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Enabling Agile Environments - Software Tools Revisited with an Agile Mindset

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ENABLING AGILE ENVIRONMENTS – SOFTWARE TOOLS REVISITED WITH AN AGILE MINDSET

Research Paper

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Abstract

Technology plays an increasing role in organisations and agile environments. The growing adoption of digital technology and the resulting unprecedented transformation of workplaces are potentially putting agile values and principles under attack. Agile mindset is a central aspect of agile concepts and embodies agile values and principles among other characteristics. In order to reconcile technology adoption and agile values, a framework is proposed which integrates agile mindset properties into software tool appropriation. The framework is based on information systems (IS) models of structuration and provides a means to translate implicit mindset properties into explicit actions performable by users. The research follows the design science research paradigm and utilises qualitative methods of data collection and analysis to create an artefact that was evaluated in practice.

Keywords: Agile Transformation, Agile Mindset, Software Tools, Agile Organisation.

1 Introduction

Organisations are exposed to profound structural and societal challenges in their immediate arenas as well as in the overarching economic environment. Over time, various solutions that promise effective strategies and suitable remedies have been introduced. One of them is agility, which utilises agile principles and practices embodied in the agile methods popularised today (Cohen et al., 2004). It has proven its merits and continues to proliferate through its broad application and global adoption beyond software development (Digital.ai, 2021). Agile transformations provide organisations with measurable performance benefits and also improve employee satisfaction and engagement (Stettina et al., 2021). Organisations seeking to undertake agile transformations have the choice between various agile methods and frameworks, depending on the desired implementation strategy and the organisational levels they plan to engage. Beside the initial group of agile methods intended for software development teams (Dybå and Dingsøyr, 2008), other recent frameworks have been proposed that target large-scale implementation across the enterprise (Dingsøyr et al., 2019). Despite the popularity of agile methods and their widespread use, there are different interpretations associated with agile methods and their underlying principles (Laanti et al., 2013). Moreover, agility exists in different forms and in various individual manifestations within each organisation (Gren and Lenberg, 2019), resulting in a multitude of understandings of agility and respective method implementation. Amid this array of diverse positions and perceptions, one aspect of agility that is acknowledged as key is an agile mindset. An agile mindset is crucial for the success of agile transformations (Dikert et al., 2016) and its significance is equally recognised by practitioners (Denning, 2018). Initially lacking a detailed description, investigations of agile mindset have recently produced a first comprehensive definition which contains a set of ten interrelated characteristics, one of them being an enabling environment (Mordi and Schoop, 2020).

Investigating human-factors in agile transformations has been placed at the top of research agendas, including further research of agile mindset (Barroca et al., 2020). Likewise, technology continues to pervade the workplace while simultaneously changing the structure of organisations and the nature of work (Baptista et al., 2020). In agile contexts where social factors and people-oriented collaboration and communication are essential (Nerur et al., 2005), software tools facilitating these efforts are key. Given the omnipresence of technology in today's organisations and the accepted significance of agile mindset, connecting these two subjects seems a corollary. Previous research has discussed the intricacies of human-technology interactions and revealed the importance of awarding human factors the necessary attention (Orlikowski, 1992). Thus, in conditions of growing exposure to technology and increased adoption of software tools, how can the tenets of the Manifesto for Agile Software Development (Beck et al., 2001) be safeguarded against omission? Current unforeseen events have thrusted entire populations into software-facilitated work scenarios, demonstrating the importance of software tools and our dependencies on those (Orlikowski and Scott, 2021). This circumstance corroborates the need to view software tools through the lens of an agile mindset and recalibrate human factors into the centre of agile transformations and technology adoption, ultimately creating an enabling environment (Mordi and Schoop, 2021). Thus, the research question reads as follows: How can software tool appropriation in agile environments be related to an agile mindset?

This research employs IS structuration models as a basic scaffolding for interpreting human-technology interaction (Orlikowski, 1992). One foundation of this research is the structuration model of collaboration technology, which provides a dynamic view of tool appropriation in a collaborative context (Lyytinen and Ngwenyama, 1992). The second foundation rests on a holistic approach that integrates agile mindset properties into a socio-technical system (Mordi and Schoop, 2021). Adopting these two pillars, a framework is developed which ties together the seemingly disparate subjects *agile mindset* and *software tools*. Overall, the research approach accords with the idea that agile transformation is a process of transforming the socio-technical structures of an organisation (Barroca et al., 2020). The study draws upon the design science research paradigm and presents a framework that constitutes a first-iteration artefact (Hevner et al., 2004). The study proceeds with providing a contextual background in the next chapter, followed by the methodology. Outcomes of the research are presented afterwards, they include the first iteration of the framework and its evaluation. In a subsequent chapter, the results are discussed, upon which implications for practice are derived prior to a conclusion in the last section.

2 Background

2.1 Software Tools in Agile Environments

Despite agile values placing an emphasis on personal interactions over tools, the current anatomy of modern work environments exposes an omnipresence of software tools in various forms. However, this need not be a contradiction, since tools have successfully been around software development for an extended time (Vessey and Sravanapudi, 1995). Accepting that tools rightfully exist in agile projects, the question is whether they have been integrated into the workplace with an agile mindset. So far, investigations concerning software tools have mainly occurred related to practices and routines of agile methods, especially in distributed software development contexts. Distributed settings qualify as agile and constitute a relevant share of existing work environments (Ramesh et al., 2006). In these scenarios, different aspects of communication tools and their usage have been investigated. Task fit of communication technology has been examined according to Media Synchronicity Theory (Niinimäki et al., 2010) as well as the communication patterns across different locations and media (Niinimäki, 2011). As a result of their expanding adoption, instant messaging tools have received increased attention in academia, including recommendations and guidelines regarding their benefits and drawbacks (Stray et al., 2019). Studies further address the challenge of coordination in global settings and provide corresponding strategies on how tools can support these arrangements (Stray and Moe, 2020). Research has also investigated team members' perception of the tool infrastructure and indicate that certain tool

