Virtual or vague? a literature review exposing conceptual differences in defining virtual organizations in IS research

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Abstract The concept of 'virtual organization' was coined about 15 years ago to describe changes in organizational structures and value creation, enabled by the affordances of ICT. Not surprisingly, the Information Systems community has been influential in researching virtual organization phenomena. However, it appears that, since the notion of 'virtual' in its most basic connotation only denotes some form of difference to a 'traditional' form of organization, the term VO has been interpreted in varied form with an unsatisfying mix of VO notions existing in the literature. What is more, papers frequently exhibit mismatches between what they characterize as VO and the real-life phenomena they discuss. Motivated by these observations we carry out a literature analysis to explore differing notions of virtual organization. Based on a systematic classification of VO definitions, we uncover three distinct types of VO that are used in the literature, each of which interprets the notion of 'virtual' differently, but is useful in its own right and exhibits its unique management challenges. The first type, named Internal VO, revolves around internal virtualization based on distributed collaboration in virtual teams. It emerged on the back of emerging new groupware and communication technologies. Its main challenges stem from distributed project and work organization. The second type, named Network VO, describes a network of smaller companies that form a virtual entity, bringing in core competencies in short term collaborative projects. It emerged on the back of a emerging inter-organizational information systems and a trend of forming network arrangement. Its main challenges are with the governance of the multi-entity network. The third type, termed Outsourcing VO, refers to a hierarchical network of suppliers to which the focal firm outsources a significant part of its value creation, thus appearing as a virtual firm. It emerged on the back of the outsourcing trend of the last decades. Its main challenge is determining the optimal degree of integration and virtualization. With the identification and detailed exploration of the three VO types, our study contributes to a better understanding of the conceptual foundation of VO research and points to the necessity for conceptual clarity in future research.

Introduction

Changes in market environments and the emergence of new information and communication technologies (ICT) are seen by many to have profound and lasting impacts on the organizational structures in which value creation is organized. For example, companies increasingly seek to cooperate with other businesses in order to gain market access, to acquire and jointly build resources or to share risks in technology development. Moreover, firms change the ways in which they are organized internally to achieve flexibility and responsiveness to changing market requirements. Against this backdrop, scholars have argued in favor of new ways of value creation in virtual forms of organizing.

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The term virtual organization (VO) was coined more than 15 years ago (Bleecker 1994; Byrne et al. 1993). Since then the concept has been adopted and researched by the Information Systems community in a range of contexts. However, this led to a rather unsatisfying picture in terms of its conceptual clarity in the literature. Today, very different interpretations of VO can be found, which in sum present a rather confusing picture of what counts as a virtual organization. In fact, a range of differing organizational phenomena and their corresponding management challenges are discussed under the VO label. We argue that this situation is unsatisfactory and problematic. In order for the VO to gain credibility and develop into a concept that can be used to research and explain real world phenomena, we need to clarify what we mean when applying the VO label. Henceforth, we argue that in order to be able to specify what one is dealing with in a particular research endeavor and for identifying distinct and credible VO management and research issues, it is necessary to achieve conceptual clarity and to spell out one's understanding of VO. To facilitate such conceptual clarity, our aim is to gain an overview of the prevalent understanding(s) of VO in the IS and neighboring literature.

To this end, we have carried out an extensive literature analysis. We apply a classification approach with the intent to uncover the variety of understandings of VO as reflected in extant literature in Information Systems and adjacent fields. As part of our review we have analyzed and classified more than 60 articles according to their VO definitions and the characteristics used for describing the VO concept. As expected, we discovered that different organizational concepts are discussed under the same umbrella term VO. Our coding and grouping of the literature then leads us to the identification of three distinct types of VO, all of which we see as legitimate interpretations of the general idea of virtual organization, albeit with very important differences in definitive characteristics and resulting managerial implications.

In summary, it is our intention to propose a classification of VO that instils conceptual clarity in distinguishing distinct types of VO, all of which exhibit different characteristics. We argue that such conceptual clarity is currently missing. For example, in a number of papers we found a mismatch of definitions provided and cases discussed later in the papers, which can lead to problems with regards to validity and transferability of the research results provided in these papers. Based on our results and these observations we advocate a more precise approach in dealing with the VO as a concept in that researchers need to spell out their specific understanding of VO (i.e., which of the three types they focus on).

The remainder of the paper is structured as follows. We begin by spelling out our research method for identifying papers and classifying VO definitions in Study overview section. In Three types of virtual organizations section we present the three identified types of VO, their constituent characteristics and typical examples. In Discussion and Theoretical reflection section we reflect on our results and theorize on the emergence of the three identified VO types. In particular, we reflect on the differing notions of 'virtual' as captured in the three types and then show how the three types originate from different business disciplines adjacent to IS. Finally, we point out typical examples of lack of conceptual clarity and discuss implications thereof. Management challenges and implications section discusses the distinct management challenges of the three VO types and related implications. We advocate a more distinct and outspoken understanding of the VO as the basis for effective VO management, but also for future research. Only by bringing to the fore conceptual differences in VO types and subsequently applying some much needed conceptual clarity can the VO gain credibility as a concept and this stream of research make a viable contribution to the literature in the fields of Information Systems and Organization Design and the practice of managing VO.

Study overview

The aim of our study is to gain a conceptual understanding of how the concept of virtual organization (VO) is conceived in the Information Systems literature and neighboring fields. To this end we carried out a systematic literature review in order to expose the characteristics of VO and how these characteristics might form certain different types of VO. To this end, our study aims to derive classification criteria from the literature, classify VO definitions and try to elicit patterns in the emerging classifications.

Paper selection process

Our study is based on in-depth literature analysis. As a first step, we needed to identify papers relevant for the purpose of our study (vom Brocke et al. 2009). Motivated by our own observations that the term 'Virtual Organization' is used quite differently by different researchers, the aim of our study was to investigate precisely this heterogeneity in notions and definitions within the VO research community. Hence, our focus was to uncover what researchers have in mind when they apply the VO label, and how they conceive of and characterize VO. For doing so, it is 1) necessary that the paper selection process captures the relevant papers within the (sub)communities researching the phenomenon, and 2) it is useful to only include those papers that explicitly use and apply the term VO, in that they provide a definition of VO or some otherwise useful characterization.

In order to identity a relevant pool of papers we compiled an initial set of papers. For doing so, we drew on a body of

core literature familiar to us from previous research in the domain and completed this with a search in the popular Ebsco and ProQuest online databases for papers that feature 'Virtual Organisation/Organization' in their title (no date criteria were used, nor did we limit publications by domain). Having identified this initial set of papers, we then followed a backward search, reviewing older literature cited in the articles yielded from the keyword search (Torraco 2005). We again focused on those publications that feature VO in their title. In doing so, we did not restrict our search to journal papers, but included conference proceedings and books as well. Also, this backward search was carried out as a snowball approach, applied multiple times to new sources we found to widen our literature base. It also led to a widening of our search space by including related key words, which featured 'virtual' in more general terms (e.g. 'virtual corporation', or 'virtual office'); this led to the inclusion of papers that discuss and define VOs, but do not necessarily feature VO in their title. Using this outward expanding approach we are confident to have covered sufficiently the VO research community.

