INFORMATYKA EKONOMICZNA BUSINESS INFORMATICS 2(28) · 2013

ISSN 1507-3858

Roy Wendler
Technische Universität Dresden, Germany
e-mail: roy.wendler@tu-dresden.de

THE STRUCTURE AND COMPONENTS OF AGILITY – A MULTI-PERSPECTIVE VIEW

Abstract: Agility is a term that is widely used. However, a common understanding of what agility means and what it consists of is missing. Many frameworks have been developed for how to approach agility, but they are very heterogeneous regarding content and structure. This paper approaches the issue by conducting a systematic comparison of 28 available agility frameworks out of the domains of agile manufacturing, agile software development, agile organization, and agile workforce. Altogether, 33 concepts related to agility were identified. The results of the comparison show that, even within the specifically examined domains, a lack of consensus is obvious. In addition, the utilized concepts are very ambiguous and overlapping. As such, the interdependencies between the identified concepts were analyzed in detail. This revealed five recurring "clusters", each of which combines several concepts with similar content, but despite the amount of available frameworks, none of them reflects these clusters directly. Hence, the study shows that factors beyond the construct of agility are not yet fully uncovered.

Keywords: agility, agility frameworks, agility concepts, multi-perspective view of agility.

1. Introduction

Over the past several years, businesses and organizations have faced a more and more volatile environment marked with challenges such as increased competition, globalized markets, and individualized customer requirements, resulting in many changes in every organizational field. Such scenarios were already described in the 1990s by Goldman et al. [Goldman, Nagel, Preiss 1995] and the Iacocca Institute [Iacocca Institute 1991]. As a response, different concepts emerged as to how organizations can master these challenges. The most recent is the concept of agility, but others like flexibility and leanness are often mentioned as well.

Many research studies about agility and its related concepts have been conducted since that time. However, until now there has not appeared any common understanding of what constitutes agility. Although many frameworks and models describe agility and its characteristics, they often differ widely in terms of content and structure. This makes it difficult for both, researcher and practitioner to build upon the insights

obtained. On one hand, researchers are missing a well-founded basis to develop the topic further, on the other hand, practitioners cannot easily uncover what parts of their organizations have to be changed and to what respect they have to be changed in order to respond to new market challenges.

This is particularly of interest for organizations in the software and information technology (IT) industry. With the appearance of agile software developing methodologies, or in a broader sense, agile values and principles (see for instance [Beck et al. 2012; Cockburn 2007; Highsmith 2002]), in the early 2000s, the advantages of these new approaches became visible. However, it was quickly discovered to be difficult to transfer the experienced benefits beyond the team level [Abrahamsson, Conboy, Wang 2009; Agerfalk, Fitzgerald, Slaughter 2009; Wendler, Gräning 2011]. This step, however, is necessary in order for the whole organization to benefit from agility.

The idea for this paper arose from an attempt to select a suitable agility framework for a further empirical study that represents the structure and components of agility in an organization. Unfortunately, it turned out that due to the aforementioned problem of a lack of consensus, a selection of one framework seemed unsatisfactory. Some were unsuitable to describe the organizations as a whole, while others were too specialized on a specific aspect only. Generally, the literature was confusing and inconsistent. Therefore, it appeared necessary to comb through the literature and systematically compare a large portion of the available frameworks. The aim of this work is to analyze the frameworks in terms of common ground and differences and to search for recurring concepts. Ultimately, this will create a basis for further work to build upon a common understanding of agility.

A review about agility is already given by Sherehiy et al. [Sherehiy, Karwowski, Layer 2007], and serves as an important starting point for this study, too. However, they mainly included work from the agile manufacturing domain, as publications about agile organizations as a whole were scarce at that time. The aim of the authors was to deduce a summarized framework describing an agile organization. Interestingly, later published frameworks again differ heavily from the one developed by Sherehiy et al., which shows that their work was still not sufficient and that a further investigation is necessary.

The remainder of the paper is structured as follows: in Section 2 the concept of agility and its history are briefly described, and its connections to the principles of "lean" and "flexible" are touched on. Section 3 introduces the agility frameworks that are analyzed in this paper. The systematic comparison of these frameworks and the discussion of the results are given in Section 4. The paper ends with a conclusion and a look at further research currently being conducted in Section 5.

2. The concept of agility

The term agile in a dictionary is defined as "having the faculty of quick motion; nimble, active, ready" [Simpson, Weiner 1989, p. 255], whereby agility is the

"quality of being agile" [Simpson, Weiner 1989, p. 256]. Using this explanation as a basis, a huge variety of definitions have emerged today that are heavily influenced by context and application domain. A discussion of all the available definitions is beyond the scope of this paper. Different authors have already listed various definitions of agility (see for instance [Bernardes, Hanna 2009; Gunasekaran, Yusuf 2002]), and another comprehensive collection is given in the appendix of Förster and Wendler [2012].

An extensive definition which fits well within the context of this work was developed by Ganguly, Nilchiani, and Farr [2009] based on the work of Dove [1999; 2001]. They define agility as "an effective integration of response ability and knowledge management in order to rapidly, efficiently, and accurately adapt to any unexpected (or unpredictable) change in both proactive and reactive business/customer needs and opportunities without compromising with the cost or the quality of the product/process" [Ganguly et al. 2009, p. 411]. The handling of change as a fundamental prerequisite for agility is confirmed by Conboy, who named creation of change, proaction (proactivity) in advance of change, reaction to change, and learning from change as components of agility [Conboy 2009].

The concept of agility is nothing new. Early works are already found within the social sciences and date back to the 1950s [Parsons, Bales, Shils 1953]. However, agility gained significantly more attention in the 1990s, especially after the so called "Lehigh Report" [Iacocca Institute 1991] was published and explained a new idea of manufacturing strategies. This development was accompanied by an increased emphasis on customer orientation and proactivity, as opposed to reactivity. In the post-2000 period, process orientation has become the focus and led to an examination of agility from an organizational perspective [Förster, Wendler 2012]. Simultaneously, agility became well-known within the software industry, and the "Agile Manifesto" [Beck et al. 2012] triggered a great deal of research in this field.