configurations are recognised as more beneficial for distributed settings (Yagüe et al., 2016). Other studies focus on the challenges of information overload and channel fragmentation, proposing tool integration as a means to amend these issues (Calefato and Lanubile, 2016). The researchers continue to highlight how changes to the use of task boards and information exchange award improvement (Calefato et al., 2020). Implementing agile software development in distributed settings is difficult to achieve. Carefully designing a suitable work environment by adapting practices and tools to fit the needs of the development team has proven to be a way towards a successful implementation (Lous et al., 2018). The existence of hybrid teams further compounds these situations, where co-located and remote team members have to collaborate in this constellation. Tools have shown to mitigate such problems and support hybrid teams by providing transparency and participation in the relevant information networks (Deshpande et al., 2016). From a socio-cultural perspective it is noteworthy to add that although regional differences might exist, agile teams tend to use the same tools all over the world and show general acceptance of established products (Ciancarini et al., 2019). Concluding the summary, what matters is *how* software tools are used (Qureshi and Zigurs, 2001). Therefore, the present study aims to deliver a *how* that can support an agile mindset within in a tool-dependent environment.

2.2 Theoretical Foundations

The theoretical foundations of our research are (1) the concept of agile mindset and (2) IS structuration models. Agile mindset can be viewed as a holistic socio-technical concept and comprises ten interrelated characteristics: focus on customer value, trust, responsibility and ownership, willingness to learn, openness and willingness to continually adapt and grow, specific personal attributes, continuous improvement, autonomy of people and teams, managing uncertainty, and enabling environment (Mordi and Schoop, 2021). Detailed descriptions of each of the ten characteristics and how these properties were derived can be found in the comprehensive definition of agile mindset (Mordi and Schoop, 2020). As illustrated in Figure 1, these characteristics can be arranged into six dimensions of a socio-technical system, namely goal, people, culture, infrastructure, technology and processes (Davis et al., 2014). Deducing from the aforementioned definition, *Enabling Environment* inhabits four dimensions: culture, processes, infrastructure and technology. Therefore, technology is a resource through which an enabling environment can be created in an organisation. It can be inferred that software tools act as a lever in enabling the other nine mindset characteristics.

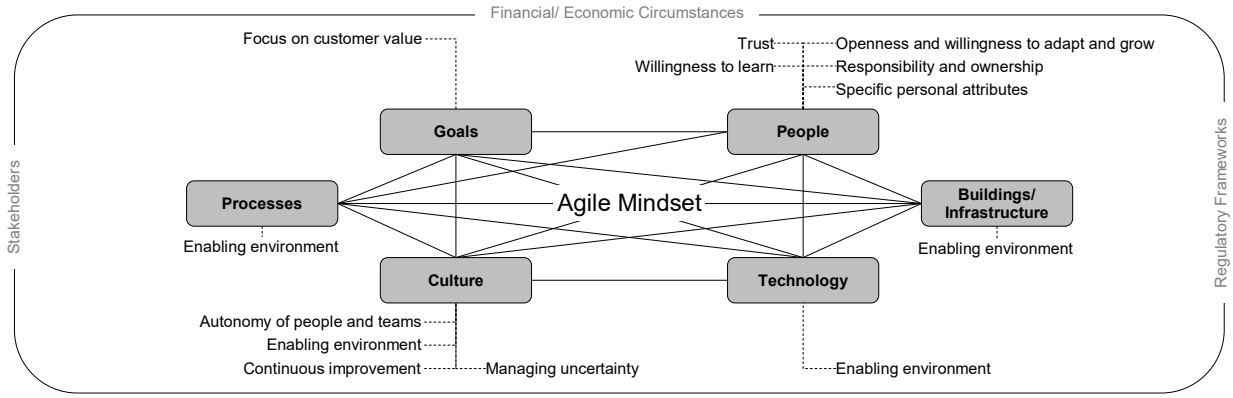

Figure 1. Agile Mindset represented through a holistic Socio-Technical System

Following this approach, the underlying notion of this research is that depending on configuration and appropriation, software tools as part of an enabling environment can support agile mindset characteristics. Therefore, the focus of this study is how tools can be related to an agile mindset and how this can be achieved. The nature of the research question lies at the intersection of humans and technology, which is why models explaining this relationship are a useful resource to invoke. Espousing recognised human-technology models also stems from the realisation that the theoretical roots of agile methods originated in established socio-technical concepts (Nerur and Balijepally, 2007). We follow that line and extend our research to incorporate a theoretical structure that suggests how to weave these

socio-technical elements together. Thus, the second foundation of this study adopts the structuration model of computer-supported collaboration (Lyytinen and Ngwenyama, 1992). Together with the structuration model of technology (Orlikowski, 1992), these concepts emerged as alternatives to traditional views that did not adequately consider reciprocal effects of human-technology interaction. The structuration models build on the theory of structuration, which views human agency and structure as a mutually constitutive duality and apply it to their respective objects of investigation (Jones and Karsten, 2008). For further insights into structuration theory and IS research we refer to the relevant academic discourse (Poole, 2009; Jones and Karsten, 2009). According to the these models, technology is both a product of human action while also being socially constructed when interacting with it (Orlikowski, 1992). It entails that when using technology users interpret and manipulate technology whilst being influenced by contextual individual and social factors. That way, people's habitual use becomes institutionalised in the organisation. Following this view, the relationship between humans and technology is influenced by the characteristics of the material artefact (technology), the agent (user) and the organisational context (Orlikowski, 1992). These three elements constitute one building block along which our framework will be developed. Beyond technology in general, the same principles apply to collaboration tools as well. It is afforded by the notion that such tools provide the means to manipulate work processes and social interactions; in effect, collaboration tools "can shape attitudes and social processes" (Lyytinen and Ngwenyama, 1992).

