

Towards a multi-dimensional framework for characterising and comparing pork chains

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Abstract

Pork chains are complex supply chains of different parties from farm to fork. Pork chains in different regions and countries seem quite similar. When looking more closely to different aspects of chains and markets served, many differences can be observed. To increase competitive advantage of pork chains, adopting different perspectives in describing and characterising pork chains is expected to support creation of encompassing change initiatives.

This paper presents an initial framework for describing, characterizing, and comparing pork chains. Various organisation metaphors, each incorporating a different perspective, are applied to the problem context of pork supply chains. The framework is illustrated with two different pork chains in The Netherlands. The framework is a first step towards developing a typology of pork chains in Europe and beyond to facilitate knowledge exchange for improving competitive advantage of pork chains in Europe.

Key words: pork supply chain, supply chain integration, systems approach

1. Introduction

Pork chains are complex supply chains involving many different parties from farm to fork. While pork chain operation has been fairly stable in the past in The Netherlands, they have faced changes in the environment in the past decade. For example, customer preferences have changed, while safety, environmental and health concerns have increased. Recent health and safety incidents have led to changes in regulations both at national and EU level (e.g., stricter quality rules). In addition, pork chain companies are growing in size, while operation and competition is increasingly global. Moreover, competition from non-European countries like China is expected to grow in the coming years.

In the FP6 Integrated program Q-Porkchains (www.q-porkchains.org), an inventory of current pork chains in five European countries, as well as in South Africa and China has been made. The objective of the inventory is to arrive at a typology of pork chains in the various countries for comparing different aspects of pork chains and support knowledge exchange. Based on interviews with experts, both from the scientific community and industry, an initial overview is created of several aspects of the pork chain, like markets and products, quality management systems, developments in the past decade. The overview shows many similarities between pork chains, like the stages of pig production, but also essential differences, like pork meat products, quality management systems, level of professionalism, power balance in the chain, and market size.

To systematically characterise similarities and differences in various pork chains, a framework is developed, based on system thinking. The system approach is considered suitable for analyzing pork chains, because of the interdependencies that exist between the various linkages within pork chains. Furthermore, the system approach is useful for characterising pork chains from different (theoretical) perspectives. Since there is not one way to model or describe a complex system like a pork chain, it is important that various perspectives are incorporated in the framework. Moreover, the framework should support application at different levels of abstraction, the chain level and the chain actor level.

The present paper describes the development of the multi-dimensional framework and aims to show the usefulness of the framework for characterising pork chains from different perspectives. To achieve this, the different perspectives are elaborated into more detail. The framework is applied to the chain level of two different types of Dutch chains: the large fresh pork meat chain and a small regional chain. The developed framework, and the confrontation of this framework with empirical data, is a first step towards developing a typology of pork chains.

The structure of this paper is as follows. In chapter 2, the system approach is outlined related to pork chains and metaphors representing different perspectives. Subsequently, our framework is introduced. In chapter 3, a short overview is given of pork chains in The Netherlands. In chapter 4, the fresh pork meat chain and the regional chain are characterised according to the framework. Chapter 5 contains conclusions and suggestions for further work.

2. Systems thinking and pork chains

System thinking has started with the recognition that a system is more than the sum of its components, while its behaviour cannot be found in any of its components as such. Systems can be closed, without interaction with their environment, but most systems are open. Systems range from simple mechanical systems with well-understood behaviour to complex organisms and even human systems like organisations. Organisations are in essence social activity systems, in which the constituting elements are dependent on each other and need to act in a synergetic way to achieve success. Organisations can even be seen as complex networks (Flood and Jackson, 1991). Pork chains are such complex networks.

In the past decades different approaches to system thinking have been developed, incorporating different views on organisations. Flood and Jackson (1991) have combined these approaches in a methodology, called Total Systems Intervention (TSI)¹. In this methodology, system metaphors are applied as a first step to better understand the particular situation of the organization. This paper uses these metaphors to identify different views on pork chains. Metaphors are encompassing, because they put various organisation and management theories into perspective. Metaphors for organisations as developed by Morgan (2006) and used by Flood and Jackson (1991) are:

- **Machine.** This metaphor focuses on mechanical thinking in which scientific approaches like classical management theory can be used.

