Agility in Information Systems – A Literature Review on Terms and Definitions

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Abstract

Agility is a term used in many works in the context of information systems. When studying the concept closer, it became obvious that there is a terminological heterogeneity preventing a common definition whilst at the same time not preventing the frequent use of the term. In order to approach the term in a structured way, the following two paths were chosen. Firstly, the term was traced back to its roots which showed its first appearance in organisational theory. Secondly, the major IS conferences (ECIS and ICIS) and the requirements engineering conference as a major computer science conference were analysed from 2001 when the agile manifesto was published which led to a wave of works on agility. The descriptive results are presented in the paper.

Keywords: Agility, Agile Manifesto, Flexibility, Agile Information Systems

1.0   Introduction

Agility seems to be the latest buzzword in research and practice. Companies offer agile software development, projects are conducted in an agile way, scrum masters appear by the minute, research approaches use agile models, funding agencies put out calls for research on agility. When we started a new project on good agile project work, one of the first questions was that on a common definition of the term agility. This internal question led to the task of analysing differences in usage of the term agility in information systems research and practice.

To this end, a literature review was conducted. The starting point was the year 2001 when the agile manifesto was published which is seen as the birth of structured approaches on agility (Agile Manifesto, 2001). The two major IS conferences, namely the International Conference on Information Systems (ICIS) and the European Conference on Information Systems (ECIS) were analysed in terms of number of publications and contents. The same was done for the International Requirements Engineering Conference (RE) as agility is often associated with requirements analysis and requirements engineering in terms of changing requirements demanding quick

modifications. It soon became clear that additional work is required to look at various definitions from other disciplines as well as looking at the development of the principle of agility from a historical point of view.

Such descriptive analysis can never be complete but it is a structured starting point for homogenising the terminological heterogeneity.

2.0   The Term Agility and its Roots

An analysis of the IS literature reveals that the term agility is ubiquitous but there seems to be a lack of common understanding about the underlying concept of agility. In everyday language, the term agility is used to refer to the ability of reacting flexibly in case of changing requirements.

Before agility became relevant in IS research, there was considerable attention in the field of organisational theory. Some researchers mention that the term agility appears in the 1950s in the field of social sciences. Nevertheless, there is low approval about the connection between these early works and the present concept of agility (Förster and Wendler 2012).

Brown and Agnew (1982) form one of the first definitions of agility in the field of organisational theory. They outline the importance of the ability to respond effectively in an uncertain world and defined corporate agility as "the capacity to react quickly to changing circumstances" (Brown and Agnew 1982, p. 29). They mention not only the requirement of flexibility, but also point out the need for the commitment of key resources to output-oriented goals. These three aspects, namely the flexibility for changing circumstances, the clarity of output goals, and the heavyweight of key resources (especially human resources), can be found in later writings and discussions about agility.

Despite some early writings, the Lehigh report is referred to as the first work to detail agility in the field of organisational theory and agile manufacturing (Hooper et al. 2001). The Lehigh Report defines agile manufacturing as:

"…A manufacturing system with extraordinary capabilities (Internal capabilities: hard and soft technologies, human resources, educated management, information) to meet the rapidly changing needs of the marketplace (speed, flexibility, customers, competitors, suppliers, infrastructure, responsiveness). A system that shifts quickly (speed and responsiveness) among product models or between product lines

(flexibility), ideally in real-time response to customer demand (customer needs and wants)." (Yusuf et al. 1999, p. 36).

After the Iacocca Institute of the Lehigh University published the 21st Century Manufacturing Enterprise Strategy Report in 1991 and the foundation of the Agile Manufacturing Enterprise Forum (AMEF) in 1992, the number of literature on agility and agile manufacturing started to accumulate. Different facets of agility and agile manufacturing were highlighted by many authors leading to a varied range of definitions in the literature.

As an extension of the Lehigh report, Goldman et al. published the book *Agile Competitors and Virtual Organisations* in 1995. They consider agility as a generic term which can be defined on different levels (i.e. marketing, production, design, organisation, management and the level of people) (Goldman et al. 1995). Furthermore they define agility as "a comprehensive response to the business challenges of profiting from rapidly changing, continually fragmenting, global markets for high-quality, high performance, customer configured goods and services" (Goldman et al. 1995, p. 4). This study was pivotal in introducing the early concept of agile manufacturing and the agile vision.