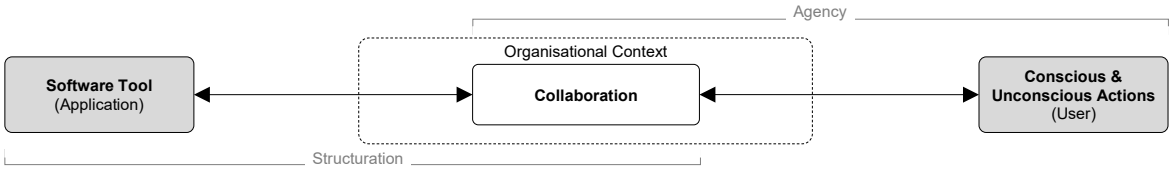

Figure 2. Simplified Structuration Model (adapted from Lyytinen and Ngwenyama, 1992)

An adapted version of the structuration model is presented in Figure 2. It stipulates the dynamic associations between applications, cooperative actions and users, and ties these characteristics together into effective relationships. Consequently, it suggests that tools and mindset characteristics (user) can be connected via processes, cooperative actions (collaboration) and context. An additional facet to elucidate is that users draw upon both implicit and explicit knowledge when in action (Orlikowski, 1992). This circumstance bears similarities with the definition of agile mindset, which manifests itself in the existence of implicit and explicit features of its interrelated properties (Mordi and Schoop, 2021). Concluding, the structuration model (typified in Figure 2) lends itself to a configuration with the interconnected agile mindset properties and introduces the structure on which the subsequent framework investigating a mindset-tool-relationship can be developed.

3 Methodology

This study employs the design science research framework (Hevner et al., 2004) and corresponding guidelines (van der Merwe et al., 2020). Within this methodological frame, the research follows an interpretive approach (Klein and Myers, 1999), including associated qualitative research methods (Walsham, 1995; Walsham, 2006). The study adopts qualitative methods of data collection and analysis and contains several iterative steps in its research process (Figure 3). In the first stage, two data collection steps were performed in order to extract the relevant information pertaining to software tools and how they are used. For this purpose, semi-structured interviews were conducted with agile teams in three companies. The goal was to identify the types of tools that are used and how they are applied in respective scenarios. Afterwards, the tools were categorised according to pertinent classification principles for collaboration tools and their functionalities. In the second stage, theoretical foundations were integrated. As outlined in the previous chapter, they comprise the concept of agile mindset in a socio-technical system and the theories related to human-technology interaction. The decomposed data was subsequently coalesced into a framework which represents the first iteration of an artefact. In the final step, the framework was evaluated within a case study in a fourth company.

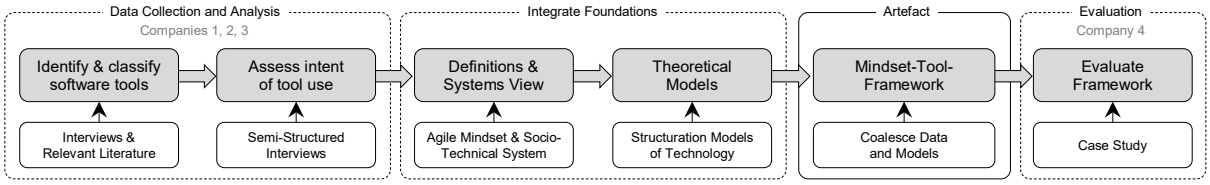

Figure 3. Methodological approach within the design research framework

3.1 Interviews

In order to collect adequate data, semi-structured interviews were conducted with 14 agile practitioners from three different companies in the European Union (EU). Their roles ranged from Developer, Scrum Master, Agile Coach, Product Owner, Consultant to Manager and thus represent a broad sample. The companies involved were part of a joint research project and had adopted agile methods between two to seven years prior to the data collection. This accounted for varying degrees of maturity and experience with agile methods in the organisations. The interview design and process followed a well-deliberated and structured approach (Roulston and Choi, 2018). With the exception of one interview executed via telephone, all interviews were held face to face at the respective participant site. One aim was to identify the software tools used in participants' routines and practices. The other aim was to investigate if specific behaviours and intentions related to mindset properties exist as part of tool use. An overview of the participants is provided in Table 1. In the first step the data was coded by a researcher unrelated with the research, afterwards coding was performed by the interviewing researcher. Upon completion, the coding scheme and associated contents were compared, discussed and solidified in a final record.

#	Role	Experience with Agile Methods	Company Size (Employees)	Industry/ Field
P1	Scrum Master	2 years	250-500	Information Technology
P2	Agile Coach & Scrum Master	2 years	>1000	Information Technology
P3	Agile Coach & Scrum Master	2 years	>1000	Information Technology
P4	Developer	3 years	250-500	Information Technology
P5	Product Owner	3 years	>1000	Information Technology
P6	Scrum Master	3 years	>1000	Information Technology
P7	Agile Coach & Scrum Master	5 years	>1000	Information Technology
P8	Developer	6 years	250-500	Information Technology
P9	Technical Consultant	6 years	250-500	Information Technology
P10	Manager	6 years	250-500	Information Technology
P11	Manager	6 years	250-500	Information Technology
P12	Manager	6 years	250-500	Information Technology
P13	Programme Manager	10 years	>1000	Information Technology
P14	Manager	13 years	>1000	Information Technology

Table 1. Interview participants (Companies 1, 2, 3)

3.2 Tool Classification

In present software development projects, a panoply of tools supporting various aspects of the development process are theoretically available to teams (Capterra, 2022). The focus of this research are collaborative human interactions; therefore, the tools studied are related to the collaboration aspects of projects, less the technical activities, such as design, coding or testing. It is cumbersome to delineate collaboration tools accurately, as their characteristics change and different classifying paradigms apply; this impedes efforts to assign tools to exclusive categories. Furthermore, precise classifications are not consistently applied throughout the tool literature and underlying principles are rarely explicated by authors. In general, classification is no easy undertaking, partly due to semantic ambiguity and partly due to the intricacies of the classification process (Bailey, 1994). In lieu of clear and concise definitions, various terms such as classification, taxonomy and typology circulate and can have different meanings (Nickerson et al., 2013). To preserve a systematic and rigorous approach, a range of classification

schemes in IS literature were analysed for our study. As a result, contemporary publications from the last decade were identified according to terse inclusion criteria (Table 2).