While research about agility has progressed continuously, there are two other closely connected and underlying concepts: flexibility and leanness. Although both share some common ground with agility, they are not the same and should be distinguished. A detailed discussion is given in Conboy [2009], which is briefly summarized here. First, flexibility is very similar to agility. The main differences with flexibility lie in issues such as a lack of speed and rapid action, continual change instead of a one-off change, a missing inclusion of knowledge and learning, and the application of single practices in specific parts of the company instead of an organization-wide view. The difference with leanness, however, is much more straightforward. In contrast to agility, leanness is unsuitable for variability and uncertainty and emphasizes simple cost reduction over value-related issues, mainly value for the customer [Conboy 2009].

3. Agility frameworks

A review of the literature revealed a variety of frameworks and models which described the concepts that determine agility, or at least proposed different items to measure agility. Finally, 28 frameworks or similar concepts were identified that can be categorized into four domains, and will briefly be introduced:

- Agile Manufacturing,
- Agile Software Development,
- Agile Organization/Agile Enterprise,
- Agile Workforce.

3.1. Agility frameworks focusing on agile manufacturing

As explained in Section 2, the concept of agility mainly originates from the manufacturing domain. Hence, ten of the identified frameworks focus on agile manufacturing [Agarwal, Shankar, Tiwari 2007; Gunasekaran, Yusuf 2002; Gunasekaran 1999; Kisperska-Moron, Swierczek 2009; Meredith, Francis 2000; Sharifi, Colquhoun, Barclay, Dann 2001; Sharifi, Zhang 1999; Vázquez-Bustelo, Avella, Fernández 2007; Yusuf, Sarhadi, Gunasekaran 1999; Zhang, Sharifi 2007].

One of the earlier frameworks was developed in 1999 by Sharifi and Zhang [1999]. The core idea is the distinction between agility drivers, agility capabilities, and agility providers. Drivers are mainly changes in the environment. Capabilities such as responsiveness, competency, flexibility, and speed are the required abilities of a company to respond to these changes. Providers are the means to achieve these capabilities in the areas of organization, technology, people, and innovation [Sharifi, Zhang 1999]. This framework was refined and extended later by Sharifi et al. [2001], however, the main structure remained stable. It eventually led to a theoretical approach to develop an agile manufacturing strategy [Zhang, Sharifi 2007].

A similar structure was chosen by Vázquez-Bustelo et al. [2007] by grouping the elements of their conceptual model into agility drivers, agility enablers (or practices), and outcomes. The core concept stems from the agility enablers, which are similar to the aforementioned capabilities, but are further detailed into human resources, value chain integration, concurrent engineering, technologies, and knowledge management [Vázquez-Bustelo et al. 2007].

Two other early frameworks were developed by Gunasekaran [1999] and Yusuf et al. [1999] and both identify four major dimensions affecting the agile manufacturing system. Gunasekaran mentions strategies, technologies, people, and systems [Gunasekaran 1999]. Yusuf et al., however, mentions that core competence management, a capability for reconfiguration, a knowledge-driven enterprise, and the formation of virtual enterprises as core concepts. They furthermore group them into 32 attributes [Yusuf et al. 1999]. In 2002, Gunasekaran and Yusuf published another framework of agile manufacturing strategies and techniques that implemented concepts of both predecessors [Gunasekaran, Yusuf 2002].

The remaining three frameworks show different approaches. Meredith and Francis propose a so called "Agile Wheel" structuring agility into strategy, processes, linkages, and people, each with four sub-practices [Meredith, Francis 2000]. Agarwal et al. focus on the agile supply chain by stating four main characteristics: market, information integration, process integration, and planning [Agarwal et al. 2007]. Additionally, Kisperska-Moron and Swierczek conducted an exploratory factor analysis with Polish companies and obtained a framework built on four factors: relation with customers, relation with suppliers, relation with competitors, and intensity of IT use [Kisperska-Moron, Swierczek 2009].

3.2. Agility frameworks focusing on software development

Research about agile software development is a much newer topic. As described in Section 2, the Agile Manifesto [Beck et al. 2001] can be seen as a trigger for further studies. The 17 initiators postulate four key values for agile software development with an emphasis on individuals and interactions, working software, customer collaboration, and responses to change. These values are further detailed into 12 principles [Beck et al. 2001]. Later, in 2008 and 2009, five frameworks dealing with the topic of agile software development were identified [Chan, Thong 2009; Chow, Cao 2008; Kettunen 2009; Misra, Kumar, Kumar 2009; Sarker, Sarker 2009], and more or less only focus on specific issues within the domain.

Two of the more general frameworks dealing with success factors associated with agile development practices are given by Chow and Cao [2008] and Misra et al. [2009]. Both publications show comprehensive lists of success factors grouped in different dimensions. Chow and Cao use organization, people, process, technical, and project factors [Chow, Cao 2008], whereby Misra et al. only distinguish between organizational and people factors [Misra et al. 2009]. However, both narrow down these lists to six (delivery strategy, proper agile software engineering techniques, high team capabilities, good agile project management process, agile-friendly team environment, and strong customer involvement) [Chow, Cao 2008] and nine (customer satisfaction, customer collaboration, customer commitment, decision time, corporate culture, control, personal characteristics, societal culture, and training and learning) [Misra et al. 2009] critical success factors via empirical investigations, respectively.

In contrast, Chan and Thong [2009] ask what affects the acceptance of agile methodologies. In this context, they built a conceptual framework where acceptance is dependent from the characteristics of the agile methodologies and knowledge management-related activities, such as creation, retention, and transfer of knowledge and experience. They furthermore identify three concepts affecting knowledge management: factors related to abilities, motivation, and opportunities [Chan, Thong 2009].

Agility in the specific domain of distributed development teams was analyzed by Sarker and Sarker [Sarker, Sarker 2009], and they distinguished three different dimensions of agility: first, resource agility that mainly consists of people and technology, second, process agility, which includes aspects like methodology, environmental awareness, and bridging time zones, and finally, linkage agility that is based on cultural and communicative issues [Sarker, Sarker 2009].

