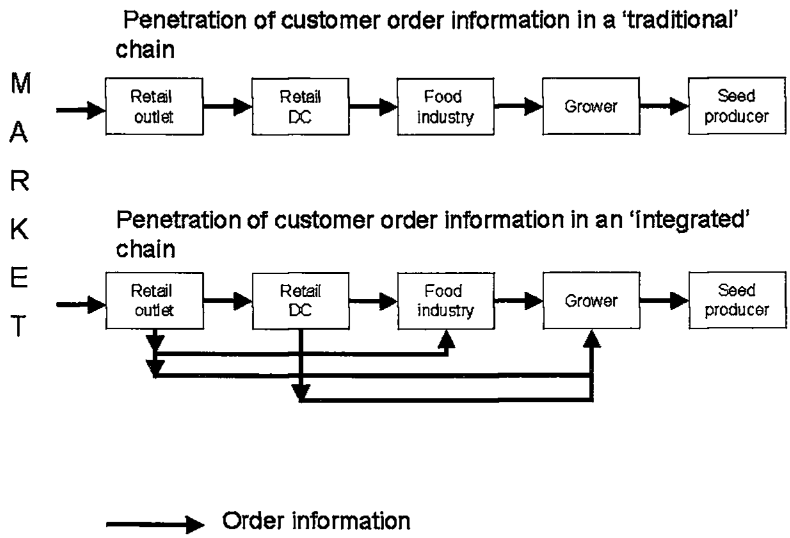


Figure 4.7 Widening the range of vision.

Figure 4.7 depicts the difference in the range of vision of chain links between a 'traditional' chain and a chain with upstream location of the CDP (in the example the customer order even reaches the grower). In the first figure, every link only gets order information from the next link downstream in the chain. In the second figure, however, every link up to to the grower receives order information from the chain customer (directly or passed through by downstream links). In the example, the seed producer is not involved in this information exchange pattern because its production lead times are too long to be responsive to individual customer orders. Of course in practice many intermediate forms exist.

4. Diffusion of chain decoupling points

Order information from a chain customer usually consists of a number of order rules. This means that orders must be 'decomposed' at various links upstream in the chain. In the example of a chain for processed products, an order from a retail outlet to the retail distribution centre is composed of many different articles. To fulfil this order the distribution centre assembles the products from several food (and other) industries into a 'complete' order to be delivered at the retail outlet. To do so the distribution centre must have the demanded products in stock or it must be able to receive these products within the range of time allowed by the order lead time. If the chain link further upstream in the chain (e.g. a food industry) is able to deliver the product within the time range asked, then the outlet order information could just as well go directly to this link. The lead time of the food industry is then composed of customer order lead time minus assemble and distribution lead time needed at the distribution centre. The same holds true for the raw materials used by the food industries. Some are held in stock, while others can be delivered by the producer within the time range allowed.

From this decomposition perspective on customer order information, more than one chain decoupling point can be recognized in a chain: a first tier chain decoupling point for the complete order, a second tier chain decoupling point, a third tier chain decoupling point, etc.

Figure 4.8 depicts the diffusion of the chain decoupling point across several chain links. (The example chain consists of a distribution process, food production processes A and B, raw materials production processes B1 and B2). The first tier chain decoupling point (CDP) is found at the distribution process. The second tier chain CDP is found at food production process A, which delivers from stock to the distribution process. A third tier CDP is found at food production process B, which delivers to order to the distribution process. A fourth tier CDP is found at raw materials production process B1, which delivers from stock to food production process B. A fifth tier CDP can be found at raw material production process B2, which delivers to order to food production process B. (For the sake of clarity the three links/processes used in the example are considered production phases which cannot be split up further. In practice of course, a further differentiation can be made within the links, according to the production phases that can be recognized there).

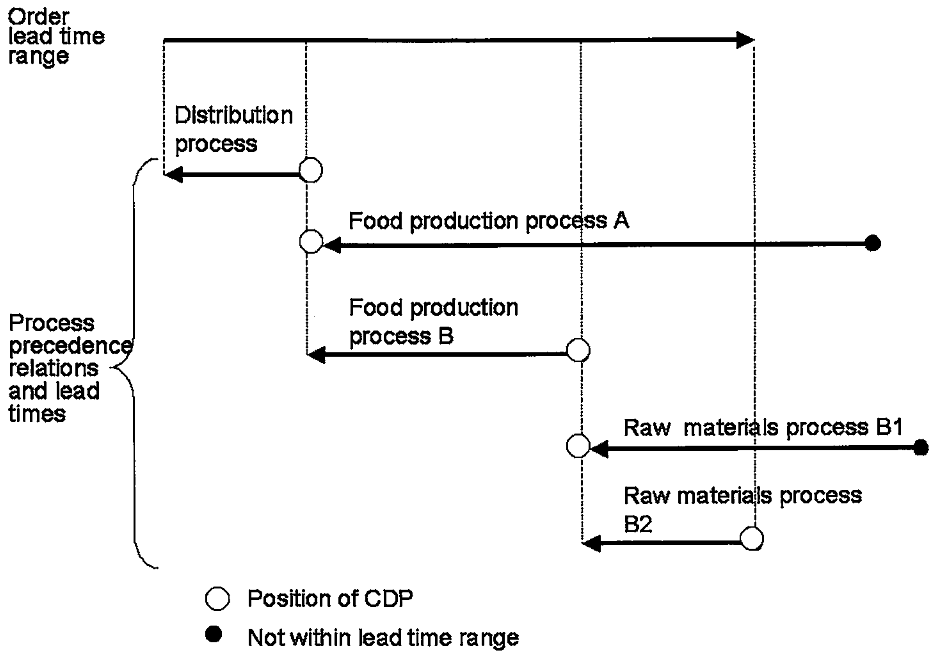


Figure 4.8 Relation between order lead time and order penetration possibilities

Chain decoupling point shifts in practice

Shifts of the chain decoupling point in the food sector are constrained by the object system in several ways:
- Related to production lead times, the customer order can only penetrate the chain as far as its delivery time allows it to.
- Uncertain supplies lead to stock formation in the chain, unless alternative sources are available.
- Perishability leads to upstream movement of the CDP (e.g. vegetables are left a few days extra in the field to prevent stock formation and postpone perishability).
- Divergent production processes may lead to upstream movement of the CDP.

In the chain for fresh products, as was described in previous sections, the chain decoupling point can move upstream in the chain for many products, often up to the primary producer (as is already the case for many chains in the Netherlands). However, the CODP in most cases cannot move further upstream in the production life cycle than packaging to order, because of the long production throughput times at the primary producer. Even packaging to order is difficult here because of the heavy dependence on weather and soil conditions, which lead to quantity and quality uncertainties. Re-packing at a link downstream in the chain and multiple-sourcing is often chosen to ascertain the supply of products in the quality and quantities desired by the customer.

In chains of processed products, the chain decoupling point can in most cases move up to the food industry. A further upstream translation of consumer demands for produce is more complex because of the many supply flows that have to be geared. Translating a product demand from a retailer up to (the many) suppliers of the food industry means synchronized production vertically over the chain up to the primary producers, but also synchronized production horizontally over the various suppliers. Indeed, product quality and delivery time of several suppliers who "participate" in the end-product should in such a case be synchronized. A factor that increases this complexity even more is the many products various companies produce and the many customer and supplier relationships they maintain (i.e. the many chains they take part in). Many food industries now try to decrease the number of suppliers to get a better grip on their supply (complexity) and to be able to integrate further upstream in the chain (Hvolby and Trienekens, 1999).

Shifts of the CODP, however, only make sense if customer demands are better met or supply chain efficiency is improved. For a lot of product market combinations this is not the case. E.g. some products will continue in the future to be produced and packed in bulk.

4.5.3 Other elements of chain infrastructure: product structure and process configuration

An important point of attention in chains is the composition of the materials/product flow in various stages of the production and distribution life cycle.

Product categories in chains

In retail stores planning of assortments developed in the last years into planning of product categories. A product category is a group of products that is recognizable as such to customers (e.g. pet product category: pet food, pet toys, pet medicines, etc.; baby product category: diapers, baby food, baby clothes, toys, etc.). Categories are regarded in ECR theory (Kurt Salmon, 1993) as business units with their own demands for management of assortments, product introduction, product promotion, and product replenishment. Product replenishment in this respect focuses on replenishment of stock throughout the supply chain up to the shelves of the retail outlet.

An important development related to category management is the tendency towards broader assortments in supermarkets, which means smaller shelf stocks per product. This again means that delivery frequency has to increase and delivery quantity will decrease. In optimizing the supply chain this can lead to lower stock levels throughout the supply chain. However, because of lower utilization degrees of capacities (transportation means, storehouses) the costs of these can rise. In such cases outsourcing often proves to be an option. These developments have major influence on product flow management throughout the chain, concerning stock management (e.g. stock safety levels), order management (frequency, quantity), production management (e.g. batch sizes), and distribution management (e.g. choice of distribution concept: delivery from stock or cross docking).

As far as logistics is concerned, products have always been grouped into logistic categories: products belonging to the same group concerning ordering, delivering and stock keeping. Typical characteristics which make products fall into a logistic category are (Vermunt, 1993)
- perishability
- conditioning
- value density
- form
- weight/volume relation
- packaging density
- discontinuity (products with a seasonal character)
- country specificity.

In the food sector, perishability and conditioning are especially important criteria in forming logistics categories. Important distinctions are made between fresh products (vegetables, fruit, potatoes), cooled products (salads, dairy products, snacks, etc.), frozen products (fish, vegetables, etc.), and non-perishables (e.g. sugar). These are often basic categories chosen by retailers for food products.

What might be expected for many chains in the near future is that this division in groups will grow more complex because of the extra (customer oriented) demands on replenishment processes (e.g. ordering and delivering of perishables may well be combined with ordering and delivering of non-perishables because of shelf presentation considerations).

An important impact of these developments is that for logistics management, information about the unit of ordering, delivery, production, etc. becomes of key importance. Indeed most companies work with different units for different processes. In chain perspective this means that many units can be identified: a retail outlet orders in categories of products; a retail distribution centre will regroup these categories into its own ordering units; the food industry decomposes the DC orders into purchase orders, etc. With regard to production and distribution, even more units can be recognized. Vermunt (1993) identifies in this respect a number of assembly units:
- modality unit (train, ship, airplane, truck)

- transportation unit (container, truck container, trailer)
- loading unit (pallet, roller container)
- packaging unit (box, tray, crate)
- product unit (article).

Assembly units can change while flowing downstream in the configuration of processes. A continuous decomposition of order information and composition of orders to be delivered takes place, in which synchronization of processes is essential.

Process configuration: network relationships

For efficient category management the buying patterns of consumers in supermarkets must be translated to all links in the supply chain in such a way that links can decide together which products to produce, how to pack the products, how and where to assemble them into a certain category of products, and where to distribute them. Often the non-food products can be part of a category, which makes the distribution and assembly process complex.

Within one branche several distribution channels can often be found. Some products are delivered directly from industry or trader to the retail outlets, others are kept as stock in the distribution centres, and again others only pass through the distribution centre. (The last type of distribution is also known as cross docking or transito. At cross docking, products enter the distribution centre just to be assembled with other products and directly distributed further. At transito products do not even need assembly anymore; the producer has already performed the assembly task.) Several distribution concepts are often combined in one chain.

> The future logistics structure in Dutch horticulture must lead to less repacking, less handling of materials and more efficient transportation. As was discussed before, one of the major issues for establishing a new chain structure is the choice of the right assembly and distribution points. In 1996, 14 auctions in Dutch horticulture merged into one organization: the Greenery International. The decision was also made to restructure the selling and distribution points in the supply chain. In the near future, only three points are expected to remain in place. These three logistics centres are meant to become assembly and distribution points at which the flows of goods merge and are distributed. The location of these points in relation to the market is obviously of great importance (VTN, 1996).

The example below depicts order and delivery relations between companies in a network. The figure shows the large number of potential partners in the network.

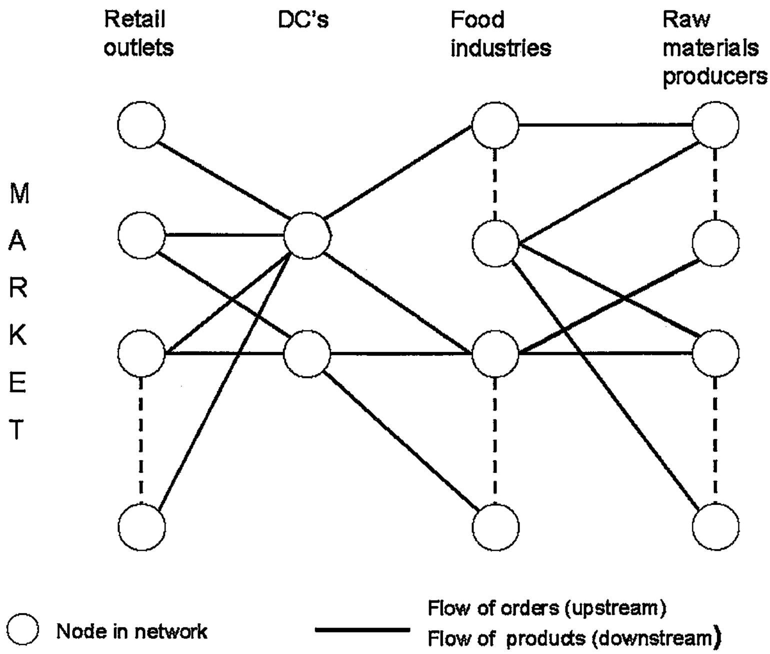


Figure 4.9 A company network

<u>Object system constraints to chain infrastructures</u>

In section 4.4 the object system with its intrinsic characteristics was described. Design opportunities for food chain infrastructures are constrained in various ways:
- Uncertain supply may lead to downstream movement of the CDP.
- Perishability may lead to upstream movement of the CDP.
- Stocks are necessary in case of imbalances between demand and supply.
- Environmental issues (often translated into legal arrangements) must be taken into account in product composition and packaging.
- Distances in space and time influence the transport system (e.g. limitations to combined transport of goods).
- Uncertain supply or demand often means investments in quality keeping facilities (e.g. cooling facilities).
- Environmental issues may lead to extra demands on capacities (e.g. animal friendly production demands specific housing conditions).

In the next section the third element of the chain managed system will be discussed.

4.6 Chain operations

As is described in chapter 1, technological developments, increased international competition, over-supply of food products and new consumer demands force food producing companies to change over from push (supply) oriented production to pull (demand) oriented production (Hughes, 1994).

Retailers, who take the lead (are 'in power') in restructuring food chains in most European countries, demand shorter delivery times, more frequent deliveries, and deliveries in smaller quantities from the food producers. The trend is towards daily deliveries of fresh products and for some products even several deliveries a day (e.g. bread is now delivered to some retail stores three times a day). The aim is to lower stock levels throughout the supply chain and offer fresher (food) products. These stronger retailer demands are translated into flexibility demands with regard to the production processes at the food processors and other links upstream in the chain: shorter throughput times, smaller batch sizes, multi-deployability of machine and human capacities, etc. (Hughes, 1994; Hvolby and Trienekens, 1998; Boehlje, 1996; Downey, 1996; Kurt Salmon, 1993).

Two major opportunities for performance improvement in food chains are transparent information exchange and throughput time reduction.

Information transparency

A major opportunity for efficient replenishment in the chain is optimal exchange of sales and stock information between chain links. This information transparency includes availability of information throughout the chain and the right translation of information between chain links.

In many chains in practice each link makes independent replenishment decisions based on its own (Silver, 1998)
- Cost factors and service considerations.
- Predicted demand-presumably forecasts which are based in turn on historical demand that it has observed from the next stocking point downstream.
- Replenishment lead time from the next stocking point upstream.

This narrow view leads easily to bullwhip effects. Silver (1998) stresses four factors that help create the bullwhip effect:
- demand signal processing (if demand increases, firms order more in anticipation of further increases, thereby communicating an artificically high level of demand),
- the rationing game (there is, or might be, a shortage so a firm orders more than the actual forecast in the hope of receiving a larger share of the items in short supply),
- order batching (fixed costs at one location lead to batching of orders), and
- manufacturer price variations (which encourage bulk orders).

Lee et al. (1997) point out that "distorted information from one end of a supply chain to the other can lead to tremendous inefficiencies: excessive inventory investments, poor customer service, lost revenues, misguided capacity plans, ineffective transportation, and missed production schedules".

Transparent information systems can help to avoid these effects: stock levels may be cut down and leadtimes can be shortened. In the next section information exchange and other coordination mechanisms will be discussed (4.7).

Throughput time reduction

Another major improvement option for chains is lead time reduction and time compression (Christopher, 1992; Stern and El-Ansary, 1996; Zuurbier et al., 1996). Towill (1996a) stresses the importance of time compression at all stages in the chain to achieve high responsiveness to market demands and efficient flows of goods throughout the chain. Time compression leads to shorter lead times and thus to lower stocks and more efficient use of resources throughout the chain. Goldratt and Fox (1986) stress that throughput time reduction also leads to flexibility improvement because reaction times to market demand are smaller.

In sections 4.4 to 4.6 the managed system of food chains was discussed. The following section focuses on some important characteristics of the managing system of food chains.

4.7 Managing system in food chains

In this section key issues on chain management as defined by various Supply Chain Management approaches will be discussed. Decisions and coordination mechanisms will be analysed jointly. With regard to coordination mechanisms major attention will be given to information systems because of their importance for chain management.

