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Understanding the Influence Mechanisms in Agile Collaboration: A Network Analysis

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Abstract

This research investigates the complex mechanisms that influence successful agile collaboration in product development environments. Despite the widespread adoption of agile methodologies, many organizations struggle to identify and address the critical factors that impact team performance and challenge resolution. The study applies Blessing and Chakrabarti's Design Research Methodology, specifically utilizing the Reference Model, to construct and validate a comprehensive network of influencing factors. The research distinguishes between directly controllable factors (e.g., team size, communication frequency, physical workspace configuration) and indirectly influenceable factors (e.g., trust, team cohesion, psychological safety). Through hypothesis-driven network analysis, the study maps the relationships between these factors and examines how interventions targeting controllable elements cascade to affect the more intangible aspects of agile collaboration. Mixed-method validation studies are employed to assess these hypothesized relationships in diverse organizational contexts. Preliminary findings suggest that strategic manipulation of specific controllable factors can produce measurable improvements in traditionally difficult-to-influence team characteristics. This work contributes to both theoretical understanding of agile collaboration dynamics and provides practical guidance for teams seeking to optimize their agile implementation. The resulting validated model offers a diagnostic framework for identifying leverage points where targeted interventions can most effectively address collaboration challenges and enhance overall team performance in agile product development environments.

Keywords: Agile Collaboration; Influencing Factors; Agile Product Development;

1. Introduction

Agile approaches have become an integral part of product development as organizations seek to remain competitive in increasingly dynamic and uncertain environments. Nevertheless, practice shows that agile collaboration often encounters persistent obstacles. Challenges such as insufficient communication, unclear responsibilities, lack of trust, and resistance to change point to the fact that the effectiveness of agile methods cannot be explained by individual factors in isolation [1, 2, 3]. Instead, they result from a complex interplay of mechanisms [4] that cut across organizational, team, and individual levels [5]. Despite substantial progress in the field, the underlying dynamics of these mechanisms remain insufficiently understood, limiting the ability to systematically design context-specific support for agile teams.

The long-term ambition of this research is therefore to provide situation-specific guidance for agile product development teams by establishing a deeper understanding of the mechanisms of action that shape collaboration. The more

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immediate objective is to develop a reference model of agile collaboration mechanisms, which integrates influencing factors and their interdependencies into a coherent structure. This model aims to serve both as a conceptual foundation for theory building and as a diagnostic tool for practice, offering a systematic basis for identifying success factors depending on the specific context. Accordingly, this study examines how relevant factors and interdependencies shape agile collaboration and how a structured model can represent these relationships to enable systematic analysis and support the identification of factors that are most critical for improving team collaboration.

2. State of Research

This section synthesizes the scientific discourse on agile product development by first examining its conceptual foundations and then analyzing the prevalent problems and challenges in agile collaboration.

2.1. Agile Product Development

Agility is commonly defined as the continuous readiness of an organization to rapidly initiate change, embrace it proactively or reactively, and learn from it while generating customer value [6]. It represents a cultural and structural foundation of an organizational capability to address uncertainty and complexity within a dynamic and volatile development environment [4] through iterative learning, goal adaptability, responsiveness to environmental changes, and transparent collaboration within and across teams [7].

Agile methods such as Scrum or Extreme Programming, originally rooted in the software domain, promise to operationalize this capabilities through greater responsiveness, stronger self-organization, and improved knowledge sharing throughout development cycles [8]. Their application in mechanical and mechatronic product development [9] requires contextual adaptations due to physical prototypes, disciplinary interdependencies, and extended iteration cycles [10]. Consequently, agile product development can be understood as a contextualized implementation of agility, which pursues the goal of aligning organizations with essential characteristics such as self-organization, transparency, flexibility, and learning ability [11].

Within this context, success factors at organizational, managerial, project, and individual levels have been identified in systematic literature reviews and visualized in agility maps These structural success factors include flat hierarchies, empowering leadership, small and self-organized teams, iterative processes, continuous reflection, and individual competencies. [12] To operationalize these conditions, various frameworks such as Scrum, Extreme Programming, or Design Thinking are embedded into development processes. Despite their shared values, however, the diversity of frameworks complicates their contextual application, as the underlying goals and principles of these frameworks are often not sufficiently clear. A limited understanding of their mechanisms of action may lead to the uncritical transfer of success stories from software development without the necessary adaptation to engineering-specific constraints [10].