Year	Authors	Title
2012	Portillo-Rodriguez et al.	Tools used in Global Software Engineering: A systematic mapping review
2012	Grudin and Poltrock	Taxonomy and theory in computer supported cooperative work
2016	Chadli et al.	Software project management tools in global software development: a systematic mapping study
2019	Ebert and Calefato	Agile Collaboration for Distributed Teams

Table 2. Sources guiding the classification of software tools

The selection includes well-recognised publications (Portillo-Rodríguez et al., 2012), more recent mapping studies (Chadli et al., 2016), theoretical underpinnings of tool classification (Grudin and Poltrock, 2012), and recent agile-related examples (Calefato and Ebert, 2019). Although not comprising the entire literature in the field, the publications are deemed sufficient for this exercise. The models were then synthesised together with the empirical findings (interviews) into a template that divides tools into three groups: communication, coordination and collaboration. Communication contains tools that are used primarily for synchronous or asynchronous information exchange. Coordination includes tools that support coordinative aspects of work such as task allocation, workflow, scheduling and creating awareness for project activities and status. Collaboration comprises tools for work on shared objects, such as documents, creative solutions and other artefacts. Collaboration is understood here as a family of complementary cooperative and collaborative actions that can be conducted jointly in real time or separately (Grudin and Poltrock, 2012). These three categories contain overlap and are exemplary rather than prescriptive, as it is difficult to determine exact lines of demarcation between these tools, especially since their functions and features alter over time. It should further be noted that contingent on era and interpretation, collaboration tools can also be referred to as groupware (Ellis et al., 1991), Computer-Supported Cooperative Work (CSCW) applications (Cruz et al., 2012) or couched in knowledge management tools (Tyndale, 2002).

3.3 Framework Development

First, the relevant data (tool use, roles, related processes, context and specific behaviours and intentions) was extracted from the interviews. The data was then documented with spreadsheets, which allowed data allocation into respective categories in accordance with the corresponding relationships of the model. That way, the data could be integrated into a basic configuration according to the structuration model (Lyytinen and Ngwenyama, 1992). Subsequently, relevant iterative additions were made to the structure, among them the identified intentions, their related mindset characteristics and the associated tools. In the next step, adjustments were made to the sequence, thereby accommodating the additions and accounting for the necessary adaptations. All steps and modifications were predicated on the designated associations specified in the original structuration model. Following this updated configuration in the spreadsheet, a generic framework was derived, which embodies the first-iteration artefact of the design science process. Figure 4 exhibits the procedure described above. The framework represents an adapted model which symbolises the relationship between tools and agile mindset characteristics.

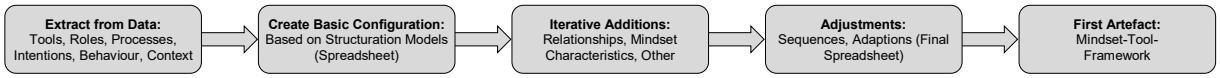

Figure 4. Process of developing the framework

3.4 Case Study

The framework was evaluated in a case study conducted within the IT-Enabled Services department of a financial services company. In the department, the investigation was focused on an organisational unit comprising roughly 100 members. They employ DevOps practices, the Scrum method and the Scaled Agile Framework (SAFe). DevOps can be understood as collaborative organisational effort to automate

delivery of software updates while maintaining reliability of the services (Leite et al., 2020). Agile methods were introduced to the unit five years ago and the group that participated in the case study exhibits a strong commitment to agile values and principles. The case company was chosen for several reasons. First, allowing for rich data collection, the studied group is located in India, as opposed to the prior data collection performed in Europe. Second, the company is active in the financial services market. Although the department studied is IT-related, it operates in a different business environment than the three other companies. Further, the entity is located on the IT services side of the organisation, whereas the previous samples lie primarily in the province of product development. The participants also expressed a level of understanding of agile mindset relevant for the scope of the study. The case details are summarised in Table 3. The choice for a case study was based on the contextual nature of the artefact and the surrounding conditions which lend themselves to this approach (Flyvbjerg, 2011).

Case Company		**Case Details**	
Market/ Industry	Financial Services	Time span	3 months
Company Size	> 10,000 employees	Locations	UK (ca. 20% workforce) & India (ca. 80% workforce)
Department	IT Enabled Services	Task	Design and Maintenance of IT applications
Organisational Unit	ca. 500 employees	Methods	DevOps practices, Scaled Agile & Scrum
Studied Entity	ca. 100 employees	Data Collection	Interviews and document review
Interviews: P15, Manager (5 years agile experience), P16, Manager (5 years agile experience), P17, Manager (10 years agile experience)			

Table 3. Case description (Company 4)

In order to evaluate the previously developed framework a series of ten interviews was conducted alongside document reviews. As not all members of the team could be integrated into the project, three managers participated in the study. The ramifications of the global pandemic limited access to more participants and other modes of data collection, as work environments were heavily impacted. The interviews were scheduled over a period of 3 months and held via video conference, along with the document reviews. Due to the circumstances, personal interaction had to be substituted with video conferencing, which necessitated thorough reflections and according interview design (Salmon, 2012; Deakin and Wakefield, 2014). In order to develop necessary alignment and a shared understanding, the first step in the evaluation was to discuss the definition of agile mindset and its specific characteristics with the participants. In the subsequent steps, the framework was evaluated by observing and discussing how it was implemented. Elements of the framework were added iteratively, in order to allow full comprehension and provide a digestible structure.

3.5 Validity Procedures

Strong attention was payed to employ rigour in the conception and execution of the data collection and analysis process (Walsham, 1995). First, the data collection involves four different companies that vary in size, background, market, locations and experience with agile methods. Although all four companies are associated with IT, the contexts in which the companies operate differ. Second, the participants are of diverse professional and cultural backgrounds, involving various roles and organisational levels. Additionally, the case company was specifically chosen as a means to generate a broader and more diverse dataset comprising a non-EU country, a different organisational unit (operations), different roles and a different market. Coding of interview data and the review process were conducted by two researchers. Regarding the study design, rigour was also applied through regular review of the different steps of the artefact development in the design research methodology (Hevner, 2007). Concerning the case study, readers should be aware of existing misconceptions of case studies that exist in academia. Certain unfavourable presumptions, including those pertaining to biases, have been refuted, awarding case study research a valid and suitable approach (Flyvbjerg, 2011).