From this emerging set of papers, we then decided to concentrate on papers that have VO in their focus, rather than papers that might only mention the concept peripherally. We followed the assumption that this will be the core set of papers needed to derive a rich understanding of VO and its varied use in the literature. While our literature search process led to a set of papers that was much bigger (e.g. more than 120 papers) only those publications were included in the classification that provide VO definitions or some form of explicit description or characterization of VO; those papers in which VOs were not discussed in sufficient detail were ruled out and eliminated from the list as they are unsuitable for our classification approach. The final list, after classification and consolidation, comprises 63 references with both academic as well as some practice-oriented papers and books.

It needs to be pointed out that widening the paper base and discounting unsuitable papers is an intertwined process. As is typical for qualitative research, which aims to uncover variance in concepts, we stopped this process once our sample approached the point of saturation, i.e. a state in which no new variance emerges, but the same patterns appear over and over again. It also needs to be noted that we were able to include both English and German language papers; it turns out that VO is a well-described phenomenon in the German community accounting for about 25 % of the papers included in our study.

In summary, while our approach does not allow finding all possible VO papers, we are confident that, by using a broad approach and applying the saturation criterion, our literature search resulted in a sample that is a sufficiently representative snapshot of how the VO is conceived of in the IS and neighboring literature, in particular in terms of its variance in characteristics and definition.

Classification and identification of VO types

The main part of our analysis was to classify papers regarding the notion(s) of VO. This process can be described as an iterative process comprising three stages: 1) identification of VO characteristics, 2) classification of papers according to the characteristics, and 3) consolidation and grouping/re-grouping of criteria (see Fig. 1). As such, it resembles a typical qualitative data analysis process (Berg 1995; Flick 1998), which draws on content analysis as its specific data analysis technique (Bryman and Bell 2003). For identifying VO characteristics all papers were read by two researchers. Each paper was classified by one researcher with the second acting as a discussant. Whenever a seemingly new VO characteristic was found, it was compared with the existing list and added once we decided that the authors of the paper indeed described a new aspect. In order to manage the list of characteristics we frequently compared similar characteristics and merged them together when they turned out to describe the same or very similar aspects. It needs to be mentioned that paper search/selection and paper classification were not two strictly sequential stages; rather we continued including more papers from the reference lists of papers while classifying, until the sample appeared saturated.

Concurrent to identifying characteristics, papers were classified using the resulting criteria list (see appendix 1); the main result of this process is a classification table that shows, for all papers, whether a characteristic was featured in the paper (marked 'X') or not (see appendix 2). Please note that in this table some papers are mentioned twice—this is the case when a paper explicitly distinguishes and describes different types of VOs.

Following the method introduced by Miles and Huberman (1994), using these tables as displays, we then grouped and re-
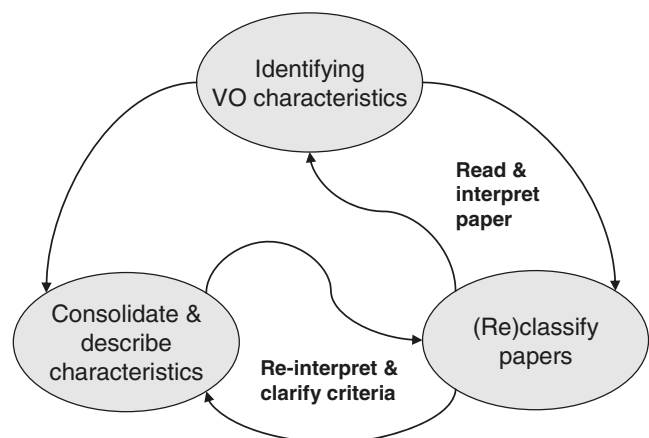

Fig. 1 Iterative research process for classifying VO papers

grouped the VO instances in order to identify patterns/clusters and types of VOs. We also counted the number of papers that showed certain characteristics and used this to identify both a set of constituent characteristics and a set of characteristics that further describe the three identified types of VO (see appendix 3). We decided to attribute as a constituent/definitive characteristic of a VO type those characteristics that were mentioned by at least two thirds of the authors (66 %); the second group is made up of criteria that were mentioned by at least one third of the authors (33 %).

A few papers could not be grouped into one of the clusters since they showed characteristics of more than one type or where very unclear, unspecific or even contradictory in terms of their VO definitions. In appendix 2 these papers are grouped into a fourth group; we will return to this issue later in the paper.

In the last step of our analysis, we identified all papers in which, in addition to a definition or description of the VO concept, the authors also presented and discussed cases or real-life examples. We analyzed the characteristics of these examples and characterized them in terms of the three types of VOs identified earlier. In doing so, it turned out that a surprising number of papers show a deviation between what is defined as a VO early in the paper and the cases that are presented later. Out of 39 papers, which present one or more VO examples, 17 showed a misfit between the cases and the definitions provided earlier in the papers (see appendix 4). We will discuss implications later in the paper.

Criteria for characterizing VOs

In this section, we give a brief overview of the (groups of) criteria, which we identified during our qualitative content analysis. These represent the final set of criteria after several steps of consolidation and regrouping. In total we used 22 characteristics to classify VO instances; these criteria are grouped in six clusters each describing a different set of aspects of VOs; the complete list we provide in appendix 1.

VO network structure

VOs are typically described as network organizations (Bekkers 2003; Travica 2005), albeit with differences in the types of underlying network structures. Firstly, VOs are often seen as a collaborative network of people, typically residing inside one organization (e.g. Bleecker 1994; Scholz 1996). This notion stresses virtual team structures (Lipnack and Stamps 2000) and the existence of virtual offices (Davenport and Pearlson 1998). Second, VOs are frequently seen as inter-organizational networks of independent firms (e.g. Franke 2001; Larsen and McInerney 2002) or actors in more general terms (Lin and Lu 2005). Third, the VO

network is sometimes described as a hierarchical network with the focus on one central actor who holds relationships with other actors (e.g. suppliers or customers) (e.g. Cooper and Muench 2000; Lawton and Michaels 2001).

VO pool and projects

Quite often the VO is associated with a strong project-oriented organization. In this respect the short-term nature of VOs and their projects is frequently stressed (Kasper-Fuehrer and Ashkanasy 2004; Saabeel et al. 2002; Tuma 1998). While projects form the short-term element within VOs, some authors also see the necessity of a long-term element such as a pool of partners from which the short-term projects are then formed (Franke 2001; Goldman et al. 1995).

Distribution aspects

Geographical, organizational and temporal distribution of value creation (and generally work processes) is described by many as one of the main characteristics of the VO concept (Bultje and van Wijk 1998); this is closely linked to the idea of ICT being the core enabler of virtual organizing (Riemer et al. 2001; Saabeel et al. 2002). With it comes the notion of being able to "work anywhere and anytime" within the VO (Cohen 1997, 30) through the use of telework arrangements (Kock 2000; Rahman and Bhattachryya 2002). Finally, as a result of distribution, aspects of integration are sometimes mentioned as a necessary complement for building a common VO identity (DeSanctis and Monge 1999) and for presenting the VO as a coherent entity to the marketplace (Jurk 2003; Lin and Lu 2005).