In this sense it is crucial to examine and thoroughly understand these mechanisms of action, which can be understood as the dynamic interplay of multiple influencing factors within adaptive process environments [4]. Recent research has therefore shifted towards identifying and assessing such influencing factors to explain why agile practices succeed or fail in daily use. For example, studies on the Daily Scrum Meeting have highlighted seven interrelated factors as critical for its effectiveness [13]. These data-driven approaches provide a systematic basis for understanding the actual effectiveness of agile practices in engineering contexts.

2.2. Problems & Challenges in Agile Collaboration

Despite the advantages of agility, numerous challenges arise in its practical implementation, particularly when applied in interdisciplinary and geographically distributed product development contexts. One major issue concerns communication, which is constrained by limited informal interactions and digital distance, often leading to misunderstandings, coordination problems, and increased planning effort. [1, 2, 3, 16].

Another persistent problem is unclear roles and responsibilities. Research has shown that responsibilities need to be fundamentally redefined in agile teams [1]. A lack of role clarity often leads to coordination problems and delays in decision-making, especially when new frameworks are introduced [15]. Furthermore, new roles are frequently perceived by employees as stressful [18, 19]. Leadership positions are particularly affected by this uncertainty, as managerial responsibilities tend to shift substantially without clear guidelines, often leaving leaders overburdened and teams disoriented [1, 17].

A third core challenge is the lack of trust within and across teams. If trust is missing, transparency and security deteriorate, creating friction in collaboration [2, 3]. Trust is not always established at the team level and is especially fragile in distributed settings, where reduced informal communication hampers the establishment of shared understanding [2, 16]. On the organizational level, building trust between partners is equally critical, yet often difficult due to institutional constraints and competition [18].

Finally, resistance to agile methods frequently undermines agile transformation initiatives. Agile approaches are not universally applicable but must be adapted to organizational conditions to achieve acceptance; otherwise they encounter scepticism and rejection [2, 17]. Established routines and practices, likewise deeply ingrained cultural attitudes and traditional patterns of thinking, tend to conflict with agile principles and hindering their adoption [2, 16, 20].

3. Research Gap & Target

The transfer of agile methods from software development to engineering domains often occurs without a sufficient understanding of the underlying mechanisms of action. As a result, recurring challenges such as unclear roles, communication barriers, lack of trust, or organizational resistance frequently hinder effective collaboration in agile teams. Existing studies have improved the understanding of benefits and limitations of agile approaches, but they typically examine such challenges in isolation. What remains missing is an integrative and validated model that captures the mechanisms of action and the interdependence among influencing factors. Without such a model, it is difficult to explain why practices succeed in one context but fail in another, and to derive situation-specific support for agile teams.

Within the scope of the present research effort, the objective is to develop a reference model of the mechanisms of action for agile collaboration, incorporating relevant influencing factors and their interrelations. This model is expected to provide a foundation for explaining how agile practices generate their effects and for guiding subsequent identification of key factors for successful collaboration. This research effort addresses the following research questions:

1) Which influencing factors and interdependencies determine the mechanisms of action in agile collaboration, and how should a reference model be structured to represent them?
2) How can key influencing factors be derived from such a reference model to provide targeted guidance for agile teams?

Research Methodology

The methodological approach follows the Design Research Methodology (DRM) [22], which provides a structured framework for analyzing design processes through networks of influencing factors and their interdependencies. Two conceptual models guide this approach: the Reference Model, which captures the current state of a design situation, and the Impact Model, which defines the desired state and anticipated improvements. Together, they support both explanation and prescription, offering scientific insights and practical guidance. Building on this foundation, the present study develops a reference model of agile collaboration mechanisms. The development starts from an initial model, which is iteratively refined through the systematic identification and prioritization of influencing factors (see Fig. 1). Relevant factors are derived from the Agility Map, complementary literature, expert assessments, and field studies. To ensure completeness, the factors are reviewed according to the MECE principle and represented in a network structure inspired by DRM, enabling dependencies to be visualized.

The factors are subsequently assessed regarding their influenceability in agile teams and their measurability through suitable indicators. This evaluation makes it possible to identify actionable levers for change. To classify their scope of action, factors are further mapped to organizational levels following the St. Galler Management Model [24, 25], extended by Lindemann's tactical level [5]. This structuring clarifies where interventions are likely to have the strongest impact.