¹ Although three steps can be distinguished within TSI, the paper only discusses the first step of the methodology. This first step is considered relevant in the context of the paper. The remaining steps require involvement of people in defining and analysing the problem area.

- Organism. This metaphor focuses on organisations as open systems. The contingency approach, for example, is applicable in this context.
- Brains. In this metaphor the focus is on information processing. Cybernetics and the learning organisation apply in this context.
- Culture. In this metaphor, an organisation itself is seen as a cultural phenomenon varying with a society's stage of development. Value's in society influence people behaviour in organisations.
- Political system. An organisation, in this metaphor is a system of governance and political activity, where people have different interests, conflicts, and exercise power.
- Psychic prison. This metaphor applies to very complex, coercive, situations in which true sources of power are hidden. In the context of pork chains, this metaphor seems less relevant.

Metaphors connect to different system methodologies. System methodologies consist of process steps to describe, analyse and improve organisational situations. They use the organisational perspectives of metaphors in a process to characterise an existing situation and define a direction for improvement, while people in the problem situations are involved to different degrees. In such problem situations, more than one metaphor may be applicable, while often one metaphor is leading in the situation at hand.

Metaphors are connected to system methodologies through problem context characteristics. Flood and Jackson (1991) following Morgan (2006) have classified problem contexts along two dimensions: the complexity of the system under study, and the type of relations that exist between the sub-elements of the system. With regard to the complexity of a system, a system can be classified as either simple or complex. With regard to the relations between the sub-systems, Flood and Jackson (1991) distinguish between unitary, pluralist, and coercive relationships. Unitary relationships are characterised as people having shared common interests, compatible values and beliefs, agreed upon ends and means, common decision making, and acting upon agreed objectives. Pluralist relationships are characterised by people having basic compatibility of interests, diverging values and beliefs to some extent, compromising upon ends and means, common decision making, and acting in accordance with agreed objectives. Coercive contexts on the other hand show absence of common interests, conflicting values and beliefs, no agreement upon ends and means, enforcement of decisions, and impossibility to achieve agreement on objectives.

The political metaphor in particular contains all three types of relationships between subsystems. According to Flood and Jackson (1991) these types of relationships can themselves rest on metaphor: the unitary upon a team metaphor, the pluralist upon a coalition metaphor, and the coercive upon a prison metaphor. The last metaphor, connecting also to the psychic prison metaphor of Morgan (2006), is not considered relevant in the context of pork chains, because existing chains cannot stay alive in a coercive context.

Flood and Jackson (1991) have made an overview of system methodologies connected to problem context characteristics and underlying metaphors. In this way, after applying metaphors to characterise problem situations, suitable system methodologies can be selected for analysis and improvement. In table 1, this overview is presented.

Table 1. System methodologies related to systems metaphors (from: Flood and Jackson, 1991).

Systems methodology	Assumptions about problem contexts	Underlying metaphors
1. System dynamics	1. Simple-Unitary	Machine Team
2. Viable system diagnosis	2. Complex-Unitary	Organism Brain Team
3. SAST (strategic assumption surfacing and testing)	3. Simple-Pluralist	Machine Coalition Culture
4. Interactive planning	4. Complex-Pluralist	Brain Coalition Culture
5. SSM (soft systems methodology)	5. Complex-Pluralist	Organism Coalition Culture
6. Critical Systems Heuristics	6. Simple-Complex	Machine/Organism Prison

Each system methodology offers decision makers methods and tools to describe and analyse the system of interest. System methodologies extend and complement each other in describing, analysing and improving problem situations. The first two system methodologies employ rather objective, mechanistic tools and methods, while the last four system methodologies focus less on objective characteristics of systems, but more on involvement of participants in describing and characterising problem contexts. In using these last four types of system methodologies, confronting and harmonising different perspectives is part of the problem solving process. In this section, further below, we will discuss what problem contexts and associated system methodologies and metaphors apply to pork chains.

