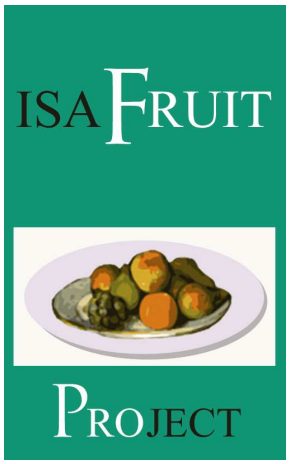

Project no.: 016279

Project acronym: ISAFRUIT

Project title: Increasing fruit consumption through a trans-disciplinary approach delivering high quality produce from environmentally friendly, sustainable production methods

Instrument: Integrated project

Thematic Priority: Food Quality and Safety

D 1.4.1: Review of Scientific Literature on Performance, Innovation and Management of Supply Chains

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RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

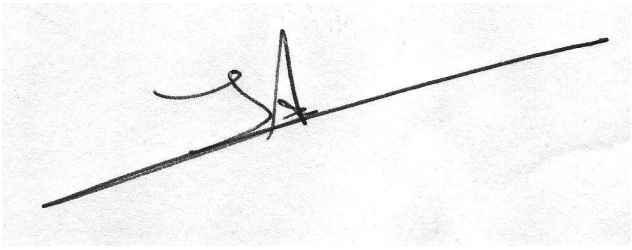
Description of deliverable

The present work was carried out within the Project 'ISAfruit'. The strategic objective of this project is to increase fruit consumption and thereby improve the health and well-being of Europeans and their environment, by taking a total chain approach and identifying bottlenecks and opportunities in the fruit chain from a consumer perspective. The report is a deliverable of Work package 1.4 (INNOCHAIN) of Pillar 1, which focuses on the area of 'Consumer driven and responsive supply chain'.

The overall objective of Work package 1.4 is to develop a conceptual framework of the mechanisms underlying innovativeness of the European fruit supply chains, in such a way that performance can be maximized. This deliverable (D1.4.1) gives the results of a review of major scientific publications on the rationales underlying consumer driven, innovative, and cost efficient supply chains and critical success factors for chain performance and successful supply chain management practices. The results from this literature study are input for the development of a theoretical framework (D1.4.2) on fruit supply chains, which will be tested, validated and adjusted for use in practice for maximizing the performance and innovativeness of European fruit supply chains.

The results from Work package 1.4 can be used as guideline for a strategic transition of the European fruit industry toward a consumer-driven and responsive supply chain. As such, they are input for Work package 1.5, which will develop transition strategies for European fruit chains. The work of Work package 1.4 makes use of research output from Work packages 1.1 and 1.2 and will be carried out in close relation with Work packages 1.3 and 1.5. It will also provide valuable input to the formulation of research guidance that will be used in other pillars (3, 4 and 5).

This deliverable was made in cooperation between the partners 10 (WUR-LEI) WP-leader, 24 (UPM), 29 (AUA) and 38 (WAU).



Wageningen, December 27th, 2007

Ivo A. van der Lans
Scientific coordinator of ISAfruit Pillar 1
10 (WUR-LEI)

D 1.4.1.
Review of Scientific Literature on Performance, Innovation and Management of Supply Chains

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Acknowledgement
The present work was carried out within the Project 'ISAFRUIT '. The strategic objective of this project is to increase fruit consumption and thereby improve the health and well-being of Europeans and their environment, by taking a total chain approach, identifying the bottlenecks and addressing them by consumer-driven preferences. The report is a deliverable of Pillar 1, which focuses on the area of the 'Consumer driven and responsive supply chain'.

The project team wants to express its gratitude to Jeremie Debaire (MSc.), who gave a lot of input for this study doing his master thesis at the Wageningen University.

More information: www.ISAfruit.org

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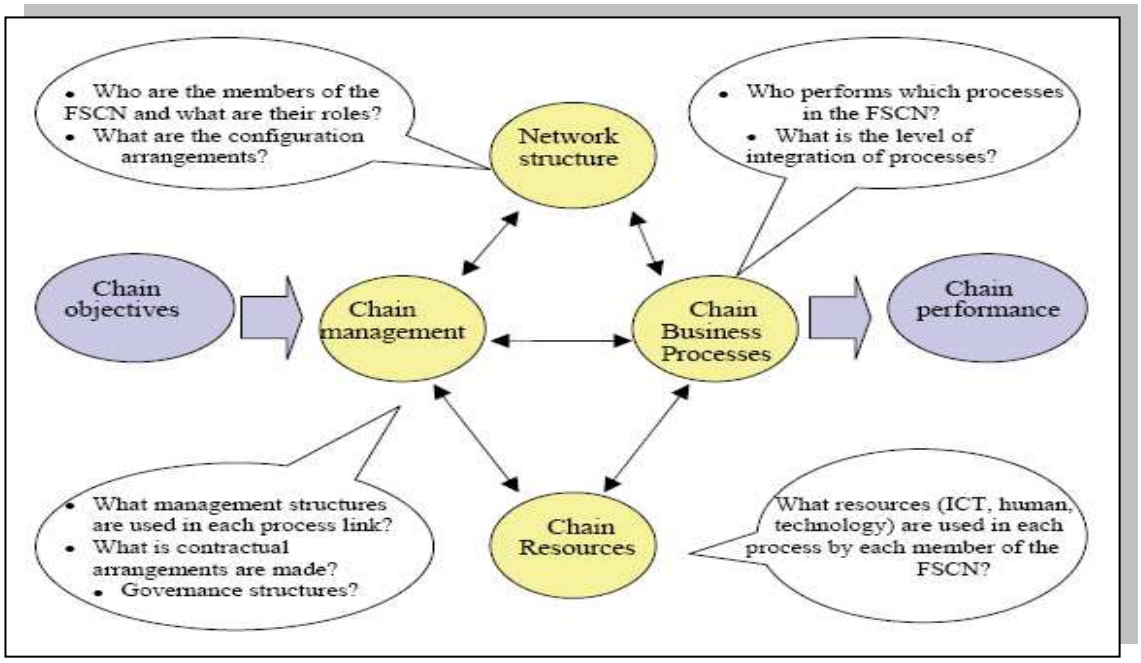
Summary

Introduction
The aim of the Work package 1.4 INNOCHAIN (WP1.4) of ISAfruit is to develop a conceptual framework of the mechanisms underlying supply chain management, in particular chain innovativeness, of the European supply chains in such a way that performance can be maximized. The results of WP1.4 will contribute to the innovativeness of European fruit supply chains by providing an overview of successful supply chain management practices and by formulating recommendations and critical success factors for chains in the European fruit industry and their individual members.

As determined by the project annex of ISAfruit, this deliverable (D1.4.1) gives the results of a review of major scientific publications on consumer driven, innovative, and cost efficient fruit-supply chains and critical success factors for chain performance. This literature study, therefore, goes into supply chain management and critical success factors and indicators for performance and innovation.

Supply Chain Management (SCM) can be defined as the integrated planning, coordination and control of all business processes and activities in the supply chain to deliver superior consumer value at least cost to the supply chain as a whole while satisfying the variable requirements of other stakeholders in the supply chain (e.g., governments and NGO's).
In the literature various frameworks for supply chain management are described, dealing with different perspectives on the chain: business process perspective, supply chain network perspective, focal company perspective, etc.
Van der Vorst et al. (2005), building on the SCM-model of Lambert and Cooper (2000), integrate various perspectives into a framework containing major elements of SCM. This framework will be used as one of the starting points for the further steps in WP1.4. Chain objectives are achieved by paying attention to chain management, chain business processes, network structure and chain resources (see Figure i). These jointly define the chain performance.



(FSCN = Food Supply Chain Network)

Figure i Framework for chain development (Van der Vorst et al., 2005)

Performance in demand-driven supply chains

According to Van der Vorst (2000), supply chain performance is the degree to which a supply chain fulfils end user requirements concerning the relevant performance indicators at any point in time and at what total supply chain costs. Performance measurement is used to evaluate, control and foster improvement of production processes. Performance measurement has been defined by Neely et al. (1995) as the process of quantifying the effectiveness and efficiency of action. Performance can be measured by indicators, as for example in the work of Aramyan et al. (2006). Building on the work of Aramyan et al., Debaire (2007) groups performance indicators in five main categories: innovation, efficiency, responsiveness, quality and flexibility and defines main sub-categories. Performance indicators can be divided into three hierarchical decision levels, namely supply chain performance, performance of an individual organisation and performance of an individual business process. This results in the following framework on supply chain performance, see Figure ii.

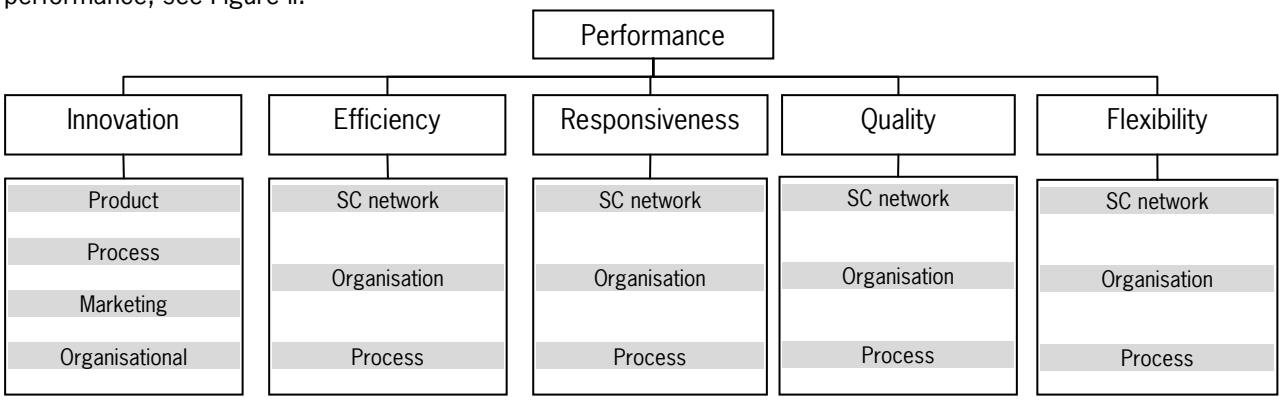


Figure ii Overview of performance and its indicators *Source: Debaire (2007)*

In our view innovation should be considered as one of the major performance categories and indicators.

Innovation ad innovativeness in demand-driven supply chains

An innovation is the development and successful implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices or external relations (De Jong and Brouwer, 1999; OECD, 2005). Innovativeness can be defined then as the ability of organisations to innovate. From the Oslo Manual, the following classification of innovations is used in the research of WP1.4: Product, Process, Marketing and Organisational (Figure iii).