Management

The criteria in this group characterize VOs in terms of specific management aspects; these characteristics highlight quite nicely the different notions authors have of the VO. While some authors stress the lack of institutionalized management mechanisms and the waiving of hierarchical structures in favor of "flat flexible organizational structures made up of self-management" (Cooper and Muench 2000, 190), others discuss the need for a central coordinator (or otherwise centralized coordination mechanisms) (e.g. Eversheim et al. 1998; Franke 2001; Pihkala et al. 1999). An even stronger contrast is made up by the next two criteria. While many authors view trust as being the key stabilizing factor within the VO in the absence of other mechanisms (Handy 1995; Jones and Bowie 1998), others argue for the design of explicit control mechanisms necessary to govern the VO (Cooper and Muench 2000; Gallivan 2001).

Value creation

VOs are most often discussed in terms of unique ways of organizing value creation in networks. The most prolific characteristic is that VO companies follow a strict core competence concentration in a sense that the VO network resembles a portfolio of individual (excellent) core competencies (Tuma 1998), where each partner brings in specialized expertise (Hughes et al. 2001; Talukder 2003). In so doing, partners might jointly create and share certain resources within the VO (Franke 2001; Weibler and Deeg 1998). A further, albeit rarely mentioned characteristic is the offering of electronic services for customers (e.g. Lawton and Michaels 2001).

VO goals

The final set of characteristics comprises a range of aims or goals that authors see as the reasons for creating VOs. The most frequently stated are: achieving virtual size by joining forces (Riemer et al. 2001), jointly exploiting market opportunities (Kasper-Fuehrer and Ashkanasy 2004), the offering of (mass-)customized products for customers (Travica 2005), the sharing of costs or achieving of cost efficiencies (Weisenfeld et al. 2001), the sharing of risks (Elliot 2006) and the sharing of knowledge and joint learning as a network (Shin 2004).

Three types of virtual organizations

Using the list of characteristics we classified 67 VO instances/definitions and then clustered these in meaningful groups of similar definitions (see appendix 2). As a result, we identified three types of virtual organizations, which we will spell out in more detail in this section.

Type 1: the internal VO

We name this type the 'Internal VO', as it describes *one* corporation, which relies internally on virtual teams using ICT in order to bridge gaps of geographical (and temporal) distribution; it thus draws on remote (tele) and mobile work practices. Under this type of VO, virtualization denotes the use of ICT to bridge gaps in geographical distance between units of one organization. The constituent characteristics for defining the Internal VO are:

- The type 1 VO resembles a collaborative network of people residing inside one organization (virtual team structures).
- It is characterized by geographical (and possibly temporal) distribution of value creation (de-centralization),
- and the linking of partners via ICT; ICT thus is the main means for communication and information sharing.

- Consequently, tele- and mobile work is quite common, with people being linked via various information and collaboration systems.

In contrast to the other two types of VO virtualization in this type of VO happens (more or less) internally, i.e. within the borders of one organization (see visualization in Fig. 2): "Building blocks of the virtual organization are work units such as virtual teams and virtual communities" (Breu and Hemingway 2004, 192) Hence, a "virtual organization is a geographically dispersed organization, in which travel for the purpose of exchanging information is minimised." (Moller 1997, 39) Authors argue that through virtualization "traditional geographically co-located work can be undertaken from geographically dispersed locations." (Tianfield and Unland 2002, 368) As such, "the emergence of virtual organization is inconceivable without the capabilities of modern day networked ICTs" (Breu and Hemingway 2004, 194). Authors have coined the term 'virtual office' (e.g. Scholz 1996) to describe the resulting work settings; the term "covers a variety of mobile and remote work environments" (Davenport and Pearlson 1998), which means that "employees can work from home or from distributed offices close to home." (Kock 2000, 108) Virtualization in this sense is about "replacing offices with technology: portable computers, cellular phones, and fax machines all enable remote or mobile work." (Davenport and Pearlson 1998, 51)

Typical examples are large multi-national corporations (e.g. Berger 1996; Breu and Hemingway 2004; Davenport and Pearlson 1998; Scholz 1996), e.g. firms with company offices spread over large geographical areas that draw heavily on ICT to organize their value creation (Kock 2000), such as IBM, AT&T, McDonald's, Hewlett-Packard or Xerox. Also typical for internal virtualisation is the consultancy sector.

Type 2: the network VO

We name this type the 'Network VO', because this VO essentially is a network of (often small and medium-sized) companies, which, by bringing in their core competencies, join forces in order to swiftly exploit emerging market opportunities in short-term projects. Virtualization for this type denotes the absence of a 'real' legal entity; small entities collaborate in a network to achieve virtual size; the network then appears like a real company. The constituent characteristics for defining the Network VO are:

- The type 2 VO is a flexible, collaborative inter-organizational network of independent (small and medium-sized) firms (or individuals).
- Partners bring in their core competencies to the network, where they are synergistically combined to create a best-of-breed organization.

Fig. 2 Visualization of the
main structural features of the
three VO types
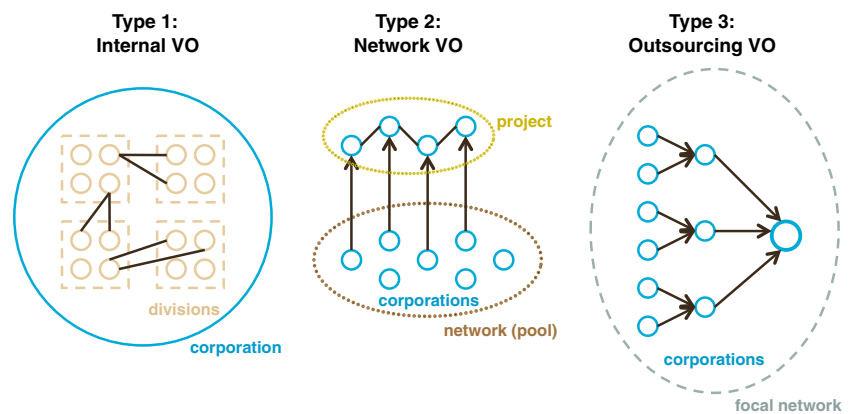
- Partners join forces to jointly exploit market opportunities.
- Work is undertaken in short-term projects,
- and is characterized by geographical (and temporal) distribution
- and the linking of partners via ICT.
- Trust is the key enabler of collaboration, which points to the importance of social relationships in the network.

The virtual network organization can be described as a "network of companies that come together quickly to exploit fast-changing market opportunities, for example, the making of a movie." (Coyle and Schnarr 1995, 41) In contrast to the intra-organizational view, in the type 2 VO "business units of different organizations collaborate" (Kasper-Fuehrer and Ashkanasy 2004, 36). Hence, the VO "is a combination of geographically distributed, functionally and culturally diverse entities (persons and/or organizations), which are devoted to achieving a collective goal by pooling their core competencies and resources." (Lin and Lu 2005, 185) In order to bridge these geographic distances "the members in a virtual organization are dependent upon information technology (IT) for the coordination of their activities." (Lin and Lu 2005, 185)

Most authors point to the short-term nature of VO projects as "a temporary network or loose coalition of (…) services that comes together for a specific business purpose and then disassembles when the purpose has been met" (Christie and Levary 1998, 7); as such, they "constitute a form of project-oriented partnership" (Kasper-Fuehrer and Ashkanasy 2004, 41). However, some authors point to the need for a long-term element so that collaborative structures have time to emerge. Sometimes called a source network (Hannus et al. 2004), a pool (Saabeel et al. 2002), a web platform (Franke 2001) or a breeding environment (Camarinha-Matos and Afsarmanesh 2006), this network is an "open-ended collection of pre-qualified partners" (Saabeel et al. 2002, 9), which "offers a rather stable environment in which trust, bonds and common visions can prosper." (Franke 2001, 51) From this pool of partners, VO projects are then created whenever an opportunity arises (see Fig. 2).