4.7.1 Decision levels and customer order information exchange

The customer order is related to the operational decision level of the managing system. This, however, doesn't mean that order information cannot be used at other decision levels (management control and strategic planning).

Operational order information can only penetrate processes as far as these can be executed within the order lead time. On a more aggregated level, this information can be used, however, for management control decisions and strategic planning. As in the example in figure 4.10 decisions concerning time and manner of harvesting at the grower and even adjustments in seed production at the seed producer might be supported by aggregate order information in the horticulture chain.

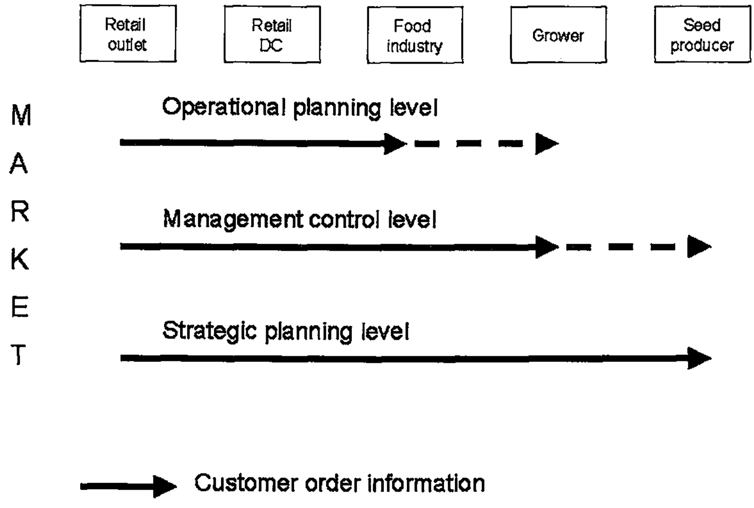


Figure 4.10 Customer order information exchange at different decision levels in a chain.

Optimal use of information in the chain should be accompanied by coordination of decision levels. A major coordination mechanism is information exchange on various decision levels, enabling lateral relationships between decision levels.

Determination of decision levels

According to Kreuwels (1994), distinction of planning (decision) levels should be based on a change
- from forecasts concerning general market demand (information used at the strategic planning level) to specific customer orders (information used at the operational planning level),
- from a product group to product families to specific product types.

In figure 4.11 a formalized example of an integrated chain planning structure for the chain of processed (food) products is depicted (decision levels and contents are arbitrary).

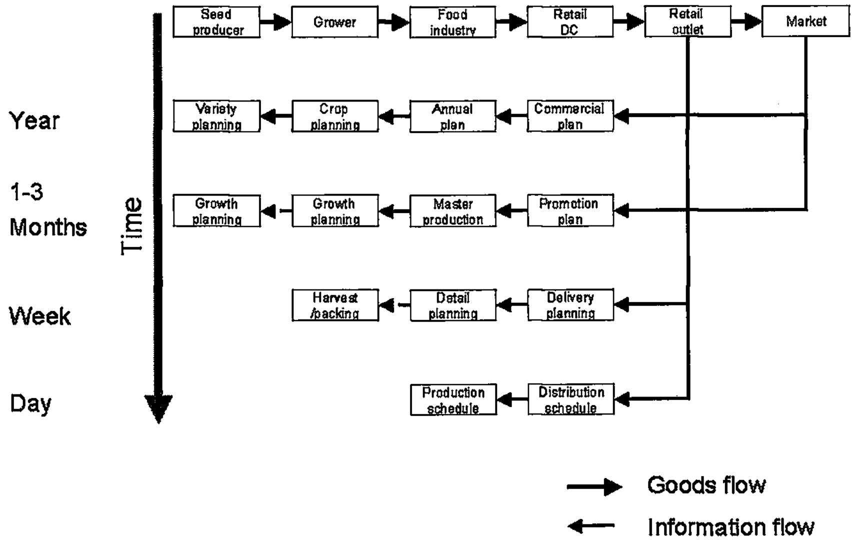


Figure 4.11 Integrated chain planning in a chain for processed products

In the example chain in the above figure (production and distribution of salads), market forecast information is used in strategic (year) planning by all chain parties. The information should be on product family level; for example, the total expected sales of salads (potato, fish, etc.) is translated upstream in the chain. Market forecast information is also used at the management control level (1-3 months) by all parties except for the seed producer, who can only use it to fine tune its growth planning. As an example, salads differentiated to groups are translated upstream in the chain. At the weekly planning level only the industry can adjust its planning on the basis of sales information (what qualities in what quantities to produce). The grower can adjust in the sense that he leaves some products (e.g. potatoes or peas) longer in the field. At a daily level, production and distribution scheduling in the chain is based on sales information. (The example is formalized. Multi-level planning will in practice usually be restricted up to the food industry. A grower will most often base his planning on information from many food industries, as will the seed producer on the basis of information from many growers).

Integrated multi-level chain planning has a number of advantages.

- It may lead to lower stock levels. On the one hand, a supplier can delay differentiation of products because he receives forecasts on production family level (which for that matter means that he can start earlier with production on family level). On the other hand, customers are able to specify orders later because the producer can do the first production step on the basis of forecasts on product family level.

- It leads to decreasing uncertainty in the chain because of intensive information exchange.

In applying integrated chain planning to chains, the following conditions must be met (Kreuwels, 1994)
- In the chain a separation must be recognizable between a process where production of product families takes place and a process where products are being specified to product type. Multi-level planning is especially suited to diverging production processess; e.g. in the food industry often a distinction can be made between production of recipees on product family level and packaging/labelling to product type level. At the buyers, a parallel separation between forecasting (on product family level) and ordering (on product type level) must be recognizable.
- Multi-level planning only makes sense if the forecast information can lead to changes in plans at the suppliers, i.e. if the planning term of the customers is less than or equal to production throughput time at the producer.
- Planning method of suppliers and customers must be (up to a certain degree) synchronous with regard to frequency, phase and product family division. An important goal of an integrated chain planning structure is to achieve synchronisation and parallellization of processes in the supply chain. For example, if a retail store outlet receives daily deliveries from the retail distribution centre, it may be possible for the distribution centre to receive daily deliveries from the producer.
- The order quantity of the customers on family or type level must be equal or larger then the minimal batch quantity the suppliers handle on family or type level.

4.7.2 Rationalization options and coordination in food chains

In many food chains the aim is to rationalize lower level decision making and perform it according to organizational procedures. However, uncertainties in demand and supply constrain rationalization options. Higher level decisions will be more of the political and individual type (e.g. finding the right partners in the international food market), whilst lower level decisions are of the 'satisficing', organizational procedures type (deployment of resources, ordering). Rationalization, however, can (up to a certain degree) take place with the help of information (systems) and mathematical models (see chapter 3). Developments in information technology (Van Beek et al., 1998) and mathematical decision support models (Silver, 1998) are promising in this respect.

As was described in chapter 3, several coordination mechanisms in chains can be defined:
- Coordination by rules and procedures. An example is coordination by way of window-contracts/agreements between links in the chain on which call-offs take place.
- Coordination by way of hierarchy. An example is coordination of chain processes by a central planning unit, decisions are taken at an integral organizational level. Most chains in practice, however, are comprised of processes which are coordinated by separate organizations; every organization coordinates a number of processes in a hierarchical manner. In most of these chains coordination between the organizations takes place by means of rules and procedures.
- Coordination by task setting. Chain processes interact with each other within a framework of arrangements. However, they are to a large degree autonomous in their actions.
- Coordination by autonomous processes. Processes make their own decisions within a wider framework of processes. No strict relationships with other parties exist. Usually,

processes are part of a dynamic network of processes.
- Coordination by lateral relationships. Chain processes exchange information in process-to-process relationships on the same decision-levels.
- Coordination by use of slack. An example is stock keeping at certain links in a chain to ensure delivery of products and to improve flexibility.
- Coordination by vertical information systems. This improves hierarchic and centralized control, which again might improve efficiency in the chain.

Most chains have a varied coordination structure, e.g. the example chain is coordinated by rules and procedures between the companies involved. However, the processes within the companies (that are not depicted in the example) are hierarchically coordinated. Between various processes lateral relationships exist for short term coordination. Information systems in this respect are of key importance for lateral relationships.

In the cases presented in chapter 5, decision structures and coordination mechanisms will be further elaborated.

4.8 Overview

4.8.1 Framework variables (What?)

In this chapter a specification of the research framework variables (chapter 3) for logistics processes has been made. Typical points of attention in food chains are the following:

Table 4.2 Characteristics of food chains

Managed system

- Typical object system characteristics:
  - Typical product characteristics of food chains are supply uncertainty, quality variations between lots, perishability of produce.
  - Typical process characteristics of food chains are unpredictable production yields, conditioning of products (cooling/freezing), diverging production processes, recycling of products.
- Typical infrastructure characteristics:
  - Position of chain decoupling points: important food chain constraints are production lead times, supply/demand uncertainties, perishability, divergent product flow.
  - The process configuration must enable fast movement of products.
  - A tendency to ordering and delivering in product categories.
- Typical operational characteristics:
  - Major attention goes to speed of the product flows and flexibility in production and distribution processes.

Managing system

- Integrated multi-level planning/decision systems:
  - Diverging processes can be found in many food chains. These are especially suited for designing of multi-level planning systems.
  - Uncertainties in demand and supply constrain the design of planning systems.
  - Perishability of products is an important aspect in many decisions in food chains (e.g ordering, delivering, stock keeping). It is therefore also an important constraint for the design of a planning system.
- Transparent information exchange is the major coordination mechanism.

The cases presented in the next chapter will reflect (most of) these typical characteristics.

4.8.2 Analysis and (re)design method (How?)

In chapter 3 a method for chain analysis and (re)design was proposed, with the following structure:
Step 1: Definition of the research objective, based on the chain improvement strategy, which again is based on the business strategy. For example, the business strategy might ask for cost reduction. An improvement strategy might then be throughput time reduction. And the research objective might then be to identify opportunities for throughput time reduction.
Step 2: Definition of the chain customer and links involved (the chain structure).
Step 3: Definition of primary chain processes. In the cases in chapter 5 this will be the order flow, including chain upstream information flows and chain downstream flows of goods and information).
Step 4: Decomposition into chain processes (iteratively focusing on the relevant variables of managed and managing system).
Step 5: Analysis and (re)design of chain managed and managing systems and interfaces to chain processes (iteratively focusing on the relevant variables of managed and managing systems).

Steps 1 to 3 form the relatively stable basis of the method. Although findings regarding the decomposition and analysis of chain managed and chain managing systems (steps 4 and 5) can lead to changes in research objective, and changes in the involvement of links in the research, once these steps are chosen they are fixed in most research projects. Steps 4 and 5, however, should be performed iteratively to arrive from the current to a future situation.

The choice of the variables in steps four and five depend on the research objective. Some examples are given below of how to proceed in analysis and (re)design
- Object system. Define object system characteristics related to the research objective. In the case of throughput time reduction, define the throughput time of processes, delivery time and delivery reliability demands from the market. Investigate opportunities and constraints (from other elements of the framework, amongst others) to change the object system related to the research objective.
- Infrastructure. Define the positions of chain decoupling points. Define product flow characteristics and characteristics of the process network (time, precedence and location relationships) as far as these are related to the research objective.
Investigate opportunities and constraints (from other elements of the framework, amongst others) to change the infrastructure (and the decomposition) related to the research objective.
- Decision structure and coordination mechanisms. Define which decisions are related to the research objective (on the particular decision levels). Analyse the type of decision making. Analyse coordination mechanisms. Tune the decision levels of various parties in the chain (keeping in mind possible constraints); try to rationalize decisions where this is possible, however, avoid rationalization where this is not wished. (Re)design coordination mechanisms. Pay special attention to information technology opportunities.

In the next section two modelling tools will be introduced that support the method for chain analysis and (re)design, and that are especially suited for logistics in food chains.

4.9 Tools for chain analysis and (re)design

In chapter 3 (section 3.4.6) a modelling tool (chain process model) was developed to support the method for chain analysis and (re)design. In this chapter two modelling tools will be added that are especially suited for analysis of logistics processes in chains. The first tool aims at analysis and (re)design of chain object system and chain infrastructure. The second aims at analysis and (re)design of chain (multi-level) decision structure and chain coordination. In both tools information technology plays a key role.

4.9.1 Event Process Chain (EPC) modelling

A (re)design method that focuses on chain infrastructures is derived from the Event-Process Chain (EPC) approach from Kim (1995). The aim of his analysis/redesign is throughput time reduction in the chain. The customer perspective is the starting point of the analysis. Only these processes that are directly related to the customer's demand are part of the model. The processes Kim recognizes can be compared with our primary processes. EPC models are cross-functional and customer oriented.

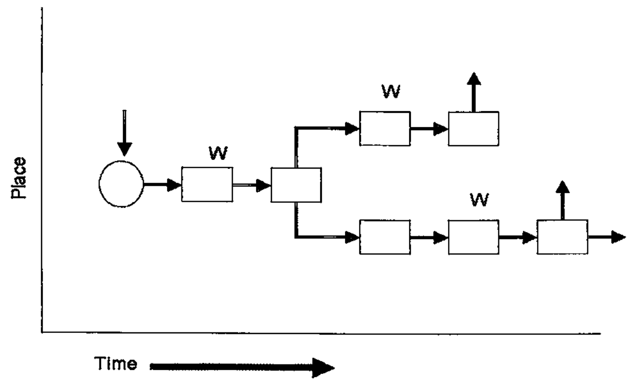


Figure 4.12 EPC model

The model is constructed around the dimensions of place and time. In the EPC model, processes in the chain are grouped into larger organizational units (the 'place' dimension). This provides better insight and understanding of the real-world situation. The time aspect of goods flow management is of particular importance for chains in agribusiness and the food industry, where a fast throughput of goods is essential. The EPC model places the time dimension on the X-axis and the place dimension on the Y-axis.

The EPC model has the following elements: 'Event', 'Process', 'Branching' and 'Wait'.
- 'Event' is defined as a perceived change of status at one point in time (an event is depicted as a circle in the model).
- 'Process' is defined as an activity or a series of activities over time, often as a response to the triggering event(s) (a process is depicted as a square in the model.)
- 'Branching' is conditional splitting of an event-process flow into multiple sub-flows, based on the value(s) of certain status variable(s). (In the figure an example of branching is depicted.)
- 'Wait' is the significant average delay before start of an event or a process due to a queue or other unfavourable conditions of the server organization. (A 'wait' is depicted as 'W' in the figure.)

In his article, Kim defines the following principles for redesigning event-process chains (Kim, 1995):
- reduction of the number of processes (e.g. by integration of processes),
- transformation of processes into events (e.g. by automation),
- minimization of travel distances (e.g. optimalization of production locations),
- parallellization of processes/events (concurrent starting of processes on the basis of intensive information exchange),
- reduction of wait time before processes, but elimination of wait time before events (e.g. real time processing of orders).

The model can be used to analyse and (re)design processes. Information and communication technology plays a significant factor.

4.9.2 GRAI grid modelling

The GRAI method (Doumeingts, 1985) is used to analyse coordination between decision levels in chains (GRAI stands for Groupe de Recherche et Automatisation Intégré, of the university of Bordeaux in France). Through a GRAI grid, relationships between decisions, decision flows and the required information flows can be identified. In the grid every cell can be regarded as a potential decision centre (nodes that receive inputs in the form of decisional frames and information, and make resultant frames and information). A decision centre can be period driven or event driven. Decision frames in a GRAI grid include both constraints and control as defined for our chain process model (chapter 3).

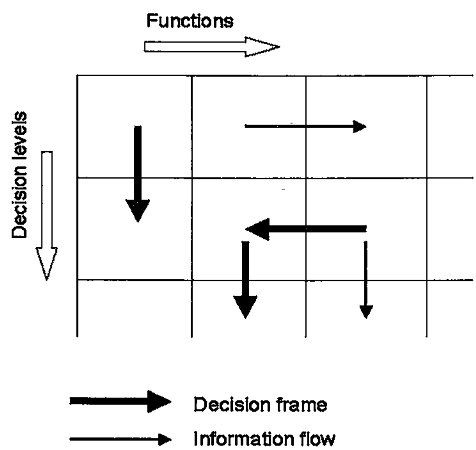


Figure 4.13 GRAI grid.

The grid is hierarchical, ranging from strategic decisions with long intervals, to frequently made decisions in real time. Each decision centre has one or more objectives that are to be achieved by a certain time- the 'horizon'. GRAI grids have typically been used to create a model of the decision making processes in the manufacturing systems of a company, but have also been used to assess the effectiveness of the management structure and information flow (Coll et al., 1998).

The three modelling methods developed in this thesis (including the process model developed in chapter 3) will be applied to the cases in chapter 5.

Chapter 5 Cases

5.1 Introduction

In chapters 3 and 4, three 3 components of the research framework were developed:
- a view of chain processes (answering the Why? question regarding framework building)
- the framework variables (answering the What? question regarding framework building)
- a method to analyse and (re)design chains (answering the How? question regarding framework building).

In this chapter the Who?, Where?, When? questions are answered to complete the research framework. As stated in chapter 1, the cases were chosen for theoretical, not statistical reasons. The case study method, based on 'theoretical sampling' (Eisenhardt, 1989) searches for cases that can throw a new light on the research object, thereby extending the theory. In this sense, the research framework developed in this thesis will never be finished. New cases can always lead to further extensions of chain theory and to the research framework presented here.

The four cases in this chapter cover a major part of the variables (What?) of the research framework.