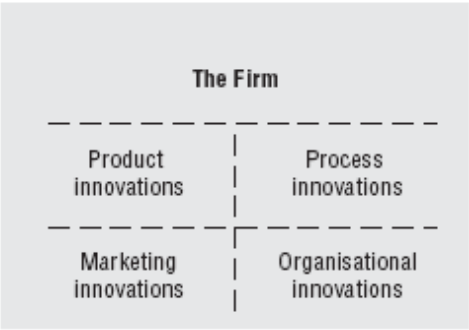


Figure iii Classification of innovations *Source: OECD (2005)*

Critical success factors and indicators for performance and innovation

Critical success factors (CSF's) are the relatively small number of truly important matters that managers should focus attention on. They represent the few 'factors' that are 'critical' to the 'success' of the organisation (Huizenga, 2000, Kaplinsky, 2002). CSF's are classified according to the performance categories depicted in Figure ii. For every critical success factor identified, a number of measurable indicators can be defined.

1 Introduction

Innovative Fruit Supply Chains (INNOCHAIN), is one of the Work packages of the ISAfruit project. ISAfruit is a large European Integrated Project (IP), which consists of 25 work packages and over 60 participants. The mission of ISAfruit is to improve human health through increased consumption of fruit, produced in a sustainable way. The vision of ISAfruit is that better fruit quality and availability, a higher convenience of fruit and fruit products and improved consciousness of consumers leads to higher consumption. Higher consumption leads to increased health and well-being. The strategic objective of ISAfruit is to increase fruit consumption by taking a total chain approach and identifying bottlenecks and opportunities in the fruit chain from a consumer perspective. ISAfruit started at the beginning of 2006 and will last till 2010.

The scientific and technological objectives are addressed by Research, Technological and Development (RTD) activities that are clustered in six Pillars encompassing the total fruit chain and one Pillar on Training and Dissemination (TD):
Pillar 1. Consumer driven and responsive supply chains.
Pillar 2. Fruit and human health.
Pillar 3. Improved appeal and nutritional value of processed fruits.
Pillar 4. Quality, safety and sustainability: improved post-harvest chain management.
Pillar 5. Quality, safety and sustainability: improved pre-harvest chain management.
Pillar 6. Genetics of fruit quality and implementation of better fruit cultivars.
Pillar 7. Knowledge management.

This literature review is part of Work package 4 of Pillar . In the following section, a description of Pillar 1 and Work package 1.4 (WP1.4) are given.

1.1 Pillar 1

Consumer driven and responsive supply chains
The development of consumer-driven, efficient, responsive, and innovative supply chains is crucial for the growth of fruit consumption in Europe and for a competitive and sustainable fruit industry. Currently fruit supply chains are characterized by a relatively low level of consumer orientation and consumer-driven innovations.

Objectives of Pillar 1
Pillar 1 consists of five Work packages each with its own objectives, but working together for an improved consumer driven fruit chain. WP1.1 EUFCON has the objective to describe consumption and fruit trends and to increase and improve interaction among consumers, producers, other supply chain actors and researchers. The objective of WP1.2 CONPREF is to understand the forces that drive consumers with respect to fruit and fruit products in order to identify consumer segments to stimulate consumption. The objective of WP1.3 INNOFRUIT is to understand the determinants of adoption and dissemination of innovations by consumers and individual chain members. Using results from CONPREF it yields insight into consumer behaviour with respect to new or modified products and identifies opportunities for fruit innovation. WP1.4 INNOCHAIN aims to identify the supply chain organization and management structure that maximizes supply chain innovativeness and performance, in terms of effectiveness and efficiency, in dynamic and/or developing markets. The objective of WP1.5 TRANSCHAIN is to collect and integrate relevant results from all Work packages and pillars in order to develop strategies for innovation implementation and transition in the fruit chain aimed at increasing fruit consumption and discuss these strategies with the fruit industry, governments and (fruit) researchers.

Results of WP1.1 EUFCON, WP1.2 CONPREF, WP1.3 INNOFRUIT, and WP1.4 INNOCHAIN are input for other pillars as well as for the development of innovation implementation and associated chain transition strategies performed in WP1.5 TRANSCHAIN.

1.2 Objectives of WP 1.4 INNOCHAIN

The aim of the WP1.4 INNOCHAIN of ISAfruit is to develop a conceptual framework of the mechanisms underlying supply chain management, in particular chain innovativeness, of the European fruit supply chains in such a way that performance can be maximized. The results of WP1.4 will contribute to the innovativeness of European fruit supply chains by providing an overview of successful supply chain management practices and by formulating recommendations and critical success factors for chains in the European fruit industry and their individual members.

WP1.4 consists of two phases. Phase 1 aims to design a model to assess and improve innovativeness and performance in fruit chains. Phase 2 includes testing of the model in practical fruit chain cases in Europe. Phase 1 will contain the following elements and steps:

1. An **overview and description of different types of fruit supply chains** in Europe, (and in the in Pillar 1 participating countries in particular) categorized by their characteristics;
2. A **definition of supply chain performance** in general and for ISAfruit in particular (i.e. consumer satisfaction, innovation and cost efficiency have to be a part of that);
3. Establishment of **critical success factors of chain performance and innovation**;
4. An **integrated perspective** (model) or if necessary different integrated perspectives which suits different supply chain types (different business environments) and with which performance (and innovativeness in particular) can be controlled, and in which is embedded:
   i. **chain structure** and **co-ordination (governance)**
   ii. partnerships and other relationships between chain actors
   iii. **supply chain responsiveness and flexibility**
5. A first overview **of successful supply chain management practices** in Europe, (and in the in Pillar 1 participating countries in particular)
6. A **detailed working plan for Phase 2**: testing the supply chain model(s) in practice to be able to validate them, adjusting the model in such a way that it can be implemented in chains and used in practice to improve performance and innovativeness in particular in European supply chains (eventually distinguished to type and country).

Our approach elaborates and extends existing work on organizational innovativeness, which focuses on determinants of individual organization development, adoption, and diffusion of innovations but largely ignores innovation and performance on supply chain-level. WP1.4 adopts an integrative perspective and explicitly considers the interrelationships between chain actors. Relevant concepts include chain structure and coordination, partnerships and other relationships, supply chain responsiveness and agility, and business environment embeddedness. Based on theoretical findings and insights from the industry, key performance indicators are formulated that focus on consumer orientation with respect to product benefits such as quality, safety, availability, convenience, price, and health, chain innovativeness, and cost efficiency.

This deliverable (D1.4.1) gives the results of a review of major scientific publications on the rationales underlying consumer driven, innovative, and cost efficient fruit-supply chains and critical success factors for chain performance and innovation. This will cover the first three steps of WP1.4. The results from this literature study will be used as input for the development of a theoretical framework (step 4) on fruit supply chains in such a way that it can be tested, validated and adjusted for the use in practice (steps 5 and 6).

1.3 Guideline for the Reader

Chapter 2 includes the literature review for this study. The chapter first elaborates on literature on supply chain management. Subsequently performance and innovation in demand-driven supply chains is described. The final part of this chapter goes into the critical success factors of performance and innovation that have to be taken into account while studying supply chains and into indicators to measure performance and innovation. Chapter 3 will give major conclusions and lessons learned from the literature study.

2 Review of Scientific Literature on Performance, Innovation and Management of Supply Chains

This chapter contains three parts. First the chapter goes into supply chain management models. Subsequently performance and innovation in supply chains is discussed. The last section goes into critical success factors in performance and innovation in the supply chain.

2.1 Supply Chain Management Models

2.1.1 Supply Chain Management

Supply Chain Management (SCM) has become a popular topic in modern business management and research. It brings a revolutionary philosophy and approach to manage the business with sustainable competitiveness (Chan, 2003). Moreover market globalization, intensifying competition and an increasing emphasis on customer orientation catalyse the surge in interest in supply chain management (Gunasekaran et al., 2001). Nowadays, chain members face an increasing pressure of customers' requirements, quality improvement and demand responsiveness. On the other hand they need to reduce production cost, shorten lead time, and lower inventory level to ensure profitability. In order to survive under these pressures, they are striving to develop long-term strategic partnerships (Chan, 2003). Thus modern business management has shown up a significant change from competing as solely autonomous entities to competing as integrated chains (Lambert and Cooper, 1998). In this emerging competitive environment, the success of the single business will depend on management's ability to integrate the company's intricate network of business relationships. Increasingly, the management of multiple relationships across the supply chain is being referred to as supply chain management (Lambert and Cooper, 1998).

Supply chain analysis is highly complicated (van Hoek, 1998):

- supply chains consist of multiple layers of companies;
- companies may be involved in multiple supply chains (Cooper et al., 1997) (Supply Chain Networks, SCnetworks);
- as integration is no longer based on large investments in vertical integration, but rather on interfaces, SCnetworks also become temporal; exit and entry barriers are lowered as capital investments can be shared among players;
- indeed, the format of the supply chain may change over time (Cooper et al., 1997);
- not all interfaces in the supply chain deserve the same amount of integration, and close co-ordination. Determining the amount of management attention needed for a particular interface is dependent on various factors (Cooper et al., 1997).

The Global Supply Chain Forum (GSCF) has developed the following definition of SCM:

> Supply Chain Management is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders.

In literature various perspectives on SCM can be distinguished. The most important will be described in the next section.

2.1.2 Perspectives on Supply Chain Management from literature

2.1.2.1 Business Process Perspective

The first perspective we want to discuss is the (business) process perspective, holding as a starting point the shift from functional organization thinking to a process orientation, which requires efficient and effective cooperation between functional departments. A process is viewed as a set of identifiable flows and value-added activities. The process approach is coherent with systems thinking and links the company's strategy and its customer focus to use of resources and organizational set-up. This perspective on SCM is illustrated by Lambert and Cooper (2000) in Figure 2.1., which depicts a simplified supply chain network structure; with the information and product flows; and the key supply chain business processes penetrating functional 'silos' (departments) within the company and the various corporate silos across the supply chain. Thus, business processes become supply chain business processes linked across intra- and inter-company boundaries. Figure 2.1 shows the eight processes, as distinguished by Lambert and Cooper, that must be implemented within the firm and then across key members of the supply chain.