To validate major agile collaboration challenges identified in the existing literature and detect additional relevant challenges, empirical data was collected through two consecutive surveys. The first survey involved six developers from an electrical engineering agile team and qualitatively explored the occurrence of challenges in agile collaboration. The second survey gathered quantitative data from 29 participants across 13 industries, most with 1–5 years of agile experience and roles ranging from team member to team leader and focused on evaluating and prioritizing the identified challenges. This step aims to verify the reference model's practicability and capability to explain these challenges. The resulting insights inform the refinement of the initial model and the derivation of prioritized influencing factors, forming the basis for identifying key levers for targeted interventions.

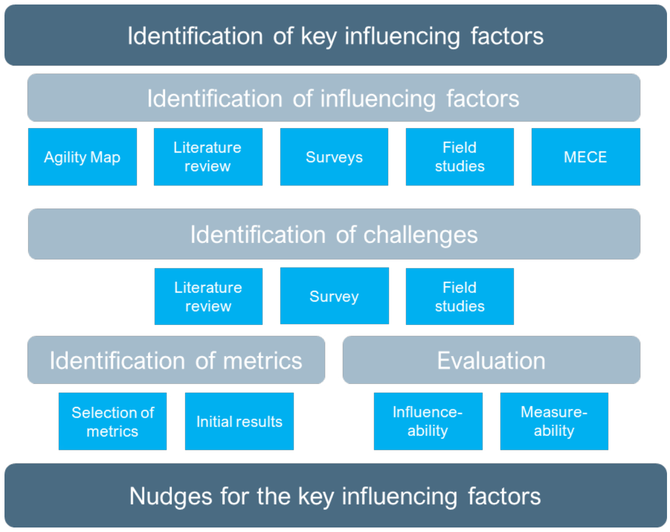

Fig. 1: Methodical approach for the identification and analysis of influencing factors in agile collaboration.

4. Findings

4.1. Surveys Evaluation - Key Challenges and Problems in Agile Collaboration

To identify key challenges in practice, two online surveys were conducted using Likert scales and free-text fields. The initial survey qualitatively examined issues described in the literature within an agile, practice-oriented team of six developers (electrical engineering) with 5–10 years of experience and three years of agile practice. A second survey quantitatively validated these findings, involving 29 participants from 13 industries, including automotive, aerospace, electrical engineering, and IT. Most respondents worked in companies with more than 250 employees, had 1–5 years of agile experience, and represented both team members and team leaders.

The initial survey indicated challenges, including excessive work-in-progress (WIP), technical legacy issues, and frequent interruptions, can present significant obstacles for agile teams. The second study confirmed these challenges as dominant and additionally highlighted deficiencies in the availability of information and general inefficiencies in agile collaboration, regarding the number of mentions in the survey. The subsequent qualitative evaluation identified further issues, including language barriers, silo thinking, unsuitable team size, unrealistic goal planning and setting, priority changes due to ad hoc issues, and various other challenges. The qualitative evaluation thus reveals a broad portfolio of different challenges and shows that challenges such as unrealistic goal planning and setting could indicate that agile methods, such as sprint planning, are used but may not be fully understood in terms of their effectiveness, which makes their adequate use difficult and thus leads to the challenges. Changes in priorities due to ad hoc issues or silo thinking may originate from a lack of flexibility and transparency. While frequency of mentions indicates of its perceived "importance," subjective weighting varies across teams and organizations.

4.2. Identification of Influencing Factors

A variety of approaches were pursued to identify relevant influencing factors in agile team collaboration, following a multi-stage procedure that combines theoretical and empirical elements. Key factors were identified through literature review, surveys, and expert interviews. This review, for example, reveals seven key influencing factors that contribute significantly to the effectiveness of daily scrum meetings , including time management, team participation, meeting structure and goal orientation, communication quality, handling of obstacles and dependencies, and team dynamics. [13] Further factors were integrated from literature on VUCA-related challenges [4], which can typically be traced to information, knowledge, or communication problems. By applying North's knowledge ladder [21], additional factors such as communication quality, accessibility and interpretability of information, and implicit and explicit knowledge were derived. Based on the AM – Agility Map by Schöck et al. [12], further relevant factors such as transparency of task status, degree of system complexity, and scaling of agile practices were identified. Expert interviews added practical insights, while the two surveys confirmed recurring issues such as excessive work in progress, frequent interruptions, suboptimal availability of information, and potential for improvement in communication, from which additional factors were derived.

The list of influencing factors is not exhaustive and will continue to be refined in further studies.