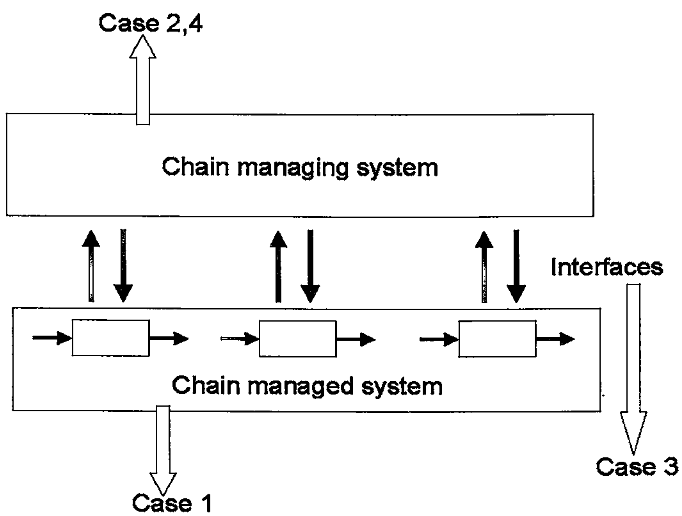


Figure 5.1 Research focus of cases

- Case 1 demonstrates a redesign of the managed system of a chain, aiming at lead time reduction and efficiency improvement. Case 1 focuses on
  - infrastructure (process configurations, stock points, chain decoupling points),
  - object system (lead times),
  - coordination mechanisms (information exchange between links).
- Case 2 is about redesign of a chain decision structure aiming at efficiency improvement by gearing decision processes and information flows. Case 2 focuses on
  - decision levels,
  - coordination mechanisms (information exchange between processes, and to a less extent other coordination mechanisms),
  - type of decisions,
  - infrastructure (the position of the chain decoupling point is taken into account in the redesign).
- Case 3 is about redesign of process interfaces, aiming at effectiveness improvement of processes in various manners. Case 3 focuses on
  - coordination mechanisms (process interfaces),
  - type of decisions.
- Case 4 focuses on design of a managing system around a chain decoupling point. Case 4 focuses on
  - decision levels,
  - coordination mechanisms (information exchange between processes),
  - type of decisions.

Cases 1, 2 and 3 concern the chain for processed products; links are: retail outlet - retail distribution centre - food industry. Case 4 concerns marketing processes in a chain for horticulture (fresh) products; links are: sales - matching of demand and supply - purchase.

The first, second and third cases originate from an ECR project performed from 1995 to 1997 in the Netherlands. The fourth case originates from a project in the Dutch horticultural sector. The first and second cases reflect successful applications in the ECR projects mentioned. The methods were used as communication tools between researchers and management of multiple companies in chain problem definition and definition of redesign opportunities. The third case reflects an application on a scientific level. Based on practical information from the companies involved in ECR projects, it has been used in discussing methods on chain redesign (Trienekens and Hvolby, 1999a) and in comparing decision structures in chains from different branches (Coll and Trienekens et al., 1998). The fourth case reflects a design for a management structure for the horticulture chain, which was developed in collaboration between representatives from research institutes, companies and consultants. So far it has been used as a tool of reflection for horticulture organizations.

5.1.1 Description of the ECR project

The project was funded in a public and private partnership project in which businesses, research institutes and universities were involved. The project was initiated by the businesses incolved and enabled by subsidies of a governement related organization (the Foundation for Agri-Chain Competence). A consultancy agency was hired for project organization and coordination. On the business side three retail companies and four food companies were

involved in the project. Four research institutes, including Wageningen Agricultural University, also participated in the project.
The project consisted of a number of sub-projects that were related to several ECR areas aiming at efficient assortment, efficient promotions and efficient replenishment.

The sub-project related to efficient replenishment included analysis and redesign of the process structure, the management (control) structure, and the information system of the chain. The aim was to lower stock levels, decrease lead times and improve freshness of products. Several researchers from the Computer Science department and the Management Studies department of Wageningen Agricultural University were involved in this sub-project. The sub-project was performed in two parts. The first part concerned analysis and redesign of the chain, focusing on the managed system. Several research techniques were used: repeated interviews with representatives of the companies, time study at various locations for process mapping and process analysis, and group discussion of the results with management employees to identify redesign opportunities.
In the second part a pilot project and a simulation study were performed to investigate the opportunities to lower integral chain stock and improve freshness in detail. Also, an information system analysis was performed to design new information architectures and related coordination mechanisms. Here again, the research methods were multiple interviewing and group discussions with participating companies and researchers. (The pilot project and simulation study are not included in this thesis; see Van der Vorst et al., 1998).

Methods developed and used in these projects were further applied and tested in several graduate-student projects in various branches in the Dutch agribusiness and food industry. The methods were also discussed with several research groups within the Netherlands and abroad (e.g. Zuurbier/Trienekens/Ziggers, 1996; Coll and Trienekens et al., 1998, Trienekens and Hvolby 1999a).

5.1.2 Description of the horticulture project

The horticulture project aimed at integral improvement of logistic structure and operation in Dutch horticulture. Various companies from the Dutch horticultural sector (including The Greenery International BV.) and various research institutes and Wageningen Agricultural University were involved in the project. Project organization, coordination and support were provided by several consultancy agencies. The project was also subsidized by a government related organization (the Foundation for Agri-Chain Competence). From Wageningen Agricultural University, the departments of Management Studies, Operations Research and Logistics, and Marketing and Marketing Research participated in the project.

The project was divided in a number of sub-projects:
1. quantitative research on horticulture product flows in the Netherlands and export/import flows,
2. qualitative research concerning problems and expectations experienced by representatives from Dutch horticulture,
3. development of theory on customer order decoupling points in horticulture chains,
4. development of a management and decision support system for matching demand and supply in Dutch horticulture,

5. development of a system for short term matching of demand and supply in horticulture,
6. development of a chain model for simulation of goods flows,
7. development of an integral quality management system for fruit,
8. research into demand forecasting techniques,
9. research into supply forecasting techniques.

The author was closely involved in sub-projects 3, 4 and 5 (and to a lesser extent in sub-project 9). Case 4 in this chapter (section 5.4) uses the results of sub-projects 4 and 5.

5.1.3 Case presentation

In the presentation of the cases below, the use of the research framework will be depicted by placing framework elements in boxes.

5.2 Case 1: redesign of a chain managed system

Case 1 concerns a chain for processed products. The goal is efficiency improvement, aiming at lower integral chain stock, less stock outs, and fresher products.

Boxes 5.1 and 5.2 give an overview of relevant case aspects that must be taken into account in the method for analysis and redesign.

Box 5.1 Improvement strategy, research objective, chain structure and primary chain processes in the case.

Improvement strategy: lead time reduction.
Research objective: identify opportunities for lead time reduction and redesign.
Chain structure: the chain consists of three links: retail outlet – distribution centre - food industry. The retail outlet is the chain customer.
Primary chain processes: the order flow.

Box 5.2 Decomposition criteria and relevant managing and managed system variables for the case.

Decomposition: decomposition of the chain is performed jointly with representatives of the case-organizations. The following variables were used: - Object system variables: separation of processes on the basis of process characteristics (e.g. because of its long duration production might be considered to be a separate process). - Infrastructure variables: several processes are combined or separated on the basis of time and precedence considerations (e.g. order processing at the distribution centre is a combination of several sub-processes which are performed simultaneously: order control, stock control, order acceptance). - Coordination mechanisms: organizational units are separated: retail outlet, distribution centre, food producer). (Not considered was decomposition in product flows (by parallelization of processes) because of the general character of the analysis. Decision structure considerations did not apply to the research objective either).
Relevant managed system characteristics: - Chain decoupling point: is positioned at the distribution centre. - Production and distribution processes: some products have a long production leadtime. - Product flow: perishability of food products. - Stock points: are retail outlet, distribution centre and food industry.
Relevant managing system characteristics: - Decisions: operational decisions 'manage' the chain: orders from the retail outlets initiate the product flow. - Type of decisions: most of the decisions are made according to the rules and procedures of the 'satisficing' type. - Coordination: takes place by link-to-link information exchange.

In the next sub-section the current situation in the case is depicted with the help of EPC models (see chapter 4).

5.2.1 Current situation in the case

Figure 5.2 reflects an EPC (Kim, 1995) model of the retail chain for the current situation. The primary processes in the model form together the order cycle.

A number of processes are recognized in the model, some of which are typed as 'events' (processes with negligible duration, see chapter 4). All processes are primary processes in the sense that they are directly linked to the order flow. No distinction has been made between 'physical' processes and administrative processes.

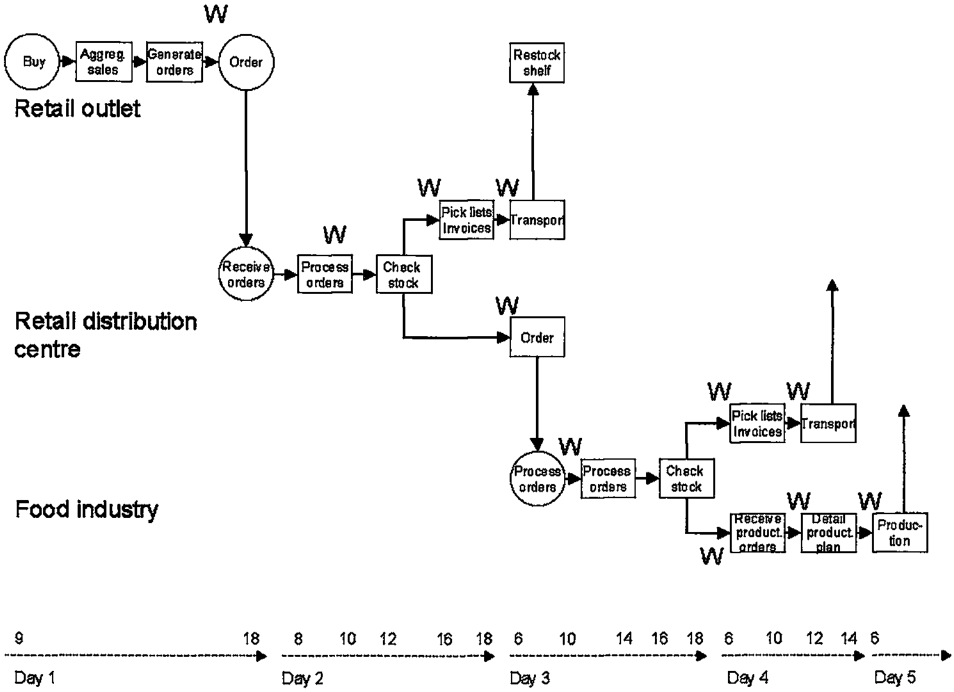


Figure 5.2 EPC model for the current situation in the case

Explanation of the current situation

In the outlet of the retail organization, the following processes take place:
- The consumer makes a purchase (which implies a scan of the barcode on the product),
- Sales at the retail outlet are aggregated, in part manually, over a certain time period (once a day, in the afternoon).
- Orders are composed by scanning the barcodes on the store shelves with a hand terminal. And, largely, manual checks take place for loss (theft, breakage of products). The next step is to determine, on the basis of shelf stock, other in-store stock and the 'instinct' of the grocer, how much of what articles have to be ordered.
- Orders are placed once a day between 16.00 and 18.00 hrs. The shopkeeper places via a modem to the distribution centre of the retailer.

In the distribution centre (DC) of the retailer, the following processes and events take place:
- The DC receives orders through a modem. These are immediately put through to an automated processing unit.
- Processing of the orders takes place the following day between 8.00 and 10.00. Processing means on the one hand control of deviations in order patterns, article numbers, data

mutilation, etc., and on the other hand grouping of the orders.
- The grouped orders are compared with the DC stocks. This takes place partly manually by checking administrative stocks and by contacting the warehouse manager by phone. The process takes place between 10.00 and 12.00.
- If the ordered products are in stock, orders are being processed, starting at 16.00, to order pick lists, packer's numbers and invoices. The process is completed at 18.00.
- The orders are collected at night, delivery of the orders takes place in the morning starting at 6.00. The orders are delivered at the retail outlets by 10.00 at the latest.
- If insufficient stock is available at the DC, shortages are divided amongst the retail outlets.
- If insufficient stock is available at the DC, or stock levels are (getting) below safety levels, orders are generated for the food industry. Orders to the food industry are placed between 6.00 and 10.00 by fax or phone.

At the food industry the following processes take place:
- The orders are received.
- Once a day, between 14.00 and 16.00, the orders are processed, in part automatically.
- Stock is checked, partly manually, from 16.00 to 18.00.
- If the demanded articles are in stock, order picking, truck loading and delivery takes place. This process starts at 6.00 the next day. The final deliveries leave between 11.00 and 12.00.
- If the demanded articles are not in stock, or if stock levels are (becoming) too low, production orders are semi-automatically generated for the production department. These are sent before 10.00 manually or by fax to the production department.
- The orders are processed every morning at 12.00 in a (detail) production plan. Creating This plan is made between 12.00 and 14.00.
- The following day production starts at 6.00. Production throughput time varies from 6 to 72 hours depending on the product.
- When a product is finished it is sent to the warehouse.

5.2.2 Improvement options in the case

The following opportunities were investigated:

Retail outlet

A considerable acceleration of the order procedure can be achieved by generating orders automatically on the basis of scan data (POS-data, Point of Sale) and by estimating losses in the shops. Because sales data are stored in the cash register anyway, this would mean a simplification of the order procedure in the retail outlets. Also, fewer errors would be made, which at this moment still lead to back orders or to high stock levels (e.g. because of missing shelf labels, typing errors, etc.). Savings on personnel can also be achieved through automation of the order procedure.

Distribution centre retailer

The flexibility and speed of the order process can be considerably improved if orders to the DC can be placed at any time. Real-time processing in the information systems of the DC is the following step, followed by automatic grouping of orders and production of order pick lists. Several manual activities can be replaced to improve the speed of the process and to decrease the number of mistakes. Labour intensive activities are skipped and a more reliable stock administration becomes possible. Also, a more efficient process can be achieved by making a direct link to the computers of the order picker. With the help of a scanner, the order picker can check the accuracy and quantity of the articles he is picking.

Food industry

In order to tune production and stock planning to demand developments, the producer receives scan information from the retailer (outlets). He also receives real-time insight in DC-stocks of the retailer. DC orders are not placed by the DC anymore; the producer delivers products on his own initiative, observing the stock levels at the retailer DC and(!) observing the stock levels at the retail outlets. With this information, the producer can tune his production and delivery cycles better to the demand patterns of the customers at the retail stores. On the basis of these data and his own stocks, pick and production orders are generated automatically. In figure 5.3 the pick and transport function are integrated in the process 'transport'. Production planning is supported by computers up to the shop floor, which improves the speed and flexibility of the process.

5.2.3 Future situation in the case

Figure 5.3 depicts an EPC model for the future situation in the case..

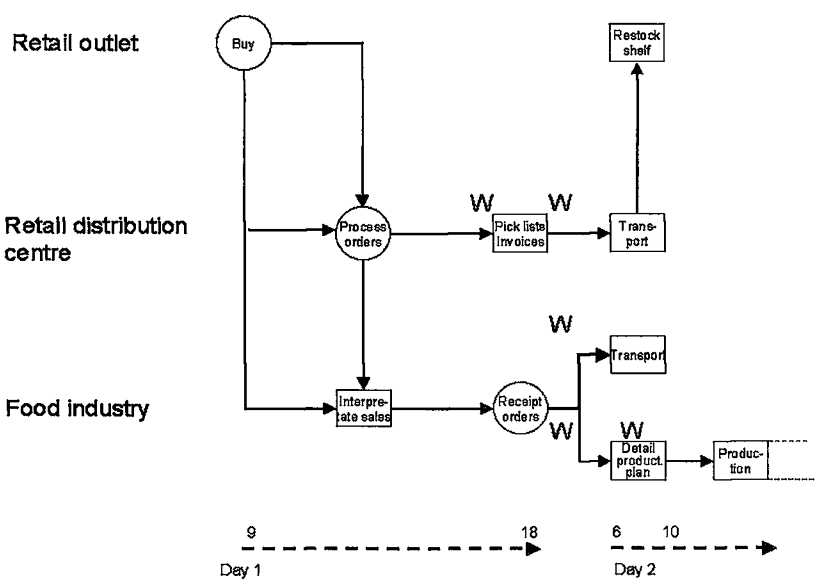


Figure 5.3 EPC model for the future situation in the case

These applications lead to the following changes with respect to the framework elements.

Box 5.3 Changes with regard to chain decomposition, chain managing and chain managed systems.

Decomposition: - Integration and moving of processes: - 'Aggregate sales' at the retail outlet is in the future situation automated and integrated with the sales process, 'receipt orders'. - 'Process orders' and 'check stock' at the distribution center and at the food producer are integrated in 'process orders' and 'interpretation of sales'. - As far as human (creative) decision making was involved (the 'generate orders' process at the retail outlet) is moved to the distribution centre of the retailer. - Reduction of the number of processes: - Barcode scanning for ordering is no longer necessary. - Ordering by the DC of the retailer can be skipped. - Parallellization of processes (on the basis of scan data of the retail outlets, production planning at the food producer can already start before the actual orders come in).
Managed system: - A first tier chain decoupling point is positioned at the distribution centre; a second tier chain decoupling point is positioned at the food industry. - For some products only one stock point is left for this chain (besides the shelf stock at the retail outlet). On the basis of outlet demands the food industry ships the products, which are transported directly via cross docking or transito to the retail outlet). - Transformation of processes in events and shortening of processes: - Stock checks at the DC of the retailer and at the producer take place automatically. - Automatic support of production planning at the producer can shorten this process considerably. - Reduction of waiting times before processes and events: - Immediate processing and sending through of scan data to the DC of the retailer or to the producer decreases waiting times for the order process. - Immediate processing of orders by integral production management systems prevents waiting times for the order processing at the retailer DC and at the food industry.
Managing system: - Rationalization by automation of ordering, order processing and production planning. - Coordination by information exchange between all chain links: POS data go directly from retail outlet to food industry.