4 Results

The first finding relates to the tools that were employed in the studied environments, as identified by the participants from all data collection phases. The tools can be categorised into the three groups

communication, coordination, and collaboration (Figure 5) and were grouped according to the scheme described in section 3.2. The scheme represents an exemplary tool classification that renders orientation for navigating the vast and confusing tool offerings users are often confronted with.

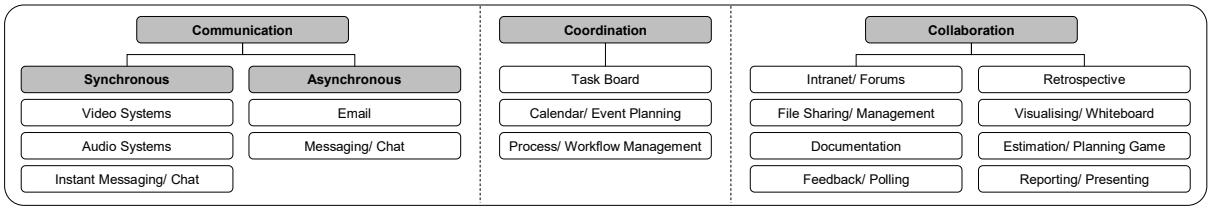

Figure 5. Categories of software tools used in the studied environments (Company 1, 2, 3, 4)

This classification further provides readers with a simple overview of collaborative project activities, as they exhibit the tools that were applied for recurring project tasks. It should be mentioned that although all tools in Figure 5 were referenced by participants, only some were reported in the context of performing mindset-related activities. This does not rule out the possibility that potentially more tools and activities can be associated with mindset characteristics; however, the underlying data only supports the results elicited in the forthcoming framework (Table 4). The tools that ultimately could be associated with mindset characteristics were video conferencing, instant messaging (chat), task boards and feedback tools.

4.1 Integrating Findings and Framework

For a better understanding of the process involved in associating tool use and mindset characteristics, excerpts from the interviews and how respective pairings were derived are reflected in the extract below (Figure 6). The excerpt contains specific elements matching the framework: tools, goals, practices, roles and indications of mindset characteristics. Other components (other roles, context and setting) were explicated in the interview, but omitted here in the transcript for space and legibility reasons.

"*Our customer had access to our task board, he could see everything… So, he could have done anything, but we had agreed to leave the product backlog to the product owner, and he really adhered to it. I mean, he only made some occasional comments here and there when he saw something… Theoretically, I think he could have changed priorities without us immediately noticing… We want to work in a trustful manner with the customer. That is the goal, keyword: transparency*" (translated, P3, Agile Coach)

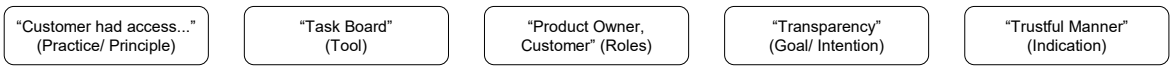

Figure 6. Extract from an interview and the identified components

The example above showcases how the different elements eventually form the relationship that is illustrated in more detail later in Table 4. Predicated on the principles just presented in this example, the empirical data was decomposed and distilled into the relevant elements for relationship configuration. Upon completion of the data allocation into the structure in Table 4, it was subsequently transformed into the generic framework (Figure 7). Another example from an interview will be used to demonstrate the principles of the framework. In the interview, a manager (P14) explained how he utilises feedback tools for specific scenarios. It begins with his understanding that under the given circumstances within the project, real insights into people's opinions and perceptions are valuable. His goal then was to allow transparency (goal) on important topics. Therefore, during a workshop with a large group of stakeholders (context), he asked questions that were answered anonymously (practice/ principle) through a simple feedback tool (tool). The workshop featured people from different parts and levels of the organisation, hence diverse moods, opinions and positions were assumed (context). The answers were made visible to all participants in real time (practice/ principle). The manager concludes that the exercise was beneficial, because it achieved important outcomes, despite potential risks the exercise engendered. Thus, the manager exhibited behaviours of *responsibility and ownership* and a *willingness to learn* as described in the definition of agile mindset. Such behaviours materialise on a continuum of implicit and

explicit features, as mindset attributes are often subtle and users might be unaware of the implicit mechanisms driving their intents. Similar to the first instance, this example illustrates how the elements are tied together in the framework (see Table 4). It should be noted that indications made in the interviews often refer to the underlying properties of the mindset characteristics that can be found in the definition, thus familiarisation with it adds to a better understanding.

Explicit			Organisational Context			Conversion/ Translation (intentions to actions)		Implicit
Tool		**User**	**Roles involved**	**Context/ Setting**	**Characteristics of Context/ Setting**	**Practices/ Collaboration Principles**	**Intentions/ Goals**	**Mindset Characteristics**
Communication	Video	AC	PT	Team meetings and alignments with individuals	Some people attend less events, are seen less regularly and engage in less activities	Video "always on" principle/ default setting (create standard of presence)	Be close to people and feel the atmosphere (reach out to those less "visible")	Trust
		AC	PT, M	Meetings and individual interactions	Certain surroundings challenge involvement/ focus and present ample distractions	Observe peoples' eyes and identify level of involvement/ commitment	Create/ enforce participant involvement & commitment (also increases own commitment)	Responsibility and Ownership
	Chat	AC	PT	Work environment with many information channels and high information load	Requires rules to prevent interruptions from work (when and how to use phone, chat etc.)	Create awareness for privacy/ individual preferences and discuss rules for communication	Individual control (decision making) over time and availability (productivity)	Autonomy of People and Teams
		D	PT	Complex tasks requiring wide range of expertise	Team members with diverse skillset; Multiple task dependencies among members	Openly share mistakes/ errors/ obstacles and voice need for support	Utilise group/ collective knowledge within network	Continuous Improvement & Willingness to Learn
Coordination	Task Board	AC	C, PO, SM, DT	Project team's customer relationship	Understanding to reduce amount of tools/ data exchange and prevent duplications	Share common task board (including permissions)	Transparency between team and customer	Trust
		TC	C, PO, SM, DT	Complex tasks requiring lucidity, breakdowns, and understanding	Discussions/ translations needed between C, PO and DT; High potential of misunderstandings	Proactive monitoring of progression & impediments (and customer re-alignment) beyond scheduled tasks	Proactive and early detection of deviations throughout the development process	Focus on Customer Value & Continuous Improvement
		D	PT	Sprints	DT highly focussed on immediate tasks; Information sharing of DT low/ limited	Observe development process (create own notifications and minimise interrupting DT)	Proactive involvement with project activities and development process beyond own responsibilities	Responsibility and Ownership
Collaboration	Feedback	M	M, PT, DE	Workshops/ events (large groups) for important topics	Diverse moods, opinions and positions; Critical for successful implementation of measures	Ask questions about relevant issues and make results visible (via anonymous responses)	Transparency by demanding honest opinions on important issues (generate real insights)	Responsibility and Ownership & Willingness to Learn
		AC	PO, SM, DT	Retrospectives	PO is supervisor/ boss of other team members; Perceived fear of repercussions	Uncover delicate (underlying) issues through skilful questioning (via anonymous responses)	Identify impediments (below the surface) and improvement opportunities	Continuous Improvement
AC: Agile Coach, M: Manager(s), TC: Technical Consultant, D: Developer, PO: Product Owner, SM: Scrum Master, DT: Development Team, PT: Project Team, C: Customer, DE: Other Departments								