Typical examples are networks of small and independent firms that team up to jointly achieve virtual size and offer a joint service; examples are the Australian computer service network TCG (Jurk 2003), VIRTEC, a VO by nine Brazilian high-tech SMEs (Bremer et al. 2001), or the Virtuelle Fabrik Bodensee, an SME-based engineering services VO in the lake Constance region, (Hannus et al. 2004; Göransson and Schuh 1997). Also, freelance networks (Camarinha-Matos and Afsarmanesh 2006) and opensource software development groups (Gallivan 2001) can be subsumed under this type.

Type 3: the outsourcing VO

We name this type of VO the 'Outsourcing VO', because this VO essentially refers to a focal firm, which outsources a major part of its value creation activities to a network of suppliers. By deciding to off-load certain business activities a company establishes a hierarchical (or focal) network of external partners, which contributes to its value creation in various ways and which it coordinates through the application of ICT (e.g. eBusiness and supply chain technologies). The focal company thus appears as something it is not, because the actual value creation is virtualized (i.e., outsourced). The constituent characteristics for defining the Outsourcing VO are:

- The type 3 VO refers to the focal network that one company has with its suppliers (or sometimes customers).
- Large parts of the value creation happen organizationally (and geographically) distributed within the external network, driven by outsourcing;
- it is governed by the application of sophisticated ICTs, such as eBusiness technologies.
- Core competence concentration is a main characteristic describing the behavior of the focal company (via outsourcing) as well as the specialized partners that are part of the network and bring in their expertise.

Different to type 2, the Outsourcing VO is defined from the point of view of the core player who governs and

controls the network (see Fig. 2). In doing so "the core power player determines strategy" (Lawton and Michaels 2001, 110), while contracts play a vital role in governing the network (Werther 1999). Outsourcing results in a geographical and temporal separation of value creation (Alt et al. 2005); by applying modern supply chain and eBusiness technologies the focal company then aims to "enhance logistics management with its suppliers" (Lawton and Michaels 2001, 109) as a means of ensuring supply chain efficiency.

Typical examples are companies that are well-known for core competence concentration and the efficient (often just-in-time) management of a network of supply-side partners, such as Dell (Lawton and Michaels 2001; Saabeel et al. 2002), Cisco Systems, Benetton, Nike, Puma, Apple (Rahman and Bhattachryya 2002), Airbus and the OEMs in the automotive industry.

Discussion and theoretical reflection

Having introduced and characterized three types of VO we will now first of all discuss our typology against existing typologies found in the literature in order to position our findings in the field. Second, we will theorize on the notion of 'virtual' and the role of ICT in the three types of VO to further explain the conceptual nature of the differences the three types exhibit. Third, we will theorize on the historical development paths of the three VO types rooted in different disciplinary areas in order to explain how the differences we find in the literature come about. Finally, we will expose the rather different management challenges the three types entail. The latter aspect serves to demonstrate the necessity for conceptual clarity as provided by our typology.

Comparison with existing typologies

Only very few of the papers we examined provide typologies of virtual organizations and none of them grounds their understanding in the literature. Three papers distinguished between two types of VO and provided definitions (Klein 1994; Scholz 1996; Tianfield and Unland 2002), while two papers provided typologies with more than two types (Bultje and van Wijk 1998; Tjaden 2003). Bultje and van Wijk (1998) distinguish an internal VO (similar to our type 1), a dynamic VO (similar to our type 2), a stable VO (not quite grasping our type 3) and finally what the authors refer to as a web-based company. Tjaden (2003) presents an intra-organizational (similar to our type 1), an inter-organizational (similar to our type 2), an extra-organizational (similar to our type 3) and a customer-oriented VO.

While both papers generally correspond with our typology (three of the types are somewhat similar) they provide much less detail in describing their types. Also, the fourth type presented in both typologies did not show up in our data, as this understanding of VO merely refers to virtualization as some form of using the Internet. Following this logic a company is virtual when it uses the Internet to provide services to its customers (Amazon.com is mentioned as an example). This notion of virtualization however does not refer to changes in organizational structures. We think that utilizing the Internet as a distribution channel should not be confused with the concept of virtual organizing.

Differing notions of 'virtual' in the three VO types

We have already argued that we see all three types of VO as valid and useful interpretations of virtual organization, as all three denote some form of moving away from a traditional view of organization. As such, the three types exhibit differences in the interpretation of the notion of 'virtual', which we will lay out in this section. While generally not discussed explicitly, the notion of 'virtual' organizing presupposes some form of 'traditional' or 'normal' organization, relative to which the 'virtual' is then interpreted. Such an understanding seems to assume an archetype notion of a firm that is defined by legal boundaries, a sense of place and location, an explicit (often hierarchical) structure (the 'org chart') and ownership of the knowledge and processes for producing. The 'virtual' in virtual organization then denotes a difference with respect to this archetype form of organizing in the following ways:

- Type 1 stresses the role of ICT for communication and coordination. It borrows the notion of 'virtual' from human computer interaction, where virtual reality describes a form of experience that is freed from physical space and location. While generally retaining other aspects of traditional organizations (e.g. legal and corporate cultural boundaries or shared practices and processes) it sees ICT as a facilitator to enable virtual collaboration across geographic distances, where physical presence is no longer a defining element for the engagement and experience of people in joint work processes. The particular ICTs at the core of type 1 VOs are thus communication and collaboration platforms and groupware systems.
- Type 2 breaks with the notion that the firm is the nucleus of value creation, stressing the importance of business networks. Under this notion, 'virtual' refers to the fact that the entity that is offering products and services in the marketplace aims to appear as a 'real' organization, but is indeed a virtual one, configured ad-hoc and dynamically once its services are wanted by a customer from a pool of partnering organizations. As such, ICT is typically not seen as the defining element, as successful

examples of type 2 are often regional networks of small businesses, where geographic distance is not necessarily an important factor (e.g. Virtuelle Fabrik Bodensee or BioRegion–see above). However, ICT still plays a supporting role and the focus is typically on inter-organizational systems (IOS) that enable coordination of joint value creation and project management.

- Type 3, much like type 1, retains the notion of the firm as the relevant legal entity offering products to the marketplace. However, 'virtual' in this case stresses a lack of ownership of significant parts of product value creation, in that the focal entity is responsible for only very limited, albeit crucial, parts of the overall value creation. Such organizations are typically brand owners that aim to be perceived by market participants as the relevant entities providing the product or service, while in fact they have virtualized most of their value creation by outsourcing production to a stable network of suppliers. The use of ICT in type 3 is predominantly operational and comprises electronic ordering systems, supply chain management, inventory data exchange and other systems that enable data transparency across organizations with the aim to strengthen network governance from the point of view of the focal actor.

The ways in which the three types are based on differing notions of 'virtual' represents at the same time different ways in which the concept of VO has evolved historically from an archetype view of 'traditional' organization.