Although Kettunen [2009] did not develop a framework in a strict sense, a comparison of practices for agile manufacturing to those of agile software development was undertaken. For this purpose, he used a comparison matrix covering five concepts: organization, process, product, operation, and people. He concludes that issues of all manufacturing concepts are covered in different amounts by agile software development models [Kettunen 2009].

3.3. Agility frameworks focusing on agile organization/agile enterprise

Research on agile organizations as a whole began with regards to agile manufacturing in the 1990s. However, a concentration of studies can be seen at the time due to the growing interest in agile software development. Additionally, the newest publications (from 2010 and 2011) of all analyzed frameworks belong to this group. This might be an indicator that it has become more important to understand the effects of agility on an overall organization beyond single development teams or the manufacturing domain. Altogether, 11 frameworks were identified covering the topic of the agile organization [Bottani 2010; Charbonnier-Voirin 2011; Eshlaghy, Mashayekhi, Rajabzadeh, Razavian 2010; Goldman et al. 1995; Lin, Chiu, Tseng 2006; Ren, Yusuf, Burns 2000; Sherehiy et al. 2007; Tallon, Pinsonneault 2011; Tseng, Lin 2011; Tsourveloudis, Valavanis 2002; Zelbst, Sower, Green Jr., Abshire 2011].

One of the first and well-known publications is a book by Goldman et al. [1995]. They label agility as "A Framework for Mastering Change" and define four dimensions to stay competitive: enriching the customer, cooperating to enhance competitiveness, organizing to master change and uncertainty, and leveraging the impact of people and information [Goldman et al. 1995].

In addition, different approaches dealing with organizational agility have been developed. A part of the literature focuses on measurement tools. Ren et al. [2000], for instance, propose a measurement system utilizing the Analytical Hierarchy Process (AHP) based on the four dimensions of Goldman et al. [Goldman et al. 1995; Ren et al. 2000].

Other authors utilize fuzzy logic as a measurement tool. Tsourveloudis and Valavanis [2002] name a set of parameters to measure agility by assessing the infrastructure of production, market, people, and information [Tsourveloudis, Valavanis 2002], whereas Lin et al. [2006] closely connect their fuzzy logic model to the concepts of agile manufacturing through agility enablers, capabilities, and

drivers (see Section 3.1) [Lin et al. 2006]. Later, Tseng and Lin used this model to introduce an agility development method [Tseng, Lin 2011].

The use of agile manufacturing concepts can also be observed in other publications. Eshlagy et al. [2010] again use the distinction of agility enablers, capabilities, and drivers in their research. They eventually identified 12 factors that have an effect on organizational agility by applying a path analysis. Interestingly, the most significant factors are leadership, organizational commitment, and job satisfaction, while typical manufacturing issues like supply chains and the like play a less important role [Eshlaghy et al. 2010]. In a similar way, Bottani [2010] used the framework of Yusuf et al. [1999] to conduct an empirical study with the aim of analyzing what profile agile companies have and which tools they use [Bottani 2010].

A comprehensive work to develop a measurement scale with qualitative and quantitative studies can be found in Charbonnier-Voirin [2011]. The given scale consists of four factors that can be seen as a framework for agility. The factors are somewhat similar to the dimensions of Goldman et al. [1995]. They are named practices directed towards mastering change, practices valuing human resources, cooperative practices, and practices of value creation for customers [Charbonnier-Voirin 2011].

Similar to Section 3.2, there also exist some publications dealing with very specific topics. Tallon and Pinsonneault investigate the impact of strategic IT alignment on agility [Tallon, Pinsonneault 2011]. Zelbst et al. show how the utilization of RFID technology enhances agility [Zelbst et al. 2011]. Both additionally identify the positive effect of agility on the performance of the firm [Tallon, Pinsonneault 2011; Zelbst et al. 2011].

Finally, a review of the concepts related to enterprise agility is given by Sherehiy et al. [2007]. They reviewed a number of frameworks, models, and measurement tools relating to agility and extracted a list of the characteristics of the agile enterprise. They separated everything based on characteristics related to global strategies including customer, cooperation, organizational learning, and culture of change, in addition to characteristics related to organization and workforce such as authority, rules and procedures, coordination, structure, human resource management, proactivity, adaptivity, and resiliency [Sherehiy et al. 2007].

3.4. Agility frameworks focusing on agile workforce

Within the domain of the agile workforce, only one publication could be identified [Breu, Hemingway, Strathern, Bridger 2001]. However, in focusing on people without referring to manufacturing or software development, it forms a unique sub-domain of agility. Breu et al. identify ten key attributes of an agile workforce that are grouped into the five capabilities of intelligence, competencies, collaboration, culture, and information systems [Breu et al. 2001].

4. Systematic Comparison of Agility Frameworks

4.1. Procedure

To achieve a systematic comparison of the frameworks introduced in Section 3, the following procedure has been applied. First, the core concepts (for instance "customer", "processes", "change", etc.) of the first framework were listed. Then the core concepts of the next frameworks were assigned to the appropriate existing concepts, or they were added to the list if new. If there were only different labels but the same content (for instance "people" vs. "workforce" vs. "teams" vs. "employees"), these concepts were treated as one. This step was repeated for every framework. At the end, this resulted in a list of 33 concepts of agility.

As mentioned in Section 3, the concepts sometimes were detailed into further indicators, attributes, etc. This information was used afterwards to assess whether or not two or more concepts were linked to each other content-wise. As a result, a network could be drawn showing the interdependencies between the different concepts.

4.2. Description of Agility Concepts

The following paragraphs briefly describe all of the identified concepts of agility. The order of the concepts is roughly based on the number of their usage in the analyzed frameworks (see Figure 1), starting with the most often named concept.