The importance of ICT applications in chain (re)design is stressed by the following summary:

- Communication with EDI (Electronic Data Interchange):
    - Orders are automatically placed with EDI. EDI messages are not only exchanged upstream in the chain (order flow), but also downstream in the chain (delivery messages, invoices).
    - Scan data at the retail outlets are sent automatically to other parties in the chain.

- Management and use of data:
    - Scan data are used for production planning at the food industry.
    - Uniform article coding is a pre-condition for identifying objects throughout the chain.
- Systems for integral production management:
    - Orders of retail outlets are automatically processed by the information systems of the retail distribution centre. Order processing, stock management, and order picking are part of an integrated information system.
    - Insight in stock positions at the retail store and scan data from the retail outlets support production planing at the food industry up to the shop floor. Furthermore, integration with order picking exists.

The new process configuration leads to throughput time reduction of four days. (The pilot project [see in project description earlier] in the second part of the project showed an increase of total product freshness of 5 days, inventory level reduction at the DC of 55% and an inventory level reduction of 38% at the retail outlet (Van der Vorst et al., 1998).

5.2.4 Further use of EPC models

Processes in any EPC model can be further decomposed into sub-processes and can be depicted in a new EPC diagram, which can be investigated on its own. For example, in the diagram above, the process 'detail-production plan' at the food industry can be further decomposed into processes and events:
- grouping of order (a process),
- consultation on production assignments and priorities (by production planner, supply manager, sales manager) (a process),
- decision making (an event),
- grouping of production assignments (a process),
- detail plan construction (a process),
- sending of detail plan to shop floor (an event).

In this case, the focus was on redesign of the managed system in a chain for processed (food) products. In the next case, the decision structure in the chain will be redesigned.

5.3 Case 2: Redesign of a chain decision structure

In this case, the decision structure in a food chain for processed products is analysed. All decision levels (strategic planning, management control and operational planning) are included: not only decisions taken at the chain management level (chain managing system), but also decisions at the level of the process. Demarcations between chain managing system and chain managed system will be discussed in the next case.

The goal of the case is efficiency improvement, aiming at lower integral chain stock, less stock outs and fresher products.
In accordance with the research framework the following description of the chain can be given: boxes 5.4, and 5.5.

Box 5.4 Improvement strategy, research objective, chain structure and primary chain processes in the case.

Improvement strategy: gearing of decisions in the chain. **Research objective:** identification of opportunities for gearing decisions and improving information exchange on various decision levels; redesign. **Chain structure:** the chain consists of three links: retail outlet - distribution centre - food industry. The retail outlet is the chain customer. **Primary chain processes:** the order flow.

Box 5.5 Decomposition criteria and relevant managing and managed system variables for the case.

Decomposition: Decomposition was performed together with members of the (international) research community in various discussion sessions (Coll/Trienekens, et al., 1998; Trienekens and Hvolby, 1999). Major decomposition criteria were coordination mechanisms: - Retail outlet: the retail outlet is considered to be one process (outlet process); in practice it is also regarded as a semi-autonomous decision unit. - DC transport: the processes 'pick' and 'transport' are planned and controlled jointly. - DC order processing: includes 'receipt order', 'process orders' and 'check stock'; decisions concerning these processes are heavily dependent on eachother and are taken concurrently. - DC ordering includes generation of orders and actual ordering (in practice regarded as an integrated process). - Industry order processing: (see DC order processing). - Industry transport: (see DC order transport). - Industry production: includes 'receipt production orders', 'detail production plan' and 'production'; decisions concerning these processes are heavily dependent on eachother and are taken in one organizational unit.
Relevant managing system characteristics: Decision levels, decision types and coordination mechanisms are described below.
Relevant managed system characteristics: - Chain decoupling point at the retail distribution centre. - Stock points at food industry, distribution centre and retail outlet.

5.3.1 Current situation in the case

Every link in the chain has its own adaptions to the generic decision levels strategic planning, management control and operational planning. Decision levels in the three organizations will first be described separately, followed by the decision structure on chain level.

At the retail outlet two decision levels can be recognized:

- A promotions order plan (every three months with a planning horizon of one year), which belongs to the management control level.
- The ordering level (from day to day with a planning horizon of one week), which belongs to the operational planning level.

At the retail distribution centre (the distribution centre in the case incorporates a head-office function) the following decision levels can be recognized:

- Long-term planning (every year, with a horizon of about five years). This includes shop formula planning, design of shop, planning, or large investments, i.e. in distribution centres, etc. This belongs to the strategic planning level.
- Anual planning (every year with a horizon of one year). The most important plan is the commercial plan which is made every year, and which includes assortment planning, promotions planning. This belongs to the strategic planning level.
- Promotions planning, a quarter-annual planning of promotions.
This belongs to the management control level.
- Operational planning (day to day scheduling of the flow of goods). This belongs to the operational planning level.

In food industries, the following decision levels can be recognized:

- Strategic planning (every year with a horizon of one to five years). Definition of product market combination and major investments. This belongs to the strategic planning level.
- Annual planning (every year with a horizon of one year). Planning of contracts (demand and supply, and filling of critical capacities, which belongs to the strategic management level.
- Master production schedule (approximately every month with a horizon of three months). In the master production schedule, the demanded products and the available capacities in the short term (a few months) are weighed and transformed into a general production plan. This belongs to the management control level.
- Detailed planning (planning period one day - one week, horizon one week) is more specific, allowing work orders to be assigned to production units. This belongs to the operations planning level.
- Scheduling is very short term planning. The planning period is from real time to daily, and the planning horizon is one day to one week. It also belongs also to the operations planning level.

Figure 5.4 depicts a GRAI grid for the current situation in a retail supply chain. The processes (horizontal axis) are aggregates of the processes in case 1 of this chapter.

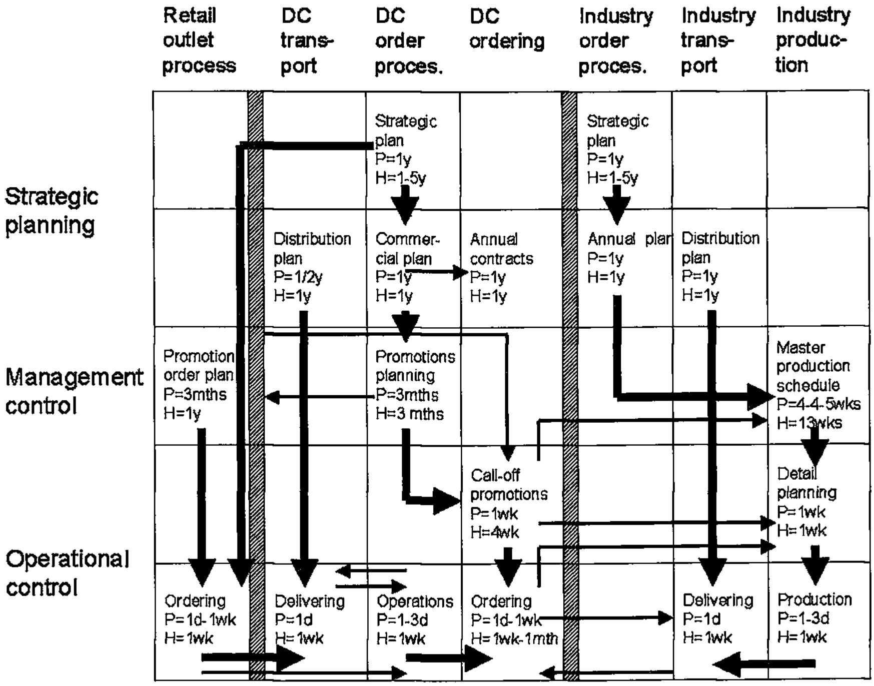


Figure 5.4 GRAI grid for the current situation in the case

Explanation of the GRAI grid: the Y-axis represents decision levels: the top two layers concern decisions at strategic level, the middle layer decisions at management control level and the two bottom layers concern decision at operational level. The X-axis represents processes, depicted above the figure. The figure consists of decision centres (cell's) from which decision frames (constraints, control) and information flow to the other centres. The wide arrows represent decision frames; the narrow arrows represent information flows. P stands for period and H for horizon of the decision. In the grid the decision centres at the lowest level include scheduling activities and execution: e.g. ordering is done once a day to once a week at the retail outlets and takes into account a one-week sales horizon.

(A simplification in comparison to the original GRAI grid (Doumeinghts, 1985) is that external information flows that do not originate in one of the decision centres are left out of the model. The information sources needed by the several decision centres will be described below.

Explanation of decision centres and information flows in the GRAI grid

Retailer:
Every year a strategic plan updated (product/market decision, sales policy, etc.) and a commercial plan is made, in which the composition of the assortment is roughly planned and promotions are planned (e.g., salads in summer during school holidays, coloured eggs at Easter). The commercial plan is supported by information and knowledge of promotions in previous years. (This information is unstructured to semi-structured; general sales data exist, however, no tools to make an in-depth analysis are available). The commercial plan is used in negotiations with food industries and gives input for making annual contracts with these industries. These contracts are based not only on the commercial plan, but also on sales figures from previous years.

Every three months a forecast is made of promotion sales (based on unstructured information concerning past experiences and expectations). This forecast is the basis for planning orders of promotion articles at the retail units. Depending on the (provisional) orders of the retail units for promotion articles (retail units subscribe for promotions initiated by the head office), promotions can be called off at the food producer four weeks before the promotion starts.

Food producer:
A strategic plan is updated every year (product/market combinations, product development efforts, etc.). Once a year a rough sales plan is made, based on information concerning contracts with retail stores, promotion plans of retail stores and sales data from previous years. (This concerns semi-structured and unstructured information.) On the basis of this production plan, contracts with suppliers are finalized a few times a year (depending on the number of production cycles per year). A master production schedule (MPS) is made every four to five weeks, based on sales data from the past and orders for promotion articles of retailers. Every week a detail plan is made for which retail order information (also concerning promotion articles), data concerning past sales (semi-structured) and sales expectations (holidays, weather conditions) are used. Every day a production schedule is made, which is based on detailed planning data and actual order information.

Explanation of type of decisions and coordination mechanisms

Retail outlet:
Decisions at the management control level of decision making are of the 'satisficing' type according to certain rules made up by the head office (the head office decides which product can be promoted and when). Within these constraints, the retail outlet management has to make its decisions. Information about past performance and future sales is incomplete and no suitable tools are available.
Operations planning decisions are taken according to rules and procedures made up by the head office. Actual ordering takes place on the basis of actual sales, stock information and the orderer's 'instinct' with respect to future sales. Every article has its own ordering constraints, e.g. product x may only be ordered on Tuesday, product z on Monday and Thursday.

Distribution centre:
The long term strategic planning decisions at the distribution centre/head office are based on considerations of competitiveness. These decisions will usually depend on the manager involved (i.e. individual differences type of decision making). The annual plan is made according to information on past sales. Analysis of this information, however, is not supported by any tools. This means that decisions at this level are mainly of the 'satisficing' type. The same holds for the management control level (promotions planning). At the operational level decisions are taken according to rules and procedures (ordering patterns, handling of deviations, etc.). Ordering and delivery schedules (including routing) are fixed.

Food industry:
At the food industry, the long term strategic planning and the annual planning are done according to political (contracting) and individual differences types of decisions (strategic position in the market). The decision type in master production planning, detailed planning and scheduling is organizational procedures (e.g. the Master Production Schedule is done according to a 4-4-5-week schedule) and 'satisficing' (incomplete information about future orders).

Chain:
Coordination in the chain between the parties is done according to rules and procedures (contracts and arrangements concerning day, time and quantity margins of ordering and delivery).

5.3.2 Description of major problems in the chain

The following problems arise in this supply chain:
Retailer:
- Sales information is not well analysed/used.
- Information for forecasting and planning is unstructured and incomplete, which leads to extra demands from the retail units (especially during promotions) or, in the case of disappointing sales, to loss of (perishable) products.

Food industry:
- Information from the retailers is incomplete and not timely.
- Fluctuating sales at the retailers lead to production planning problems.
- The delivery planning is for an important part based on the production schedule, which again is based on the detail planning. This, in turn, is not based on short term sales expectations at the retail stores. There is no weekly information from the retailer that can serve as input for the detail plan at the food industry (only promotions information).

Entire supply chain:
- Decision centres along the supply chain at various levels are mismatched (points in time of decisions mismatch; period and horizon of planning differ; planning levels differ).
- Bull whip effects (Lee 1997) emerge because of fluctuating sales.
- No transparent information structure exists (information exchange is incomplete and not timely).

5.3.3 Information exchange and integral chain planning.

The ideas behind multi-level planning (chapter 4) can help in investigating opportunities for chain improvement in this case.

For the retail supply chain the following multi-level information exchange structure can be designed.

Figure 5.5 depicts multi-level planning in the retail supply chain.

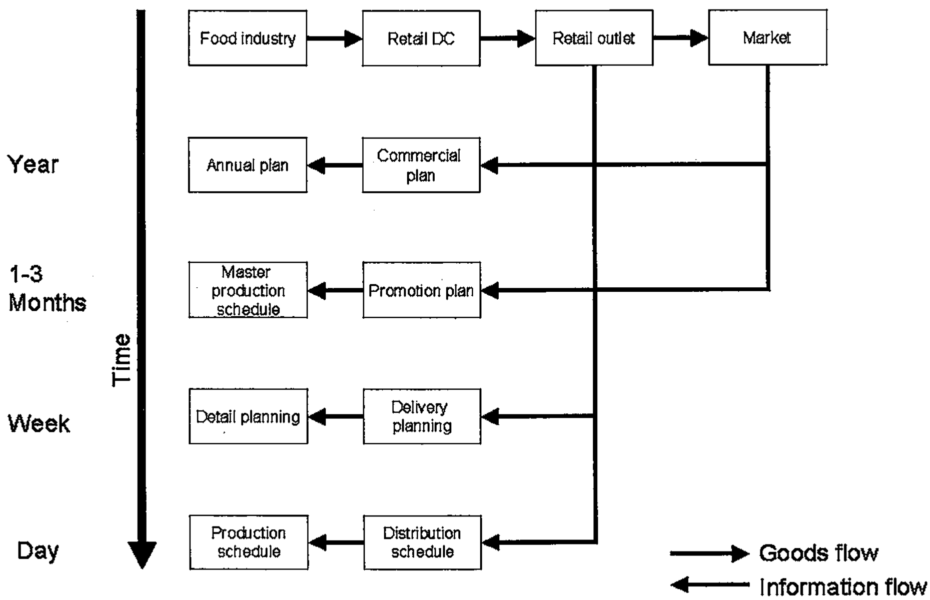


Figure 5.5 Multi-level planning in the retail chain

The figure depicts how market and sales information is used to plan on several decision levels by different parties in the chain. Market information should be used on product family group. This information is refined at a later point in time.
Integration of decisions can move the chain decoupling point upstream in the chain. The producer can separate his production process into a customer-specific part and a

> For example, at week-level: a retail store forecasts its total needs for salads for a week and passes these through to the producer. He can already start with preparation, purchase, and production of ingredients. A few days before delivery, the retail store gives an order with a differentiation in salad types, after which the producer can mix the right quantities per salad type.

non-customer-specific part. The buyer has to give forecasting information at product family level to the producer before he places his final orders. On the other hand, the CODP can move downstream in the production cycle. Production to order can change into packing to order at the producer. Customer specific production is delayed in this example. The buyer can give his final orders later in time and only has to give forecasting information at the original ordering point of time at the product family level.

5.3.4 Future situation in the case

These changes lead to the following additions to the GRAI grid for the future situation. The GRAI grid only depicts changes compared to the current situation: in figure 5.6 the changes in decision centres are depicted by shading, and only the additional information flows are given.

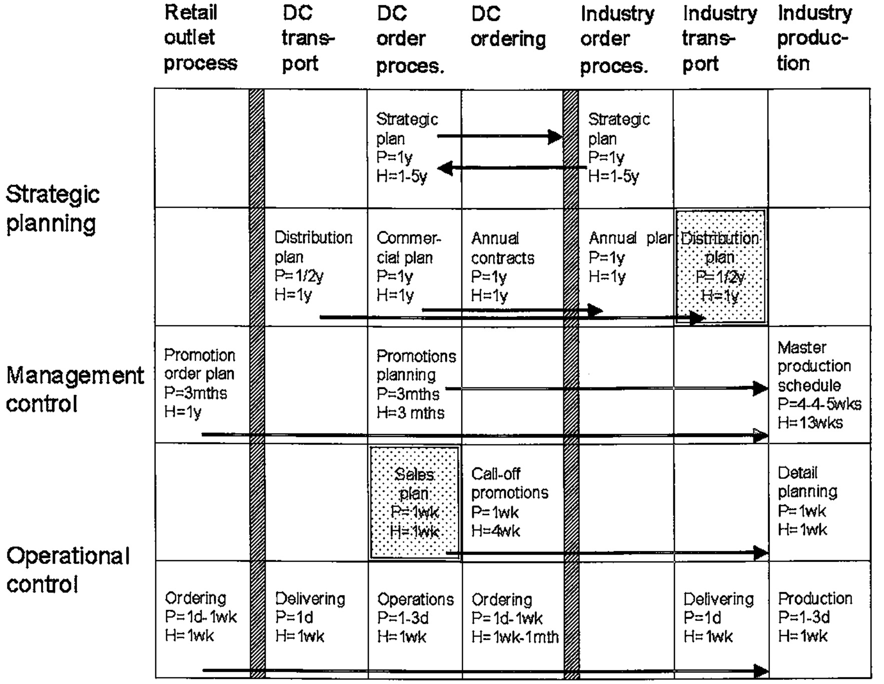


Figure 5.6 Changes in the GRAI grid of the future situation in the case

Future situation related to the framework

Box 5.6 Managing and managed system improvements.