In the systems approach, the first step in modelling systems is to identify the function of the system to be modelled before framing the system to study. For a pork chain, this is the production of pork meat to satisfy consumer needs and at the same time to achieve value for all parts of the chain. The elements of the pork chain have to collaborate to achieve this function. At the same time, a pork chain is a supply chain consisting of several very different organisations, with different goals, ambitions, and cultures. In system terms, the chain is a system, and the constituting organisations are subsystems of this system.

In terms of problem contexts, pork chains may be characterized differently, depending on the level on which the problem context is defined. For example, at chain level, problem contexts are unlikely to be defined as simple, because of the complexity of inter-firm relations (as is outlined below). At chain-member level, problem contexts may be different with respect to the chain level. For example, a small farm may be characterised as a simple system, a large farm as a complex system. This paper is limited to definition of problem contexts on the chain level. Multi-level analysis is left for further work.

From the various problem contexts outlined in table 1, number 1, 3 and 6 are unlikely to apply to pork chains, because they characterize problems contexts as simple, while pork chains are typically complex systems. This is because the various subsystems have different goals, while also the chain evolves over time. Number 6 is also deemed unsuitable for characterising pork chains for another reason: it describes the relations between the sub-systems as coercive. Even though interests among chain members

can be diverse, chain members have to achieve the same overall goal. Therefore, chain members need to come to some type of common agreement, and consequently, the relations have either a unitary or pluralist character. Coercive relations are likely to exist only in dysfunctional chains, which, because they fail to perform their function, cease to exist over time. Therefore, only problem contexts number 2, 4 and 5 are likely to apply to existing pork chains that succeed in achieving their function.

The problem contexts applicable to pork chains (2, 4 and 5) are related, as is outlined in table 1, only to four of the six organisation metaphors identified by Flood and Jackson (1991): organism, brains, culture and political (coalition) system. Therefore, only these metaphors are likely to apply to pork chains. The metaphors can be outlined along the two dimensions, which Flood and Jackson (1991) use to classify problem contexts: complexity of system and type of relation between sub-systems. This is shown in figure 1, which forms the basis for our framework for the empirical part of the study.

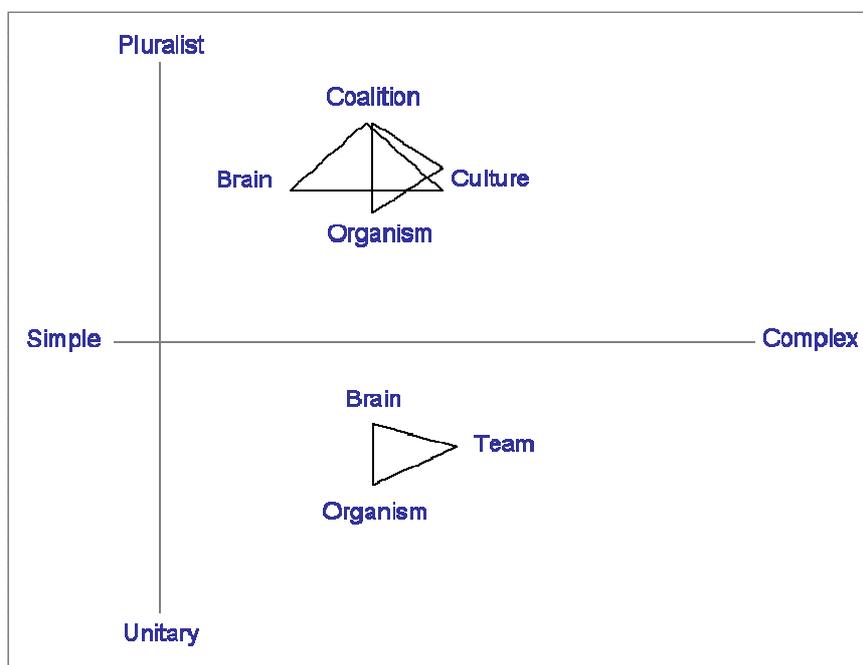


Figure 1: Framework for classification of problem contexts and metaphors in pork chains

