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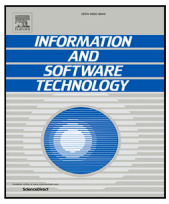

Data-Driven Agility: Assessing Agile Culture transformation in a technology organisation

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ABSTRACT

Context: Gaining an understanding of the state of an organisation's culture during Agile transformation is important because culture underpins all aspects of an organisation's way of working and can indicate how successful the transformation has been.

Objective: This paper explores the impact of Agile transformation on various dimensions of organisational culture over time within a technology organisation. Additionally, it demonstrates how datasets collected using the Pulse survey instrument, a tool for assessing an organisation's culture, can be analysed to provide actionable insights to support organisations in their cultural transformation efforts.

Methods: This paper employs a mixed research method to conduct a post-hoc analysis of the datasets obtained from a technology organisation that utilised the survey instrument in 2021 and 2022 to assess its transformation agenda. The collected data were analysed using descriptive and inferential statistics. We also assess the internal reliability and validity of the instrument using Cronbach's Alpha, Composite Reliability, factor loadings and Average Variance Extracted.

Results: Results show that all the Alpha values of the instrument fall between 0.744 and 0.901, which are higher than the satisfactory value of 0.700, indicating acceptable to excellent reliability. After the intervention, the targeted cultural area, that is, Trust and Transparency (TT) improved significantly, and there was a general improvement across almost all areas. The organisation found the insights provided by the survey instrument aided their understanding of the change process.

Conclusion: This study presents an analysis framework to support organisations using or seeking to use the Pulse survey instrument in their efforts to transform culture. The findings validate the use of statistical analysis and data-driven approaches to track shifts in various dimensions of organisational culture over time. The study concludes that targeted efforts on culture elements can lead to corresponding improvements in many areas including those not targeted, emphasising the interconnectedness of Agile culture elements.

1. Introduction

1.1. Motivation

Agile culture is a collection of beliefs, principles and behaviours related to the Agile methodology in the context of software development, project management, and general business agility [1]. According to Kuchel et al. [2], Agile culture embodies the behaviours of individuals in an organisation who apply Agile practices, guided by the values and principles outlined in the Agile Manifesto and the frameworks of Agile methodologies. The Agile Business Consortium (ABC) [3], defines Agile culture as a work environment built on values, behaviours, and practices that empower organisations, teams and individuals to be more adaptable, flexible, and resilient when navigating through complexity, uncertainty and change. Adopting Agile culture necessitates a significant organisational transformation that goes beyond incorporating new procedures and includes adjustments to processes, cooperation, conventions, mentality, behaviours, and business units [4]. Karvonen

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et al. [5] suggest that Agile change can focus on operational, strategic or cultural aspects of agility. However, holistic transformation towards organisational agility necessitates a very sophisticated and unique interplay of all of these elements. This interplay can lead to tensions during transformations [6]. According to Agile professionals and scholars in [7–9], aligning organisational culture with Agile concepts is a critical determinant of the successful implementation of Agile methodologies. The outcomes and impacts that emerge from this alignment serve as indicators of the level of Agile culture adoption within an organisation. Šmite et al. [10] noted that Agile culture is characterised by a commitment to iterative development, collaboration, and flexibility. Kuchel et al. [2] identified seven key challenges that arise from the interplay between organisational culture and Agile practices: respectful treatment between individuals, agile leadership, trust in interactions, a learning culture, rigid hierarchies, involvement of all organisational levels, and undervalued feedback. Altuwaijri and Ferrario [11] maintains that rigid hierarchical structures significantly hinder the development of Agile culture, particularly in optimising value-based work and fostering a learning environment. The transformation from a traditional "boss" culture to a "leader" culture, where management exemplifies the values needed for Agile practices, is crucial for fostering self-optimisation, feedback, and learning within Agile teams. This attitude places a strong emphasis on the value of adaptability and team-centricity in the development and delivery of products and services.

Research by Naveed et al. [12] and Jivan et al. [13], highlights that an organisation's values, presumptions, and beliefs have a substantial impact on how it accepts and maintains change. Lee et al. [14] argue that organisations fostering strong and supportive cultures are better positioned for the successful adoption of innovative methodologies. According to these scholars, organisations that prioritise adaptability, innovation, and employee involvement have a higher chance of effectively implementing Agile concepts. Jovanović et al. [15] suggest that successful Agile culture alignment demands organisational cultural transformation. This transformative process involves cultivating a cultural shift that values cooperation, openness, and continual development alongside the implementation of Agile methods. Their research highlights the vital role of committed leadership in driving cultural change and fostering an environment conducive to Agile practices.