Evolution paths of the three VO types

The emergence of virtual organization in the literature is a gradual process with first noteworthy publications exposing the concept in the mid 1990s. In the following we theorize on how the three different notions emerged from different business disciplines. At the same time it is worth acknowledging that, on a more abstract level, the VO phenomenon shows a range of similarities across the three types, but is encountered from different angles and on different organizational and managerial levels.

Type 1: emergence from work and organization studies and CSCW

The Internal VO (type 1) has its roots in both the organization and workplace studies and in the collaborative systems communities. Gradual advances in computer-mediated communication and collaborative systems go hand in hand with the emergence of new, distributed work arrangements (e.g. Hughes et al. 2001), in particular what is referred to as virtual work (Watson-Manheim et al. 2002). Consequently, virtual teams, supported by collaborative technologies (e.g.

Johansen 1988; Jang et al. 2000), become an increasingly popular form of organizing work on the group level. Such advances can gradually lead to the point where organizations appear virtual as they lose their traditional, material (i.e. physical and spatial) nucleus, such as buildings or offices. Hence, we theorize that type 1 is rooted in advances that grew out of computer-supported collaborative work (CSCW) in computer science, intersecting with the application of such technologies on the group and workplace level, with many publications on virtual teams appearing in general management and organization journals (e.g., DeSanctis and Poole 1997; Arnison and Miller 2002).

Type 2: emergence from strategic management and inter-organizational systems

The Network VO (type 2) has its roots in strategic management, in particular in the discussion around strategic alliances (e.g. Hamel 1991; Khanna et al. 1998) and relational strategy (Dyer and Singh 1998). The move to more inter-firm collaboration in various forms of bilateral and multi-lateral arrangements, and accompanying management research, is mirrored in Information Systems with the emergence of Inter-organizational Systems (IOS) (e.g., Klein 1996). Following the emergence of new strategic orientations (Best 1990), e.g. network-level competition (Gomes-Casseres 1994) or co-opetition (Brandenburger and Nalebuff 1996) and the resulting discussion regarding the boundaries of the firm, as spurred by IOS (e.g. Garbe 1998), the Network VO emerged as one particular form of network organization. This is reflected in the inclusion of the VO as one type of network organization in respective classification approaches (e.g. Riemer et al. 2001). In particular, the VO was seen as a vehicle for smaller market players to reap the benefits of inter-firm collaboration often associated with strategic alliances of large firms. The argument is that, based on new ICT-based forms of coordination, organizations build the capability to collaborate swiftly in dynamic network arrangements.

Type 3: emergence from operations management, supply chain management and outsourcing

Finally, the Outsourcing VO (type 3) has its roots in the operations management community, in particular in purchasing, supplier management and its later cousin supply chain management. Since the 1990s, purchasing and supply management have increasingly taken an outward perspective with the role of suppliers changing from providers of goods, kept at arm's length, to valuable business partners, which take an increasing proportion of the entire value creation. This is reflected in dedicated approaches to managing relationships with (groups of), often strategic, suppliers (Olsen and Ellram

1997; Cox et al. 2003). At the operational level, spurred by advances in ICT (e.g. EDI, and business-to-business ecommerce solutions), firms began to manage 'their' material flows across networks of external partners (Harland 1996). It is this change of perspective by (mostly large) firms in the market place to actively manage the (virtual) supply chain (Lawton and Michaels 2001), in combination with core competence concentration and outsourcing, that gave rise to the trend which cumulated in what has been described as the Outsourcing VO above.

Information systems as an inter-disciplinary 'VO melting pot'

Information Systems as an 'inter'-discipline, which often operates at the intersections of the above-discussed disciplines, has naturally engaged with the VO concept due to the prominent role ICT plays in its proliferation. However, much as IS research cuts across these fields, the varying notions of VO have blended together in IS literature without the necessary exposition of conceptual differences. Our analysis and the above reflection have shown that it is crucial to be aware of VO origins and the subtle differences the term holds in different contexts. It is thus crucial to apply conceptual clarity when researching concrete VO phenomena and expose what exactly one is investigating (using typology and characteristics), in particular as the different VO types exhibit different management challenges (see below). The following paragraph aims to shed some light on the existing lack of conceptual clarity.

Lack of conceptual clarity in VO research

During the course of our analysis, we found two forms of lack of conceptual clarity in dealing with the VO. First of all, a few papers provide, in a rather uncritical fashion, a range of VO characteristics that are typically taken from other papers and which do not describe one distinct VO type, but rather mix-up different characteristics, some of which are contradictory and do not make sense in combination. Five papers in our sample fall in this category. Four of these mix type 1 and type 2 characteristics by not clearly stating whether virtualization is an internal or external phenomenon thus mixing the notions of a VO "that has several headquarters in different countries" (Shin 2004, 727) and the VO as being a network of "different organizations involved at different times" (Shin 2004, 730). The second and more prevalent form is the mismatch between definitions and case examples discussed in the same paper. Eleven of the papers we analyzed provide type 2 definitions, but discuss (at least some) examples that do not fit these definitions. Most commonly, type 3 examples are provided that do not fit the characteristics provided in the VO definitions.

For example, Lin and Lu (2005) provide a typical type 2 definition but then go on to discuss as a VO case a Taiwanese semiconductor company that draws heavily on outsourcing and web-based tools in order to coordinate information flows in its external supply network. Similarly, Grabowski and Roberts (1999), after introducing type 2 characteristics, discuss as VO examples companies such as Nike, Sun and the Ambra alliance.

Management challenges and implications

While from a top-level (abstract) perspective the three VO types share some common properties (e.g. distribution of value creation, ICT usage, network character), the three types show very different structural properties, once the focus is shifted to a meso or micro level of analysis, where virtual teams, inter-firm projects or operational value creation processes come into view. A closer scrutiny of the literature and the practical examples featured therein reveals that such structural differences go hand in hand with very different management needs and challenges. With the following we aim to make a practical contribution by exposing the unique management challenges of the three VO types. However is not our intention and beyond the scope of this paper to discuss in full detail all associated management challenges, in particular due to the comprehensive bodies of knowledge that exist in the above discussed disciplinary areas.

Type 1 challenges: virtual work and electronic communication

Management challenges in the type 1 VO arise in three areas: 1) project and work management challenges, 2) mediated communication-related (CMC) challenges and 3) human resources and people management challenges.