Managing system:

Decision levels:

- Strategic plans are fine tuned.
- If cross docking is used in the retailer distribution centre, (long term) distribution schedules of the food industry and the retailer should be fine tuned.
- Production plans at the food industry (MPS, detail planning) are fine tuned with promotion planning at the retailer; this requires a change in planning method at the retailer (e.g., the addition of an extra planning level to "feed" the detail plan of the food industry with information).
- Interval and horizon of detail planning and short term planning (schedules) are fine tuned throughout the supply chain (e.g. delivery planning at the food industry should be deduced more from the retailer's orders, instead of being constrained by the production schedule and the detail planning of the food industry, respectively).

Coordination mechanism:

- Point of sale data at the retail units are the basis for chain ordering.
- Multi-year strategic decisions might be taken autonomously by top management. At the annual plan level, lateral relations at inter-company level can be introduced.
- Management control decisions might be taken according to rules and procedures on the one hand and lateral relations on the other.
- Operational control decisions are mostly governed by rules and procedures, although lateral relationships might also occur.

Type of decisions:

Increased information exchange at lower levels in the chain enables decisions to be taken more according to rules and procedures. At higher decision levels, a similar development may occur with a tendency to switch from political/individual differences to 'satisficing' decisions:

- Long term decisions (1-5 years) may largely depend on the manager involved (individual differences) and the political structure of the company network. Annual plans, however, might be made more according to market information and contract information.
- Management control might also be performed more according to rules and procedures because of the extra information available, although the political and 'satisficing' element can be strong in order to cope with exceptions due to demand and supply mismatches.
- Operational control can be performed more according to rules and procedures and can be more rationalized, enabled by extended information exchange and more automated systems, e.g. automatic ordering (see also case 1).

Managed system:

- A first tier chain decoupling point is positioned at the distribution centre; a second tier chain decoupling point is positioned at the food industry.

systems, e.g. automatic ordering (see also case 1).

5.3.5 Comments to GRAI grids

In analysing the GRAI grid two things must be borne in mind:
- A link in a chain always has multiple relationships with suppliers and customers. This means that bilateral integration of decisions always implies a simplification of reality. Decision making in different decision centres must be tuned with respect to period and horizon. This means that decisions of intersecting chains must be tuned as well. In the case this means that period and horizon of decisions at different food industries delivering at the same distribution centre must be tuned, which again means that decisions in the various distribution centres involved must be tuned. If this process is extended to suppliers of food industries, it will become even more complex.
- In all chains the customer order/market demand should be the starting point of any analysis. This means that starting from customer demand, tuning of demand and supply will take place step by step at the assembly and distribution points upstream in the chain. Tuning activities in one link will thereby constrain tuning activities of a link further upstream in the chain, etc. Also upstream tuning of activities constrains downstream tuning of activities, which gives the total process an iterative character. This method resembles the Silver-Meal heuristic (Silver, 1998) for multi-echelon replenishment systems. This heuristic could be utilized "to schedule replenishments for the retailer [.....]. This would imply a pattern of requirements for the warehouse [....] which would then be used as input to the Silver-Meal heuristic to plan the replenishment of the warehouse", etc.

Another important consideration with regard to chain decision structures is which decisions belong to the chain managing system and which decisions belong to the processes. In the next case interfaces of processes will be redesigned, hereby also defining the borders between chain managing system and chain managed system. The way decisions are taken by the chain managing system is defined by the coordination mechanism used (hierarchy, lateral relationships, etc.).

5.4 Case 3: redesign of chain processes

Case 3 concerns (re)design of chain process interfaces. Three processes will be analysed that are part of the retail supply chain: retail outlet - retail distribution centre - food industry.
The processes are
- ordering at the retail outlet
- order processing at the distribution centre
- order picking at the food industry.

The analysis and redesign is carried out according to the chain process model developed in chapter three. The case description differs from the other three case descriptions, for the sake of readability. Te current and future situations are presented per process in a figure and a box. Furthermore, the changes in the process related to the research framework are also depicted in a box.

5.4.1 Ordering at the retail outlet

Current situation

Figure 5.7 depicts the interfaces of the process ordering at the retail outlet, in the current situation.

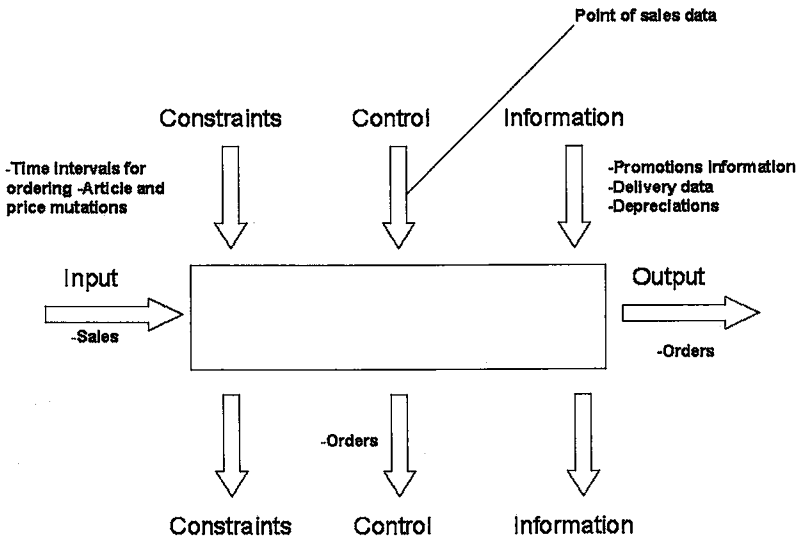


Figure 5.7 Order process at the retail outlet in the current situation

Box 5.7 Process description current situation

<u>Function of the process:</u>
- generation of orders (activities related to the ordering process that are incorporated in the process, including stock keeping (including information on stock mutations) and price reductions.)

<u>Input:</u>
- sales (generic).

<u>Output:</u>
- orders (generic).

<u>Input constraints:</u>
- time interval when ordering must take place,
- article and price mutations (generated by head office/DC),

<u>Input control:</u>
- point of sales data.

<u>Input information:</u>
- information concerning actions (generated by head office/DC),
- data about annnounced deliveries (generated by head office/DC),

- depreciations (generated by head office/DC)
Output constraints:
- none.
Output control:
- orders.
Output information:
- none.

As was described in chapter 3 'input' and 'output' in the chain process model reflect intrinsic (status independent) characteristics of 'input' and 'output'. That is why in the above figure, for example, 'order' is depicted twice (at 'output' and at 'control'). 'Order' at 'output' in the figure includes such things like the range of products that can be ordered, the suppliers where the order can be placed, etc. 'Order' at 'control' in the figure concerns actual order information (demands with regard to quantity, quality, delivery time, etc.).

Future situation

In the future situation, the process can be improved and further integrated in the chain. The process can be largely automated, which eases the functioning of the process. The process in the retail outlet is performed by the outlet's management in a largely autonomous way. However, to improve performance, several constraints could be added to the process (e.g. automated ordering see figure below). Information output enables analysis of the process, on the one hand, by the internal management system of the process itself (not given in the model), and on the other hand by the retailer's head office to enable benchmarking and improve the process by stimulating the learning capacities of the process.

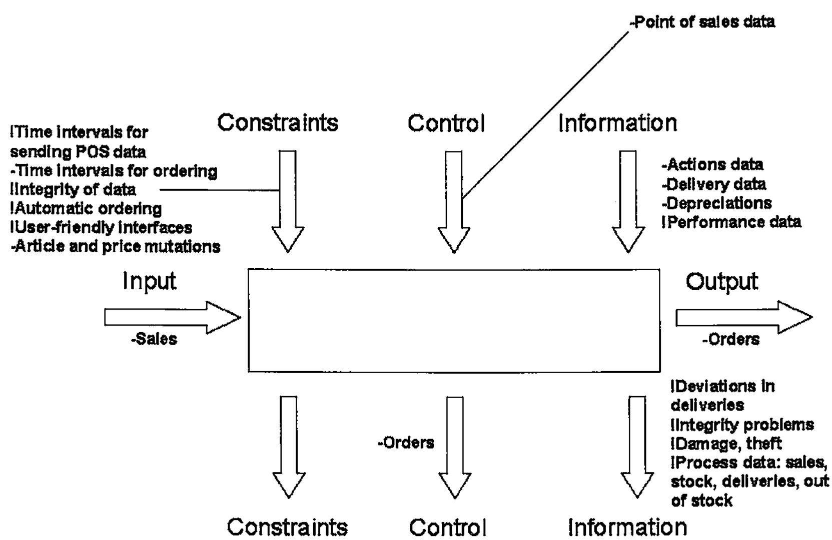


Figure 5.8 Order process at the retail outlet in the future situation
(*New inputs and outputs in the figure are indicated with an exclamation mark.)

Only additions are mentionde in the description of the future situation in Box 5.7.

Box 5.8 Process description future situation

Function of the process:
The function of the process is broadened by:
- sending through data about sales (POS data) and stock to the central retailer information system),
- reporting for analysis goals (per point of sales per time unit, data concerning losses, analysis on behalf of assortment management, data for stock management, delivery and order data, etc.).
Input:
no additions.
Output:
no additions.
Input constraints:
Several constraints are added to the process in order to achieve a better performance:
- integrity of data,
- automatic ordering as much as possible,
- user-friendly interfaces,
- time intervals to send POS data to the retail head office.
Input control:
- no additions.
Input information:
The head office, which processes output information of the retail outlets, uses these for benchmarking, on the one hand, and performance reporting to the process on the other.
- performance data.
Output constraints:
no additions.
Output control:
no additions.
Output information:
- deviations in deliveries,
- integrity problems (e.g. incorrect assortment mutations from head office),
- damage, theft,
- data concerning sales, stock levels, deliveries, out of stock,
- exception reporting,
- article and price mutations to points of sale.

Box 5.9 Future situation related to framework

Managing system (interfaces):
- addition of constraints to improve performance on a chain level,
- input of performance data to support process improvements,
- output of performance data for control reasons and benchmarking.

Managed system:
- rationalization of process,
- addition of a report function.

5.4.2 Order processing at the distribution centre

The second process in case 3 is order processing at the distribution center.

Current situation

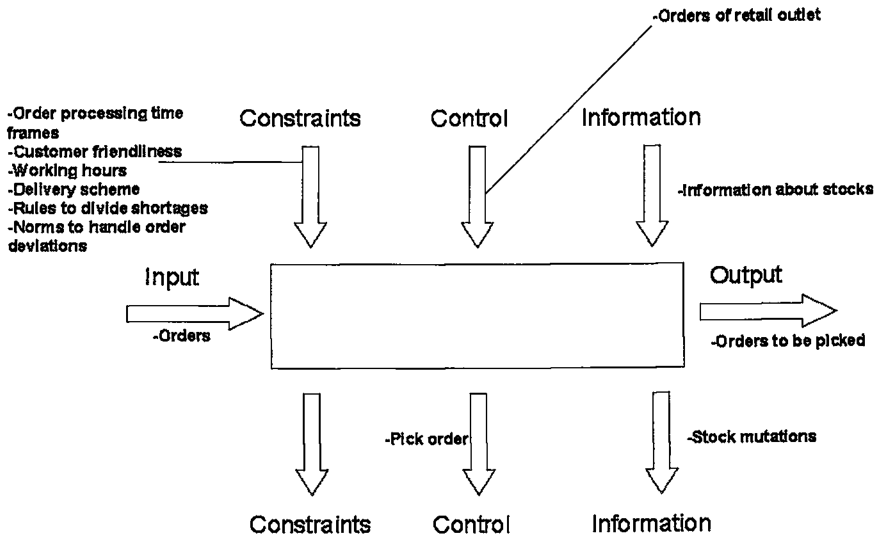


Figure 5.9 Order processing at the retail distribution centre in the current situation

Box 5.10 Process description current situation

Function of the process: - processing of orders and generation of pick-orders, - possible stock shortages are divided amongst the customer orders according to a certain key. Input of the process: - generic orders from certain customers concerning certain articles. Output of the process: - generic orders to be picked and transported concerning certain articles for certain customers. Input constraints: - order processing time frames, - customer friendliness, - working hours, - delivery scheme (for the outlets to be delivered), - rules to divide shortages, - norms to handle deviations in orders, Input control: - orders of retail outlets. Input information: - information about stock. Output constraints: - none Output control: - orders to be picked. Output information: - stock mutations.

Future situation

In the future situation, the most important changes in this process are the improved automatic support and real-time processing of orders (during working hours). Another gain is the provision of information about the process performance, which is reported back from the process environment through the information input function. This may stimulate process improvement.

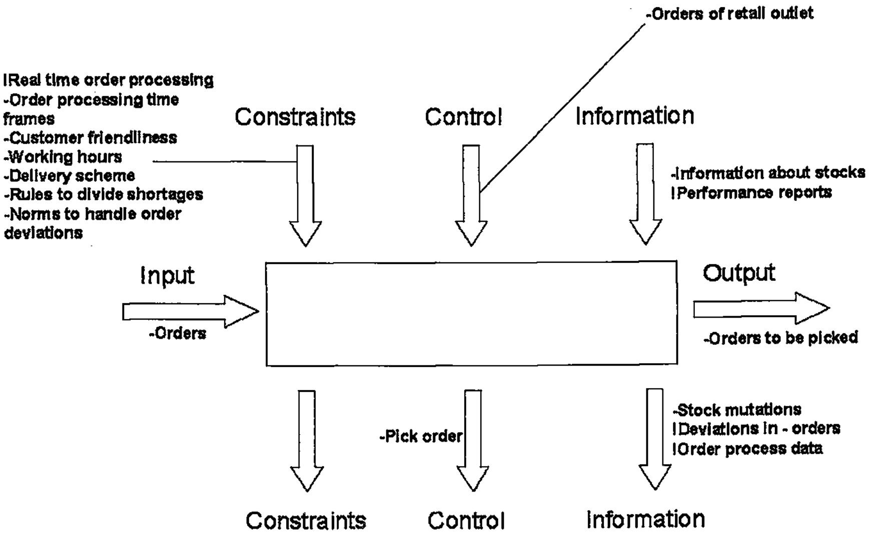


Figure 5.10 Order processing at the retail distribution centre in the future situation (*New inputs and outputs in the figure are indicated with an exclamation mark.)

In Box 5.11 only additions are mentioned in the description of inputs and outputs in the future situation.

Box 5.11 Process description future situation

Function of the process:
- real-time processing takes place.

Input of the process:
no additions.

Output of the process:
no additions.

Input constraints:
- real-time order processing.

Input control:
no additions.

Input information:
- performance reports.

Output constraints:
no additions.

Output control:
no additions.

Output information:
- deviations in orders,
- data regarding order processing (throughput times, etc.).

Box 5.12 Future situation related to framework

Managing system (interfaces): - real-time order processing constraints, - input of performance data to help process improvements, - output of performance data for control reasons and benchmarking. **Managed system:** - real-time order processing.

5.4.3 Order picking at the Food industry

The third process in this case is order picking at the food industry.

Current situation

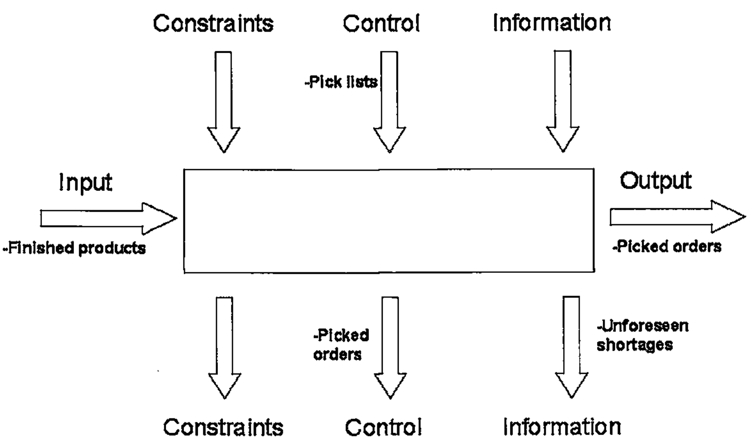


Figure 5.11 Order picking at the food industry in the current situation

In the current process, the planning department makes order pick lists and gives them to the order pick department. The order pickers must follow the pick lists exactly, regardless of unforeseen shortages, problems with delivery schedules, etc. In practice, this often means that orders can be picked only partly, which leads to situations in which many partly picked orders are made (which again leads to confusion, mistakes, etc.).