Models for implementing and monitoring an Agile culture serve as a guiding framework for organisations seeking to cultivate an Agile mindset and practices, according to Limaj & Bernroider [16]. To assist organisations in understanding where they are in their Agile transformation, the ABC developed an Agile Culture Matrix in 2018 using a practitioner-led, interdisciplinary, collaborative workshop approach [17]. The group of practitioners involved in the development of the matrix came from a range of different backgrounds including Lean Six Sigma, psychology, systems thinking, project management, and organisational development. Alongside the matrix they also created an assessment instrument, the Pulse Survey, designed to provide organisations with a data-driven assessment of their culture [4]. An internal experience report by the ABC describes its application, but so far, there has been no empirical analysis examining the use of the Agile Culture Matrix (ACM) and the Pulse Survey. This study aims to fill this gap by analysing data resulting from the application of the ACM and the Pulse survey toolkit in an organisation undergoing Agile transformation.

1.2. Research overview

This study aims to assess the impact of Agile transformation on the cultural dimensions of an organisation over time using a data-driven approach. Rather than simply analysing the current state of Agile culture, the research investigates how Agile practices influence key cultural elements such as leadership, collaboration, trust and adaptability. Additionally, this study demonstrates how organisations can leverage Pulse Survey data to monitor cultural evolution and guide Agile transformation efforts. The internal reliability and validity of the Pulse Survey is to be examined, but the main focus of the research remains on understanding Agile culture shifts and providing actionable insights for practitioners. The research aim is to understand how companies can use the Pulse Survey and analyse the resulting data to help improve their Agile transformations. To address this, the study focuses on the use of the instrument in the technology company described above.

The research questions guiding this study are:

(i.) How reliable is the Pulse survey instrument? (ii.) What areas of the organisation's culture are well-aligned with Agile culture, and which require improvement? (iii.) How have perceptions of the organisation's culture changed since the last survey? (iv.) Can targeted efforts on specific elements of the culture matrix contribute to a corresponding increase in other Agile culture elements?

The three contributions of the research are: (a.) Validation of Tools: The study assesses the internal reliability and validity of the ABC's Agile Culture Matrix and the 35-question Pulse Survey Instrument. This establishes how well all the statements for each Agile culture element measured the respective construct. (b.) Empirical Insights into Cultural Changes: By applying the Pulse survey instruments to a technology organisation, the research provides concrete data on how different dimensions of organisational culture evolve over time due to Agile practices. This helps organisations understand specific cultural shifts and manage them effectively. (c.) Analytical Framework for Continuous Improvement: The study presents a comprehensive framework for analysing Pulse data, offering actionable insights. This framework aids organisations in continuously monitoring cultural changes and making informed adjustments to their Agile transformation strategies.

The subsequent sections are organised as follows: Section 2 presents the background, Section 3 delves into the related studies, Section 4 outlines our methodology. Section 5 presents the results, which are arranged according to the elements of Agile Culture Matrix. Section 6 discusses our findings in relation to answering the research questions, Section 7 provides retrospective reflection, while Section 8 offers conclusions and recommendations for future work.

2. Background

2.1. Agile culture matrix

The Agile Culture Matrix (ACM) serves as a comprehensive model focusing on the alignment of Agile principles with organisational culture. It visually presents key cultural dimensions and their compatibility with Agile values (Fig. 1). Gregory & Taylor [4] underscore the significance of this culture matrix in elucidating how specific cultural attributes can either facilitate or impede the adoption of Agile practices. Seven fundamental elements of Agile culture emerged from a combination of literature review and workshops, forming the foundation for the ACM. These elements encompass:

- Purpose and Results (PR): This element emphasises the importance of a clear and meaningful purpose for the work being done. It focuses on delivering tangible and valuable results in alignment with organisational goals.
- Agile Leadership (AL): This element highlights the role of leadership in supporting and enabling Agile practices. It encourages leaders to facilitate collaboration, remove obstacles, and promote a culture of continuous improvement.
- Well-being and Fulfilment (WF): This culture element acknowledges the significance of team members' well-being and job satisfaction. It stresses the importance of creating an environment where individuals feel fulfilled in their roles.
- Collaboration and Autonomy (CA): This element highlights the balance between fostering collaboration and providing individuals with autonomy. It encourages cross-functional collaboration while allowing team members the freedom to make decisions within their areas of expertise.