4.3. Assessment of Influenceability and Measurability

To identify actionable levers within agile collaboration, the influencing factors identified in section 4.2 were assessed with respect to their influenceability and measurability. This distinction clarifies whether a factor can be directly controlled through organizational or team-level interventions, or whether it is only indirectly influenceable and thus requires long-term cultural or structural adjustments.

Directly controllable factors include, for example, team size, communication frequency, or the configuration of the physical workspace. These can be adjusted relatively quickly and allow for immediate observation of their effects. Indirectly influenceable factors, on the other hand, such as trust, team cohesion, or psychological safety, cannot be directly imposed but can only be fostered over time through leadership behavior, organizational culture, and repeated team interactions.

By additionally evaluating the factors with respect to their measurability, it becomes possible to determine which of them can be empirically captured through suitable indicators. The combination of these two perspectives enables a structured differentiation between factors that can serve as immediate levers for targeted interventions and factors that require systemic, long-term approaches.

This assessment thus provides an essential foundation for deriving the key influencing factors in the subsequent analysis.

4.4. Structural Mapping of Influencing Factors in the Reference Model

For the structural design of the identified influencing factors, the authors based their approach on the reference model described by Blessing and Chakrabarti in ([20], section 2.4.1 (pp. 20-24), figures 2.3 and 2.4.). The aim was to map the current situation based on the identified challenges. Building on this, the dependencies between the influencing factors identified from the multi-stage approach were mapped and weighted in the reference model. The relationships were derived through a combined procedure integrating literature-based causal links, expert assessments, and empirical indications from the surveys. Weighting followed a consensus-based expert rating of expected influence strength. This ensures methodological transparency and aligns with the subsequent Main Model in which causal relations and factor attributes are systematically consolidated. An exemplary representation of the structure is illustrated in a simplified form in Fig. 2.

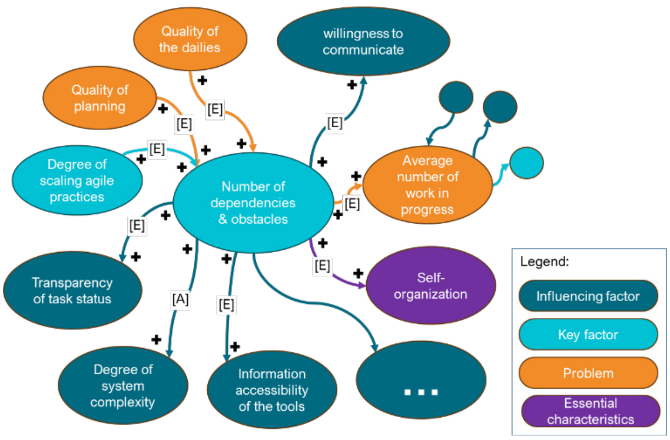

Fig. 2. Exemplary mapping of influencing factors and problems in agile collaboration.

The objective of the structural representation is twofold: first, to more clearly illustrate the mechanisms of action and interactions of the influencing factors; and second, to better develop an understanding of these factors. In order to develop and propose concrete support in an agile organization, the origin of the identified challenge must be examined and clarified, as well as the impact of the anticipated measures to overcome the challenge.

In the context of organizational analysis, it becomes evident that organizations function within complex and dynamic system boundaries that also interact with their environment in a variety of ways [24, 25]. To enhance comprehension of this dynamic and complex system and develop effective support, as well as to understand the mechanisms of action across all hierarchical levels of an organization, the reference model was expanded to include a level structure based on the St. Galler Management Model. The three-part structure of the model is characterized by the ability to subdivide into three distinct levels: the normative, strategic, and operational levels. The structural architecture of these levels, as understood by the authors, is expanded to include an additional level, referred to as the tactical level [5], which is located between the strategic and operational levels. A simplified representation of the levels is illustrated in Fig. 3.

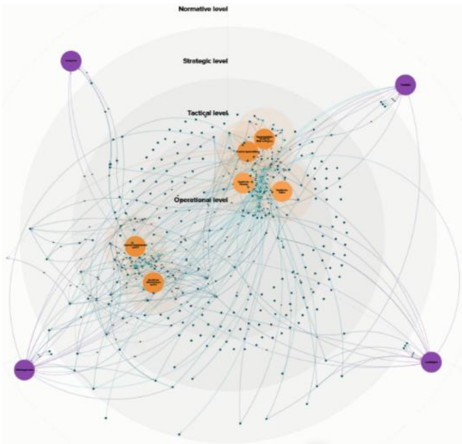

Fig. 3. Structural mapping of influencing factors across organizational levels.