Box 5.13 Process description current situation

Function of the process:
- order picking.
Input of the process:
- finished products come into the warehouse.
Output of the process:
- picked orders (generic).
Input constraints:
- none.
Input constrol:
- pick lists.
Input information:
- none.
Output constraints:
- none.
Output control:
- picked orders.
Output information:
- unforeseen shortages

Future situation

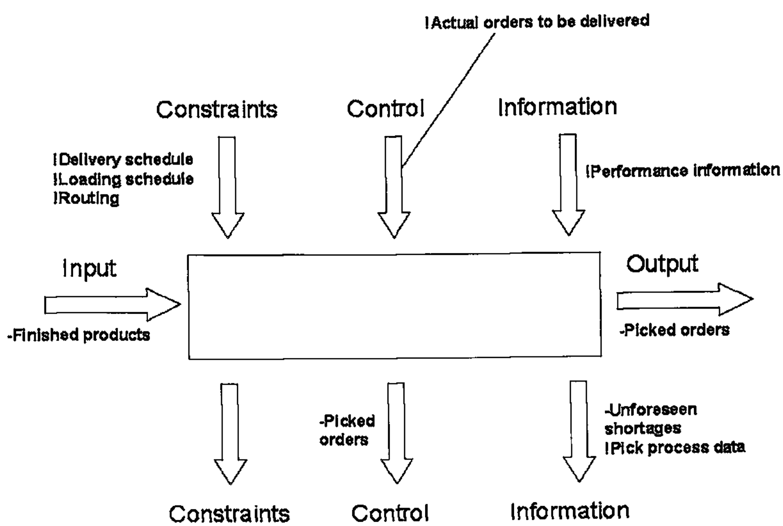


Figure 5.12 Order picking at the food industry in the future situation
(*New inputs and outputs in the figure are indicated with an exclamation mark.)

In the future situation the order pick process will be far more autonomous. The process will be constrained by the delivery schedule, the loading schedule and the routing. Any problems that occur can be handled up to a high degree by the process itself. Order pick lists can be printed whenever the order pickers choose to. This autonomy makes the department far more flexible.

In Box 5.14 only additions are mentioned in the description of inputs and outputs of the future situation.

Box 5.14 Process description future situation

Function of the process: no additions. Input of the process: No additions. Output of the process: No additions. Input constraints: - delivery schedule - loading schedule - routing. Input control: - actual deliveries to be madee. Input information: - performance information. Output constraints: - none. Output control: - none. Output information: - pick process data.

Box 5.15 Future situation related to the framework

Managing system (interfaces): - the process does its own planning, therefore is now constrained by delivery schedule, loading schedule and routing, - the process is managed by delivery information, - output and input of performance data for control reasons and benchmarking. **Managed system:** - autonomous order picking.

5.4.4 Case discussion

Remarks regarding decision structure and coordination mechanisms:

- The aim in this chain is to enlarge the share of rational and procedural decisions in the processes, on the one hand (by increasing decision support with information systems), and on the other hand, to keep them flexible by using human creativity to cope with exceptional situations (DC order procesing and food industry order picking). Decisions are of the type
  - rational (e.g. automatic ordering in retail outlet, large part of DC order processing,
  - procedural (rules to react to shortages, peaks in sales in outlet ordering and DC order processing, pick scheduling in food industry order picking), and
  - (for some orders) 'satisficing' (rules of thumb in all examples).
- A number of extra constraints are put on outlet ordering and DC order processing. Outlet ordering is in the current situation to a large degree autonomous in its decision making. It is, however, increasingly expected to work by means of rules and procedures: more constraints and application of information technology. The information output function also provides control opportunities for the head office (besides the purely financial figures that are provided now). Food industry order picking can especially be more autonomous in the future situation.
- The relation to the customer is altered (in DC order processing and food industry order picking the customer is now 'in charge' of the process (real-time order processing and customer oriented order picking).

Relation to the GRAI grid in case 2: managed system versus managing system in chain perspective

It is interesting to note the demarcation of processes in comparison with the decision structure in case 2. The choice of which decisions to include in a process is a chain management decision. From the point of view of modern process management, external control can often be minimized by transferring control capacity to the process itself (compare Sociotechnics, chapter 3):
- With respect to the retail outlet ordering process, all decision levels (promotion order plan and ordering) could easily be considered to be part of one and the same process (organizational process unit), because of the relative small size of retail outlets and because several decision functions will probably be performed by the same person, the outlet manager.
- With regard to order processing in the distribution centre, higher level decisions are taken by a distinct organizational level. An important reason for this is that for different types of decisions different people with different capabilities are involved: higher level decisions are of the political or 'satisficing' type, whilst lower level decisions are more of the organizational procedures type (decisions concerning ordering and delivering).
- The order pick process at the food industry could be considered to be a distinct process because of its specific location in the company combined with the short term decision horizon compared to other decision levels. It could, however, easily be integrated with transportation processes (especially if transportation processes are regarded as the customer of order picking processes).

5.5 Case 4: managing system in a chain assembly and distribution link

In chapter 4, the importance of assembly and distribution links in the chain was underlined. This case depicts a managing system in such a link.

5.5.1 Integral decision structure

In this case, a marketing organization will be interpreted as an assembly and distribution point in the chain of fresh products. In the assembly and distribution point, demand (from the retailers) meets supply (from the primary producers).

In the chain, no straigth forward translation of demand upstream in the chain to the primary producer can be made, because of the uncertainties in demand (often due to weather cicumstances) and supply (uncertainty with regard to delivery time, quantity of delivery, quality of delivery). The process of tuning demand and supply is also very complex because of the large numbers of suppliers (more than 5000 for the largest marketing organization in the Netherlands) and the number of products involved (more than 5000 articles). Also, suppliers deliver products in different time frames. (Food industries are confronted with a similar problem in that their suppliers are primary producers who have contracts with the food industry. Uncertainty of delivery (time, quantity and quality) is also normal practice in this sector.

Box 5.16 Improvement strategy, research objective, chain structure and primary chain processes in the case and relevant managing and managed system characteristics.

Improvement strategy: gearing of decision making in a chain assembly and distribution link.
Research objective: design of a multi-level planning system around the chain decoupling point.
Chain structure: the chain consist of three links: sales, matching (of supply and demand) and purchase.
Primary chain processes: the order flow.
Relevant managing system characteristics:
- untuned decision levels,
- coordination problems lead to many mismatches between supply and demand.

Relevant managed system characteristics:
- complex process network,
- large product assortment,
- perishable products,
- uncertain supplies/demand.

In box 5.17 the proposed design of the decision structure is depicted (managing system).

Box 5.17 Description of design

Managing system (decision levels):

- In the long term (1-5 year level) an innovation plan is made on the basis of (international) market and product information, demographic data etc. On the basis of this plan and marketing information (supply and demand), a marketing plan is made every year.
- Forecasts of customer demands are made on the basis of market information and information from existing contracts with customers (wholesalers, international chain stores etc.).
- Before every growth cycle (season) frame contracts are made with suppliers and customers to make an initial match between demand and supply (e.g. time period every three months, time horizon every year). Growers get pre-planting advice about which products to grow in which amounts. This advice includes a rough indication of expected market demands for product types. On the other hand, growers give a forecast of their production figures (on product family level, unpacked) to the marketing organization: the products in quantity and quality to be expected for the coming harvest.
- Some time before harvesting customer demands are further specified in product types. Rough indications of packaging materials needed and quality classes are given. The marketing organization divides (buyers) demand as far as possible amongst the growers (e.g. grower X packages mushrooms in green private lable packages, quality of the product is 1A). This makes it possible for the growers to make their harvesting and packaging plans. At the same time, growers give information about the expected harvest (quantity and quality) for purchase and sales planning at the marketing organization. At the detail planning level, market position monitoring takes place on the basis of input from short and middle term demand and supply expectations.
- During harvesting the marketing organization gives the final specifications of the customer demands to the growers. The growers give final information about the products, packaging and quality to be delivered to the marketing organization. In the short term, day to day (period one day, horizon one week) order planning takes place. Demand and supply may be called off. Also ad-hoc orders come in on the demand side and deviations from planned supply occur on the supply side. If demand and supply in the short term do not match, active buying or selling has to take place. Figure 5.13 shows a one-way incoming arrow from sales (decision centres call off etc.) to order planning, which reflects that orders must always be fulfilled. On the other hand, there is a continuous information exchange with buyers to cope with unexpected orders.

Managing system (type of decisions and coordination mechanisms):

Type of decisions:

It is interesting in this case that decision making for one part can hardly be rationalized, because of demand and supply uncertainties. Even at the operational level, a continuous search to match demand and supply has to take place, which asks for human creativity. Decision types will vary from political and individual differences to 'satisficing'. In another (large) part of the goods flow, however, demand and supply can be predicted up to a high degree and can therefore be more rationalized. Contracts with suppliers and customers play an important role here. Decisions will be more of the organizational procedures type.

Coordination mechanisms:

The coordination mechanism will vary from procedures and rules for matching of the 'static' (contract) part of supply and demand to task groups (to find solutions for certain groups of products), and to a large extent to autonomous decision making in case of ad hoc ordering/ purchasing and active selling and buying. Probably, division of the process in different organizational units could be in order here, because of the different decision types, coordination mechanisms and capabilities that are involved.

The following management model was designed for a marketing organization in the horticulture sector (figure 5.13).

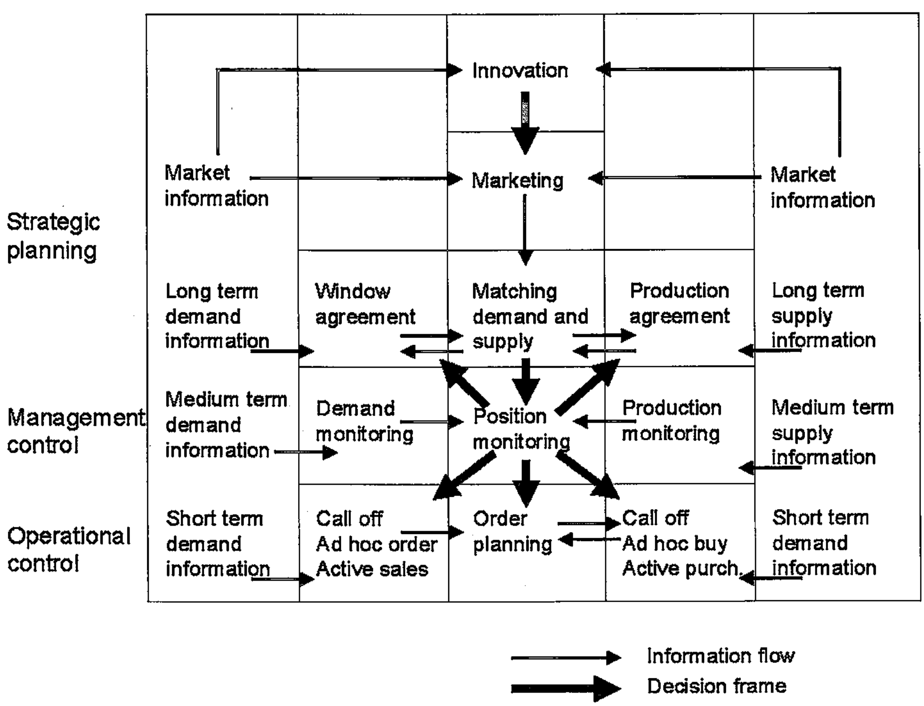


Figure 5.13 GRAI grid for an assembly and distribution point

Obviously, the core of this management structure is the search for the right match between demand and supply at all decision levels. Position monitoring (at management control level) takes a central place in this structure. If necessary, changes in frame window agreements for the longer term can follow. Also, changes in short term demand and supply can be imposed by this monitoring function.

The problem of matching supply and demand is especially complex in the short term. In the next sub-section a design for short term demand and supply will be worked out.

5.5.2 Gearing demand and supply in the very short term

One of the sub-projects in the case aimed at development of a short term supply and demand matching system. The following solution was designed.

Often a demand cannot be satisfied immediately; a certain quantity of products in the right quality and the right packaging is not available to match a sudden demand. If a certain order cannot be delivered by one primary producer, the marketing organization will try to find another primary producer who can deliver. Another option is for the marketing organization to repack the products itself, or to ask a primary producer to (re)pack the products into another package. In this way, gearing demand and supply in the very short term can take place.

Because the matching problem concerns only a limited part of the total demand, the problem can be solved with a small group of primary producers. These producers have to be very flexible in packing and delivery of products. Another pre-condition is that a seamless information flow between these growers and the marketing organization must exist. The marketing organization must posess actual data about products that can be supplied and about the packages that are available at these producers (because the group of flexible producers is small, the variety in packages at these producers can be larger, without high costs).

Every day the producer sends an estimation of his produce to be harvested that day to the marketing organization (e.g. by EDI). Every change during the day (less produce, sales of part of the products, etc.) must be reported to the marketing organization. The marketing organization has a complete overview of the expected produce (quantity and quality) of his flexible producers each day. If a special demand occurs, an intermediate at the marketing organization starts (with the help of a DSS) a search for the right (quantity and quality of) products and the right packages at the producer who is nearest in time to the customer. As soon as a choice has been made, a message is sent to a supplier (primary producer) who has to confirm the order. Then the customer gets a message so that the order can be fulfilled. At this moment, part of the production of the flexible producer has been assigned and will, naturally, not be available anymore for a next search. If for some reason the assigned order cannot be fulfilled (wrong estimation of producer, system fault, etc.), the producer sends a message back immediately saying that the order cannot be fulfilled. Then a next search has to be started.

Section 5.6 will give an overview of the cases and introduce the discussion in chapter 6.

5.6 Overview and discussion

Overview

In this chapter several methods of redesign in chains were presented:

- Case 1: redesign of a managed chain system supported by EPC models. In this case the aim was throughput time reduction. A similar case is thinkable, however, regarding cost reduction or quality improvement. Methods like supply chain costing and quality function deployment could be helpfull here (chapter 2).
- Case 2: redesign of the decision structure in a chain supported by GRAI grid modelling. In this case, the importance of coordination of planning levels and information exchange in chains was stressed.
- Case 3: (re)design of chain processes, supported by chain process modelling. In this case considerations regarding information exchange between chain processes and the chain managing system were stressed.
- Case 4: the fourth case (supported by GRAI grid modelling) stressed the function of assembly and distribution points in chains and the different types of decision making needed there.

Methods and models used in this chapter can be used in combination and iteratively in chain redesign projects in practice.

Logistics strategy

In analysing the cases it becomes clear that no one solution for managed and managing systems in chains can be designed. Every chain will have its own design (see also chapter 2). An important point of discussion, therefore, is what strategy to choose in what situation.

A logical approach often chosen in Supply Chain Management applications is translation of customer demand upstream in the chain to the chain decoupling point. These applications seem especially valid if demand and supply relationships reach an acceptable degree of certainty. Chains can then be characterized by short throughput times, high efficiency/low costs and high delivery reliability. Upstream of the chain decoupling point, planning can be based on aggregate customer order information.

However, when demand/supply relationships are characterized by more uncertainties and are more complex, gearing of demand and supply might become as equally important as the straigthforward translation of customer demand as described above. Within any single food chain (network), aspects of both can be found.

This discussion will be elaborated on in the next chapter.

Chapter 6 Conclusions and further research

6.1 Conclusions

6.1.1 Three research perspectives on chains

In chapter 2 three research perspectives on chains were defined: institution, performance and process perspective. The scope and position of various scientific approaches to vertical coordination were related to these perspectives. Practical chain problems can be linked to one or more perspectives and, via these, to appropiate scientific approaches to solving the problem. This can easily lead to a multidisciplinary approach to chain problems (including elements of more than one scientific approach).

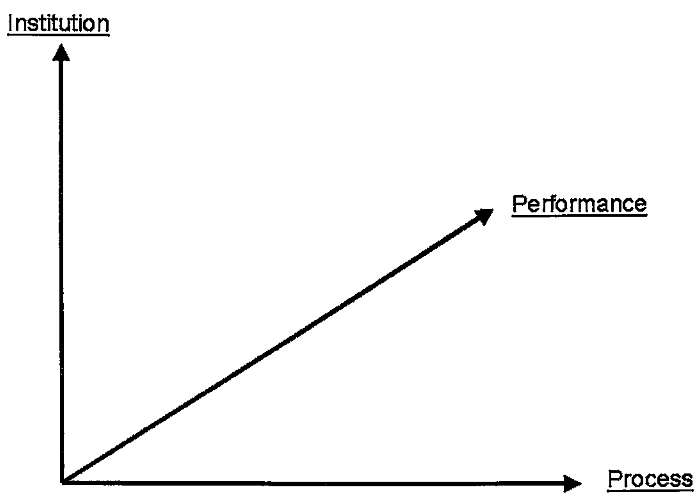


Figure 6.1 Research perspectives on chains

As theory development on chains continues, the description of research perspectives may be further sharpened. This again might stimulate multi-perspective research.

6.1.2 Research framework

In chapters three to five a research framework from the process perspective on chains was developed. Elements of this framework were further specified to logistic processes and illustrated in cases.

Below an overview of the framework is depicted. The framework includes a Why? component, referring to the view of the researcher on the research object, a What? component, referring to the relevant variables of the research framework, a How? component, referring to relations between the variables and a method to apply the framework to practical chain problems, and a 'Who?, Where?, When?' component referring to applications of the framework in practice.

Why? (general research objective and view of chains)

The goal of chain research is chain performance improvement related to practical chain problems.
The view of the research object is the starting point of any research. In this thesis the view is: a chain consists of a network of customer oriented and cross-functional processes with precedence relationships. In chain research the focus is on primary processes which are most closely linked to the product flow in the chain. Non-primary processes are designed to support primary processes and can or should be deduced from primary processes. A chain process is managed through its interfaces by the chain managing system. It also has its own managing system, however, which allows for autonomous decision making up to a certain degree.