The concept **Workforce/Teams** was used the most, namely in 19 out of the 28 identified frameworks. This may indicate the great importance for the human factors within an agile organization. The key features of an agile workforce are the empowerment of teams (regarding autonomy in tasks and decision making), intensive face-to-face communication, and increased collaboration. Furthermore, people should be multi-skilled, inclined to continuously participate in further training, and open to innovations and new ideas [Breu et al. 2001; Goldman et al. 1995; Gunasekaran 1999; Kettunen 2009].

Nearly as often mentioned is the concept of **Cooperation**. However, this concept is twofold. Within the domain of agile manufacturing, the focus is mostly external cooperation with suppliers and/or customers, whereby integrated supply chain planning, joint product development, and virtual enterprises are key aspects [Agarwal et al. 2007; Kettunen 2009; Meredith, Francis 2000; Sherehiy et al. 2007]. Looking at the agile organization, internal cooperation gains additional attention. This aspect is closely connected to the above concept of Workforce/Teams by emphasizing the importance of cooperation within and between teams or departments, as well as bringing together people with different skills and experiences [Charbonnier-Voirin 2011; Goldman et al. 1995].

The concept **Technology** is mainly about the supporting character of technologies to achieve agility. Again, there were two points addressed within this concept. Within agile manufacturing, technologies mainly refer to advanced design, manufacturing and administrative technologies like systems for enterprise resource planning (ERP), material requirement planning (MRP), computer aided design (CAD), etc. [Gunasekaran, Yusuf 2002; Vázquez-Bustelo et al. 2007]. From an organizational perspective, technology which enhances internal communication and the integration of processes is equally important [Breu et al. 2001; Eshlaghy et al. 2010].

The concepts **Organizational Abilities/Competences** and **Organizational Culture** are closely connected to each other. The former examines if an organization has a strategic vision, is able to utilize technologies and people to its advantage, can introduce high quality products and innovations, and knows its core competences [Kettunen 2009; Sharifi et al. 2001]. Organizational culture, however, includes issues like openness for change, emphasis on individuals and teams, and open and trustful working environments [Misra et al. 2009; Sarker, Sarker 2009].

The concepts **Customer** and **Market** are often mentioned together or used synonymously, although they are not the same. To enrich and satisfy the customer is one of the central characteristics of agility [Goldman et al. 1995; Sherehiy et al. 2007]. Customer collaboration and commitment are additional factors to achieve agility, especially in the domain of agile software development [Misra et al. 2009]. Market related aspects cover the continuous monitoring of market activities and response to changes, as well as fast new product introductions [Ren et al. 2000; Yusuf et al. 1999].

Processes are often referred to as prerequisites for agility, and to that effect have to be flexible, enable an integrated and continuous execution of tasks, and allow fast problem solving and immediate reaction to changes [Meredith, Francis 2000; Sarker, Sarker 2009]. The latter – reaction to changes – introduces the next concept. **Change** is often seen as a core driver of agility. In addition, a culture of change with a continuous monitoring of the environment, updating of strategies and tasks, and improvement is necessary [Ren et al. 2000; Sherehiy et al. 2007; Yusuf et al. 1999].

The concept of **Quality** is related to processes and customer satisfaction by emphasizing high quality products and built-in quality control measures [Kettunen 2009; Yusuf et al. 1999]. The concept of **Product** has a similar meaning, but puts more emphasis on customer satisfaction through product design and features [Gunasekaran, Yusuf 2002], and increased rates of product innovation and a shift to mass customization are covered by the concept of **Innovation** [Sharifi et al. 2001].

Another relatively important aspect is **Integration**. Integration can be seen from two perspectives again: on the one hand, process integration helps ensure the concurrent execution of activities, on the other hand, information integration allows for important information to be accessible to all employees [Tseng, Lin 2011; Yusuf et al. 1999].

Responsiveness, **Flexibility**, and **Quickness** are always presented together as core capabilities of an agile organization. Responsiveness is the ability to detect and anticipate changes. Flexibility describes the ability to adapt and change the components of an organization and achieve different goals with the same resources, namely: processes, staff, and products. Quickness includes fast product development and fast service delivery [Sharifi et al. 2001; Tseng, Lin 2011].

The concept of **Systems** is mainly used in agile manufacturing in terms of use of design, production planning, and control systems [Gunasekaran 1999]. **Information** is often seen in a broader sense, including information integration of customers and suppliers within an organization [Sharifi et al. 2001].

Education, **Organizational Learning**, and **Intelligence** are closely connected and cover different perspectives on knowledge management, for example, continuous training and improvement, the willingness to life-long learning, and a skilled workforce [Breu et al. 2001; Chan, Thong 2009; Vázquez-Bustelo et al. 2007]. Also, **HRM practices**, **Motivation**, and **Authority** are closely connected to this issue with an additional emphasis on employee empowerment and job enrichment [Chan, Thong 2009; Sherehiy et al. 2007; Vázquez-Bustelo et al. 2007]. **Welfare** covers the issue of employee satisfaction [Yusuf et al. 1999].

Management activities to support and promote agile principles are covered by the concept of **Strategy** [Meredith, Francis 2000], whereby issues of an organizational structure, like hierarchies or teamwork, are covered by the concept of **Structure** [Sherehiy et al. 2007].

The aspects of teamwork are further refined within the concepts of **Coordination** and **Collaboration** [Breu et al. 2001; Sherehiy et al. 2007]. The concept of **Project** additionally focuses how well teamwork is carried out in projects particularly [Chow, Cao 2008].

Finally, the concepts of **Proactivity**, **Adaptivity**, and **Resiliency** are referred to as additional characteristics of an agile workforce. Proactivity focuses on the anticipation of problems and changes instead of simply a pure reaction to them. Adaptivity enables employees to spontaneously collaborate in changing working environments. Resiliency is the ability to cope with uncertain and unexpected situations, as well as stress [Sherehiy et al. 2007].

The above descriptions of the identified concepts already show a great deal of connections and make it clear that it is sometimes difficult to differentiate between these concepts. This issue will be further discussed in Section 4.4.