Much research has been conducted about the various definitions of agility as some form of new manufacturing paradigm (Ganguly et al. 2009, Bernardes and Hanna 2009, Yusuf et al. 1999). Research in agile manufacturing points out that there is not only a huge variety in definitions of agility but also a gap between practice and theory (Gunasekaran and Yusuf 2002, Bernardes and Hanna 2009).

Yusuf et al. (1999) suggest a comprehensive definition of agility that shares some properties with earlier definitions but also includes the aspect of different levels of agility highlighted by Goldman et al. (1995). They define agility as "the successful exploration of competitive bases (speed, flexibility, innovation proactivity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge-rich environment to provide customer-driven products and services in a fast changing market environment" (Yusuf et al. 1999, p. 37).

Most definitions and concepts of agility cover essential characteristics of time, flexibility of the system and responsiveness (the ability to response), thereby indicating earlier definitions to be much more vague in their characterisation (Bernardes and Hanna 2009, p. 37, Gunasekaran and Yusuf 2002, p. 1361, Ganguly et al. 2009, p. 411).

It is also mentioned that agile manufacturing encompasses the concepts of lean and flexible manufacturing (Ganguly et al. 2009). There are different approaches to identify a differentiation between the terms agility and flexibility (Bernardes and Hanna 2009, Termer 2016, Evans 1991). Evans (1991) was one of the first who tried to differentiate between flexibility and agility and defines agility as a subset of the construct flexibility. Bernardes and Hanna (2009) reveal that the content of the terms agility, responsiveness and flexibility have overlapping notions in literature and therefore attempt to bring the three concepts to a higher level of abstraction. Based on this conceptual differentiation, Bernardes and Hanna (2009) identify that flexibility may be subsumed by agility. They characterise agility by the attribute of reconfigurability of the system itself to deal with unpredictable change. At the organisational level they define agility as "an approach to organize the production system that allows for fast reconfiguration and that requires resources that are beyond the reach of a single company" (Bernardes and Hanna 2009, p. 44). In addition to that, Backhouse and Burns (1999) reason that agility is the ability of an enterprise to adapt to unpredicted changes in the external environment, which is in contrast to flexibility as the ability to respond to a variety of customer requirements within defined constraints. Besides these approaches, Termer (2016) lists many other reconditioning of the definition of agility and flexibility. This comparison makes clear that there is no conceptual distinction of the terms in literature.

As a provisional conclusion, it must, therefore, be stated that there are various definitions of agility in the business and organisational theory literature and there is no clear differentiation between agility and flexibility.

3.0   Agility in the IS Literature

To understand the field of agility, its seminal sources need to be identified. Most of the definitions of the term agility have started to appear since 1991, drawn mainly from manufacturing and the organisational field. Termer (2016) identifies five main sources which are mostly referred to in the current WI and IS literature and which determine the definitions of the term agility in the current research literature. It is also mentioned that besides these five main sources there are numerous single sources which are used.

Besides the seminal publication of Sambamurthy et al. (2003) Sambamurthy et al. (2003) Termer also identified Goldman et al. (1995) as one of the main sources. This underlines the finding that the source of agility is in the manufacturing theory. For instance, Cockburn (2003), one of the early representatives of the agile development community, uses the description of Goldman et al. (1995) as the basic definition of agility and calls this definition the best he could find so far: "Agility is dynamic, context-specific, aggressively change-embracing and growth-oriented. It is not about improving efficiency, cutting costs, or battening down the business hatches to ride out fearsome competitive ´storms´. It is about succeeding and about winning: about succeeding in emerging competitive arenas, and about winning profits market share, and customers in the very center of the competitive storms many companies now fear." (Goldman et al. 1995, p. 42). Also Sambamurthy et al. (2003) derive their definition of agility from Goldman et al. (1995). They define agility as the "ability to detect opportunities for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise" (Sambamurthy et al. 2003, p. 245). Both definitions deal with the aspect that agility is an ability to make use of the competitive markets. This ability encompasses the organisational experimentation with new alternatives and pursuit of knowledge about currently unknown opportunities for competitive action (exploration) and the use and development of things already known through refinement and extension of existing competencies, technologies, and knowledge (exploitation) (Sambamurthy et al. 2003).