What? (variables)

The variables of the framework can be divided in two groups: managed system variables and managing system variables. (The chain managing system manages the chain managed system). The variables in the framework depicted below are specified for logistic processes in food chains.

Managed system (typical points of attention in food chains)

- Typical object system characteristics:
    - Typical product characteristics of food chains are supply uncertainty, quality variations between lots, perishability of produce.
    - Typical process characteristics of food chains are unpredictable production yields, conditioning of products (cooling/freezing), diverging production processes, recycling of products.
- Typical infrastructure aspects:
    - Position of chain decoupling points: important food chain constraints are production lead times, supply/demand uncertainties, perishability, divergent product flow.
    - The process configuration must enable fast movement of products.
    - A tendency to increase ordering and delivering in product categories.
- Typical operational aspects:
    - Major attention goes to the speed of the product flows and flexibility in production and distribution processes.

Managing system (typical points of attention in food chains)

- Integrated multi-level planning/decision systems:
- Diverging processes can be found in many food chains. These are especially suited for the design of multi-level planning systems.

- Uncertainties in demand and supply constrain the design of planning systems,
- Perishability of products is an important point of attention in many decisions in food chains (e.g. ordering, delivering, stock keeping). It is an important constraint for the design of a planning system.
- Transparent information exchange is the major coordination mechanism.

How? (method for chain analysis and (re)design)

Steps in the method are performed iteratively to move from the current situation to a future one:
- Step 1: definition of research objective, based on the chain's improvement strategy
- Step 2: definition of chain customer and links involved
- Step 3: definition of primary chain processes (e.g. the order flow for logistics management)
- Step 4: decomposition into chain processes, iteratively focusing on the relevant variables of managed and managing system. The relevance of variables is defined by the research objective.
- Step 5: analysis and development of chain managed and managing system and chain process interfaces, iteratively focusing on the relevant variables. The relevance of variables is defined by the research objective.

Three modelling tools were designed to support the method for chain analysis and (re)design:
- a modelling tool for analysis and (re)design of chain infrastructures: EPC modelling,
- a modelling tool for analysis and (re)design of chain decision structures: GRAI grid modelling,
- a modelling tool for analysis and (re)design of chain process interfaces: chain process modelling.

The first two models are derived from adaptation of existing models for analysis and (re)design of processes on a company level.

Who?, Where?, When? (cases)

Application of the research framework is performed in cases in chapter 5. In the cases the modelling tools were used for analysis and (re)design of chains. Cases aimed at:
- throughput time reduction and efficiency improvement in a retail chain,
- gearing decisions in a retail chain to improve efficiency and effectiveness of a chain,
- redesign of chain process interfaces in a retail chain to improve efficiency and flexibility of chain links/processes,
- design of a decision structure for an assembly and distribution point in a horticulture chain, to improve efficiency and effectiveness of matching of supply and demand in this chain.

Although not all variables in the framework are equally exposed in the cases, the framework proves to be valuable for analysis and (re)design of chains. Further application and evaluation of the framework (by design and regulative cycles explained in chapter 1) will lead to its further elaboration.

In the following section an overview of research opportunities related to application of the framework and its relation to other perspectives will be investigated.

6.2 Opportunities for further research

Three groups of research opportunities can be recognized:
- use of the framework to identify opportunities for logistics management in chains,
- use of the framework to support decision making concerning the logistics strategy of chains,
- use of the framework for multi-perspective research on chains, integrating elements of various scientific approaches to chains.

6.2.1 Research opportunities for logistics management in chains

Because of the large range of issues that can be approached with the framework, many research opportunities exist. These are not restricted to the field of logistics. For example, quality and environmental issues can also be analysed from a process perspective (e.g. Quality Function Deployment, chapter 3). There are many interesting topics related to logistics, including the following:
- Research into technologies to alter object system characteristics. Examples with ICT applications are given in the cases in chapter 5 (especially lead time reduction). However, product, process, and transportation technology can also be used to improve/alter chain object systems.
- Design of information systems to support customer order translation upstream in the chain. Examples of important issues are item coding in chains, electronic data interchange throughout the chain, automated processing of sales data, chain databases, and chain information models.
- Design of methods and models for decision making in complex chain environments with high demand and supply uncertainties. Some examples are advanced decision support systems and methods to enlarge human capabilities.

6.2.2 Research opportunities concerning logistics strategy building

The second area of research opportunities concerns building logistics strategies. The choice for a logistics strategy (a coherent set of choices concerning the managed and managing systems of a chain) depends on complexity of the flows of products and information and on the business strategy.

With regard to the complexity issue, chapters 4 and 5 showed that the less complex and uncertain relationships between companies are, the more rationalized decision making and formalized (i.e. mechanistic) coordination can be designed for a chain. On the other hand, more complexity and uncertainty leads to less opportunities for rationalized decision making and formalized coordination. Complexity of flows of products and information is closely related to environmental dynamics. On the one hand, customer demands are increasing, and on the other hand, food companies are becoming part of a bigger network of companies and institutions because of the widening scope of production and trade (e.g. internationalization). This creates a more dynamic environment for these companies: product/market combinations and processes continuously change, implying a constant change of the total network of relations between companies.

The second important aspect that defines a logistics strategy is the business strategy. Choices in business strategy are illustrated by two polar strategies, an exploitation strategy and an exploration strategy (March, 1991): "Exploration includes things captured by terms such as search, variation, risk taking, experimentation, play, flexibility, discovery, innovation. Exploitation includes such things as refinement, choice, production, efficiency, selection, implementation, execution..... The essence of exploitation is the refinement and extension of existing competences, technologies, and paradigms. Its returns are positive, proximate, and predictable. The essence of exploration is experimentation with new alternatives. Its returns are uncertain, distant, and often negative."

On the one hand, companies aim to gain as much as possible from existing structures and relationships. On the other hand, however, in a dynamic environment companies have to strive for competitive advantages by finding new opportunities. This means for most companies that, besides investing in existing structures, investments in uncertain and risky future structures should be made.

As March (1991) states: "It is assumed that there are several alternative investment opportunities, each characterized by a probability distribution over returns that is initially unknown. Information about the distribution is accumulated over time, but choices must be made between gaining new information about alternatives and thus improving future returns (which suggests allocating part of the investment to searching among uncertain alternatives), and using the information currently available to improve present results (which suggests concentrating the investment on the apparently best alternative)".

Parallel to the difference between exploitation and exploration in business strategy is the difference between lean production and agile production in logistics strategy:
- Lean production (Womack et al., 1990; Lamming, 1993) focuses on smooth and fast materials flows, optimal use of capacities, and minimal stock levels in production and marketing channels. Lean production focuses in the first place on efficiency of operations.
- Agile production focuses on flexibility and responsiveness (Preis et al., 1996). Kasarda and Rondinelli (1998) define agile production as " the ability of a company to thrive in a competitive environment of continuous and unanticipated change".

Both approaches are customer oriented. Rationalization and formalized coordination are aims in lean operating chains, whereas flexibility and standardization are aims in agile operating chains. Standardization of technologies and methodologies for product flow and information management are of vital importance for agile chains (i.e. multimodal transportation systems, integrated telecommunication networks, commercial and service support, knowledge centers, etc.).

Traditional Supply Chain Management approaches fit with lean production and distribution: they aim at a limited number of parties involved and they are efficiency oriented (the seamless flow of products and information). Agile production and distribution fits more with network approaches in chains in which companies try to take (changing) positions in dynamic company networks. Referring to the cases in chapter 5, a choice for a lean distribution strategy means trying to stabilize and optimize existing network connections, e.g. the retail distribution centres in many food chains; a choice for an agile distribution strategy means exploring supply and demand markets for new opportunities (e.g. a marketing organization).

What logistics strategy to choose in what situation is an interesting field for further study. The appropriate approach for most chains should probably be somewhere in between the two polar strategies described here.
Strategic choices are strongly related to elements of approaches with an institution perspective on chains. Further research must include these elements. In the following section, a first step will be made by showing a number of relations between elements of the research framework and elements of other scientific approaches.

6.2.3 Relations between framework elements and elements of other scientific approaches

The number of possible cross links between scientific approaches that can be defined in multi-disciplinary research is almost infinite. The range of research opportunities will therefore be elucidated by posing a limited number of relations in the form of hypotheses around three subjects: governance structure and control philosophy, and market strategy.

<u>Hypotheses concerning governance structure and chain logistics</u>

As was described in chapter 2, Transaction Cost Theory makes a distinction between market and hierarchy as polar governance structures. High frequency of transactions between parties, high uncertainty and high asset specificity may lead to a striving for an integrated (hierarchic) governance structure. With regard to logistics it may lead to a choice for lean chains. Uncertainties in transactions, low frequency of transactions and low asset specificity might easily go together with rising stock levels and process networks that are not well tuned. On the other hand, in some cases in agribusiness, it might easily lead to movement of the CDP upstream in the chain (e.g. keeping raw materials alife/in the field until the customer order comes in).

Some interesting hypotheses link Transaction Cost Theory elements to the managing system part of the framework:
- Low uncertainties in transactions might go together with rationalized decision making and formalized coordination.
- Low frequency of transactions might go together with less rationalized decision making and less formalized coordination (ad-hoc management structures).
- High asset specificity of transactions might mean (inter)dependence of companies, which might lead to a choice for rationalized decision making and formalized coordination.

Other interesting hypothesis link Transaction Cost Theory elements to the managed system part of our framework:
-Integrated governance structures can help move the chain decoupling point upstream in the chain. Because integration on a chain level enhances collaboration and control possibilities between parties, it fulfils an important condition to upstream movement of the CDP: parties <u>downstream</u> of the CDP must work closely together in fulfilling customer

orders.,
-Integrated governance structures (with centralized control) may lead to lower stock levels, e.g. Silver, in an overview of literature on multi-echelon replenishment systems (1998), points out that centralized control has the best results in maintaining low stock levels.,
- Integrated governance structures may go together with a more tuned network (in the sense of efficient use of resources and short lead times).

Figures 6.2 and 6.3 depict possible relationships between the degree of structured decision making, on the one hand, degree of uncertainty, frequency and asset specificity of transactions on the other. ('Structure of decision making' in this sense may vary from a rationalized type of decision making and formalized type of coordination to a political/individual differences type of decision making and organic type of coordination (see chapter 3).

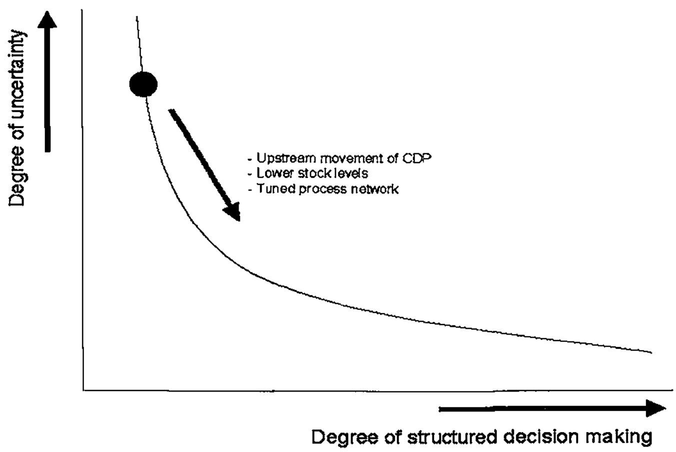


Figure 6.2 Relation between uncertainty, degree of structured decision making and logistics infrastructure characteristics

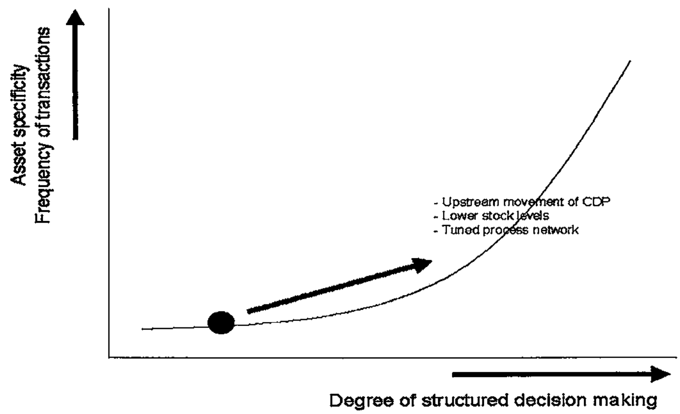


Figure 6.3 Relations between asset specificity and frequency of transactions, degree of structured decision making and logistics infrastructure characteristics

In conclusion, integrated (hierarchic in terms of Transaction Cost Theory) governance structures might go together with rationalized and formalized (lean) structures, whilst market governance structures might to go together with less rationalized and formalized (more agile) structures.

Hypotheses concerning control philosophy and logistics management.

The heart of Agency Theory is the trade-off between the cost of measuring behaviour of the agent and the cost of measuring outcomes of the agent. Risk attitudes of the principal and the agent, outcome uncertainty, and information systems are key issues in Agency Theory.

Agency Theory can help us to understand decisions concerning outcome based and behaviour based systems. In this sense it is closely related to the issue of autonomy of chain processes (chapter 3). At highly autonomous processes the environment is especially interested in the (expected) process output. The (internal) behaviour is of importance only as far as constraints are involved. This fits with the approach in Agency Theory in which risk is transferred to the agent. The agent only provides information concerning (expected) deviations in behaviour; it does not provide process data that is or could be used for control. In the last decade certification systems have been implemented in many food chains in the Netherlands, meaning that constraints are put on chain links within which these can operate (to a high degree autonomously). See the example on integrated quality management, IQC, in the pork chain (chapter 3).

Autonomous processes controlled by output based measurement systems imply decentralized control, which again might easily lead to higher stock levels, untuned process networks, bull whip effects, and downstream positioned chain decoupling points (see also the discussion on governance structures earlier in this section). The opposite applies to processes with little autonomy controlled by behaviour based measurement systems.

In conclusion, behaviour based measurement systems seem to be related to rationalized and formalized logistics management structures, whereas output based measurement systems seem to be related to less rationalized and formalized logistics management structures.

Hypotheses concerning strategic management and logistics management

Strategic management as understood in this thesis, is about positioning the company in its environment. Porter (1980) distinguishes between two polar strategies: differentiation and cost strategy. Related to elements of our framework the following hypotheses can be formulated:

- A differentiation strategy might lead from a logistics management point of view to choices for upstream movement of the CDP (to avoid high stock levels), which might go together with lower stock levels, and a more tuned process network downstream of the CDP. It might also go together, however, with lower customer service (obsolete stock, longer lead times), or higher capacities investments downstream of the CDP (to handle demand variety).
- A cost strategy might go together with bulk production and downstream movement of the CDP, which might lead to better customer service (delivery lead time), but also to higher stock levels and less tuned process networks.

Discussion

Related to the hypotheses stated earlier, one might expect that a differentiation strategy implies rationalized decision making and formalized coordination, a behaviour based control philosophy and hierarchic governance structure. In line with this Lassar and Kerr (1996), among others, achieved interesting results in their research into the structure of distribution channels, in which they related Agency Theory to the generic competitive strategies of Porter. They showed that companies with a differentiation strategy use behaviour based measurement systems for their distributors, whilst companies with a cost strategy use output based measurement systems. If, however, a differentiation strategy goes together with elements of a 'lean' logistics strategy, which has an image of inflexibility, non-innovativeness, etc, this doesn't seem to fit with the exploration image (and agility image) that differentiation strategies generally have (innovative, unique product, flexible).

These and other relationships between elements of the framework and elements of other scientific approaches show important considerations and choices that must be taken into account in chain strategy building. They also offer interesting opportunities for further research.

6.3 Closing

In this final chapter an overview of the research framework and a number of major opportunities for further research were given. Because of the newness of chain theory it is no surprise that these opportunities cover a wide range of research objects.

This thesis covered only a small part of the field of chain research. Within this part, several elements were delineated:
- the process perspective on chains (chapter 3),
- logistics processes in chains (chapter 4),
- testing/application of the framework in cases.

As chain theory continues to evolve, the three research perspectives on chains can be further developed, leading to a coherent set of research frameworks for chains. Besides the many practical applications of the framework, another interesting challenge is the design of multi-disciplinary research projects covering elements of more than one framework. Examples of relevant questions to be answered in these projects are given in the previous section in this chapter.

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Summary

Problem description and goal

Chain research, strongly related as it is to management sciences, involves many interrelated aspect systems. No research, however, is able to take into account the whole diversity of aspects that are generally related to chain problems. The choice of what aspects to take into account in what situations is therefore a crucial one.

This thesis has two goals:
- It aims to demarcate areas for research on chains. The areas resemble different perspectives on chains. Various scientific approaches to chains will be related to these areas.
- It aims to develop theory and a method for chain research. Because of the broadness of chain research, the focus here is limited to one important area: analysis and (re)design of chain processes.

Perspectives on chains

With regard to the first aim, three basic research perspectives on chains are recognized:
- The institution perspective focuses on the possible ways of linking chain participants together and on the relation between the chain and its environment.
- The process perspective focuses on chain processes. These encompass primary processes which are directly linked to the product flow in the chain (such as production and distribution processes).
- The performance perspective focuses on the chain output as it is perceived by its stakeholders. Performance concerns several dimensions: quality, time, costs, flexibility and environment.