4.3. Mapping of the frameworks

Figure 1 shows the complete mapping of the analyzed frameworks to the extracted concepts of agility. The numbers on the right side show how often a concept was used in each of the frameworks. It becomes clear that the concepts and frameworks are very ambiguous. In every domain there is not one which has a more or less stable

Focus	Agile Manufacturing											*	Agile SW Development							Agile Organization / Enterprise										
Author(s)	Agarwal et al. (2007) [26]	Gunasekaran (1999) [23]	Gunasekaran & Yusuf (2002) [11]	Kisperska-Moron & Swierczek (2009) [27]	Meredith & Francis (2000) [25]	Sharifi & Zhang (1999) [19]	Sharifi et al. (2001) [20]	Vázquez-Bustelo et al. (2007) [22]	Yusuf et al. (1999) [24]	Zhang & Sharifi (2007) [21]	Breu et al. (2001) [42]		Agile Manifesto (2001) [3]	Chan & Thong (2009) [30]	Chow & Cao (2008) [28]	Kettunen (2009) [32]	Misra et al. (2009) [29]	Sarker & Sarker (2009) [31]	Bottani (2010) [38]	Charbonnier-Voirin (2011) [39]	Eshlaghy et al. (2010) [37]	Goldman et al. (1995) [1]	Lin et al. (2006) [35]	Ren et al. (2000) [33]	Sherehiy et al. (2007) [9]	Tallon & Pinsonneault (2011) [40]	Tseng & Lin (2011) [36]	Tsourveloudis & Valavanis (2002) [34]	Zelbst et al. (2011) [41]	
Customer				X						X			X				X			X	X	X			X	X	X			10
Market	X		X						X										X				X	X		X	X	X	X	10
Product			X													X										X			X	4
Quality									X				X			X			X				X	X					X	7
Cooperation	X		X	X	X			X	X	X			X						X	X	X	X	X	X	X	X	X		X	18
Organizational Culture							X			X	X		X		X	X	X	X			X	X			X					11
Structure																					X				X					2
Coordination																		X							X					2
Authority																									X					1
Change									X				X						X	X	X		X	X	X					8
Integration	X								X	X									X				X	X			X			7
Organizational Learning								X						X											X					3
HRM Practices								X													X				X					3
Processes	X				X			X					X		X	X		X									X		X	9
Innovation							X			X																	X			3
Strategy		X			X																								X	3
Workforce / Teams		X	X		X		X		X	X			X	X	X	X	X	X	X	X	X	X	X	X				X		19
Proactivity										X															X					2
Adaptivity																									X					1
Resiliency																									X					1
Org. Abilities / Competences						X	X		X	X	X		X	X			X		X		X		X	X			X		X	14
Intelligence											X																			1
Collaboration											X																			1
Motivation														X							X									2
Welfare									X										X				X	X						4
Education									X										X				X	X						4
Technology		X	X	X				X	X	X	X	X						X	X		X		X	X		X	X		X	16
Systems		X	X							X																		X		4
Information							X														X						X	X		4
Project															X		X													2
Responsiveness						X	X			X											X						X			5
Flexibility						X	X			X											X						X			5
Quickness						X	X			X											X						X			5

*** Agile Workforce**

Figure 1. Mapping of agility frameworks and agility concepts

Source: own elaboration.

structure. This indicates that despite the ongoing research, there is still no common understanding of what constitutes agility.

A few of the concepts are prevalent in every domain. Most used was the concept of "Workforce/Teams", which seems obvious, because workforce plays an important role when talking about agility. Closely connected are the "Organizational Competences/Abilities", which are also often used and nearly equally distributed over all domains.

In addition, two other often recalled concepts are interesting and among the most used: "Cooperation" and "Technology". However, they are both only once mentioned

within the domain of agile software development. This may indicate that both are not regarded as important concepts within this domain, because they are prerequisites to develop software. Technology is the basis for new software and cooperation within a development team is essential. However, the neglect of these two concepts within the agility frameworks is questionable.

The concepts "Customer" and "Market" are noteworthy, too. Although enriching the experience of the customer and reacting appropriately to market changes are often considered as core drivers of agility [Goldman et al. 1995; Sherehiy et al. 2007], both concepts are not included in even half of the frameworks. They are mostly utilized within the domain of the agile organization. Interestingly, they play a less important role within agile manufacturing and agile software development. The gaps within agile software development are surprising, because software is often developed individually for customers.

Another concept that is clearly prevalent within the domain of the agile organization is "Change". Many publications state that it is necessary for organizations to strive for agility because of the increasingly changing and volatile environment (see for example [Goldman et al. 1995; Iacocca Institute 1991; Sherehiy et al. 2007; Yusuf et al. 1999]). However, only one framework within both agile manufacturing and agile software development incorporates change concretely.

The situation is different with the concept "Processes", which is among the most used concepts as well. In contrast to the aforementioned concepts, processes are most recognized within agile software development. This could explain some of the gaps mentioned above, because processes have an influence on many other organizational issues. However, within the domain of the agile organization, they are obviously underrepresented.

Figure 2 summarizes the mapping per domain. The numbers in the cells represent the number of frameworks that use the corresponding concept. Figure 2 reveals that the domain of the agile organization is the most comprehensive domain and covers 30 of the 33 identified concepts. However, as mentioned in Section 3.3, many of the frameworks in this domain utilize structures of agile manufacturing. This is also made notable by the fact that every concept of the manufacturing domain is used at least once within the domain of the agile organization. However, Eshlaghy et al. showed that pure manufacturing related concepts had the least significant effect on agility from an organizational perspective [Eshlaghy et al. 2010] (see Section 3.3). As such, one should ask if it is useful to simply transfer the concepts of agile manufacturing to the agile organization.

Another interesting fact lies in the domain of the agile workforce. As one would expect, the number of concepts is the lowest, as only one framework was identified. However, two concepts, namely "Intelligence" and "Collaboration", are only present in this domain. This is surprising, because it could be assumed that these workforce-related concepts are important in every domain. In addition, one should not be surprised that "Workforce/Teams" is not covered within the domain of agile workforce, as Breu et al. [2001] looked at this concept more in detail.