Table 4. Structure of relationships between tools and mindset characteristics (Companies 1, 2, 3)

Interestingly, not all mindset characteristics were identified in the data. It suggests that some are more recognisable than others and that some hold more implicit properties. For instance, *managing uncertainty* appears difficult to translate directly into explicit tool-related activities. Presumably, it is tied to a range of behaviours that might evolve over time and thus are rather difficult to convert into singular identifiable actions. The analysis of the data further indicates the interrelated nature of agile mindset characteristics (Mordi and Schoop, 2021). The data suggests that certain *specific personal attributes* (e.g. empathy, proactivity and problem-orientation) seem implicitly present as underlying factors of the identified characteristics, for example for *responsibility and ownership*. However, these attributes were not directly mentioned and are thus interpretations and not included in the table. Another aspect to point out is the occurrence of various roles. Developers, scrum masters, product owners, managers and consultants are as much involved in appropriating technology in a mindset-related form as are agile coaches. This supports the applicability of the framework to a broad range of users.

The table represents individual accounts, it can by no means capture all details of user's actions and all contextual factors. With so many tool functions and individual choices at one's disposal, this would pose an impossible task (Lyytinen and Ngwenyama, 1992). However, the insights from the examples in Table 4 can be translated into a generic framework that represents an adaptation of the initial structuration model. Observing the underlying relationships of the model, certain abstractions were added: the implicit and explicit nature of the different components and the conversion that occurs between them. The result is presented in Figure 7 below. It captures the basic relationships of tool interactions according to the theoretical model and applies the modifications derived from the data. One modification pertains to the conversion step (practice or principle) which is contingent on individual tool appropriation and is influenced by role and context, and to some degree reliant on them. It acts as part of a translation between implicit characteristics and explicit tool features and functions.

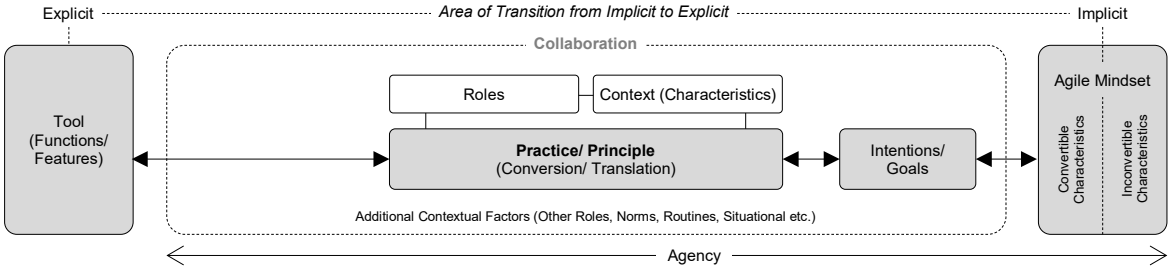

Figure 7. Framework relating tool use with agile mindset characteristics

Another element added are the intentions or goals that engender respective practices. These are conscious or unconscious results of the mindset characteristics exhibited by individuals. The final adjustment to the model is the representation of mindset characteristics, which are separated into convertible and inconvertible parts that represent respective underlying properties. This distinction evolved from the findings which indicate that some properties might be too broad and ambiguous for users to convert into single discernible tool-related human actions. Readers should recall that in the socio-technical system the properties are interrelated, therefore inconvertible characteristics could still exert influence over the others and possess indirect mandate.

Despite the modifications, the framework maintains the substance of the structuration model while emphasising and explicating specific aspects derived from the data (Lyytinen and Ngwenyama, 1992). As evident in the data, agency and context provide the means for users to exercise their tool appropriation in a specific manner. The framework delivers a means to understand the correlations of mindset and action and the processes in between in a better way. It further fosters an awareness that there are actionable means to exercise an agile mindset through digital tools and their specific features and functions.

4.2 Evaluation

The framework was exposed to a business environment where it was used for identifying mindset-related tool use. The evaluation confirmed the usefulness and applicability of the framework in its intended context, along with exposing interesting insights and challenges. The participants of the case study were able to identify specific practices that relate tool use and mindset characteristics. Examples of the evaluation process are presented in Table 5. The framework was presented to the practitioners in form of a table, which contained a pre-defined structure so that the necessary information could be entered directly. The first result was that certain tool categories (task board, workflow, documentation) were attended to much quicker than others, which needed to be brought into attention anew (communication, collaboration). An explanation for this could be a potentially skewed perception of agile activities towards the coordination aspect of managing teams (Berntzen et al., 2021). Another result was that defining context and general aim of tool use seemed easier to achieve than to express the mindset-related aspects. It should be noted, that the two columns “intentions” and “principle” were added later to the table in order to prevent information overload and allow the participants to ease into the task. Although mindset characteristics were assigned promptly, the conversion principles and the underlying reasoning for their choices demanded higher efforts and added loops of reflections and discussions. Understanding intentions and linking them to practices might prove arduous a task and thus result in less lucid descriptions. Another insight of the evaluation is the existence of two groups of agile mindset characteristics, those that could be linked (convertible characteristics) and those that remained dormant (inconvertible characteristics). What this alludes to is that in practice the characteristics *managing uncertainty, specific personal attributes* and *openness and willingness to adapt and grow* are difficult to relate to in terms of (consciously) actionable properties. They appear to have strong intangible elements which might require more in-depth contemplations on behalf of the intended audience. Concluding the evaluation, the respondents also touched on their company role and its effect on the results. As they reported from a managerial view, their tools and considerations exceed those of the development team. Therefore, they were involved with a variety of legacy tools of which they included

only a small fraction as part of the evaluation, as they were deemed less relevant for the agile practices and primarily dedicated to the demands of the traditional structures of the organisation.