In an agile organization, interactions and mechanisms of action can extend across all hierarchical levels due to the close interconnection of influencing factors. Consequently, it is necessary to identify the root of a challenge and its effects to effectively design a specific intervention at the most appropriate level. It is important to acknowledge that not all interventions are equally effective, can be implemented immediately, or have an immediate effect across the levels. The initial impact of a specific intervention at the operational level (e.g., modifying a routine of the daily meeting) is more rapid in comparison to the effect of a change at the normative level, where the fundamental norms and values of an organisation are established.

4.5. Identification of Key Influencing Factors

The second research question addresses how key influencing factors can be derived from such a reference model to provide targeted guidance for agile teams. We address this by extending DRM with a lean network-analytic procedure. Once the model's mechanisms of action are understood, we trace those factors most promising for improving agile collaboration. We prioritize factors that are both structurally central and practically influenceable. As a simple first step, we combine degree-based centrality with the previous assessed influenceability. Degree centrality counts the number of ties a node has and is the classic indicator of local connectedness ("hubs") [24, 25]. We also report indegree (incoming ties, often interpreted as how much a node is acted upon or "receives") and outdegree (outgoing ties, often interpreted as how much a node acts upon others or "broadcasts") [25].

Top 10 factors by degree (current reference model): Implicit knowledge level of the developer (19 degree); quality of communication (17 degree); number of dependencies & impediments (16 degree); average amount of work in progress (WIP) (14 degree); quality of structure and goal orientation (14 degree); developer's ability to act (agency) (14 degree); explicit knowledge level of the organization (13 degree); quality of team participation (13 degree); quality of team dynamics (12 degree); information availability (11 degree).

The result is not a static, universally valid list of key influencing factors but a context-sensitive procedure for deriving key influencing factors from the evolving reference model. By pairing DRM constructs with basic network metrics, the approach creates a transparent, well-grounded path from practical challenges to actionable interventions – first by surfacing structurally central nodes, then by filtering for factors that teams can realistically influence in the near term.

5. Discussion

This study contributes a reference model that articulates the mechanisms of action in agile collaboration and a procedure for deriving key influencing factors from that model. By combining DRM with a lean network-analytic prioritization – teams can move from concrete challenges to actionable levers, offering a structured alternative to generic best-practice lists. The results underscore that effectiveness in agile collaboration emerges from interdependent mechanisms rather than isolated practices, and they provide a transparent path that links observed challenges to measurable outcomes via clearly identified levers.

At the same time, limitations point to further work. First, the current model is only partially weighted and includes hypothesized relations; iterative validation with empirical data and longitudinal observation is required. Second, our prioritization method intentionally uses a minimal metric set (degree + influenceability). While this supports interpretability and speed, alternative metrics (e.g., weighted degree/strength, betweenness, MICMAC, or eigenvector-like measures) and alternative ranking logics may yield different orderings and should be explored as robustness checks. Third, despite a MECE-oriented factor review, completeness can only be provisional; the reference model should be treated as a living artifact that evolves with accumulating evidence. To foster transparency and collaborative improvement, the current version is openly available and intended to mature as researchers and practitioners apply it in different contexts.

Finally, identifying key influencing factors is necessary but not sufficient; value accrues only when levers are translated into viable interventions that fit organizational constraints. The diagnostic procedure presented here therefore needs to be complemented by systematic solution design and testing, including explicit measurement plans and feedback loops.

6. Conclusion & Outlook

We presented a reference model of agile-collaboration mechanisms and a context-sensitive procedure for deriving key influencing factors. The model integrates heterogeneous factors into a coherent, analyzable structure; the procedure uses a minimal prioritization method combined with influenceability – to move from challenges to actionable levers. The findings demonstrate that agile collaboration is shaped by a network of interdependent factors whose structural configuration can be systematically represented and analyzed. The study further shows that identifying practically influenceable and structurally central factors provides a reliable basis for deriving targeted guidance for agile teams.

Looking ahead, the next step is the validation of the proposed approach. Beyond diagnosing challenges and problems, the approach must be extended toward solution development, for example through targeted interventions such as nudging. To support this, a so-called Nudge Navigator will be developed as methodological guidance for designing interventions to the identified key influencing factors. The solution will be validated in practice through specific interventions, e.g. in form of nudges. In this way, the model can mature from a diagnostic tool into a practical framework that not only identifies but also addresses collaboration challenges, thereby contributing both to scientific understanding and to actionable improvement in agile product development.

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