	Agile Manufacturing	Agile Workforce	Agile Software Development	Agile Organization / Enterprise
Customer	2	-	2	6
Market	3	-	-	7
Product	1	-	1	2
Quality	1	-	2	4
Cooperation	7	-	1	10
Organizational Culture	2	1	5	3
Structure	-	-	-	2
Coordination	-	-	1	1
Authority	-	-	-	1
Change	1	-	1	6
Integration	3	-	-	4
Organizational Learning	1	-	1	1
HRM Practices	1	-	-	2
Processes	3	-	4	2
Innovation	2	-	-	1
Strategy	2	-	-	1
Workforce / Teams	6	-	6	7
Proactivity	1	-	-	1
Adaptivity	-	-	-	1
Resiliency	-	-	-	1
Org. Abilities / Competences	4	1	3	6
Intelligence	-	1	-	-
Collaboration	-	1	-	-
Motivation	-	-	1	1
Welfare	1	-	-	3
Education	1	-	-	3
Technology	7	1	1	7
Systems	3	-	-	1
Information	1	-	-	3
Project	-	-	2	-
Responsiveness	3	-	-	2
Flexibility	3	-	-	2
Quickness	3	-	-	2

Figure 2. Number of frameworks regarding agility concepts

Source: own elaboration.

At this point it becomes clear that the inherent ambiguity makes it difficult to compare the frameworks in more detail. Of course, concepts that occur only once may also be covered by differently named concepts. For instance, "Adaptivity", "Resiliency", "Collaboration", or "Intelligence" may also be covered by "Organizational Culture" or others. Also, the fact that "Workforce/Teams" is not used in every framework, for instance, may be an indicator that it is also covered by other concepts. Hence, as described in Section 4.1, the links between the concepts need to be analyzed further.

4.4. Interdependencies of agility concepts

It became possible to determine connections between the different concepts after looking into the details of each. Some of the concepts are rather abstract, and as such include other concepts. In other situations, two concepts overlap in some parts (for instance "Customer" and "Market", or "Education" and "Intelligence"). Nevertheless, the related concepts cannot be merged because both also include unique content. Generally speaking, a connection between two concepts means that they are linked to each other content wise, but without further semantic specification. After the identification of every connection, a network was drawn visualizing the interdependencies. This network was created with the open-source tool Gephi [Gephi 2013] using the layout algorithm ForceAtlas 2, with the concepts as nodes and the connections between them as unweighted edges. The resulting graph is given in Figure 3.

The first noticeable issue is the high number of linkages between the single concepts. This again underlines the fact that a common understanding of agility is missing. However, by arranging the network with the layout algorithm mentioned above, some "clusters" that have connections to many other concepts become visible. These are illustrated as grey ellipses in Figure 3 and are each named by their central concept:

- **Organizational Culture** includes concepts that have an influence at a strategic level within an organization. They describe leadership issues and aspects that have to be established as values and principles for all employees. Projects are important, too, because the support of teamwork and projects has to be emphasized strategically.
- **Workforce** summarizes concepts that take aim directly at the working environments and methods of the employees, teams, or departments. This includes processes that are carried out and the organization of projects.
- **Customer** bundles concepts that are clearly related to activities concerning customer enrichment. Hence, product and quality are the focus. However, organizational abilities are important, too, as they determine how customer satisfaction can be achieved.
- **Organizational Abilities** comprise of concepts that describe abilities and capabilities needed to stay competitive. Therefore, internal and external cooperation is essential and the organization has to be innovative and able to fulfill customer needs.

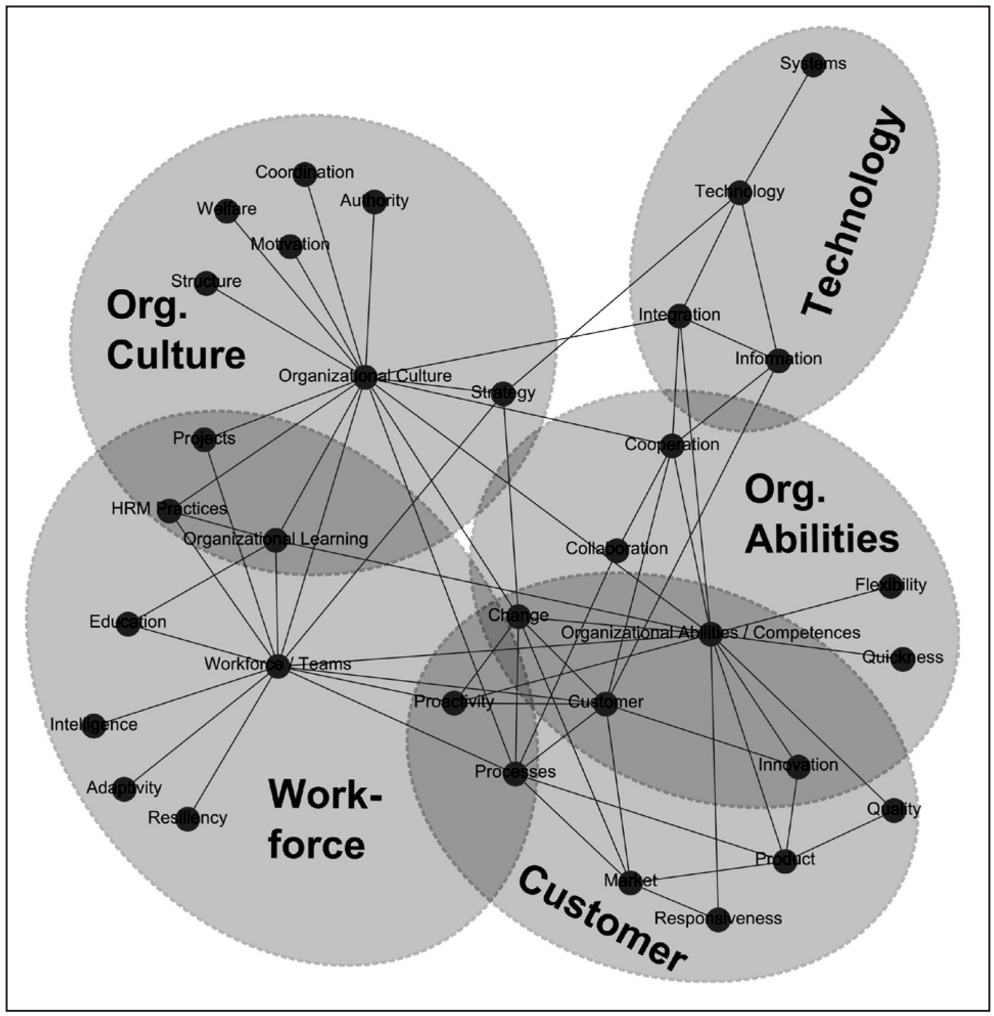

Figure 3. Interdependencies of agility concepts

Source: own elaboration.