As is shown in figure 1, two different types of problem definitions can be defined in pork chains: Complex-Pluralist situations and Complex-Unitary situations. As is explained above, coercive relations are not applicable to the study of pork chains functioning. Therefore, relations between subsystems can have either a unitary or a pluralist character. Furthermore, as is explained above, pork chains are typically complex systems. Complex-Pluralist systems can be described by means of the organism, brain, coalition and culture metaphor. Depending on the type of systems methodology used (Interactive Planning or SSM), either the brain-coalition-culture combination of metaphors or the organism-coalition-culture combination is suitable. In any case, the metaphor or combination of metaphors chosen support the perspective from which an organisational system can be described. Complex-Unitary systems can be described by means of the organism as well as the brain metaphor.

In chapter 4, the framework will be specified into more detail by exploring the variables that are involved in each of the metaphors that apply to problem contexts of two different pork chains in The Netherlands.

3. Pork chains

In the Q-Porkchains project (www.q-porkchains.org) an extensive overview of current pork chains in The Netherlands has been developed based on interviews with experts in the field. A brief introduction to these pork chains is given below.

About 95% of all pork meat products in the Netherlands is produced in a more-or-less standard supply chain, the fresh pork meat chain. This chain is depicted in figure 2. The pork meat production process is depicted in the centre part of the figure, involving breeding, farrowing and finishing, slaughtering and processing, and retailing, which involve also the so-called out-of-home channels to consumers. At the input site of the chain, find the feed industry, veterinarians providing advice, and technology providers can be distinguished. Parties influencing chain activities are breeding companies focusing on genetic improvement and cultivation of pig species, technology developers and research institutes, branch organisations, financial institutes, and government. Important support parties are transporters, traders and distributors.

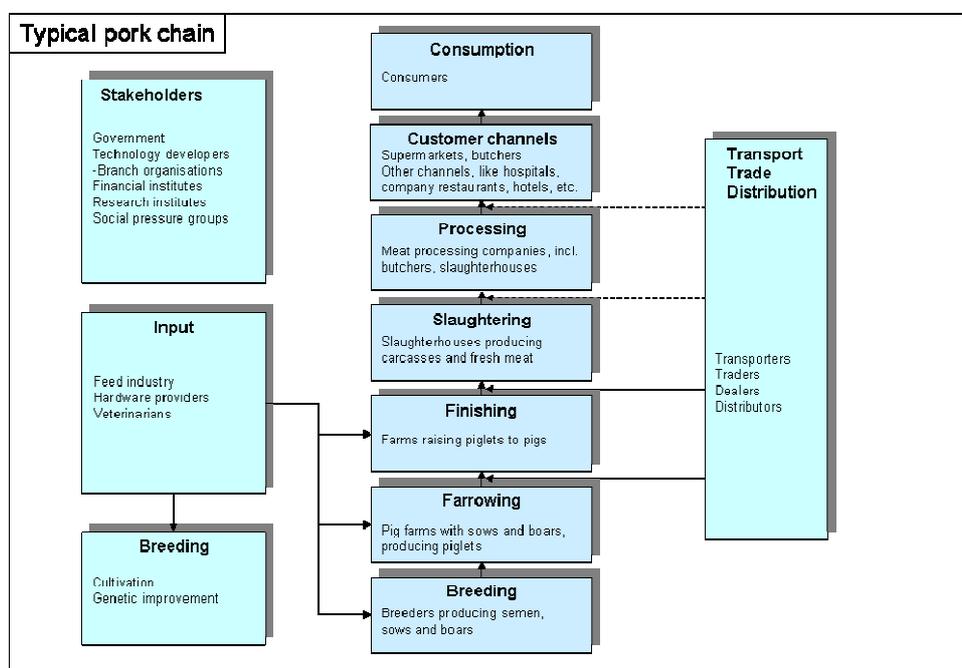


Figure 2 Typical pork chain in the Netherlands

The part of the chain producing and fattening pigs is often called the primary production process. After this part of the chain process, the pig is divided into parts with different value. A major problem facing slaughterhouses and processors is to create value for all parts of the pig. This problem is called 'vierkantsverwaardig' in Dutch. A pig is not only meat. About 70 kg of every living pig of about 114 kg (slaughter weight) is used for human consumption partly as fresh meat, partly processed into food products. Other parts are sold to parties that can process the slaughter waste products, like feed producers, pharmacy, and destruction (Hoste et al., 2004).