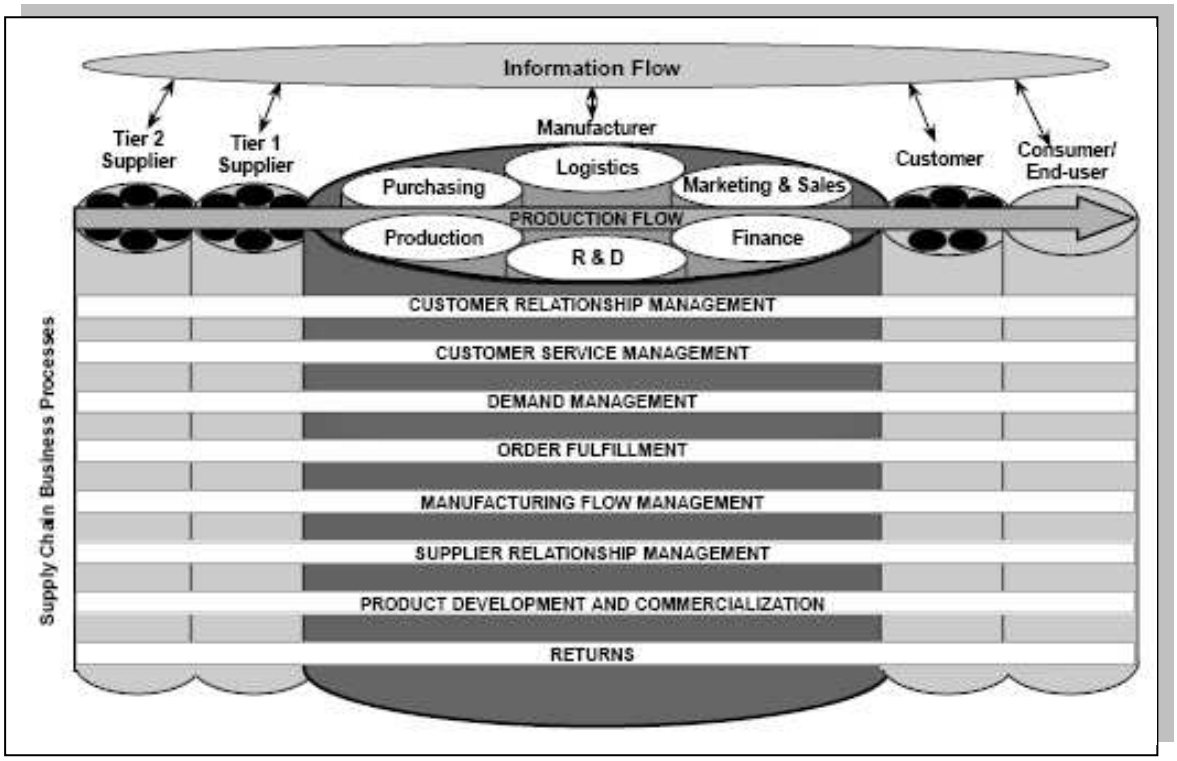


Figure 2.1 SCM: Integrated and managing processes across the supply chain

Source: Lambert and Cooper (2000)

Van der Vorst (2006) extends the SCM definition of Lambert and Cooper by describing a supply chain as a series of (physical and decision-making) activities connected by material and information flows and associated flows of money and property rights that cross organisational boundaries. The term 'business process' refers for van der Vorst to a structured, measured set of activities designed to produce a specified output for a particular customer or market. In the definition of SCM the term 'value' is associated to financial performance ('Profit': the amount of money consumers are willing to pay for what a company provides); social performance ('People'); and environmental performance ('Planet'). The concept 'value-added activity' originates from Porter's 'value chain' framework and characterizes the value created by an activity in relation to the cost of executing it (Porter 1985), and is thus expanded to the so-called 'Triple P': People, Planet and Profit (Van der Vorst 2006).

2.1.2.2 Supply Chain Network Perspective

Figure 2.2 depicts a generic supply chain at organization level within the context of a complete supply-chain network. Each firm is positioned in a network layer and belongs to at least one supply chain: i.e. it usually has multiple (varying) suppliers and customers at the same time and over time. Other actors in the network influence the performance of the chain. Therefore, the analysis of a supply chain should preferably take place or be evaluated within the context of the complex network of food chains, in other words a Supply Chain Network (SCN) (Lazzarini et al.,*2001;* Van der Vorst, 2006).

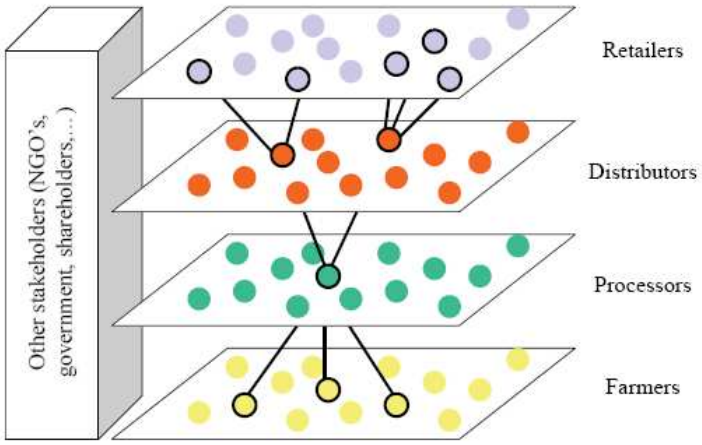


Figure 2.2 Schematic diagram of a supply chain from the perspective of the processor (bold flows) within the total SCN

Source: Van der Vorst et al.(2005)

In the network view, the variety of relationships between parties and how these interfere with other parties' relationships are of key importance. Borgatti (2003) suggests that *network analysis* provides numerous tools to map the structure of organizational forms characterized by repetitive exchanges among semi-autonomous organizations that rely on trust and embedded social relationships to protect transactions and reduce their costs. Powell (1990) argues that due to the increased complexity of the world and commerce both (spot) markets and hierarchies (read: organizational integration) became insufficient modes of organizing production. Then the network paradigm emerges as the new and flexible organizational structure that governs relationships between different parties.

Most authors have treated supply chain and network analysis as separate forms of inter-organizational collaboration. Lazzarini et al. (2001) attempt to integrate these concepts by introducing the notion of *net chain analysis*. According to these authors, net chain analysis use both network and supply chain perspectives to explain the value creating and coordination mechanisms underlying each transaction of any intra- or inter-organizational collaboration scheme. Lazzarini et al. (2001) build on Thompson (1967) when they distinguish sequential (output of one actor is input for the succeeding actor in the chain), pooled (joint use of resources between multiple actors) and reciprocal relationships (partners provide input to each other). A network comprises a multitude of interacting relationships of different kinds, in which concepts like trust, communication and information exchange are key concepts for research.

2.1.2.3 Focal Company Perspective

Chain actors may be involved in different supply chains in different SCN's, and participate in a variety of business processes that change over time and in which dynamically changing vertical and horizontal partnerships are required. A map of the supply chain, from a focal company perspective, from the point-of-origin to the point-of consumption is given by Lambert and Cooper (2000) (see Figure 2.3). A supply chain can be represented as an uprooted tree, where the roots are the suppliers and the branches are the

customers. Relationships with direct suppliers and customers are tier-1 relationships, suppliers' suppliers and customer' customers are tier-2 relationships etc.

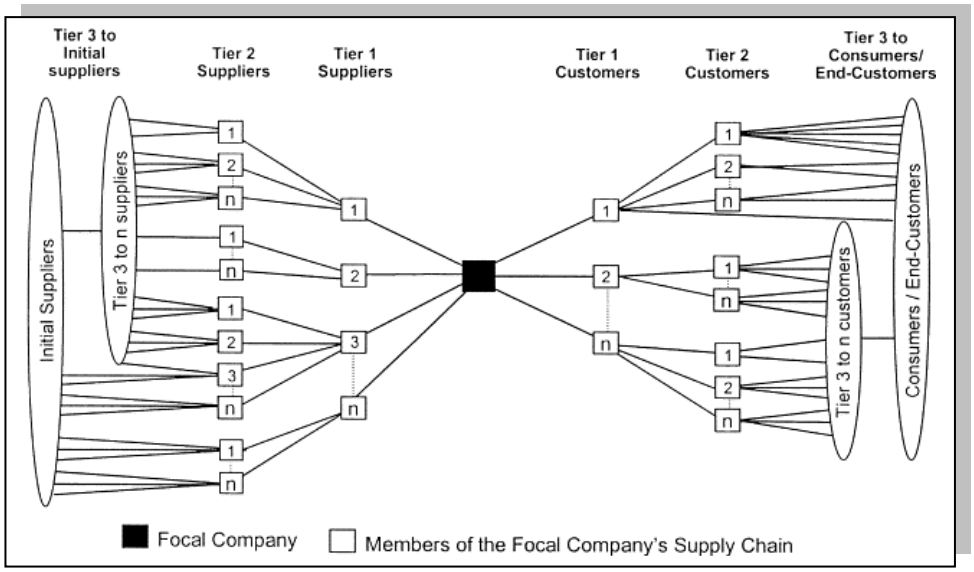


Figure 2.3 Supply Chain Network structure *Source: Lambert and Cooper (2000)*

With this map, Lambert and Cooper (2000) stress the high degree of complexity required to manage all suppliers back to the point of origin and all products/services out to the point of consumption. It helps to understand why executives would want to manage their supply chains to the point of consumption, because whoever has the relationship with the end user has the power in the supply chain.

Managing all tier-1 suppliers' networks to the point of origin is an enormous undertaking. Managing the entire supply chain is a very difficult and challenging task. Therefore, to have a better understanding of the links in the supply chain, Lambert and Cooper (2000) suggested to differentiate them by types of business process links (see Figure 2.4).

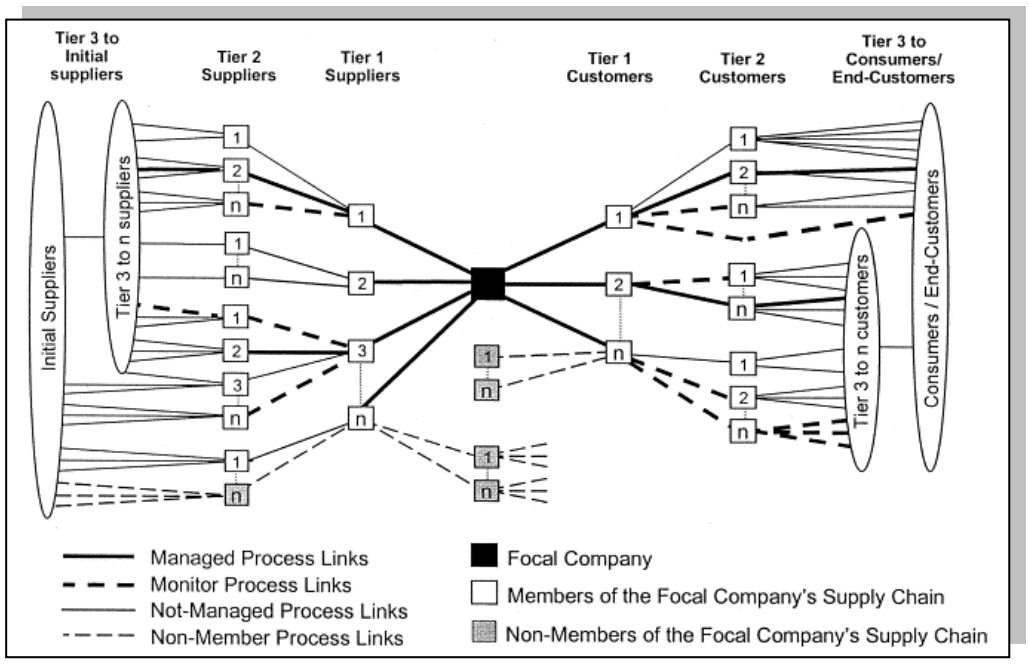


Figure 2.4 Managing process links in the chain. *Source: Lambert and Cooper (2000)*

Tier 1 and the most important tier 2 and following relationships have to be 'managed' (the focal company has to be operationally involved). Less important processes, of which, however, process information is essential to the focal company, have to be monitored.