3.1 Agile Software Development

The unprecedented rate of change in business and technology environments has it made difficult for software teams to determine user requirements. Since the mid-1990s, agile software development approaches have evolved as new alternatives to traditional approaches to improve the responsiveness to changing user requirements (Lee and Xia 2010). In 2001 a group of researchers, i.e. the so-called Agile Alliance, met to discuss their underlying concepts for agile software development methods. They all agreed on four core values and twelve principles and endorsed the publication of the Agile Software Development Manifesto (2001). These principles are not supposed to be understood as a formal definition, but more as guidelines to satisfy the customer through early and continuous delivery of valuable software

(2001). Since the manifesto was articulated, agile development has attracted much interest.

Dingsøyr et al. (2012) highlight the extent of research on agile development undertaken during the past decade across different countries and also identify popular conferences and journals in which publications on agile research appear. As a result, they point out that the International Conference on Agile Software Development based in Europe has been the main forum for agile research and is followed by the Agile Conference in the US. The IEEE Software journal has the largest number of papers. Besides the area of software engineering the topic has gained traction also in the journal of Communications of the ACM with five articles on agile software development (Dingsøyr et al. 2012). Besides this study, there exist a number of systematic literature reviews and mapping studies of agile software development. Hoda et al. (2017) provide an overview of these reviews and studies on agile software development and identified ten different agile software development research areas. The category "Agile practices" is the area most of the systematic literature reviews focus on (Hoda et al. 2017). This range of different research areas underlines the finding, that there is a huge variety in the term agility and the research field. As a result, the concept of software development agility has not been well understood and organisations adopt these approaches without clear understanding how the term agility is defined or measured (Lee and Xia 2010).

3.2 The Term Agility in the International Conference of Information Systems, the European Conference of Information Systems, and the International Requirements Engineering Conference

The awareness of the term agility has grown rapidly after the agile manifesto was published. Whilst there is a huge number of systematic literature reviews and mapping studies about the main forums for agile research, our work observes whether and how intensive agility was a topic discussed in the International Conference on Information Systems (ICIS), the European Conference of Information Systems (ECIS), and the International Requirements Engineering Conference (RE). We especially focus on the years after 2001 when the agile manifesto was published. We searched for all submissions using the search phrase "agile" and "agility".

Figure 1 shows the number of submissions concerning agility during the three conferences. As can be seen, the topic of agility pops up in ICIS in 2002 and 2003. In

contrast, the first submission in ECIS was in 2004 and started to be more important in the years 2006 and 2011. In total, there are 44 submissions with the term agility or agile for ICIS during the years 2001 to 2017. For ECIS, there are 46 submissions. This goes in hand with the findings of Dingsøyr et al. (2012), where the International Conference on Agile Software Development based in Europe has been identified as the main forum for agile research, followed by the Agile conference in the US. There is a slight tendency to draw the conclusion that the term of agility is more discussed in Europe than in international comparison. The International Requirements Engineering Conference has the first submission concerning the term agility in 2006. But as can be seen in Figure 1, the issue was not intensively discussed in RE.
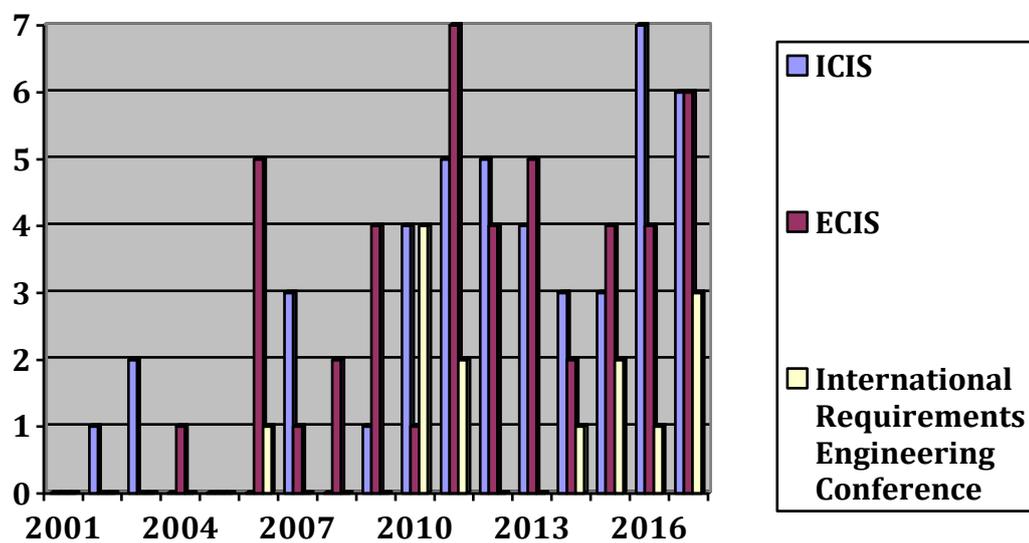