The fresh pork meat chain produces pork meat not only for the Dutch market, but also for markets in different European countries and in other parts of the world. About 0.873 million tons of pork meat was exported in 2004 (see www.topigs.com). Part of the pork meat is also imported. For example, in 2004, 0.263 million tons of pork meat were imported (PVE, 2005). The fresh pork meat chain involves large companies,

including farms, slaughterhouses, processors, and retailers. There are also still smaller parties in this chain, in particular farmers, but their number is reducing.

An important market is the British bacon market. About 15% of pork meat production is aimed at the bacon market. This market requires leaner pigs with a slaughter weight limited to about 90 kg. Primary production of pigs for the bacon market slightly differs from this part of the process in the fresh pork meat chain, e.g., with respect to the feed used.

A small part of the pork meat, about 5%, is produced in smaller regional chains or biological chains. Regional chains primarily operate on a small scale with other parties in the region in a mainly closed system. For example, manure is delivered to a farmer who produces grain. This grain is then delivered to the local feed producer involved in the chain, who mixes it into the feed delivered to the pig farm. Close relationships often exist between pig farmers and customer channels, in particular quality butchers and restaurants.

An important, growing, part of regional chains consists of the so-called organic or biological chains. The biological chain differs from the fresh pork meat chain in several ways. Biological chains have to satisfy strict rules and regulations on EU level as well as on national level. The primary process is different from the fresh pork meat production, because pigs need space outside the barn, they do not receive medication and anti-biotic medicine, only when needed, feed does not contain GGOs, GMOs, and components from animal sources. Moreover, the land on which pigs grub is not treated with chemicals and synthetic fertilizers. In The Netherlands, a large part of biological pork meat is produced in a national professional chain involving about 52 farmers and (www.degroeneweg.nl), 12 quality butchers, and one slaughterhouse. It also includes supermarkets where pre-packed biological pork meat products are sold. The biological farmers delivering to 'De Groene Weg' slaughterhouse have no direct links with customer channels.

Several regional chains can be found in between the fresh pork meat chain and the biological chain. Some are close to the fresh pork meat chain, while some differences can be observed. In one regional chain, for example, sows in gestation are kept on straw in a large stable with lots of fresh air, while no antibiotics are used in the feed. Another chain is quit close to the biological chain, but does not adhere fully to all strict rules set for biological production. This chain differentiates itself with respect to meat quality and brand image.

Pork chains in the Netherlands have to comply with EU regulation as well as national regulation on top of EU rules. Almost all farmers produce according to the IKB (integrated chain management) quality rules. Veterinarians, feed producers, transporters, slaughterhouses, processors, and retailers have their own rules in addition to the general risk management rules adopted for the sector, like HACCP. Tracking and tracing is performed to prevent and act upon safety and health problems in the chain.

4. Modelling pork chains

The exploration of metaphors starts with the *fresh pork meat chain*. This chain consists of several, mostly large, subsystems. These systems, the member organisations of the chain, have their own goals, while they also have to comply with the overall goal of serving the consumer. Although long-term relationships exist in the fresh pork meat chain, chain members (wish to) remain largely independent. The problem context of the fresh pork meat chain, therefore, can be characterised as

Complex-Pluralist at the chain level. The Organism, Brain, Culture, and Coalition metaphors apply to these contexts as outlined in the framework in figure 1. The paper gives an brief introduction to the metaphors, the essential variables they address, and examples from the Dutch part of the Q-Porkchains inventory. A more in-depth exploration is left for further work.

The *Organism metaphor* focuses essentially on interaction of organisations with their environment and adaptation to the environment, organisational lifecycles, factors influencing organisational health and development, organisational types and their relationships with ecology (Morgan, 2006). Contingency theory is an important source for applying the Organism metaphor in practice. Variables, like nature of environment, nature of task and authority, communication systems and nature of employee commitment, can be mentioned (based on Burns and Stalker, 1994).