Since the drivers for integration are situational and different from process link to process link, the levels of integration should vary from link to link, and over time. Some links are more critical than others. As a consequence, the task of allocating scarce resources among the different business process links across the supply chain becomes crucial. One important theory that adds to our understanding of relationships between partners in the chain is Transaction Cost Economics.

Transaction Cost Economics

Companies in agro-food chains are linked through transactions and supporting governance mechanisms. The choice of governance mechanism is largely dependent on the costs of the transactions. Transaction costs consist of ex-ante costs (searching for potential exchange agents, screening of potential agents, bargaining) and ex-post costs (transfer of property rights, monitoring compliance with contractual terms, enforcement of sanctions in case of non-compliance). If transaction costs are low, economic actors will favour market governance. If they are high, they favour contracting or integration, thereby lowering these costs. Governance forms can range from arms-length contracts (market), preferred suppliers, single sourcing, network sourcing, strategic partnership to internal contracts with vertical integration (Cox, 1996).

Contracts represent a common governance mechanism. Typical elements of a contract include: product quality (standards, consistency), delivery conditions (timing), price, information exchange (e.g. deviations), order frequency and timing, payment conditions, transportation specifics (e.g. cooling), packaging, traceability, promotion, sanctions in case of non-compliance, contract duration. In literature a distinction is made between the classical version of a comprehensive contract (where everything is fixed ex ante for the entire duration of the contract, covered by the law of contract) or the relational version (allowing for gaps not closed by contract law, embedded in a social system of relationships and subject to continuous re-negotiations). Because there is no such thing as a 'complete' contract many companies tend to prefer relational contracts implying interpersonal relationships and trust.

Transaction Costs Economics focuses on four key assumptions: bounded rationality, opportunistic behaviour, asset specificity and informational asymmetry. The bounded rationality condition implies that the human capacity to evaluate all alternatives in order to make a rational decision is physically limited. Williamson (1979, 1996) defines opportunistic behaviour as the one where the transacting party will seek to exploit a situation to his own advantage. Asset specificity arises when assets involved in a transaction are more specific to the transaction and have little or no value in an alternative use. Information asymmetry arises when the transacting parties do not possess the same levels of information. Information asymmetry is important because it can lead to opportunistic behaviour mainly in two ways. The first refers to what Akerlof (1970) defined as adverse selection, and involves *ex ante* opportunism where information is not revealed until after the transaction has taken place. The second is widely known as moral hazard and it involves *ex post* opportunism which occurs after the conclusion of a transaction when some transacting parties act opportunistically because their actions are not observable by others.

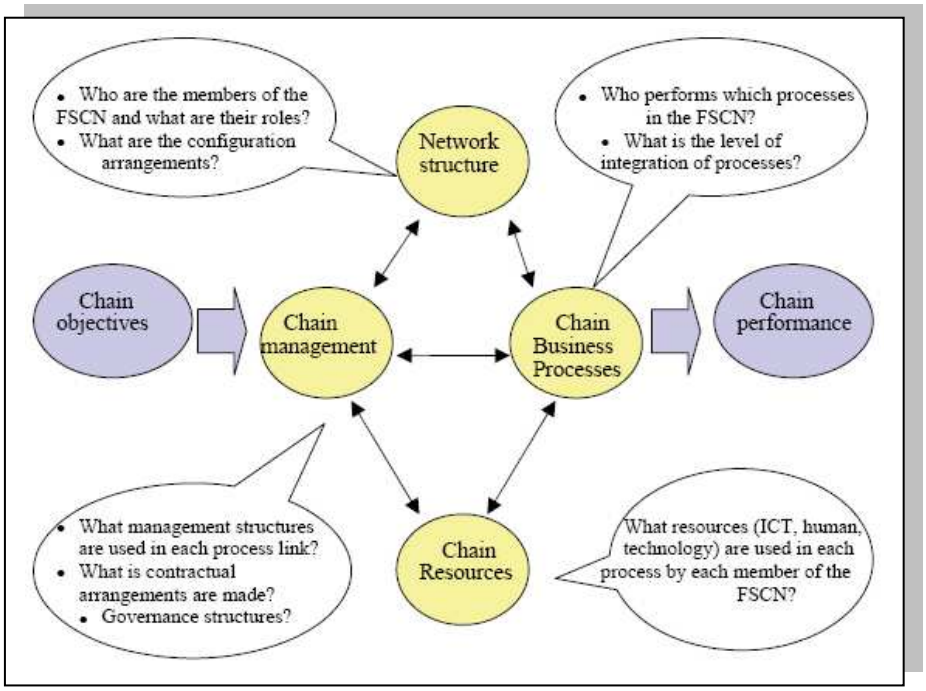
Transaction Costs Economics is important in supply chain analysis because it provides a basis for understanding and analyzing the transactions around which supply chains are structured and co-ordinated. One of the contributions of Transaction Costs Economics as presented by Williamson (1979, 1996) is the hypothesis that the 'transaction' and its attributes becomes the focal point of analysis. Then, the diversity of governance structures is explained by the diversity of economic transactions and their attributes. In other words, firms make strategic decisions which define the modes of multilateral governance structures, in a transaction cost-minimizing way. Put simply, the modes of governance chosen can be seen as attempts to solve coordination problems arising when firms are transacting with each other, thus reducing transaction costs.

Three distinct governance structures are defined in the literature, namely markets, hierarchies and the hybrid forms of organization which include all kinds of arrangements (such as contracts) between legally autonomous entities (for a discussion of the hybrid forms, see Menard (2004)). The choice of a particular governance structure aims at mitigating all forms of contractual hazards found between the different contracting parties in such a way that transaction costs are minimized (Williamson, 1996). When studying hybrid forms of organization such as SCNetworks, two main dimensions should be identified: the allocation of decision rights, in other words who has the authority to take strategic decisions within the SCNetwork, and the interorganizational mechanisms aiming at rewarding desirable behavior and preventing undesirable behavior. These two dimensions affect the design of a SCNetwork or in other words, the SCNetwork governance structure (Sauvee, 2002). Furthermore, in order to design an optimal governance structure for a SCNetwork two principles must be considered: efficiency and effectiveness. The first concept refers to the organizational choice made when no 'feasible superior alternative can be described and implemented with expected net gains' (Williamson, 1999:1092). Effectiveness depends on who is doing the assessment within a SCNetwork. Effectiveness as assessed by each organizational evaluator involves 'how well the organization is meeting the needs or satisfying the criteria of the evaluator' (Pfeffer and Salancik, 1978:34).

2.1.2.4 Framework for Supply Chain (Network) Management

Lambert and Cooper (2000) emphasized the need of a conceptual framework for SCM embedding the various perspectives on the chain: business process, network and management. Their framework was further elaborated by Van der Vorst et al. (2005). They suggested the following framework constituted of four elements (see Figure 2.5):

1. The Network Structure which demarcates the boundaries of the supply-chain network and describes the main participants or actors of the network, accepted and/or certified roles performed by them and all the configuration and institutional arrangements that constitute the network.
2. Chain Business Processes which are structured, measured sets of business activities designed to produce a specified output (consisting of types of physical products, services and information) for a particular customer or market.
3. Network and Chain Management which typifies the coordination and management structures in the network that facilitate the instantiation and execution of processes by actors in the network, making use of the chain resources with the objective to realize performance objectives.
4. Chain Resources which are used to produce the product and deliver it to the customer (so-called transforming resources). These enablers include people, machines and Information & Communication Technology (ICT).



(FSCN = Food Supply Chain Network)

Figure 2.5 Framework for chain development *Source: Van der Vorst et al. (2005)*

In WP1.4 of ISAFRUIT we will take this framework as a starting point for the design of supply chain analysis frameworks. After our discussion of SCM and SCM models/frameworks, the next section will go into supply chain performance and innovation.

2.2 Performance and Innovation in Demand-driven Supply Chains

2.2.1 Demand-driven Supply Chains

The total performance in turnover and margin of the entire chain is largely dependent on the proper functioning of supply chain members and their interrelations. To have the right innovative products timely available requires collaboration and information sharing between chain levels. But at which point does effective collaboration of supply chain parties translate into optimal supply chain performance? The question is then when does a chain succeed in fulfilling consumer demand effectively and efficiently? Can this be combined with true innovativeness? The challenge for each supply chain is to maximize the difference between the total value delivered to their end-consumers and the total supply chain costs (see Table 2.1). In general, consumer value can be increased by, for example, ensuring that customers have the variety of products they expect. Another way is to minimize the total cost of production, handling, transportation and inventory storage, by for example Activity Based Costing methods. But how can chain members observe that total chain performance is less than optimal? Market information sharing is a means of comparing and confronting each other's propriety to detect the discrepancies between ideal and actual chain performance (Smit, 2006). The balanced scorecard (www.globalscorecard.net) is one approach that offers the possibility to identify these discrepancies between (more) ideal and actual performance and decide which actions to take with respect to the two main functions of the supply chain; i.e. optimal *physical supply* and optimal consumer value or *market mediation* (according to Fisher, 1997). The physical supply includes producing and transporting the goods.
Regarding physical supply Smit (2006) has identified five cost areas:

- Inefficient transactions between chain members that raise total supply chain costs;

- Errors in the flow of goods like ordering errors, handling errors, and/or delivery errors causing the supply chain costs to rise needlessly;
- Low customer service can cause out-of-stock situations in retail outlets and subsequently to lost sales (opportunities);
- Relatively high inventory levels in the supply chain can be attributed to a lack of coordination and chain partners want to avoid the risk of having an out-of-stock situation;
- Large variations in product flows in the whole supply chain, also referred to as the bullwhip effect (Forrester, 1961).

Less immediately visible but equally important is market mediation, whose purpose is to ensure that the variety of products reaching the marketplace matches with what consumers want to buy (see Table 2.1).