Explicit					Organisational Context		Conversion/ Translation		Implicit
Tool		**User**	**Roles involved**	**Participants**	**Context/ Setting**	**Characteristics of Context/ Setting (aim of tool use)**	**Practice/ Principle**	**Intentions/ Goals**	**Mindset Characteristics**
Com	Chat	M	DT, MT	100 (across 2 locations)	Regular collaboration in large/ dispersed unit	Desired ease of collaboration; Historic communication data often necessary	Provide safe collaboration space	People can freely/ safely exchange information	Autonomy of people and teams
Coordination	Doc	M	DT	100 (across 2 locations)	Regular collaboration in large/ dispersed unit	Structured way of information storage and ease of information retrieval needed	Train and align how to structure and visualise information (of others)	Reusable knowledge repository	Continuous Improvement
	Task Board	M	DT	100 (across 2 locations)	Sprints	Required ease of concept implementation; Mapping of program strategy on regular basis	Regular mapping of story and responsibility to program/ strategy	Clear display of responsible	Responsibility and Ownership
	Task Board	M	DT	20 (across 2 locations)	Regular collaboration in large/ dispersed unit	Backlog management needed; Tool was already in use, hence adoption	Split ideas/ stories to iteratively deliver those with the most value	Value slicing for business	Focus on customer value
	WF	M	DT, MT	10 (across 2 locations)	Management meetings/ alignment	Dashboard needed for leadership; Ease of visualisation required	Clear demarcation of work ownership	Clear visualisation of ownership	Responsibility and Ownership
	WF	M	DT	100 (across 2 locations)	Planning and Sprints	Required structured workflow for all phases; Workflow managed in one place	Create transparency and clear roles	Clear visualisation of ownership	Responsibility and Ownership
M: Manager(s), DT: Development Team, MT: Management Team, D: Documentation, WF: Workflow, Com: Communication									

Table 5. Examples of results emerging from the evaluation process (Company 4)

In summary, the following critical findings of the evaluation were observed. In the process of using the framework to describe goals, practices and related mindset characteristic, it surfaced that practitioners experienced challenges to organise and articulate their approach in a precise manner. An explanation could be that implicit (ambiguous) mindset properties now need to be substantiated and verbalised, a practice seldom exercised in common work scenarios. Another aspect relates to the discovery that mindset characteristics possess convertible and inconvertible layers. This poses a challenge to relate principles and actions to mindset, as practitioners might be unaware of which layer to refer to and of what is actually actionable in terms of tools. Exacerbating this condition are individuals' different levels of understanding of agile mindset, despite prior alignment on the definition and its properties. It appears that the deeper underlying properties might be overlooked in favour of individual interpretations of the succinct titles (e.g. *Responsibility and Ownership*). Ultimately, a certain subjectivity and contextual contingency remains inherent in human-technology-interactions (Orlikowski, 1992). The identified challenges do not render the framework ineffectual but underline the importance of joint reflections and the guidance these provide for subsequent action. Despite the challenges, the evaluation proved successful in validating the application of the framework and the philosophy behind it. It should be added, that this evaluation is preliminary and calls for further evaluation of the artefact. So far, the accounts are from a limited group of individuals and subject to their understanding. More research is needed to assess whether the framework can effectively and efficiently support practitioners to better comprehend and design tool-related actions according to specific mindset properties.

5 Discussion

This study delivers contributions that seek to ameliorate human-technology interactions by integrating the socio-technical concept of agile mindset into the idea of tool appropriation. First, the framework presents a structure for associating implicit agile properties with explicit actions performed by users. A necessary obstacle to overcome is the implicit nature of holistic agile mindset characteristics and the resulting challenge to translate these into action. Hence, the framework proposes a process in which a conversion from implicit to explicit properties can materialise. This principle of conversion exists in other domains as well, exemplified in the knowledge conversion model (Nonaka, 1994). The underlying notion is that implicit knowledge can transform into explicit knowledge and vice versa through specific procedures of human interaction. Although knowledge conversion is predicated on the particular characteristics of knowledge (tacit and explicit), it stipulates the general possibility to traverse explicit and implicit boundaries (Nonaka et al., 2000). Our framework transfers this principle to the concept of agile mindset and tool use, albeit in its specific alteration.

Second, the study encourages users to approach tool appropriation from the perspective of agile mindset by linking characteristics with tool specific manipulation. The framework supports practitioners to deliberately reflect on their tool approach, desired agile mindset qualities and subsequently incorporate appropriate practices and tools. This is meaningful given the circumstance that tools are often not systematically reviewed and selected by users in agile projects, which poses the risk of having to employ tools that were inherited without regard for fit or specific context (Mordi, 2021). A consequence could be to introduce a tool reflection process that allows teams to reflect and derive relevant functions based, for example, on mindset-related intentions (Mordi, 2021). As affirmed by practice, a mindset change of leadership roles is key for the success of agile transformations (Sommer, 2019). Building on this notion, creating an enabling environment by fostering an awareness of appropriate tool utilisation and the possibility to integrate mindset properties through the proposed framework is a relevant contribution. This pertains not only to management but includes several stakeholders as potential enablers. Scrum Masters as the custodians of Scrum method implementation (Schwaber and Sutherland, 2020) could utilise the framework to design specific setups that fit individual contexts and necessities. Occupying an important role in organisations adopting agile methods (Stray et al., 2021), agile coaches could assist teams and organisations with necessary deliberations and changes to tool utilisation and tool infrastructure. By creating conducive conditions with the surrounding organisation, agile coaches can support teams to find and improve good ways of working, have a sense of autonomy and ownership and create value (Bäcklander, 2019). Thus, the framework presents itself as a useful instrument suitable for facilitating the functions these coaches and other roles adopt and exercise.