Values for these variables may be different on the chain level and on individual chain member level. For the fresh pork meat chain as a whole the environment consist of EU and national regulation, certification bodies, consumer organisations, pressure groups, foreign competition, etc. The task facing the whole chain is to produce pork meat products to satisfy consumer demands, while creating value for all chain elements. Authority on the chain level is centred on the dyad between retail and slaughterhouse. Retail pushes requirements up the chain, while the slaughterhouse is an intermediary between retail and farmers. The slaughterhouse is a key player in pushing quality requirements to farmers. Communication is extensive between slaughterhouse and farmers, and between retail and slaughterhouse. Farmers are highly committed to producing strong and healthy pigs, because their incentive is to earn the best price for each pig. Organisations downstream the chain are fairly large. In these organisations employee commitment strongly depends on, e.g., organisational structure, culture, and management.

The *Brain metaphor* focuses essentially on information processing (Morgan, 2006). Organisations in essence are information systems, in which communication and decision making are necessary for daily practice. An important aspect of the Brain metaphor is also self-reflection and learning, not only single-loop learning, but also double-loop learning (see e.g., Argyris and Schön, 1996). Cybernetics provides concepts to study information, communication, and control, which are necessary for the learning organisation. The learning organisation is the basis for definition of variables, in particular aspects, like changes in the wider environment, operating norms and assumptions, ability to question, challenge, and change operating norms and assumptions, organisational strategy in alignment with pattern of organisation, and barriers to change, like management control systems and defensive routines of organisational members. These barriers must be understood to allow double-loop learning instead of being trapped in only single-loop learning.

For the fresh pork meat chain, variables address, for example, the changes in consumer needs, which may induce innovations in meat products, but may also lead to other ways of farming. For example, consumer concern for animal welfare has led to changed requirements for pig farming. With respect to organisational strategy and pattern of organisation, the chain member organisations have to collaborate to produce pork meat products as desired by the consumer. On the other hand, these organisations wish to remain largely independent to remain flexible to react to changing circumstances. Information exchange is essential in the chain to align operations and to increase quality. For example, a large slaughterhouse in the fresh pork meat chain exchanges information with the supplying farmers about carcass

properties of the pigs delivered. This information helps farmers to improve their processes and increase quality. An important incentive for improvement is that payment is directly linked to the carcass quality level.

The Brain metaphor also connects to quality management systems and strategic choices made by subsystems in the chain. Currently, alignment between quality management systems and strategic choices of subsystems in the pork chain are subject to improvement.

The *Culture metaphor* challenges belief systems like rationality and objectivity. It addresses the underlying social constructions and meanings to understand organisational functioning (Morgan, 2006). Variables can be defined for aspects, like ideologies, values and norms, beliefs, language, ceremonies and other social practices. Creating appropriate systems of shared meaning is considered a fundamental task of managers. On the chain level of the fresh pork meat chain, such shared meaning connects to the Dutch society in which currently animal welfare, human health, and environmental safety are key concerns. Currently, these key concerns have been addressed in EU and national regulations that apply to all parts of the chain. Difference in commitment to the rules can be observed, though. Some members apply rules at a basic level, while others try to achieve excellence. On individual chain member level, differences in cultures can be observed, which may influence mutual alignment and communication.

The *Coalition metaphor* is the pluralist variant of the Political metaphor (Flood and Jackson, 1991). The Political metaphor focuses on the politics influencing organisational practice (Morgan, 2006). In particular, the focus is on (sources) of power. Morgan (2006) mentions 14 sources of power among which are formal authority, control of scarce resources, use of organisational structure, rules and regulations, control of decision processes, control of knowledge and information, etc. A detailed application of these sources of power is left for further work for now.