While virtualization opens up a range of opportunities in terms of distribution of work, global access to knowledge or expertise and new practices of 24-h project work, it also increases considerably the organizational complexity. For example, geographical distribution and inter-unit collaboration creates inter-group interfaces, which can act as barriers to communication and collaboration, and the need to build new social relationships and networks (Breu and Hemingway 2004). Particularly challenging is the management of the resulting multi-project organization where people work in more than one (virtually organized) project at the same time. At the group level, new problems of information exchange and knowledge sharing arise due to the emergence of new spatial and social barriers in distributed environments (Breu and Hemingway 2004). Cramton found that "a central problem of dispersed collaboration is maintaining mutual

knowledge [… in that] failure to establish and maintain mutual knowledge can have serious consequences for the viability of the collaboration" (2001, 363). Spatially dispersed teams experience further problems due to a lack of awareness of others' availability, activities, progress in work processes, as well as the different perspectives held by the team members (Travica 2005)

The problems are further aggravated by the challenges of computer-mediated communication (CMC). While "ICT allows organizations to bridge time and distance barriers with once undreamed of ease" (Kasper-Fuehrer and Ashkanasy 2001, 240), it also creates new boundaries at the level of the work unit (Breu and Hemingway 2004). The resulting communication problems and inefficiencies can increase the informational and knowledge-sharing problems of spatial distribution (Andres 2002; Putnam 2001). In such an environment, "something intangible is lost when individuals composing a group do not have the opportunity to meet face-to-face to work on their tasks." (Davenport and Pearlson 1998, 59)

Moreover, the virtualized organization has to invest in new skills of relationship management and people have to exhibit certain social competencies (Scholz 1996) and to learn to act as boundary spanners to enable knowledge sharing (Breu and Hemingway 2004). From a human resource perspective further problems are posed by the control and incentive aspects of the new work settings. Controlling people and their work processes becomes much more challenging once traditional co-located settings are given up. And by establishing flexible and ever-changing teams the focus of performance assessment and incentive schemes might shift from a team to an individual level, since the teams as such are no longer recognizable as separate entities.

Type 2 challenges: network governance, project and team management

Management challenges of the Network VO can be identified on two levels of analysis–1) the organizational level, which comprises typical strategic alliance and business network management issues, and 2) the group level, which refers to social and people-related issues of collaborating in a virtual project/team environment.

Network management challenges refer to the initiation and the configuration of the network and the management of the subsequent network operations (Riemer and Klein 2006). During the initiation of the virtual network organization one challenge is the identification of partners for inclusion in the VO pool (Albers et al. 2003; Camarinha-Matos and Afsarmanesh 2006). In doing so "the competence mix and market orientation of a network needs to be carefully evaluated and jointly defined." (Hannus et al. 2004, 8) Moreover, finding the right people to work in and manage

the VO network is another challenge, as is the configuration of the network management structures, especially in terms of finding the right coordination and control mechanisms that allow for effective management without hampering network flexibility. Many authors stress that decentralized self management by the individual partners might be an ideal in a federated network, but rather unrealistic so that coordination mechanisms have to be agreed upon that help dealing with problems and precarious project situations (e.g. Albers et al. 2003; Klein 1994; Weibler and Deeg 1998; Wirtz 2000; Hans 2008; Orman 2009). Finally, the distribution of incentives, network rents, costs and risks also has to be managed (Scholz 1996); this is especially important in order to avoid conflict and to uphold a common perception of network fairness.

While the configuration and positioning of the VO network is a challenging task, the main management challenges happen to be on the group or team level, since VO structures create environments that challenge effective inter-personal collaboration due to both 1) cultural diversity and 2) temporal fluidity (Riemer and Klein 2008). The idea behind the Network VO is the creation of a best-of-breed collaboration that brings together specialized experts from different organizations. Hence, it can well capitalize on superior expertise and human capital. Yet at the same time, diversity and cultural barriers are obstacles for collaboration on the team level, so that a main challenge is "overcoming mismatches (…) from heterogeneity of potential partners" (Camarinha-Matos and Afsarmanesh 2006, 1) While achieving effective group work is challenging within companies, it becomes even more challenging in an inter-firm environment, where people come from different organizational backgrounds (Riemer and Klein 2008). With increasing group diversity the development of social relationships and a shared group-level understanding becomes more difficult and time consuming challenging the sharing and development of new knowledge (Anand et al. 2003). Similarly, the limited duration of projects and the switching of partners create a challenging work environment that provides little incentives for people to invest in social group structures or to engage in time consuming social alignments. In fact, people brought together in such an environment face the paradox that they are expected to form teams quickly in order to collaborate, but that in-depth collaboration normally only develops in medium or long-term relationships (Larsen and McInerney 2002).

Type 3 challenges: outsourcing and organizational responsiveness

The core management challenges of this type of VO stem from the outsourcing of business activities to outside partners. First, challenges arise in regards to make-or-buy

decisions and the determination of the optimal degree of integration and virtualization (Lawton and Michaels 2001). Second, effective outsourcing depends on finding "partners that can share costs and risks, and swap skills and competencies" (Lawton and Michaels 2001, 107). Third, the outsourcing relationships have to be managed effectively (Kern and Willcocks 2002), while negotiation and contracting also play a vital role (Werther 1999). Fourth, hand in hand with effective management of outsourcing relationships go challenges in regards to IT-enabled supply chain management through eBusiness technologies, i.e. for coordinating and controlling the virtual value chain via information systems (Lawton and Michaels 2001). Finally, outsourcing and the management of external partner relationships puts pressure on the internal organization of the focal company as well. Authors see flexible internal structures as a key success factor for this type of VO (Lawton and Michaels 2001): "failure may arise from the internal burden of bureaucracy and outdated structural components that slow responsiveness to an ever-changing competitive environment." (Werther 1999, 18)

Figure 3 provides a summary of the above-described management challenges.

Conclusions

In this study, we have undertaken a systematic review of the literature on virtual organization research. Motivated by the observation that virtual organizations are described and defined quite differently across the IS literature and that in many studies the notion of VO remains rather vague, our analysis and classification of VO definitions led us to the identification of three distinct (ideal) types of virtual organization that exhibit not only different structural properties, but also show different management challenges. Hence, one main contribution of our paper lies in the structured presentation of these three types of VO and their properties, all of which represent valid VO types in their own right. Moreover, as a further contribution we demonstrated how the different VO types have emerged from and have their roots in different neighboring disciplinary areas from where they have been imported into Information Systems research. Finally, we have exposed different managerial challenges exhibited by the three VO types, which contributes to a better understanding of the VO in general.

Our study has certain implications for both individual researchers and VO research in the IS field in general. The differences in management challenges of the three VO types call for a succinct approach to defining the VO in future research studies. VO researchers will produce inconsistent and rather arbitrary results when mingling characteristics of different VO types in their studies. Therefore, authors should spell out in detail what they regard as a VO in the context of their particular research endeavor. In order to gain credibility
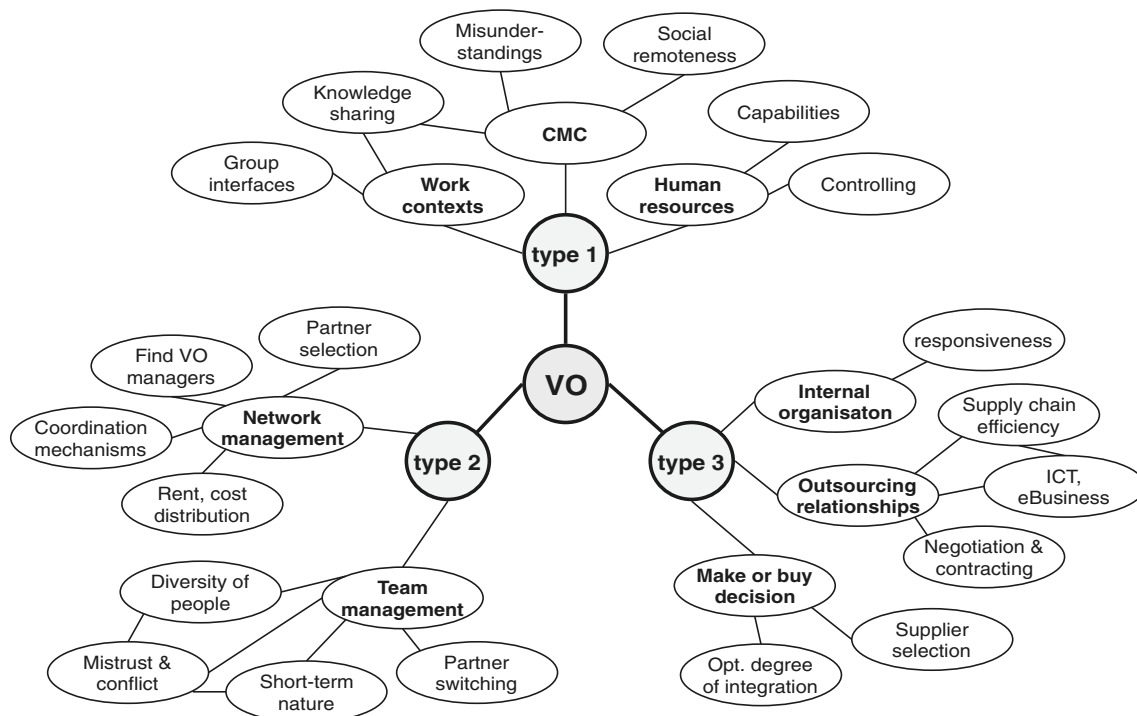