Table 2.1 Maximizing total chain performance

[Channel Performance] ≈ { [Market Reach × Consumer Value$_i$] - Σ [Supply Chain Costs] }

Joint Challenges	Cost-saving efficiency opportunities	Demand-enhancing opportunities
	Improvement in efficiency (by reduction of Physical Supply failures)	*Increase in effectiveness of marketing efforts (by elimination of Market Mediation mistakes)*
Symptoms	• High transaction costs • Errors in ordering, handling, delivery • High shrinkage • Low customer service / poor order fulfillment • Excess of pipeline inventory in the channel • Amplifying variations in product flow from down- to upstream	• Low success rate of new product launches • Obsolete retail inventories • Markdowns to clear inventory • Failure to offer large product variety • Product recalls
Type Demand Forecast Error	Inaccurate quantity of products	Inadequate fit of products with consumer demand

Source: Smit, W. (2006) based on Fisher (1997)

However, new technology (e.g. point-of-sales scanners) and concepts that incorporate it to capture consumers' choice (e.g. Quick response, Efficient Consumer Response) have improved supply chain performance. The rate of new-product introductions has skyrocketed, fuelled by both an increase in the number of competitors and by the efforts of existing competitors to protect or increase profit margins. As a result, many companies have turned or tried to turn traditionally functional products into innovative products. But they have continued to focus on physical efficiency in the processes for supplying those products (Fisher, 1997). The fact that more than 50% of new products have disappeared from the shelves within a year, thereby wasting enormous efforts and expenses, proves that true innovation is critical but rare (Ernst&Young/ACNielsen, 2000).

Fisher (1997) argues that the root cause of the problems plaguing many supply chains is a mismatch

between the type of supplied products and the type of supply chain (Figure 2.6). Therefore, the supply chain first has to consider the nature of the demand for the products the chain supplies. Many aspects are important – for example, product life cycle, demand predictability, product variety, and market standards for lead times and service. A distinction can be made between primarily functional products or primarily innovative products. Functional products satisfy basic needs, which don't change much over time, and have stable, predictable demand and long life cycles. Innovations give consumers an additional reason to buy their offerings.

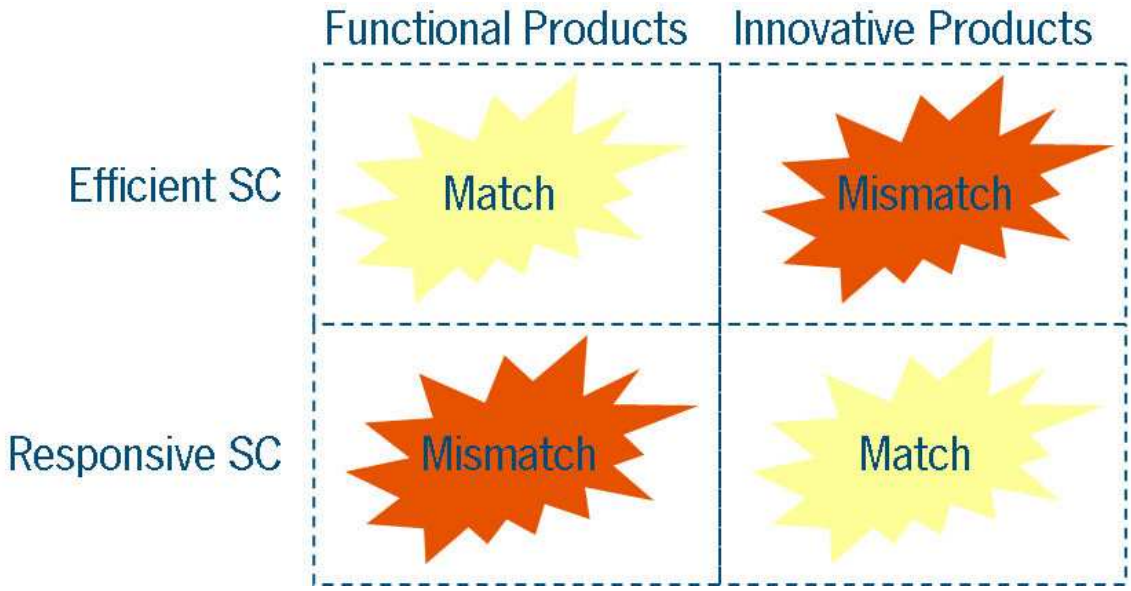


Figure 2.6 (Mis-)Match supply chain with product/market

Source: Fisher (1997)

For innovative products, related to demand-enhancing opportunities (Table 2.1), it is important to ensure that supply chains are coordinated in a way that leads to increased market mediation i.e. the products that reach the market are the ones that consumers want to buy. The uncertain market reaction to innovation increases the risk of shortages or excess supplies. High profit margins and the importance of early sales in establishing market share for new products increase cost of shortages. And short product life cycles increase the risk of obsolescence and the cost of excess supplies. Most important is to read early sales numbers or market signals and to react quickly, during the new product's short life cycle. For example attention should be paid to:

- producing the desired service outputs to the targeted and reached consumer segments (cf. Bucklin, 1966, 1970);
- offering the appropriate assortment of products the channel is associated with (Inman et al., 2004);
- near-by outlets (spatial convenience);
- attractive and large assortments (e.g., De Vries-van Ketel et al., 2004);
- consumer minded organized assortments (Morales et al., 2005).

To assess success or failure of a company's strategy, performance on various attributes has to be measured. The next section will go into measurement of performance.

2.2.2 Performance and Performance Measurement

Whether objectives are realized in practice can be measured via output performance of the company or the supply chain. On the organisation level, performance measures are used to evaluate, control and improve production processes and to foster improvement in order for companies to ensure achievement of their goals and objectives (Ghalayini and Noble, 1996). Performance measurement has been defined by Neely et al. (1995) as the process of quantifying the effectiveness and efficiency of action while performance measurement systems are described as the overall set of metrics used to quantify both of them. Neely et al. (1995) identify a number of approaches to performance measurement. Building on Neeley, Aramyan et al. (2006) present an overview of the most common performance measurement methods (Table 2.2).

Table 2.2 Advantages and disadvantages of methods to assess supply-chain performance

Methods	Advantages	Disadvantages
Activity-Based Costing (ABC)	Gives more than just financial information Recognizes the changing cost behaviour of different activities	Costly data collection Difficulties to determine appropriate and acceptable costs drivers Difficulties to collect initially required data
Balanced Scorecard	Balanced view about the performance Financial and non-financial factors Top-level strategy and middle-management-level actions are clearly connected and appropriately focused	Not a quick fix Complete implementation should be staged
Economic Value-Added (EVA)	Considers the cost of capital Allows projects to be viewed separately	Computation difficulties Difficult to allocate EVA among divisions
Multi-Criteria Analysis (MCA)	Enables decision-maker to learn more about the problem Suitable for problems where monetary values of the effects are not readily available A participatory approach to decision-making	Information requirements to derive the weights can be considerable Possibility to introduce implicit weights leading to results that cannot be explained
Life-Cycle Analysis (LCA)	Allows to establish comprehensive baselines of information on a product's or processor's resource requirement Allows to identify areas where the greatest reduction of environmental burdens can be achieved Possibility to assess the cost and environmental effects associated with the life cycle of a product or process	Data-intensive methodology Lack of confidence in the LCA methodology
Data-Envelopment Analysis (DEA)	Generates detailed information about the efficient firms within a sample All inputs and outputs are included Does not require a parametric specification of a functional form	Deterministic approach Data-intensive
Supply-Chain	Takes into account the performance of the	Does not attempt to describe every

Methods	Advantages	Disadvantages
Council's SCOR® Model	overall supply chain Balanced approach Performance of the supply chain in multiple dimensions	business process or activity Does not prioritize measures Does not explicitly address training, quality, information technology and administration

Source: Aramyan et al. (2006)

As Neely et al. (1995) observe, performance measurement systems can be analyzed at three levels: (i) the individual metrics; (ii) the set of measures, or performance measurement system as an entity; and, (iii) the relationship between the measurement system and the internal and external environment in which it operates. Table 2.3 gives key considerations for analyzing performance measurement on these three levels.

Table 2.3 Key consideration for analyzing performance measurement system

Level (1, 2 or 3)	Considerations
Individual performance measures	What performance measures are used? What they are used for? How much they cost? What benefit do they provide?
Performance measurement system	Have all the appropriate elements (internal, external, financial, non-financial) been covered? Have measures which relate to the rate of improvement been introduced? Have measures which relate to the long-term and short-term objectives of the business been introduced? Have the measures been integrated, both vertically and horizontally? Do any of the measures conflict with one another?
Relationship with internal and external environments	Do the measures reinforce the firm's strategy? Do the measures match the organizational culture? Are they consistent with the recognition and reward structure? Do some measures focus on customer satisfaction? Do some measures focus on what the competition is doing?

Source: Neely et al. (1995)

In this study we will focus our attention on the most appropriate performance measures and performance measurement systems. Although the overview of performance measurement provided by Neely et al. (1995, 2000) has been widely cited in recent research into supply chain performance measurement systems and metrics (e.g. Beamon, 1999; Gunasekaran et al., 2001), these studies have also highlighted the lack of consensus over the way to classify or categorise performance measures and systems.

In literature performance measures have been categorized in many different ways, as stressed by Shepherd and Gunter (2006). They have been grouped according to:

- Whether they are qualitative or quantitative (Beamon, 1999; Chan, 2003);
- What they measure: cost and non-cost (Gunasekaran, 2001; De Toni and Tonchia, 2001); cost, quality, resource utilization, flexibility, visibility, trust and innovativeness (Chan, 2003); resources, outputs and flexibility (Beamon, 1999); supply chain collaboration efficiency; coordination efficiency and configuration; and, input, output and composite measures;
- Their strategic, operational or tactical focus (Gunasekaran et al., 2001);
- Their hierarchical decision level: Supply chain, organisation, process (Van der Vorst, 2000) or the analytic hierarchy process (AHP) approach of Korpela et al. (2002);
- The process in the supply chain they relate to.

Shepherd and Gunter (2006) pointed out that the vast majority of articles on performance measurement could be classified as operational, design or strategic. Operational studies develop mathematical models for improving the performance of the supply chain, whilst design studies aim to optimize performance through redesigning the supply chain. The latter include deterministic analytical models, stochastic analytical models, economic models and simulation models. Finally, strategic studies evaluate how to align the supply chain with a firm's strategic objectives. Other researchers focused on how conflict and power affected the performance of supply chain networks.
A classical approach to performance measurement described by Rolstadås (1998) is based on the Sink and Tuttle model (1985, 1989). The model claims that the performance of an organizational system is a complex interrelationship between the following seven performance indicators: (1) Effectiveness, 2) Efficiency, (3) Quality, (4) Productivity, (5) Quality of work life, (6) Innovation and (7) Profitability/ budgetability. Rolstadås describes innovation as a key element in sustaining and improving performance. Chan (2003) also include innovativeness in his framework for performance measurement in the supply chain.