This division offers a tool to relate various scientific approaches to chains to practical chain problems. The following scientific approaches are related to the perspectives:
- Transaction Cost Theory, Agency Theory, Strategic Management, Network Theory, and Resource Dependency Theory view chains from an institution and a performance perspective.
- Supply Chain Management, information technology approaches and cost approaches view chains from a process and a performance perspective.

Research framework

The second aim of this thesis is achieved through the design of a research framework for chains from the process perspective.

The framework consists of four essential elements answering the following questions:
- Why?: in what context are chains studied, for what kind of problems, and what is the view of the researcher on chains?
- What?: which variables should be considered?

- How?: how are these variables related and what method is used to approach practical chain problems.
- Who?, Where?, When?: concern how the framework can be tested/validated.

The framework is applied to one area of research, logistics. The empirical domain in this thesis is food chains.

The box below depicts the components of the research framework (specified for food chain logistics).

Why? (general research objective and view of chains):

The goal of chain research is chain performance improvement related to practical chain problems . The view of the research object is the starting point of any research. In this thesis the view is: a chain consists of a network of customer oriented and cross-functional processes with precedence relationships. In chain research the focus is on primary processes which are most closely linked to the product flow in the chain. Non-primary processes are designed to support primary processes and can or should be deduced from primary processes. A chain process is managed through its interfaces by the chain managing system. It also has its own managing system, however, which allows for autonomous decision making up to a certain degree. .

What? (variables):

The variables of the framework can be divided into two groups: managing system variables and managed system variables. (The chain managing system manages the chain managed system). Managed system variables are object system (defined by typical characteristics of product and process), infrastructure (defined by the configuration of processes and goods flow characteristics) and operations (defined by performances). Managing system variables are decision levels (strategical planning, management control and operational planning), type of decision making (e.g. rational versus political) and coordination mechanisms (e.g. hierarchy verus autonomy). The variables depicted below are specified for logistics processes in food chains.

<u>Managed system</u> (typical points of attention in food chains)
- Typical object system characteristics:
  - Typical product characteristics of food chains are supply uncertainty, quality variations between lots, perishability of produce.
  - Typical process characteristics of food chains are unpredictable production yields, conditioning of products (cooling/freezing), diverging production processes, recycling of products.
- Typical infrastructure aspects:
  - The position of chain decoupling points in food chains is constrained by production lead times, supply/demand uncertainties, perishability, divergent product flow. (A chain decoupling point, CDP, is the process/link in the chain up to where the customer order penetrates).
  - The process configuration must enable fast movement of products.

- There is a tendency to increase ordering and delivering in product categories.

- Typical operational aspects:
    - Major attention goes to speed of the product flows and flexibility in production and distribution processes.

Managing system (typical points of attention in food chains)

- Integrated multi-level planning/decision systems:
    - Diverging processes, that can be found in many food chains, are especially suited for the design of multi-level planning systems.
    - Uncertainties in demand and supply constrain the design of planning systems.
    - Perishability of products is an important point of attention in many decisions in food chains (e.g. ordering, delivering, stock keeping). It is an important constraint for the design of a planning system.
- Transparant information exchange is a major coordination mechanism.

How? (Method for analysis and (re)design of chains):

Steps in the method are performed iteratively to move from the current situation to a future one:

- Step 1: definition of research objective, based on the chain's improvement strategy.
- Step 2: definition of chain customer and links involved
- Step 3: definition of primary chain processes (e.g. the order flow for logistics processes)
- Step 4: decomposition into chain processes, iteratively focusing on the relevant variables of managed and managing system. The relevance of variables is related to the research objective.
- Step 5: analysis and development of chain managed and managing systems and chain process interfaces, iteratively focusing on the relevant variables. The relevance of variables is related to the research objective.

To support the method, three modelling tools are designed:

- A modelling tool for analysis and (re)design of chain infrastructures (Event Process Chain (EPC) modelling).
- A modelling tool for analysis and (re)design of chain decision structures (GRAI modelling).
- A modelling tool to analyse and (re)design chain process interfaces (Chain Process Modelling, CPM).

The first two models are derived from adaptation of existing models for analysis and (re)design of processes on a company level.

Who?, Where?, When? (application):
Application of the research framework is performed in cases. - Case 1 focuses on (re)design of a managed system. The focus is on the variables process network, stock points and chain decoupling point. In the case EPC modelling is applied. The case aims at throughput time reduction, which might lead to lower stock, fresher products and more efficient use of resources. - Case 2 focuses on (re)design of a managing system. Here special attention is paid to the variables decision levels and coordination mechanisms. In the case GRAI modelling is applied. The case aims at gearing of (decision) processes, which leads to improved information exchange and coordination, which again might improve efficiency of logistics processes. - Case 3 focuses on (re)design of interfaces of chain processes. Process interfaces belong to the managing system of chains. Special attention is paid to the variables coordination mechanism and type of decision making. In the case Chain Process Modelling is applied. The case aims at building responsive chain links, which might lead to greater efficiency in the chain and improves flexibility of processes. - Case 4 focuses on design of a managing system in a chain assembly and distribution point. Just as in case 2, special attention is paid to decision levels and coordination mechanisms. The same modelling method as in case 2 is applied. The case aims at effective management of an assembly and distribution point in a chain, which might lead to finetuning of flows of products, fewer losses and less handling.

Although not all variables in the framework are equally exposed in the cases, the framework proves to be valuable for analysis and (re)design of chains. Its practical use is shown in the cases. Further use of the framework will lead to its further elaboration.

Opportunities for further research

Three groups of major research opportunities are recognized:
- Use of the framework to identify opportunities for logistics management in chains. Examples are research into technologies to alter object system characteristics (such as lead time reduction), design of information systems to support customer order translation upstream in the chain, and design of methods and models for decision making in complex chain environments.
- Use of the framework to support decision making concerning the logistics strategy of chains. Two extremes are identified: lean production and distribution and agile production and distribution. 'Lean' focuses on efficiency of operations. 'Agile' focuses on flexibility of operations.
- Use of the framework for multi-perspective research on chains, integrating elements of various scientific approaches to chains. Examples of relations between chain governance structure, chain control philosophy, chain strategy and chain logistics are given.

Samenvatting

Probleembeschrijving en doel

Ketenonderzoek omvat vele aspect systemen. Geen onderzoek is echter in staat de hele diversiteit van aspecten die over het algemeen aan ketenproblemen gerelateerd zijn mee te nemen. De keuze welke aspecten mee te nemen in welke situaties is daarom van groot belang.

De doelstelling van het proefschrift is tweeledig:
- Het beoogt onderzoeksgebieden voor ketens af te bakenen. Deze onderzoeksgebieden weerspiegelen bepaalde perspectieven op ketens. Verschillende wetenschappelijke benaderingen van ketens worden aan deze onderzoeksgebieden gerelateerd.
- Het beoogt theorie en een methode voor ketenonderzoek te ontwikkelen. Vanwege de breedte van ketenonderzoek ligt de nadruk in dit proefschrift op één belangrijk gebied: analyse en (her)ontwerp van ketenprocessen.

Perspectieven op ketens

Met betrekking tot de eerste doelstelling worden drie onderzoeksperspectieven op ketens onderscheiden:
- Het institutionele perspectief richt zich op de mogelijke manieren om ketenparticipanten aan elkaar te koppelen en op de relatie tussen de keten en zijn omgeving.
- Het proces perspectief richt zich op ketenprocessen. Het gaat hierbij om primaire processen die direct gekoppeld zijn aan de productstroom in de keten (zoals productie- en distributieprocessen).
- Het prestatie perspectief richt zich op de ketenoutput zoals die wordt ervaren door de stakeholders van de keten. Prestatie omvat verschillende dimensies: kwaliteit, tijd, kosten, flexibiliteit en milieu.

Deze indeling biedt een instrument om verschillende wetenschappelijke benaderingen van ketens te relateren aan (praktische) ketenproblemen. De volgende wetenschappelijke benaderingen worden gerelateerd aan de drie perspectieven:
- Transaction Cost Theory, Agency Theory, Strategic Management, Network Theory en Resource Dependency Theory beschouwen ketens vanuit een institutioneel en een prestatie perspectief.
- Supply Chain Management, informatie technologie benaderingen en kosten benaderingen beschouwen ketens vanuit een proces en een prestatie perspectief.

Onderzoeksraamwerk

De tweede doelstelling van dit proefschrift wordt gehaald middels het ontwerp van een onderzoeksraamwerk voor ketens vanuit het procesperspectief.

Het raamwerk omvat vier essentiële elementen, antwoorden op de volgende vragen:
- Waarom?: in welke context worden ketens beschouwd, voor welk type problemen, en wat

is de beschouwingswijze van de onderzoeker van ketens?
- Wat?: welke variabelen moeten in beschouwing worden genomen?
- Hoe?: welke relaties bestaan er tussen deze variabelen en welke methode wordt gebruikt om praktische ketenproblemen te benaderen?
- Wie?, Waar?, Wanneer?: gaan over hoe het raamwerk gevalideerd kan worden.

Het raamwerk wordt toegepast op één onderzoeksgebied, logistiek. Het empirische domein in het proefschrift wordt gevormd door agribusiness ketens.

De onderstaande tabel beschrijft de componenten van het onderzoeksraamwerk .

Waarom? (algemeen onderzoeksdoel en visie op ketens):
Het doel van ketenonderzoek is keten-prestatieverbetering gerelateerd aan praktische ketenproblemen. De beschouwingswijze van het onderzoeksobject is het startpunt van elk onderzoek. De beschouwingswijze in dit proefschrift is: een keten bestaat uit een netwerk van klantgeoriënteerde en multi-functionele processen met precedentierelaties. In ketenonderzoek ligt de nadruk op de primaire processen die het nauwst verbonden zijn met de productstroom in de keten. Niet-primaire processen zijn ontworpen om primaire processen te ondersteunen en kunnen afgeleid of zouden afgeleid moeten kunnen worden van primaire processen. Een ketenproces wordt gemanaged middels zijn interfaces met het keten managementsysteem. Het heeft echter ook zijn eigen management systeem, dat het nemen van autonome beslissingen tot op zekere hoogte toelaat.
Wat? (variablen):
De variabelen van het raamwerk kunnen in twee groepen worden verdeeld. Variabelen van het besturende systeem en variabelen van het bestuurde systeem. Bestuurd systeem variabelen zijn object systeem (bepaald door typische kenmerken van produkt en proces), infrastructuur (bepaald door de configuratie van processen en door goederenstroomkarakteristieken) en operaties (bepaald door prestaties). Besturend systeem variabelen zijn beslissingsniveaus ('strategical planning', 'management control' en 'operational planning'), type besluitvorming (bv. rationeel versus politiek) en coördinatiemechanismen (bv. Hiërarchie versus autonomie). De variabelen die hieronder worden weergegeven zijn gespecificeerd voor logistieke processen in abribusiness ketens. Bestuurd systeem (typische aandachtspunten in agribusiness ketens): - Typische object systeem karakteristieken. Typische productkarakteristieken van abribusiness ketens zijn aanbod-onzekerheid, kwaliteitsvariatie tussen partijen, bederfelijkheid van producten. Typische proces-karakteristieken van abribusiness ketens zijn onvoorspelbare productie opbrengsten, conditionering van producten (koelen), divergerende productieprocessen, hergebruik van producten.

- Typische infrastructuur karakteristieken.
De positie van het ketenontkopppelpunt in agri-business ketens wordt beïnvloed door productie-doorlooptijden, aanbod/vraag onzekerheden, bederfelijkheid, divergerende productstroom. (Een ketenontkoppelpunt, CDP, is het proces/de schakel in de keten tot waar de klantorder doordringt). De procesconfiguratie moet een snelle doorstroom van producten mogelijk maken. Er is een tendens in de richting van het plaatsen en afleveren van orders volgens product categorieën.
- Typische operationele karakteristieken.
Belangrijke aandacht gaat naar de snelheid van de productstroom en flexibiliteit van productie- en distributieprocessen.

Besturend systeem (typische aandachtspunten in agribusiness ketens):
- Geïntegreerde meerniveau planning/beslissingssystemen.
Divergerende processen, die in vele agribusiness ketens worden gevonden, zijn bijzonder geschikt voor meerniveau planningsystemen. Onzekerheden in vraag en aanbod beïnvloeden het ontwerp van planningsystemen. Bederfelijkheid van producten is een belangrijk aandachtspunt in vele beslissingen in agribusiness ketens (bv. Het plaatsen van orders, uitleveren, voorraadbeheer). Het is een belangrijke beïnvloedende factor in het ontwerp van planningsystemen.
- Transparante informatie-uitwisseling is een belangrijk coördinatiemechanisme.

Hoe? (Methode voor analyse en (her)ontwerp van ketens):

Stappen in de methode worden iteratief doorlopen om van huidige naar toekomstige situatie te komen:
Stap 1: bepalen van het onderzoeksdoel, gebaseerd op de verbeteringsstrategie van de keten
Stap 2: bepalen van de klant in de keten en de betrokken schakels
Stap 3: bepalen van de primaire ketenprocessen (bv. de orderstroom voor logistieke processen)
Stap 4: decompositie van ketenprocessen, iteratief kijkend naar de relevante variabelen van bestuurd en besturend systeem. De relevantie van variabelen is gerelateerd aan het onderzoeksdoel
Stap 5: analyse en ontwikkeling van een keten bestuurd en besturend systeem, iteratief kijkend naar de relevante variabelen. De relevantie van variabelen is gerelateerd aan het onderzoeksdoel.
Ter ondersteuning van de methode zijn drie modelleer-instrumenten ontworpen:
- Een modelleerinstrument voor analyse en (her)ontwerp van keteninfrastructuren (Event Process Chain (EPC) modellering).
- Een modelleerinstrument voor analyse en (her)ontwerp van keten besluitvormingsstructuren (GRAI modellering).
- Een modelleerinstrument voor analyse en (her)ontwerp van ketenproces interfaces (Ketenproces modellering, CPM).
De eerste twee methoden zijn afgeleid van bestaande modellen voor analyse en (her)ontwerp van processen op bedrijfsniveau.

Wie?, Waar?, Wanneer? (toepassing):
Het onderzoeksraamwerk is toegepast in cases. - Case 1 richt zich op (her)ontwerp van een bestuurd systeem. De nadruk ligt op de variabelen procesnetwerk, voorraadpunten en ketenontkoppelpunt. In de case wordt EPC modellering toegepast. Het doel van de case is doorlooptijdverkorting, hetgeen kan leiden tot lagere voorraden, versere producten en efficiënter gebruik van middelen. - Case 2 richt zich op (her)ontwerp van een besturend systeem. Hier wordt speciale aandacht gegeven aan de variabelen beslissingsniveaus en coördinatiemechanismen. In de case wordt GRAI modellering toegepast. Het doel van de case is afstemming van (beslissings-)processen, hetgeen leidt tot verbeterde informatieuitwisseling en coördinatie, hetgeen op zijn beurt weer kan leiden tot verhoogde efficiency van logistieke processen. - Case 3 richt zich op (her)ontwerp van de interfaces van ketenprocessen. Procesinterfaces behoren tot het besturende systeem van ketens. Speciale aandacht wordt geschonken aan de variabelen coördinatiemechanisme en type besluitvorming. In de case wordt keten procesmodellering toegepast. De case is gericht op het ontwerpen van responsieve ketenschakels, hetgeen kan leiden tot efficiëncyverhoging in de keten en verbetering van de procesflexibiliteit. - Case 4 richt zich op het ontwerp van een besturend systeem in een keten assemblage- en distributiepunt. Net als in case 2 wordt speciale aandacht gegeven aan beslissingsniveaus en coördinatiemechanismen. Dezelfde modelleermethode als in case 2 is toegepast. De case is gericht op effectief management van een assemblage en distributiepunt in een keten, hetgeen kan leiden tot afstemming van productstromen, lagere verliezen en minder handling.

Hoewel niet alle variabelen van het raamwerk in gelijke mate aan bod komen in de cases, blijkt het raamwerk waardevol voor analyse en (her)ontwerp van ketens. Z'n praktische nut wordt getoond in de cases. Verder gebruik van het raamwerk zal leiden tot de verdere verfijning ervan.

Mogelijkheden voor verder onderzoek

Drie groepen van onderzoeksmogelijkheden worden onderscheiden:
- Gebruik van het raamwerk om mogelijkheden voor logistiek management in ketens te identificeren. Voorbeelden zijn onderzoek naar technologieën om objectsystemen te veranderen (zoals doorlooptijdverkorting), ontwerp van informatiesystemen om de vertaling van de klantorder stroomopwaarts in de keten te ondersteunen, en ontwerp van methoden en modellen voor besluitvorming in complexe ketenomgevingen.
- Gebruik van het raamwerk om besluitvorming betreffende de logistieke strategie van ketens te ondersteunen. Twee extremen worden onderscheiden: 'lean' productie en distributie en 'agile' productie en distributie. 'Lean' productie en distributie richt zich op efficiency van processen, 'agile' productie en distributie richt zich op flexibiliteit van processen.
- Gebruik van het raamwerk voor multi-perspectief onderzoek in ketens, waarbij elementen

van verschillende wetenschappelijke benaderingen van ketens worden geïntegreerd. Voorbeelden worden gegeven van relaties tussen ketenbesturingsstructuur, keten-'control' filosofie, ketenstrategie en ketenlogistiek.

About the author

Jacques Trienekens (1954). Studied Geography at Nijmegen University. Worked as a researcher in social sciences, as a teacher in higher education and as a consultant in the field of organization and information in public health organizations. Since 1991 he works at the Management Studies Group, Department of Economics and Management, of Wageningen University. His research fields are logistics and information systems in agribusiness and food chains.