Fig. 3 Network of management challenges of the three VO types

and make useful and relevant contributions to both practical management and information systems literature, researchers need to be more specific about the characteristics of what is being researched and to appreciate the different challenges of the three types of VOs. In particular, researchers should provide rich case descriptions and then take into account the implications these characteristics might have for the management and application of systems in the respective case and for one's own research.

At the same time, we propose to divide efforts and establish three more or less separate, albeit related, streams of research in Information Systems, which mirror and engage with the existing strands of research in the neighboring fields. Given the rather different management challenges of the three types, we argue that different research issues should guide inquiries into real-life cases of any of the three types of VO and that authors should be clear about what they are dealing

with conceptually. In doing so, meta research can then expose and discuss structural similarities in light of the structural differences, which might in turn lead to a more precise understanding of virtualization as a general, more fundamental phenomenon. By doing so, we believe that VO research can gain credibility, build out distinct streams of research and make a lasting contribution to Information Systems research. This seems important given that the sample of VO studies resulting from our literature search shows that there is a distinct lack of VO research published in the top-level IS journals.

Appendix 1

The following table provides a list of all criteria used in classifying VO definitions taken from the papers examined.

Table 1 The classification criteria

Network	
Intra-organisational	Collaborative network of people residing inside one organisation (virtual team structures)
Inter-organisational	Flexible, collaborative inter-organisational network of independent firms (or individuals, e.g. freelancer)
Hierarchical network	Focal network of one company with its suppliers (or customers)
Projects	
Short-term nature	Short-term nature of VO, existence of specific projects
Existencs of pool	Existence of a pool (network) as the long-term element from which projects are formed
Distribution aspects	
De-centralisation	Geographical (and temporal) distribution of value creation (decentralisation)
ICT as enabler	Linking of partners via ICT; ICT as means for communication and information sharing
Joint marketing	Joint market presentation of the partners–VO as a discrete entity
Tele work	Remote (tele) work and mobile work with ICT-linkage to company systems
Management	
No hierarchy	Lack of institutionalised management mechanisms and hierarchical structures –> flat, flexible organisation
Coordinator	Existence of a coordinator or dedicated coordination mechanisms
Control	Use of control mechanisms
Trust	Trust as enabler (importance of social relationships)
Value creation	
Core competencies	Core competence concentration (synergetic combination of partner competencies)
Joint resources	Resources are jointly built up and shared between partners
E-commerce	Offering of electronic services for end customers (via Internet/eCommerce)
Reasons/goals	
Virtual size	Achieve virtual size (collaboration of SMEs)
Market opportunities	Jointly exploit market opportunities
Customization	Individual customized products for customers
Costs	Sharing costs/Cost efficiencies
Risks	Sharing of risks
Knowledge	Sharing of knowledge, joint learning

Appendix 2

The following table is the result of the main analysis step.
Constituent characteristics are marked yellow.