Figure 1. Number of submissions concerning agility

Tables 1 to 3 list all submissions for the three conferences in detail.

year	number	submissions
2001	0	
2002	1	• Balancing Quality and Agility in Internet Speed Software Development,
2003	2	• Agile Government and Global Market-Driven E-Commerce: The Cases of Denmark, France, and Germany • Managing Information Technology for Strategic Flexibility and Agility: Rethinking Conceptual Models, Architecture, Development, and Governance,
2004	0	
2005	0	
2006	0	
2007	3	• Agile Practices in Use from an Innovation Assimilation Perspective: A Multiple Case Study • Agility, Improvisation, or Enacted Emergence

		• IT-Enabled Organisational Agility and Firms' Sustainable Competitive Advantage
2008	0	
2009	1	• Leveraging Digital Business Ecosystems for Enterprise Agility: The Tri-Logic Development Strategy of Alibaba.com
2010	4	• Transforming Organisational Capabilities into Agile IT Adoption: A Case Study of Beijing International Airport • The Main and Interaction Effects of Process Rigor, Process Standardization, and Process Agility on System Performance in Distributed IS Development: An Ambidexterity Perspective • beyond budgeting and agile software development: a conceptual framework for the performance management of agile software development teams • conceptualizing interpersonal relationships in agile is development, • Enabling Agility through Routinized Improvisation in IT Deployment: The Case of Chang Chun Petrochemicals
2011	5	• Developing Routinized Information Processing Capabilities for Operational Agility: Insights from China • Comparing Apples with Oranges? The Perceived Differences between Agile and Lean Software Development Processes • Optimal Refactoring Policy for Agile Information Systems Maintenance: A Control Theoretic Approach • Evolving IT Organisational Identity as a Source of IT-enabled Enterprise Agility in China • Impact of Business Intelligence and IT Infrastructure flexibility on Competitive Performance: An Organisational Agility Perspective
2012	5	• Being Responsive to Your Customer: Developing Customer Agility through Information Management (Research in Progress) • Formulating Effective Coordination Strategies in Agile Global Software Development Teams (Research in Progress) • The Influence of Internet-Enabled Technologies on Customer Agility: A Strategic-Cognitive Perspective (Research in Progress) • Effect of Business Intelligence and IT Infrastructure Flexibility on Organisational Agility • Is Implementing ERP Like Pouring Concrete into a Company? Impact of Enterprise Systems on Organisational Agility
2013	4	• Do Organisational Competencies Influence How Enterprise Systems Foster Organisational Agility? • Exploring the Customer Perspective of Agile Development: Acceptance Factors and On-Site Customer Perceptions in Scrum Projects • How the Effects of IT Capability and Knowledge Capability on Organisational Agility are Contingent on Environmental Uncertainty and Information Intensity • Team Adaptability in Agile Information Systems Development (Research in Progress)
2014	3	• Exploring Coordination in Large-Scale Agile Software Development: A Multiteam Systems Perspective • How Agile Practices Influence the Performance of Software Development Teams: The Role of Shared Mental Models and Backup • Exploring the Influence of Service-oriented Architectures on Organisational Agility – A Case Study
2015	3	• The Effects of Task Conflict and Relationship Conflict on Workforce Agility: Moderating Role of Social Media Usage • Understanding Agility in ISD Projects • An Exploration of the relationship between Contribution Behaviours and the Decision Making Process in Agile Teams
2016	7	• Diving into the Relationship of Information Technology and Organisational Agility: A Meta-Analysis • In Search of Explanations: Conceptualizing the Relationship between Service-oriented Architecture and Organisational Agility • Realizing Value from Business Analytics Platforms: The Effects of Managerial Search and Agility of Resource