When confronting the Coalition metaphor to the fresh pork meat chain, it becomes apparent that a very powerful party in the fresh pork meat chain is the retailer. The retailer translates consumer needs to requirements for processors and slaughterhouses. They also put pressure on these chain members to deliver what, when, and how, and with what quality level. On the other hand, the largest slaughterhouse in the fresh pork meat chain is also a powerful party. In effect, the slaughterhouse is a spider in the web consisting of farmers, processors, retail, and even the feed producer. The slaughterhouse has extensive control of the boundaries between chain members and also controls knowledge and information gathered from the feed company involved, the farmers, and also from down-stream members. Slaughterhouses, processors, and retailers are increasing in size. Farms also increase in size, but many farms are still fairly small. The farmer determines to what extent he or she is politically active in, for example, networking and boundary control.

The position of the slaughterhouse in the fresh pork meat chain also leads to questions. For example, is the slaughterhouse the right party for translating consumer demands to quality requirements for farmers? What capabilities should the slaughterhouse have for serving different consumer demands? What strategic choices are relevant for the slaughterhouse to satisfy consumer demands? What types of relationships should exist between slaughterhouse and retail? These questions need further exploration in future research.

This exploration for the fresh pork meat chain can be contrasted with the *regional chain*. The problem context of the regional chain can be characterised as mainly

Complex-Unitary, since chain members constituting this chain interact frequently to maintain one goal: satisfying consumer needs in the region by producing high-quality pork meat and meat products. Since the number of chain members is fairly small, maintaining one goal and managing conflicts is more easily achieved. Next to the Organism and Brain metaphors, the Team metaphor supports the C-U problem context. The Team metaphor is the unitary variant of the Political metaphor (Flood and Jackson, 1991). Although interests are different for members of the regional chain, a common shared goal is more easily achieved and maintained.

In *Organism* terms, the regional chain has a less turbulent environment, communication is often face-to-face between the chain members, the task is quit simple. Legislation, social pressure, etc., faced by the regional chain is similar to the fresh pork chain environment. In *Brain* terms, the regional chain has more informal information exchange, feedback is direct. After a period of turbulence, in which the regional chain established itself, the market is quit stable. In *Team* terms, power balance is quit different from the fresh pork meat chain. In the regional chain, the pig farmer has initiated the chain in collaboration with a number of local quality butchers. The slaughterhouse is a service to the chain. It slaughters pigs and delivers carcasses to the butchers. The interest of chain members to keep the chain alive is very large, leading to large commitment, but also to large dependence. Since the particular chain depends on one farm only, vulnerability is high.

In summary, the initial framework for describing, characterising and comparing pork chain is presented in table 2. The framework will be further developed in future work as the next step towards a typology of pork chains in Europe.

Table 2. Initial multi-dimensional framework for describing, characterising and comparing pork chains (based on Flood and Jackson, 1991).

Metaphor	Variables, e.g.,
Organism	Nature of environment Nature of task and authority Communication systems Nature of employee commitment
Brain	Changes in the wider environment Operating norms and assumptions Ability to question, challenge, and change operating norms and assumptions Organisational strategy in alignment with pattern of organisation Barriers to change, like management control systems and defensive routines of organisational members
Culture	Ideologies Values and norms Beliefs Language Ceremonies and other social practices.
Team	Communication Control
Coalition	Sources of power, like Formal authority Control of scarce resources Use of organisational structure

	Rules and regulations Control of decision processes Control of knowledge and information
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5. Conclusions and further work

In this paper, we have developed an initial multi-dimensional framework for describing, characterising and comparing pork chains. The framework is based on the first step of the Total System Intervention methodology (TSI) developed by Flood and Jackson (1991). This first step uses various metaphors to characterise a system of interest. While each metaphor relates to particular organisation and management theories, the variables of interest to study also become apparent.

We have illustrated the application of the framework with two different pork chains in The Netherlands. This is a first step in identifying interesting similarities and differences between national pork chains, but also pork chains in Europe and beyond. A typology of pork chains will be developed in a later stage of the research. The typology is meant to support exchange of knowledge to improve the competitive position of pork chains in Europe.

In further work, a more detailed list of variables will be made. A in-depth description and characterisation of pork chain will be made, not only on the chain level, but also on the chain actor level. The multi-dimensional, multi-level characterisation will lead to identification of essential similarities and differences between pork chains. Identification of opportunities for improving the competitive position of pork chains in Europe is the final aim of the work.

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