Table 2 Final classification table

	Intra-organisational	Inter-organisational	Hierarchical network	Short-term nature	Existence of pool	De-centralisation	ICT as enabler	Joint marketing	Tele work	No hierarchy	Coordinator	Control	Trust	Core competencies	Joint resources	E-Commerce	Virtual size	Market opportunities	Customization	Costs	Risks	Knowledge
Type 1: Virtualised corporation:																						
Berger (1996)	x					x	x		x			x	x			x				x		
Bleecker (1994)	x			x		x	x		x						x				x			
Burkhard, Horan (2006) [Telework]	x					x	x		x				x									x
Breu, Hemingway (2004)	x			x	x	x	x		x	x			x	x	x					x		x
Cohen (1997)	x					x	x		x				x									x
Davenport, Peralson (1998)	x					x	x		x		x									x		
Handy (1995)	x			x		x	x		x				x									
Klein (1994) [functional]	x					x	x		x													
Kock (2000)	x			x		x	x		x											x		x
Moller (1997)	x					x	x															
Scholz (1996) [virtual office]	x					x	x		x	x			x							x	x	
Tianfield, Unland (2002) [de-localization]	x					x	x		x						x							
Type 2: Virtual network organisation:																						
Albers et al. (2003)		x		x	x		x	x		x	x			x	x	x	x		x	x	x	x
Alt, Legner, Österle (2005) [institutional]		x		x			x	x		x				x								
Bremer et al. (2000)		x		x	x	x	x				x			x	x	x	x	x	x	x	x	x
Brütsch, Frigo-Mosca (1996)		x		x	x						x			x	x	x	x	x	x	x		
Bullinger, Thaler (1994)		x		x			x			x				x				x	x			
Bultje, van Wijk (1998)		x		x		x	x	x						x	x			x	x			
Byrne, Brandt, Port (1993)		x		x		x	x			x				x	x			x	x			
Camarinha-Matos, Afsarmanesh (2006)		x		x	x		x				x			x				x				
Christie, Levary (1998)		x		x		x	x			x				x	x			x	x	x	x	x
Coyle, Schnarr (1995)		x		x		x	x							x	x			x				
Eversheim et al. (1998)		x		x	x	x	x				x			x	x			x	x	x		
Franke (2001)		x		x	x	x	x				x			x	x		x	x	x	x		x
Gallivan (2001)		x		x		x				x		x		x	x		x					
Göransson, Schuh (1997)		x		x	x		x	x			x			x	x	x	x	x	x	x		x
Grabowski, Roberts (1999)		x		x	x	x	x							x				x			x	
Hannus et al. (2004)		x		x	x		x			x	x			x	x		x	x	x	x		x
Hansmann, Ringle (2005)		x		x	x	x	x	x		x	x			x	x			x	x	x		
Jones, Bowie (1998)		x		x	x	x	x			x				x	x			x	x			
Jurk (2003)		x		x	x	x	x	x		x	x			x	x			x		x	x	x
Kasper-Fuehrer, Ashkanasy (2004)		x		x		x	x	x		x	x			x	x		x	x	x			x
Kemmner, Gillessen (2000)		x		x	x	x	x	x		x	x			x	x					x	x	x
Klein (1994) [institutional]		x		x		x	x	x		x	x			x	x		x	x		x		x
Larsen, McInerey (2002)		x		x		x	x							x	x			x	x			
Leimeister, Weigle, Krcmar (2001)		x		x		x	x	x		x				x				x	x			
Lin, Lu (2005)		x				x	x	x		x				x	x	x		x	x			
Mertens (1994)		x				x	x							x	x							
Mertens, Faisst (1996)		x		x		x	x	x						x	x		x	x	x	x	x	x
Mertens, Griese, Ehrenberg (1998)		x		x	x	x	x	x			x			x	x							
Orman (2009)		x		x			x					x		x				x				
Pihkala, Varamäki, Vesalainen (1999)		x		x	x	x	x			x	x			x	x		x	x	x			x
Rahman (2002)		x		x		x	x			x				x	x		x	x	x			x
Riemer, Klein, Seiz (2001)		x		x	x		x			x	x			x	x		x	x	x			
Romero, Molina (2009)		x		x	x	x	x				x	x		x	x			x				
Saabel et al. (2002)		x		x	x	x	x							x	x		x	x	x			
Scholz (1996) [Virtual company]		x		x			x	x		x				x	x			x	x			
Sitek, Seifert, Thoben (2010)		x		x		x	x							x	x		x	x	x			
Tianfield, Unland (2002) [co-localization]		x				x	x								x		x					
Tjaden (2003)		x		x	x			x		x	x				x			x	x	x	x	
Travica (2005)		x		x	x	x	x	x										x	x			
Upton, McAfee (1996)		x				x	x	x			x			x								x
Voss (1996)		x		x		x	x							x	x		x		x			x
Weibler, Deeg (1998) [institutional]		x		x		x	x	x		x	x			x	x			x	x	x		x
Weisenfeld et al. (2001)		x		x	x	x	x			x	x			x	x			x		x	x	x
Wirtz (2000)		x		x		x	x			x	x			x	x			x		x	x	x
Zwicker (1996)		x		x	x		x	x		x	x			x	x			x	x			
Type 3: Virtual value chain network:																						
Alt, Legner, Österle (2005) [functional]			x	x	x	x	x	x			x			x	x		x		x			x
Burkhard, Horan (2006) [Outsourcing]			x			x	x					x		x						x		x
Cooper, Muench (2000)			x	x		x	x			x		x		x	x				x			
Lawton, Michaels (2001)			x			x	x				x	x		x		x				x	x	x
Werther (1999)			x	x			x			x				x		x		x				
mixed / not clustered:																						
DeSanctis, Monge (1999)	(x)	x		x		x	x	x		x		x					x	x	x			
Elliot (2006)		x					x	x						x	x	x				x	x	
Hans (2007)		x	x	x	x		x				x	x		x				x	x	x		
Shin (2004)	x	x		x		x	x			x			x	x								x
Tuma (1998)		x	(x)	x		x	x			x	x			x				x	x			
Vakola, Wilson (2004)	(x)	x		x		x	x			x			x									x

Appendix 3

The following table provides an overview of criteria distribution across the papers. It is the basis for identifying constituent and further characteristics of the three types of VOs. Marked in green (yellow) are all criteria per group that were mentioned in at least 66 % (33 %) of all definitions.

Table 3 Distribution of criteria across VO types

No of papers	Type 1		Type 2		Type 3	
	12		45		5	
	x	%	x	%	x	%
Network						
Intra-organisational	12	100%	0	0%	0	0%
Inter-organisational	0	0%	45	100%	0	0%
Hierarchical network	0	0%	0	0%	5	100%
Projects						
Short-term nature	4	33%	40	89%	3	60%
Existencs of pool	1	8%	22	49%	1	20%
Distribution aspects						
De-centralisation	12	100%	33	73%	4	80%
ICT as enabler	12	100%	42	93%	5	100%
Joint marketing	0	0%	21	47%	1	20%
Tele work	11	92%	0	0%	0	0%
Management						
No hierarchy	2	17%	24	53%	2	40%
Coordinator	0	0%	23	51%	2	40%
Control	2	17%	3	7%	3	60%
Trust	6	50%	34	76%	1	20%
Value creation						
Core competencies	1	8%	38	84%	5	100%
Joint resources	3	25%	26	58%	2	40%
E-commerce	1	8%	0	0%	2	40%
Reasons/goals						
Virtual size	0	0%	17	38%	1	20%
Market opportunities	0	0%	35	78%	2	40%
Customization	2	17%	25	56%	2	40%
Costs	5	42%	22	49%	2	40%
Risks	0	0%	12	27%	0	0%
Knowledge	4	33%	19	42%	3	60%

Appendix 4

The following table shows all papers in which VO cases or examples were discussed. Marked with grey colour are those papers in which the definitions provided did not match with the characteristics of the examples discussed.

Table 4 Deviations between definitions and case examples

Paper	Definition	Case examples
Albers et al. (2003)	Type 2	Type 2
Alt et al. (2005)	Type 2 and 3	Type 2 and 3
Berger (1996)	Type 1	Type 1
Bleecker (1994)	Type 1	Type 1 and 3
Bremer et al. (2001)	Type 2	Type 2
Breu and Hemingway (2004)	Type 1	Type 1
Brütsch and Frigo-Mosca (1996)	Type 2	Type 3
Bultje and van Wijk (1998)	several	several (matching)
Camarinha-Matos and Afsarmanesh (2006)	Type 2	Type 2
Christie and Levary (1998)	Type 2	Type 3
Cooper and Muench (2000)	Type 3	Type 3
Davenport and Pearlson (1998)	Type 1	Type 1
Franke (2001)	Type 2	Type 2
Gallivan (2001)	Type 2	Type 2
Göransson and Schuh (1997)	Type 2	Type 2
Grabowski and Roberts (1999)	Type 2	Type 3
Handy (1995)	Type 1	Type 2 (and 4)
Hannus et al. (2004)	Type 2	Type 2
Hans (2008)	Type 2 (unclear)	Type 3
Jones and Bowie (1998)	Type 2	(strategic alliance)
Jurk (2003)	Type 2	Type 2
Kasper-Fuehrer and Ashkanasy (2004)	Type 2	Type 2
Kemmner, Gillessen	Type 2	Type 2
Klein (1994)	Type 2	Type 2
Kock (2000)	Type 1	Type 1
Lawton and Michaels (2001)	Type 3	Type 3
Lin and Lu (2005)	Type 2	Type 3
Mertens (1994)	Type 2	Type 2
Mertens and Faisst (1996)	Type 2	Type 3
Moller (1997)	Type 1	Type 1
Rahman and Bhattachryya (2002)	Type 2	Type 2 and 3
Saabeel et al. (2002)	Type 2	Type 3 (and 4)
Scholz (1996)	Type 1	Type 1
Tjaden (2003)	Type 2	Type 2
Travica (2005)	Type 2	Type 3
Upton and McAfee (1996)	Type 2	Type 2
Voss (1996)	Type 2	Type 1, 2 and 3
Weisenfeld et al. (2001)	Type 2	Type 2
Werther (1999)	Type 3	Type 3 (and 4)

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