		Allocation Processes
		• Developing Socially-Constructed Quality Metrics in Agile: A Multi-Faceted Perspective
		• Problematizing Agile in the Large: Alternative Assumptions for Large-Scale Agile Development
		• Remote Working and Collaboration in Agile Teams
		• Self-Organisation in Agile ISD Teams and the Influence on Exploration and Exploitation
2017	6	• ICT Enabling Customer Agility: A Dynamic Capabilities Perspective
		• Internally or Externally-oriented IT Competencies: A Configuration Theory Perspective on How to Build Demand Management Agility
		• Journey Towards Agility: Where Are We Now and Where Are We Heading?
		• Team Diversity and Performance – How Agile Practices and Psychological Safety Interact
		• A Workaround Model for Competent Project Managers using Agile Development in a Traditional Organisation
		• Exploring IT/S Risk Management Agility
total	44	

Table 1. ICIS submissions

year	number	submissions
2001	0	
2002	0	
2003	0	
2004	1	• Agile Security for Information Warfare: A Call for Research
2005	0	
2006	5	• Open source networks: an exploration of business model and agility issues
		• Cost estimation in agile development projects
		• Looking for a place to hide: a study of social loafing in agile teams,
		• Towards the development of a simple tool to assist in agile methodology adoption decisions: agile adoption matrix
		• Organizing for agility: A complex adaptive systems perspective on agile software development process,
2007	1	• Mapping Social Network to Software Architecture to Detect Structure Clashes in Agile Software Development
2008	2	• A Paradoxical Perspective on Contradictions in Agile Software Development
		• Information Systems Integration Mechanisms within Supply Chain Agility in the Chinese Automotive Industry,
2009	4	• presenting data for team-based decision-making in agile information systems projects
		• A case study of risk management in agile systems development
		• IT impacts on operation-level agility in service industries
		• Understanding agility in software development through a complex adaptive systems perspective
2010	1	• Combining Open Innovation and Agile Approaches: Implications for IS Project Managers
2011	7	• IT-enabled strategic-level agility and firm performance: service versus manufacturing industry
		• Utilising mindfulness to analyse agile global software development
		• Business agility within is value research - proposing a measurement framework
		• Agile & distributed project management: a case study revealing why scrum is useful
		• Tracking the digital footprints of customers: how firms can improve their sensing abilities to achieve business agility
		• Impact of grid assimilation on operational agility in turbulent environments: an empirical investigation in the financial services industry
		• From agile to lean: the perspectives of the two agile online