Another well known approach to performance measurement is developed by Kaplan and Norton (1992) through the balanced scorecard, Figure 2.7. This framework for an integrated performance measurement system for strategic, operational and financial measures also includes innovation. According to this framework, innovation and learning (later changed to learning and growth) was one of the four basic perspectives taken into account to assess performance. Innovation enables improvement and the creation of value.

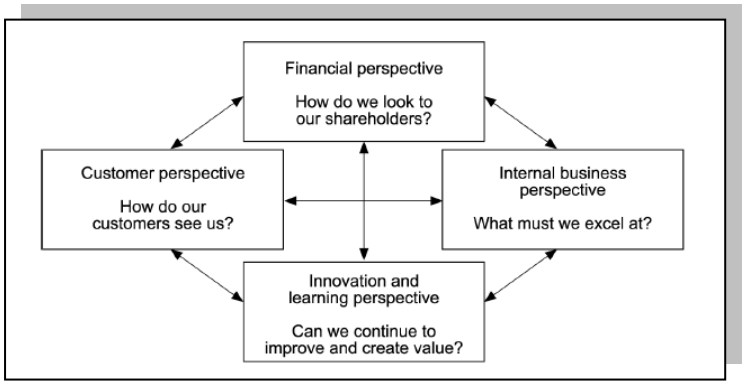


Figure 2.7 The balanced scorecard

Source: Kaplan and Norton (1992)

Aramyan et al. (2006) conclude from an extensive literature study to the following major performance metrics for food chains: efficiency, flexibility, responsiveness and quality. Responsiveness aims at a high level of customer service. Flexibility indicates the degree to which the supply chain can respond to a changing environment. Efficiency aims at maximizing value added and minimizing the cost absorbed in inventories (Aramyan et al., 2006). Quality is added as a category of specific importance for food chains, because of the performance implications of quality variation in and between production lots and perishability of food products. We will build on the framework of Aramyan, adding innovation as an important class of measures.

Thus the performance framework developed for this research is the following (Figure 2.8):

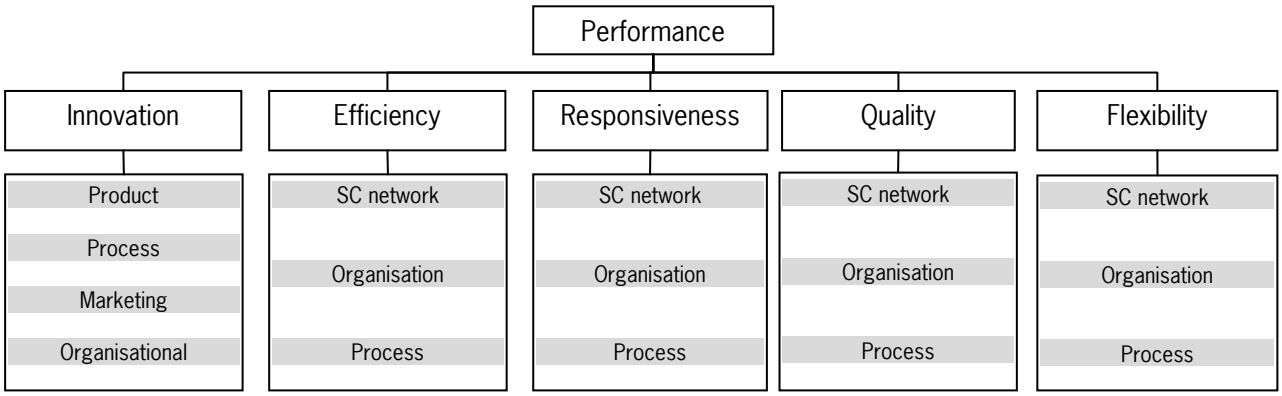


Figure 2.8 Performance framework within WP 1.4 INNOCHAIN

Another perspective on performance we want to address in this study is of van der Vorst (2000); performance indicators can be divided into three hierarchical decision levels, namely supply chain performance, performance of an individual organization and performance of an individual business process (Figure 2.9). All indicators are composites of, and dependent on, lower-level measures.

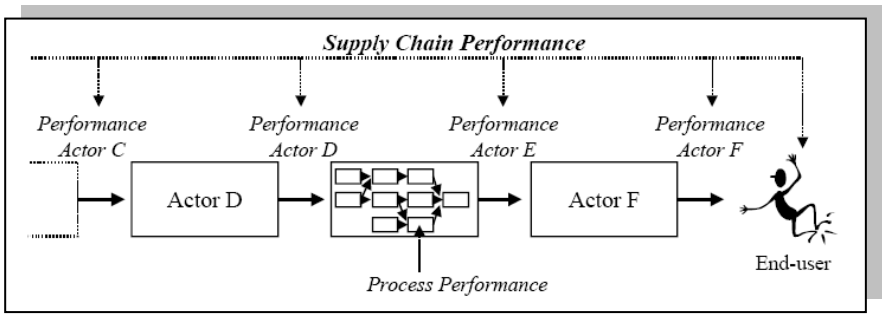


Figure 2.9 Three levels of SC performance

Source: van der Vorst (2000)

Maybe due to the complexity depicted in Figure 2.9, the performance measurement literature deals mainly with the firm level and not with the supply chain level. Over the last decade of evolution of SCM, a steady stream of articles dealing with the theory and practices of SCM have been published, but the topic of performance measurement has not received the attention it needs in SCM literature yet (Beamon, 1999; Chan, 2003; Gunasekaran et al., 2004). A range of limitations of existing measurement systems and their application to SCM has been highlighted in recent researches (Beamon, 1999; Chan, 2003; De Toni and Tonchia, 2001; Gunasekaran et al., 2001, 2004; Neely et al. 1995, 2000; Shepherd and Gunter, 2006) (see also Table 2.3):

- Lack of connection with strategy;
- Focus on cost to the detriment of non-cost indicators;
- Lack of a balanced approach;
- Lack of distinction between metrics at strategic, tactical, and operational levels;
- Insufficient focus on customers and competitors;
- Loss of supply chain context, thus encouraging local optimization;
- Lack of measures that capture performance across the entire supply chain;
- Lack of system thinking;
- Measurement systems tend to be static rather than dynamic;
- Performance measurement systems encourage short termism;

- Lack of empirical studies of the factors influencing the success or failure of attempts to implement performance measurement systems,
- Supply chain metrics are, in actuality, about internal logistics performance measures and do not capture how the supply chain as a whole has performed;
- Lack of integration of performance measurement systems with human resource management (HRM) and modern manufacturing practices such as total quality management (TQM), business process re-engineering, just-in-time (JIT), or new information technologies (IT);
- Lack of studies on cost/ benefits: Are the benefits of supply chain performance measurement systems outweighed by the cost of implementing and maintaining them in increasingly dynamic business environments;
- Need to determine the interrelationship between corporate and supply chain performance.

In recent times, researchers have attempted to respond to these limitations by designing systemic and balanced performance measurement systems. Perhaps the most well known are the supply chain operations reference (SCOR) model and the balanced scorecard. However these new methods must be considered only a first step to solve the problem.

2.2.3 Innovation

Although innovation is an important concept and is often treated distinct from performance, in this research, as suggested by the above authors, it is not treated separately from performance. For the purpose of this research, innovation is studied in detail as a key element in sustaining and improving performance.

The terms innovation and innovativeness are used randomly in several literature sources. In this report the term innovation is preferably used. According to De Jong and Brouwer (1999) innovation is the development and successful implementation of a new or improved product, service, technology, work progress or market condition, aimed at gaining a competitive advantage. Both innovation research and policy discussions emphasise the importance of taking a broad perspective on innovation. While R&D plays a vital role in the innovation process, much innovation activity is not R&D-based, yet relies on highly skilled workers, on interactions with other firms and public research institutions, and on an organisational structure that is conducive to learning and exploiting knowledge.

Research on innovation spans a number of disciplines, with economic approaches alone adopting several different theoretical perspectives, each of which offers significant insights. While these can be presented as alternatives, they can also be seen as complementary. The work of Joseph Schumpeter has greatly influenced theories of innovation. He argued that economic development is driven by innovation through a dynamic process in which new technologies replace the old, a process he labelled 'creative destruction'. In Schumpeter's view, 'radical' innovations create major disruptive changes, whereas 'incremental' innovations continuously advance the process of change. Schumpeter (1934) proposed a list of five types of innovations:

- Introduction of new products;
- Introduction of new methods of production;
- Opening of new markets;
- Development of new sources of supply for raw materials or other inputs;
- Creation of new market structures in an industry.

A Schumpeterian perspective tends to emphasise innovation as market experiments. However, there are various other approaches to innovation.

Neoclassical economics views innovation in terms of asset creation as well as market experiments. In this view, innovation is an aspect of business strategy, or part of the set of investment decisions to create capacity for product development or to improve efficiency.

Organisation theory has emphasised the significance of competitive positioning. Firms innovate to defend their existing competitive position as well as to seek new competitive advantages. A firm may take a

reactive approach and innovate to avoid losing market share to an innovative competitor. Or it may take a proactive approach to gain a strategic market position relative to its competitors.
Evolutionary approaches view innovation as a path-dependent process whereby knowledge and technology are developed through interaction between various actors and other factors. The structure of such interaction affects the future path of economic change.
Closely linked to the evolutionary approach is the view of innovation as a system. The **systems innovation approach** studies the influence of external institutions on the innovative activities of firms and other actors. It emphasises the importance of the transfer and diffusion of ideas, skills, knowledge, information and signals of many kinds (OECD and Eurostat, 2005, Lundval, 1992, Nelson, 1993).

Several important aspects of innovation can be derived from the above mentioned theories:

- The decision to innovate often takes place under great ***uncertainty*** which can lead firms to hesitate. Organisational structures, learning processes and adaptation to changes enable to face this problem.
- A firm's organisational structure can also affect the ***efficiency*** of innovation activities, with some structures better suited to particular environments (for example, a greater degree of organisational integration may improve the co-ordination, planning and implementation of innovation strategies).
- The ***diffusion*** of new knowledge and technology (e.g. Rogers, 1995) is a central part of innovation. The diffusion process often involves more than the mere adoption of knowledge and technology, as adopting firms learn from and build on new knowledge and technology.
- ***Appropriation*** is also an important factor in innovation. According to Transaction Cost Economics appropriation considerations (fear of hold-up problems) may dilute investment incentives and thus inhibit innovation. Once disseminated, users cannot be denied further access to such an innovation. In such cases, the firm cannot capture all the benefits generated by its innovation. Therefore, the ability to protect innovations will have an important influence on innovation activity.