Certain findings of this study confirm initial assumptions and previous research, although this time in a novel context. For example, the participants associated specific activities of video communication with trust. This is consistent with other studies, as the information richness of video technology can contribute to the development and maintenance of trust (Olson and Olson, 2014), especially at the early stages of team development (Kirkman and Mathieu, 2005). Another example pertains to autonomy of people and teams, enabled through safe collaboration spaces in instant messaging tools. Correspondingly, research confirms the relevance of instant messaging for enabling autonomy of teams, autonomy further being a prerequisite for successful agile teams (Stray and Moe, 2020). Knowledge sharing was reported as a vehicle to achieve continuous improvement, realised here through communication and documentation tools. This falls in line with previous research which highlights the use of appropriate technology and practices as a success factor for knowledge sharing in computer-mediated environments (Rosen et al., 2007).

Emerging from this research are limitations as well as opportunities for future research. This study represents a base level on which to further flesh out the framework and deliberate on tool appropriation from a mindset perspective. As the research question is relatively broad, the results presented here cover broad tool scenarios. Future research could build on the framework and select specific tools and contexts to extend and enrichen our understanding based on individual levels of underlying mindset properties. For example, more refined research questions could be derived that examine how a specific role addresses a specific mindset characteristic with a given tool infrastructure. The interconnectedness of mindset characteristics also introduces the question of hitherto unidentified relationships within the framework. Existing tool and mindset relationships could emerge as antecedents of other mindset characteristics, for example task boards and trust for responsibility and ownership, or vice versa (Malhotra et al., 2007). Dependencies with interrelated mindset properties might also exist indirectly. Ownership for instance, has an influence on other factors such as shared leadership and team performance (Gu et al., 2021). Another limitation of the current research is its short-term view of user engagement with technology, which might limit the applicability of the framework. Follow-up longitudinal studies along with quantitative evaluations are proposed in order to capture more long-term aspects of tool utilisation and changing organisational context. An additional aspect to elucidate is the demarcation of convertible and inconvertible mindset characteristics. This juxtaposition is contingent on the available data, which generated no (direct) tool links with three agile mindset properties: *specific personal attributes*, *openness and willingness to adapt and grow* and *managing uncertainty*. It suggests that some properties do not lend themselves to discernible technology appropriation and may not be able

to cross the boundaries of implicitness in an explicit tool-related manner. As the framework gets exposed to more data and to additional contextual information, more insights on these aspects will be gained. Limitations also exist regarding the collected data, as it only contains the views of those queried. Compensation for this limitation was attempted by involving a diverse group of companies (size, culture, locations, environments, markets) and participants (roles, education, culture, agile experience, personal background).

The participants raised the question what the limits of tool deployment in agile ecosystems are. General concern was expressed over the heavy use of software in agile settings, even mentioning that the currently established tool infrastructure goes against agile values, citing the necessity to regularly feed numerous tools and questioning the added value of this salient challenge to agile principles (P16, Manager). Based on our findings, we advocate to capitalise on the merits of corporeal copresence (Zhao, 2003), reflect tool utilisation and to appropriate tools and corresponding practices only if they are rendered useful. Digital stress is a factor to consider in tool-supported environments and has an impact on people and performance (Gimpel et al., 2019). An in-depth engagement with tool saturation and limits of tool adoption in agile environments is thus an important avenue of future research. Tools are created by humans in a specific context, which influences how tools are designed (Orlikowski, 1992). This entails that tool developers could design products facilitating mindset characteristics by familiarising themselves with the framework and its principles. Information technology needs to be built around humans and their behaviour as the centre of design considerations (McDermott, 1999). Thus, practitioners and developers now have guidelines on how to adopt and appropriate tools with mindset properties in mind. For instance, knowledge-sharing and trust play a significant role for collaboration and performance in virtual teams (Alsharo et al., 2017). They also constitute properties of an agile mindset that can be leveraged through the proposed framework. Approaching tool use from a novel perspective of mindset characteristics might pose an initial challenge. However, it can create awareness for human-centred technology interaction and engender important reconsideration of prevalent practices. This applies to academics as well, who already utilise project management tools to their benefit (Nowogrodzki, 2020).

The results of this research are not limited to virtual teams; they are conducive to co-located settings as well. It can be expected that tool use will not subside in future and that technology-dependent settings will gain significance in organisational contexts (Baptista et al., 2020). This also implies that future technology such as augmented and virtual reality as well as artificial intelligence (AI) will potentially play an important role for agile concepts (Hoda et al., 2018). Thus, an important research agenda for the agile community is to develop AI to the benefit of mindset characteristics. Such calls include new forms of hybrid socio-technical systems such as metahuman systems, which ultimately will need to integrate agile mindset properties into work systems (Lyytinen et al., 2021).

6 Conclusion

The nature of a task will often determine the choice of technology and the organisational arrangements needed to enable completion (Zammuto et al., 2007). This research proposes a novel approach to tool use by incorporating agile mindset characteristics. The novel approach is solidified in a framework that allows users to translate implicit properties of agile mindset into explicit tool-related action through specific practices. An important aspect to recall is that tools should merely assume the role of facilitators and not take precedence over human-factors (Beck et al., 2001). To render this possible, technology and necessary arrangements should be determined not only by the nature of the task, but by the nature of agile mindset practices as well. This principle is encapsulated in the proposed framework, which aims to fortify agile values in a world of increasing digitalisation and workplace transformation. The artefact presented in this study embodies the result of the first iteration of the design science loop and through its communication we intend to gain further insights which to incorporate in the next evolutions of the framework (Vom Brocke and Maedche, 2019). Our artefact supports agile transformations by enabling people to make sense of implicit mindset properties and explicit applications; because ultimately, “to make sense is to connect the abstract with the concrete” (Weick et al., 2005).

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