- **Technology** is the smallest and best distinguished group. It focuses on information and information systems, but also includes the integrative aspects of technology and business needs.

It is important to keep in mind that the structure in Figure 3 was not based on a cluster analysis or similar methods, rather it was derived from a structured content analysis. Hence, there are some open questions remaining unanswered that have to be investigated in more detail in further research (see Section 5). For instance, the clusters "Customer" and "Organizational Abilities" overlap in huge parts and are

Focus	Agile Manufacturing										*	Agile SW Development						Agile Organization / Enterprise										
Author(s)	Agarwal et al. (2007) [26]	Gunasekaran (1999) [23]	Gunasekaran & Yusuf (2002) [11]	Kisperska-Moron & Swierczek (2009) [27]	Meredith & Francis (2000) [25]	Sharifi & Zhang (1999) [19]	Sharifi et al. (2001) [20]	Vázquez-Bustelo et al. (2007) [22]	Yusuf et al. (1999) [24]	Zhang & Sharifi (2007) [21]	Breu et al. (2001) [42]	Agile Manifesto (2001) [3]	Chan & Thong (2009) [30]	Chow & Cao (2008) [28]	Kettunen (2009) [32]	Misra et al. (2009) [29]	Sarker & Sarker (2009) [31]	Bottani (2010) [38]	Charbonnier-Voirin (2011) [39]	Eshlaghy et al. (2010) [37]	Goldman et al. (1995) [1]	Lin et al. (2006) [35]	Ren et al. (2000) [33]	Sherehiy et al. (2007) [9]	Tallon & Pinsonneault (2011) [40]	Tseng & Lin (2011) [36]	Tsourveloudis & Valavanis (2002) [34]	Zelbst et al. (2011) [41]	
Organizational Culture	0	1	0	0	1	0	1	2	1	1	1	1	2	2	1	2	2	1	0	4	1	1	1	6	0	0	0	1	20
Workforce	1	1	1	0	2	0	1	3	2	2	1	2	2	3	2	2	2	2	1	2	1	2	2	5	0	1	1	1	25
Customer	2	0	2	1	1	2	3	1	4	5	1	5	1	1	3	2	1	4	2	4	1	4	4	3	3	6	1	5	27
Organizational Abilities	1	0	1	2	1	3	4	1	3	6	2	4	1	0	0	2	0	3	3	6	2	3	3	3	2	6	0	2	23
Technology	1	2	2	1	0	0	2	1	2	3	1	0	0	0	0	0	1	2	0	2	0	2	2	0	1	3	2	1	18
clusters covered	4	3	4	3	4	2	5	5	5	5	5	4	4	3	3	4	4	5	3	5	4	5	5	4	3	4	3	5	

*** Agile Workforce**

Figure 4. Mapping of agility frameworks and identified clusters

Source: own elaboration.

difficult to distinguish. Additionally, it seems more appropriate to regard "Processes" as an organizational ability, because this determines how tasks are carried out and how other abilities are realized.

Another issue that calls for attention are the two concepts of "Processes" and "Change". They both have a very central position with many connections to other concepts, but it is difficult to identify new clusters around them. Change itself is often named as one of the key drivers of agility. Processes are an important internal element of every organization. Without changing processes, it will not be possible to change the way work is completed. Hence, their central position and large number of connections to other concepts may be an indicator that many authors consider them relevant within other concepts.

Finally, the analyzed frameworks can be compared to the new structure. An overview is given in Figure 4.

It turns out that only ten frameworks cover all five clusters [Bottani 2010; Breu et al. 2001; Eshlaghy et al. 2010; Lin et al. 2006; Ren et al. 2000; Sharifi et al. 2001; Vázquez-Bustelo et al. 2007; Yusuf et al. 1999; Zelbst et al. 2011; Zhang, Sharifi 2007]. None of these frameworks are out of the domain of agile software development. In contrast, seven frameworks only cover concepts from three out of the five clusters: two frameworks in the domain of agile manufacturing [Gunasekaran 1999; Kisperska-Moron, Swierczek 2009], two in the domain of agile software development [Chow, Cao 2008; Kettunen 2009] and three in the domain of the agile organization [Charbonnier-Voirin 2011; Tallon, Pinsonneault 2011; Tseng, Lin 2011]. One framework even covers only two clusters [Sharifi, Zhang 1999].

However, a pure interpretation of these numbers without looking at the content may be misleading. For instance, the framework of Vázquez-Bustelo et al. [2007] covers all five concepts, but includes only one concept of "Customer", Organizational Abilities", and "Technology" each. In particular, the only concept for "Customer" is "Processes". As mentioned above, the classification of "Processes" into the clusters remains unclear. Hence, these results can only deliver initial insights and clues to help in interpreting the components of agility, and must be further detailed via an empirical study (see Section 5).

There are also differences between which clusters are missing within the frameworks. The cluster covered by the most frameworks is "Customer". Only one framework is missing any concept in this cluster. This underlines the strong customer focus in agility literature. Furthermore, it may explain why the concrete concept "Customer" is only covered by ten frameworks (see Section 4.3). As shown in Figure 3, there are many customer-related concepts that all serve the aim of fulfilling customer needs. Hence, the different frameworks put their emphasis on different aspects regarding customer satisfaction.