year	number	submissions
		• communities of interest
2012	4	• The interpretation and legitimization of values in agile's organizing vision • How sustainable are agile methodologies? Acceptance factors and developer perceptions in scrum projects • Sensing social media for corporate reputation management: a business agility perspective • Towards an understanding of the contextual influences on distributed agile software development: a theory of practice perspective
2013	5	• A Classification for Business Intelligence Agility Indicators • Explaining the Changing Communication Paradigm of Agile Information Systems Development: A Research Model, Measurement Development and Pretest • How IT-Enabled Supply Chain Integration Is Achieved for Supply Chain Agility: An Institutional-Political Perspective • Agility of The Firm: Customers' Perspective (Research in Progress) • Agile Behavior Of Business Intelligence Systems: An Empirical Study on The Impact Of In-Memory Technology
2014	2	• Adaptation Patterns in Agile Information Systems Development Teams • We´ve Got 99 Problems, But A Phone ain't One: Mobile ICT And Academic Agility in Information Systems Research
2015	4	• IS Agility Research: An Assessment and Future Directions • Personality Traits of Scrum Roles in Agile Software Development Teams - A Qualitative Analysis • Building Enterprise Systems Infrastructure Flexibility as Enabler of Organisational Agility: Empirical Evidence • Toward a General Theory of Agile Project Management - A Research Design (Research in Progress)
2016	4	• Collaboration Amidst Volatility: The Evolving Nature of Boundary Objects in Agile Software Development • Improving ISD Agility in Fast-Moving Software Organisations • Governing for Agility and Innovation in Data-Rich Environments: The Role of Data Analytics Capabilities • Team Agility and Team Performance – The Moderating Effect of User Involvement (Research in Progress)
2017	6	• Reinventing the IT Function: The Role of IT Agility and IT Ambidexterity in Supporting Digital Business Transformation • Developing Intellectual Capital Within Agile IT Teams: A Literature Review • How to Implement Agile IT Setups: A Taxonomy of Design Options • Information Technology Competency and Organisational Agility: Roles of Absorptive Capacity and Information Intensity • When Is Agile Appropriate for Enterprise Software Development? • Adapting Agile Methods to Develop Solutions for the Industrial Internet of Things
total	46	

Table 2. ECIS submissions

year	number	submissions
2001	0	
2002	0	
2003	0	
2004	0	
2005	0	
2006	1	• Agile Requirements Engineering for a Social Insurance for Occupational Risks Organisation: A Case Study
2007	0	•
2008	0	•

2009	0	•
2010	4	• Do We Know Enough about Requirements Prioritization in Agile Projects: Insights from a Case Study • Transition to Agile Development - Rediscovery of Important Requirements Engineering Practices • Realizing Business Agility Requirements through SOA and Cloud Computing • Guiding Requirements Scoping Using ROI: Towards Agility, Openness and Waste Reduction
2011	2	• There's never enough time: Doing requirements under resource constraints, and what requirements engineering can learn from agile development • How to assign cost to "avoidable requirements creep": A step towards the waterfall's agilization
2012	0	
2013	0	
2014	1	• Decisively: Application of Quantitative Analysis and Decision Science in Agile Requirements Engineering
2015	2	• Forging high-quality User Stories: Towards a discipline for Agile Requirements • Agile requirements engineering with prototyping: A case study
2016	1	• Trace++: A Traceability Approach to Support Transitioning to Agile Software Engineering
2017	3	• How Much Undocumented Knowledge is there in Agile Software Development?: Case Study on Industrial Project Using Issue Tracking System and Version Control System • Requirements Engineering Challenges in Large-Scale Agile System Development • An Approach to Support the Specification of Agile Artifacts in the Development of Safety-Critical Systems
total	14	

Table 3. International Requirements Engineering Conference submissions

4.0   Conclusion

The current paper was motivated by our quest for the definition of "agility" which was generally accepted and used by most authors. Whilst it seemed to be an easy task to accomplish, it became clear that there is a variety of definitions and underlying concepts leading to a terminological heterogeneity that is paired with different schools of thought based on different subjects such as organisational theory, manufacturing, information systems.

Therefore, we set about to conduct a descriptive study of research by analysing the literature and answering the questions of historical development of agility (stemming from the 1980s), main definitions that shaped important work, and the special conduct of research on agility including its definition in information systems.

The main conclusion is that the first impression of heterogeneity is indeed correct. However, there are approaches trying to structure what is out there after opening Pandora's Box of agile approaches. The Agile Manifesto is the main source of communality in information systems. Nevertheless, an overall definition considering all influence factors is missing. A valid conclusion might be such an attempt is futile

because different research approaches (an indeed approaches in industrial practice) focus on different aspects of agility. We strongly argue for the need of definitions of agility for each approach instead and will do so for our project on good agile project work which is multidisciplinary (sociology, information systems, organisational theory) and has participants from research and practice.

Acknowledgements

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