Classification
The different theories cited before form the state-of-the-art of innovation. From them result various classification of innovation. The different theories cited above are proven useful for the classification of innovation into the following categories (Pannekoek, 2004):

- Product and Process innovation;
- Marketing and Organisational innovations;
- Incremental and Radical innovations;
- Technological push and Market pull innovations;
- Bottom up and Top down innovations;
- Competence enhancing and Competence destroying innovations.

Product and Process innovation:
Among various ways to categorize innovation, product and process innovation appears to be central in innovation literature: Product innovations are significant improvements of existing products (good or service) and development and commercialisation of new products (Pannekoek et al., 2005). Process innovations are significant changes and improvements on existing processes and the development and implementation of new processes (Pannekoek et al., 2005).

Marketing and Organisational innovations
A marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing (OECD and Eurostat, 2005). Organisational innovation involves the development and transformation of organisational structures and processes (Huizenga, 2000). Organisational innovation is the implementation of a new organisational method in the firm's or network business practices, workplace organisation or external relations (OECD and Eurostat, 2005).

Incremental and Radical innovations
Another distinction is made on the impact of the innovation. For a firm, an innovation can be incremental, implying small improvements, or radical, which means that it has a radical impact on existing structures (Huizenga, 2000). Incremental innovations refer to the continual process of improvement of already existing production techniques or products. These rather small improvements can be very important for the company as well as the customer (Pannekoek et al., 2005).
Radical innovations refer to products and processes that result from advances in knowledge and have a great or radical impact on the products, processes, and organisation of the firm or even the entire industry (Pannekoek et al., 2005).

Technological push and Market pull innovations
Technological innovation is the process of technical, design, manufacturing, management and commercial activities involved in marketing of a new or improved product or service (Huizenga, 2000). Technological pushed innovations are advances in science and later in technology, which lead to changes in the composition of products and processes. The relationship between science and technology is an interactive one (Pannekoek, 2004).
In initiating market pulled innovations the market need is the major influence on innovating activity. This may be in the form of market demands, government or environmental requirements or social needs.

Bottom up and Top down innovations
The classification of innovation in Bottom up and Top down innovations is based on the source and the following order of the different stages of innovation development. Bottom up innovations are initiated in the lower levels of the company by the purposeful behaviour of individual(s). These innovations are developed and promoted bottom up (Pannekoek, 2004). Top Down innovations are initiated in the higher levels of the company by top managers or entrepreneurs. They have the role of orchestrator, creating the right structures and climate for general innovation, or retroactive legitimizer or can act as judges (Pannekoek, 2004).

Competence enhancing and Competence destroying innovations
Competence enhancing innovations are radical innovations helping companies to further extend their resources and capabilities. They are associated with little environmental disturbance and reduce market uncertainty. Competence destroying innovations are radical innovations requiring new skills, knowledge and abilities. They are initiated by new market-entrants or spin-off companies. They are associated with high environmental disturbance and increase market uncertainty.

In order to ensure a consistent meaning of innovation throughout the research study and within WP1.4, innovation is defined based on the definition of De Jong and Brouwer (1999) and OECD (2005), as follows:

An **innovation** is the development and successful implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisational or external relations.

Among various ways to classify innovation, product innovation and process innovation would appear to be central in the innovation literature. Therefore this classification is used in this research, but is broadened (as suggested by WP1.4 - based on the Oslo Manual of OECD and Eurostat (2005)) in order to ensure a consistent meaning of innovation throughout the study and with the other work packages of ISAFRUIT. Thus the classification used becomes the following one, see Figure 2.10:

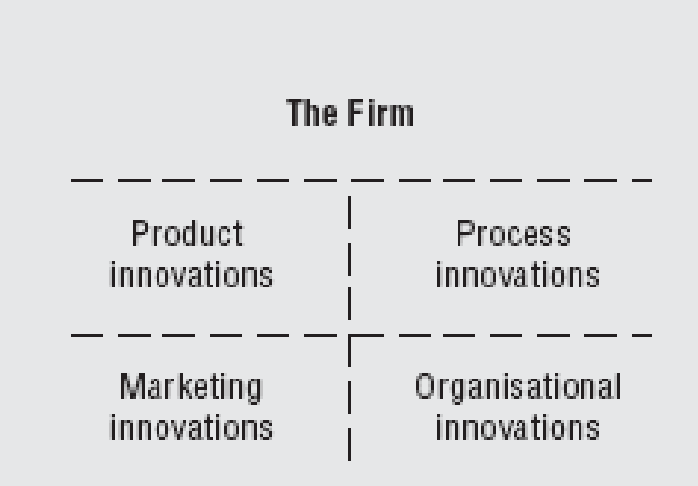


Figure 2.10 Innovations classification and measurement framework

Source: OECD and Eurostat (2005)

2.3 Critical Success Factors and Indicators

2.3.1 Critical Success Factors (CSF's)

New concepts and approaches on management have often arisen out of management practices. The management field has initiated the interest to find critical success factors without a need for theoretical foundations (Huizenga, 2000). Managers were confronted with new problems requiring new solutions quickly and the CSF's were part of these solutions.

CSF's are the relatively small number of truly important matters that managers should focus attention on. They represent the few 'factors' that are 'critical' to the 'success' of the organisation (Huizenga, 2000, Kaplinsky, 2002).

The key to success for managers is to focus their limited resources on things that really make the competitive advantage or the difference between success and failure (for example management systems that can limit costs compared to competitors or a specific capability to develop new products).

CSF's can be ordered in typical areas (Huizenga, 2000):

- Industry: each sector has a set of CSF's that are determined by the characteristics of the sector itself;
- Competitive strategy and industry position: each company's situation within the industry is determined by its history and current competitive advantage;
- Environment factors;
- Temporal factors: a number of areas of activity become critical for a particular period of time for a company or a sector. Either because something out of the ordinary has taken place or a unique resource is temporary available;
- Functional management focus: Each management area has a set of CSF's associated with functional disciplines.

Narrowed down to the internal company perspective, Huizinga (2000) classifies CSF's as follows:

- Process (e.g. specific innovative activities or resources in the production processes);
- Strategy (e.g. an innovative niche market strategy as part of the business strategy);
- Organisation (e.g. flat organization tuned to a dynamic market);
- Culture (e.g. the firm's climate for innovation);
- Commitment (management involvement and corporate commitment).

The elaboration of the CSF's in the next two paragraphs is split into those of innovation and those of the other performance indicators namely efficiency, responsiveness, quality and flexibility. This, because the are divided into different levels or factors.

2.3.2 CSF's and Performance Indicators

Performance indicators are operationalized process characteristics, which compare the performance of a system with a norm or target value. They refer to a relatively small number of critical dimensions which contribute to the success or failure in the marketplace (in other words: CSF's). It depends on the objectives of the supply chain as to which specific key performance indicators are appropriate and used (Van der Vorst, 2006). In summary, a supply-chain measurement system should reflect the objectives of main interest groups (customers, owners and personnel), it should combine operational and financial follow-up data, and link operational objectives to critical success factors and goals (Aramyan et al., 2006). Thus in the next paragraph, objectives are first discussed, and related CSF's are described. Later, the performance indicators of each CSF are investigated. This approach is based on the performance management process depicted by Bititci et al. (1997). From a business vision through objectives and critical success factors finally performance measures/indicators are derived, see Figure 2.11.

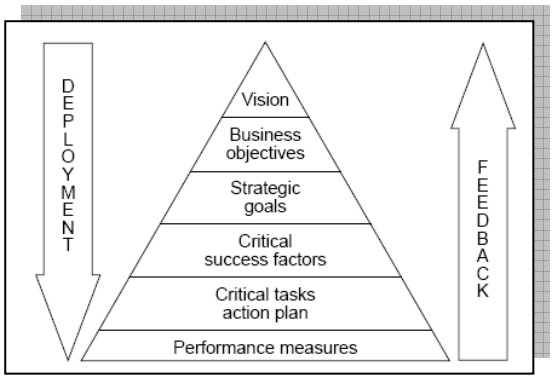


Figure 2.11 Performance management process

Source: Bititci et al. (1997)

According to Chopra and Meindl (2006), a company's success or failure is closely linked to the following key aspects:

- The competitive strategy and all functional strategies must fit together to form a coordinated overall strategy;
- The different functions in a company must appropriately structure their processes and resources to be able to execute these strategies successfully;
- The design of the overall supply chain (SC) and role of each stage must be aligned to support the SC strategy.

To achieve the fit between competitive and functional strategies, a company must ensure that its supply chain capabilities support its ability to satisfy the targeted customers. In this respect Chopra and Meindl design the so-called uncertainty – responsiveness matrix, in which high responsiveness implies high uncertainty. There are three basic steps for companies to achieve the strategic fit:

- Understanding the customer and SC uncertainty by mapping where their demand is located on the implied uncertainty spectrum;
- Understanding the SC by mapping it on the responsiveness spectrum;
- Achieving strategic fit matching the SC responsiveness with the implied uncertainty.

The relation between the uncertainty – responsiveness matrix and Fisher's innovation – responsiveness matrix (Figure 2.7), can be illustrated by Figure 2.12 (Lee, 2002). Innovative businesses in many cases must be responsive and have to deal with large uncertainties. These demands are much lower for so-called functional oriented businesses.

Functional	Innovative
Low demand uncertainties	High demand uncertainties
More predictable demand	Difficult to forecast
Stable demand	Variable demand
Long product life	Short selling season
Low inventory cost	high inventory cost
Low profit margins	High profit margins
Low product variety	High product variety
Higher volume per SKU	Low volumes per SKU
Low stockout cost	High stockout cost
Low obsolescence	High obsolescence

Figure 2.12 Demand characteristics

Source: Lee (2002)

Analysis of the fresh fruit sector shows that in general fruits have a low demand uncertainty. However, if the sector wants to answer consumer wishes by producing fruit products or ready-to-eat fruits, then the demand uncertainty becomes higher. In that perspective we can imagine a move on the implied uncertainty spectrum toward uncertain demand. Based on Chopra and Meindl, the supply chain then has to be more responsive to achieve strategic fit.

Another approach illustrated by Collins (2006) is based on the concept of 'value chain'. The marketing of fresh produce is driven by the interplay of price and quality which are not mutually exclusive conditions. It is the interaction of price and quality that results in what buyers regard as 'value for money'. The concept of value drives buyer/seller transactions at all stages of the chain between the primary producer and the final consumer. This is why the chain has been referred to as a 'value chain' and its management has become a source of increased competitiveness for its participants (Collins, 2006). Hence, the objective is to supply fresh produce in ways that represent value to consumers, or in other words, provide fresh produce that answer consumers demand and therefore have a value for them.