"Workforce" is the second most covered cluster and has three frameworks missing any of its concepts. In contrast to the cluster "Customer". this seems obvious, because the concept "Workforce/Teams" was the most used concept among all frameworks (see Section 4.3).

Five frameworks do not cover concepts of the cluster "Organizational Abilities". The remaining two clusters are the most missed within the frameworks. Eight do not share concepts of "Organizational Culture", and an astonishingly amount of ten neglect "Technology".

Interestingly, all but one framework of agile software development misses the latter. The only one covering the technology aspect is the one of Sarker and Sarker [2009]. Although this effect was already discussed in Section 4.3, it is still surprising that even related concepts within the cluster "Technology" are not covered by these frameworks. The reason may be that agile software development technologies and systems are basic prerequisites, and therefore not seen as factors affecting agility. Also, the gaps in "Organizational Abilities" are prevalent in frameworks of the software development domain [Chow, Cao 2008; Kettunen 2009; Sarker, Sarker 2009]. There are studies reporting many problems when adopting agile methods beyond the development team (see, for instance, [Abrahamsson et al. 2009; Agerfalk et al. 2009; Wendler, Gräning 2011]). The gaps in the analyzed frameworks regarding organizational abilities may be the cause of these problems. This aspect should be examined further in future research.

A similar accumulation of gaps can be observed for the cluster of "Organizational Culture". Four frameworks within agile manufacturing do not cover concepts of this cluster [Agarwal et al. 2007; Gunasekaran 1999; Kisperska-Moron, Swierczek 2009; Sharifi et al. 2001]. Surprisingly, the other four frameworks missing any concept of organizational culture are to be found in the domain of the agile organization [Charbonnier-Voirin 2011; Tallon, Pinsonneault 2011; Tseng, Lin 2011; Tsourveloudis, Valavanis 2002]. However, these frameworks cover many more concepts from the clusters "Workforce" and "Organizational Abilities", which are closely connected to organizational culture. This again underlines the ambiguity and differing understandings of agility.

5. Conclusion and outlook

This study identified and systematically compared 28 frameworks of agility, and covered the domains of agile manufacturing, agile software development, agile organization, and agile workforce. As the observations in Section 4 clearly reveal, it is difficult to draw a sharp line between the five identified clusters of agility concepts. Furthermore, there is absolutely no consensus of what really constitutes the construct of agility. The analyzed frameworks are very different in their structure and content, and even within the specific domains of agility the frameworks vary greatly.

This all has significant implications for research. Due to a lack of consensus it is difficult to conduct empirical studies or build upon the existing frameworks. When researchers have to decide between one of the available frameworks as the basis for their research, they will most likely miss certain concepts of agility, as shown in Section 4.3.

Hence, this study may serve as a good starting point to choose one of the frameworks, because it will give the reader an overview of the covered concepts of each framework. It sharpens the awareness that the frameworks have gaps and gives the reader the opportunity to close these gaps by using parts of other suitable agility frameworks. However, to date there has been no empirical study that has delivered a comprehensive picture of organizational agility in an exploratory way. As such, it remains unclear which concepts of the frameworks are prevalent in practice and how the factors behind agility are composed.

Of course, some of the analyzed publications included exploratory analyses, but they all show some limitations. Examples are the works of Kisperska-Moron and Swierczek [2009] and Charbonnier-Voirin [2011], which both conducted exploratory factor analysis. However, both are missing certain important concepts (see Section 4.3). Apart from that, other authors conducted empirical studies, too, but only used a specific framework that, once again, does not cover all the identified concepts of agility. For example, Bottani [2010] used the framework of Yusuf et al. [1999], and Zhang and Sharifi [2007] used their own developed framework [Sharifi et al. 2001; Sharifi, Zhang 1999; Zhang, Sharifi 2007].

Due to this limitation, the author of this paper is currently conducting an empirical study about the question of what constitutes an agile enterprise at organizational level. Therefore, the identified agility concepts were merged into a questionnaire with 68 items. The final aim is to conduct a factor analysis to uncover the structure that lies behind the construct of agility. The currently focused target group consists of both general and IT-related decision makers in companies in the software and IT service industry. In contrast to the aforementioned studies, it contains all of the concepts given in Figure 1. Thus it will deliver a comprehensive view on organizational agility which has not been seen in other studies to date. According to Conboy, who states that "the search for a definitive, all-encompassing concept of agility might not be found simply through an examination of agility in other fields" [Conboy 2009, p. 334], this ongoing research will ideally solve the contradictions identified within this paper and contribute to an increasing consensus of what constitutes agility.

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STRUKTURA I KOMPONENTY ZWINNOŚCI – BADANIE W WIELU PERSPEKTYWACH

Streszczenie: „Zwinność" to termin, który jest powszechnie stosowany. Jednak potoczne rozumienie tego, co on oznacza i z czego się składa, jest błędne. Opracowano wiele podejść do zwinności, ale są one bardzo zróżnicowane zarówno w zakresie treści, jak i strukturze. W tym artykule opisano podejście do tego problemu poprzez systematyczne prowadzenie porównania 28 dostępnych ram (struktur) zwinności z dziedzin zwinności produkcji, zwinności rozwoju oprogramowania, zwinności organizacji oraz zwinności pracowników. W sumie zidentyfikowano 33 koncepcje dotyczące zwinności. Wyniki porównania wskazują, że nawet

w specjalnie badanych obszarach oczywisty jest brak porozumienia. Ponadto stosowane są pojęcia bardzo niejednoznaczne i nakładające się. W związku z tym szczegółowej analizie poddano wzajemne zależności między określonymi koncepcjami. To ujawniło pięć powtarzających się „klastrów", z których każdy łączy wiele pojęć o podobnej treści, ale mimo liczby dostępnych ram, żaden z nich nie odzwierciedla tych klastrów bezpośrednio. Badanie pokazuje, że czynniki spoza konstrukcji zwinności nie są jeszcze w pełni odkryte.

Słowa kluczowe: zwinność, struktury (ramy) zwinności, koncepcje zwinności, wieloaspektowe spojrzenie na zwinność.