Members of fresh produce chains have to create, deliver and share value being involved in the management of their supply chains to be competitive. To evaluate the ways in which a fresh produce chain operates, Collins listed eight criteria. Thus he could map the 'value orientation' of any particular fresh produce chain (see Table 2.4, *with the best current example of fresh produce chains in gray*).

Table 2.4 Mapping of the fresh produce chains

Evaluative Criterion	Characteristics of chain activities Least value orientation - Greatest value orientation			
Balance between price and value	Almost always price	Usually price	Usually value	Almost always value
Amount and type of information shared	No significant information shared	Little information shared	Some information shared	Extensive information shared
Time orientation	Short term, transaction to transaction	Short term, periodic	Short to medium term	Medium to long term
The nature of relationships	Adversarial	Occasionally co-operative	Mostly cooperative	Collaborative
Interactions between chain members	Transaction based	Mostly transaction based	More relationship based	Always relationship based
Dependence in the chain	Independence	Occasionally relies on others	Usually relies on others	Interdependence
Power in the chain	The individual has the power	The individual has the power	Some recognition of the consumer	The consumer has the power
Orientation of chain members	Always self maximising	Self first, chain second	Chain first, self second	Always chain optimising

Source: Collins (2006)

To achieve those objectives of being a more value oriented chain or moving from an efficient toward a responsive supply chain, several CSF's have been suggested in recent studies. The selection of the CSF's is based on the findings of research with the closest context to this research. Articles from Grant (1995), Fearne and Hughes (1999), Hack (2000), Poot et al. (2000), Splinter et al. (2000), Wijnands et al. (2000), Collins (2003, 2006), Müller et al. (2004) are the most relevant for the selection. Grant studied the changing structures and strategies of European fruits supply chain players; Fearne and Hughes listed the success factors in the fresh produce supply chain in UK; Hack and Wijnands underlined the determinative key factors for the Dutch horticulture industry; Poot et al. emphasized the needed information to support Dutch vegetable supply chain effectiveness; Splinter et al. stressed out the critical arrangements for the success of the Dutch horticultural chains; Collins made a map of the fresh produces supply chains performance criteria and listed the critical quality drivers of those chains; and Müller et al. listed the success factors fruit and vegetables organic supply chains in Germany.

Basis of the selection of the indicators, related to the CSF's, were articles of Van der Vorst (2006) dealing with performance measurement in agri-food supply chains and Aramyan et al, (2006) dealing with performance indicators in agri-food supply chains, since they investigated performance indicators in similar research context. In this section we focus on efficiency, responsiveness, quality, and flexibility. The next section will pay special attention to innovation, as a special category of performance. After having extracted indicators from the performance CSF's articles and from Van der Vorst (2006) and Aramyan et al, (2006), few more indicators have been added from the articles cited above in order to explain the meaning of each CSF. Table 2.5 lists the performance indicators related to the chosen CSF's. These indicators are classified according to four of the chosen categories (Efficiency, Responsiveness, Quality, and Flexibility) and then according to the hierarchical decision level (Supply Chain, Organisation, Process). The last column of the table indicates whether the indicator is quantitative or qualitative. In the first column has been added the possible related CSF's.

Table 2.5 Performance indicators (excl. innovation)

CSF's I Cost II Profitability III Lead time IV Collaboration V Food safety VI Collaboration VII Environment VIII Market adaptability	Efficiency Responsiveness Quality Flexibility	SC Network Organisation Process	**Indicators**	Quantitative (QN) Qualitative (QL)
I	Efficiency	SC	Total supply chain management costs	QN
I			Information costs	QN
I			Total logistics costs	QN
I		Organisation	Total organisation's costs	QN
II			Sales	QN
II			Net Profit margin	QN
II			Return on investment	QN
II			Return on assets	
I		Process	Total cost of resources	QN
I			Manufacturing cost	QN
I			Process cost	QN
II			Process yield	QN
II			Average collection period	
II			Inventory turnover ratio	QN
II			Days of Inventory	QN
I			Warranty/returns processing costs	QN
III	Responsiveness	SC	Total supply chain response time	QN
III			Total supply chain cycle time	QN
III		Organisation	Order lead time	QN
III			Customer response time	QN
III			Product development cycle time	QN
IV			Horizon of business relationship	QL
III			Throughput time (Time required to perform chain business process)	QN
III		Process	Time required to perform the process	QN
IV			Delivery reliability	QN
III			Delivery lead time	QN
IV			Shipping errors	QN
IV		SC	Product availability on shelf	QN
V	Quality	SC	Product quality	QL
V			Traceability	QL
V			Product safety	QN
V			Tracing /tracking	QL
VI		Organisation	Buyer-supplier partnership level	QL
VI			Mutual trust	QL
VI			Satisfaction with supplier relationship / knowledge transfer	QL
VI			Extent of mutual planning cooperation leading to improved quality	QL

CSF's I Cost II Profitability III Lead time IV Collaboration V Food safety VI Collaboration VII Environment VIII Market adaptability		SC Network Organisation Process	**Indicators**	Quantitative (QN) Qualitative (QL)
VI			Quality and frequency of exchange of logistics information between supplier and customer	QL
VI			Information availability accuracy and timeliness	QL
VII		Process	Environmental aspect	QN
VII			Energy usage	QN
VII			Input usage	QN
V			Damage rate	QN
VIII	Flexibility	SC	Customer satisfaction (or dissatisfaction)	QL
VIII			Inventory range or capacity	QN
VIII		Organisation	Inventory level	QN
VIII			Production flexibility	QN
VIII			Volume flexibility	QN
VIII			Delivery flexibility	QN
VIII		Process	Process flexibility	QN
VIII			Number of backorders	QN

Sources: Beamon (1999), Gunasekaran et al. (2001), Chan (2003), Shepherd and Gunter (2006), Aramyan et al. (2006), Van der Vorst (2000, 2006).

2.3.3 Innovation Indicators

Innovations in marketing and business practices are as vital as technical innovations in order to develop competitive supply chains (McEvilly, 2006). Previous findings in literature demonstrate that the size of R&D expenditure might explain innovation performance differences between firms. However, more recent research has indicated that there might be other intervening indicators that are even of greater importance to innovation performance. Such indicators might reside in the way processes are designed, activities are organised and conducted, resources are allocated, and strategic objectives are pursued.

Interest in measuring innovation is due to its relation to the performance of enterprises, industries and the economy as a whole as stated before. Enterprises may or may not succeed in achieving their objectives by implementing innovations, or innovations may have other or additional effects than those that initially motivated their implementation. While objectives concern enterprises' motives for innovating, effects concern the actual observed outcomes of innovations.

The same indicators may play a role in objectives and effects of innovation, although they will be interpreted differently. On the other hand the same indicator might be relevant for more than one type of innovation. In particular product and marketing innovations or process and organisational innovations may have a number of indicators in common. In our literature search we have searched for CSF's for innovation and measurable indicators that are common in food chain analysis. Starting from the basic categorizations of Huizinga (2000) we have arrived at the following CSF's and related indicators as in Table 2.6. In the table we classify CSF's and indicators according to our innovation classification: product, process, market, organization.

Table 2.6 Innovation CSF's and Indicators, classified according to type of innovation

CSF	Classification / Indicators	Product innova-tions	Process innova-tions	Organisa-tional innovations	Marke-ting innova-tions
A Product attributes	% of environment-friendly products	*			
	% turnover invest to improve health and safety	*	*	*	
	% turnover invest to improve product quality	*	*	*	
B Product assortment	Speed of the replacement of products phased out	*			
	% Of new products in total turnover	*		*	
	Range of products	*			
C Process superiority	Response time to customer needs		*	*	
	Flexibility of production		*	*	
	Newest machinery		*		
	Speed of innovation		*	*	
	% total turnover affected by process innovation			*	
D Top-management support and skill	% of employees involved in innovation		*	*	
	% of employees with training		*	*	
	% of employees with master degree		*	*	
E Market	Relative market share			*	*
	Sales of new to market product			*	*
	Rank in the market			*	*
	% turnover invested in market research				*
	% total turnover affected by marketing innovation				*
F Company environment	Numbers of patents			*	*
	Level of relationship with customers			*	*
G Strategic fit	Strategic attention for innovation			*	
	Continuous innovating as part of the company strategy			*	
	Plans to invest in innovation			*	
H Communication / organisation	Number of projects with shared knowledge with other organisations			*	
	ICT expenditures			*	
	Achieve industry technical standards	*	*	*	

Sources: Based on De Jong & Vermeulen (2006), Hessels (2006), Kemp et al. (2003), OECD/ Eurostat (2005), Tanewski et al. (2003)

3 Conclusions

Out of the literature study, the following interesting definitions and conclusions came forward for the research in INNOCHAIN on consumer driven supply chains.

- **Supply chain management** is the integrated planning, coordination and control of all business processes and activities in the supply chain to deliver superior consumer value at least cost to the supply chain as a whole while satisfying the variable requirements of other stakeholders in the supply chain (*e.g.* government and NGO's).
- From the literature study **the framework from Van der Vorst et al**. (2005) has been adopted as a promising fundament for the development of a chain framework to be used in WP1.4.
- From Fisher (1997) we conclude that **consumer or demand-driven supply chains** have to be responsive. In order to be responsive they have to be innovative. For innovative products, related to demand-enhancing opportunities, it is important to ensure that supply chains are coordinated in a way that leads to increased market mediation i.e. the products that reach the market are the ones that consumers want to buy
- **Critical Success Factors** are the relatively small number of truly important matters that managers should focus attention on. They represent the few 'factors' that are 'critical' to the 'success' of the organisation (Huizenga, 2000). Performance on these CSF's, can be **measured by performance indicators**.
- We group the **indicators** in five main categories: **efficiency, responsiveness, quality, flexibility and innovation**. In this regard we consider innovation as one of the important performance categories. Following the Oslo Manual (OECD, 2005) we further categorize innovation into **product, process, marketing and organizational innovation**.
- **Performance indicators** can be divided into three hierarchical decision levels, namely supply chain performance, performance of an individual organisation and performance of an individual business process.
- Based on different sources Beamon (1999),), van der Vorst (2000), Gunasekaran et al. (2001), Chan (2003), Shepherd and Gunter (2006), Neeley (2005), Aramyan et al. (2006), the following Critical Success Factors for company performance (innovation not included) have been found: **Cost, profitability, lead-time, collaboration, food safety, communication, environment and market adaptability**.
- Based on different sources De Jong & Vermeulen (2006), Hessels (2006), Kemp et al. (2003), OECD/ Eurostat (2005), Tanewski et al. (2003), the following Critical Success Factors for innovation have been found: **product attributes, product assortment, process superiority, top management support and skill, market, company environment, strategic fit and organisation & communication**.

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