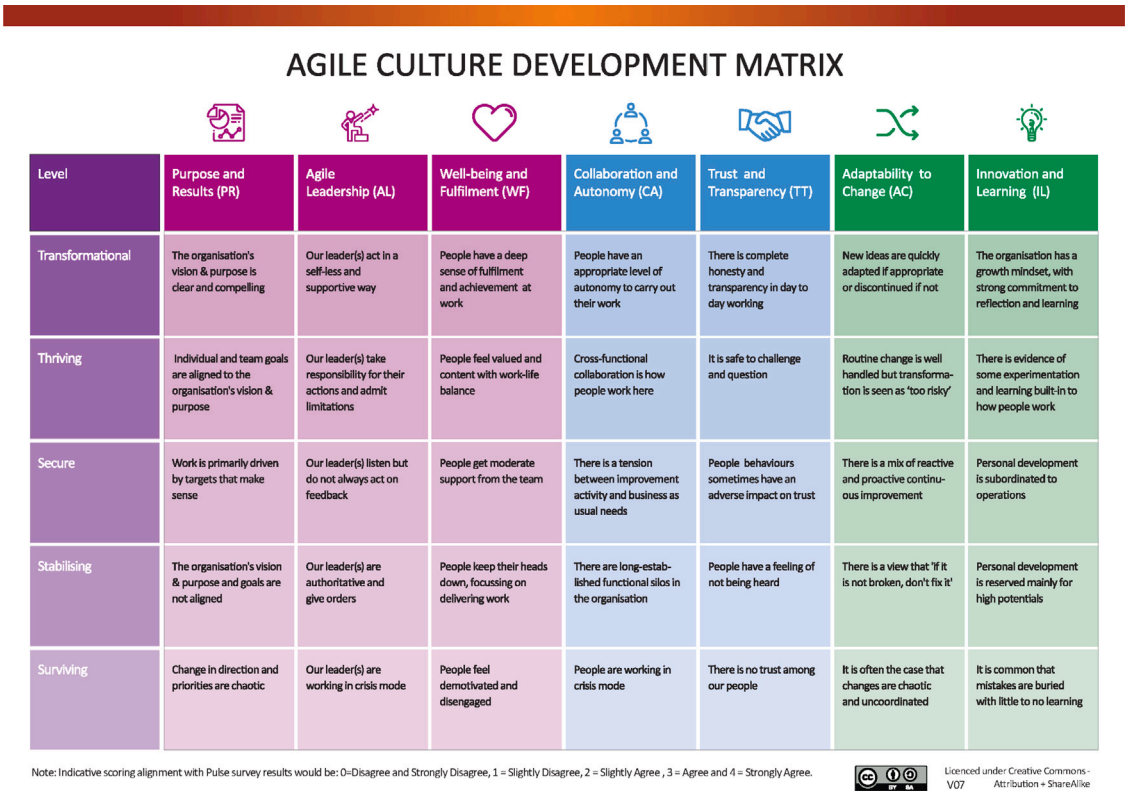

Fig. 1. Agile culture matrix, [17].

- Trust and Transparency (TT): This element promotes a culture of trust among team members and with stakeholders. It encourages transparency in communication, decision-making, and progress reporting.
- Adaptability to Change (AC): This element recognises the inevitability of change and the need for a flexible mindset. It encourages teams to adapt quickly to changing requirements, customer feedback, and market dynamics.
- Innovation and Learning (IL): This element emphasises a culture that values continuous learning and improvement. It encourages experimentation, creativity, and the pursuit of innovative solutions.

The ACM has evolved into a practical toolkit, incorporating the Pulse survey (a Likert-scale questionnaire aligned with the principles set out in the ACM) and a Coaching Toolkit, which is designed to guide the organisation towards adopting and strengthening Agile practices, enhancing team collaboration, and fostering a culture that aligns with Agile values and principles. Over time, iterative improvements have been made to all these elements based on feedback and real-world application.

2.2. Pulse survey

The Pulse Survey [17] is a questionnaire consisting of 35 statements, grouped into seven categories that correspond to the elements of the ACM (Table 1). This tool, which is in English, gathers participants' perspectives on how well their organisation adheres to the principles outlined in the ACM. The instrument was developed by a group of ABC members who conducted literature review which identified theoretical underpinnings followed by multiple practitioner workshops, involving experienced Agile practitioners with substantial expertise in Agile culture transformation [4]. Each category within the matrix includes five statements for respondents to evaluate. The statements are assessed using a Likert scale where 1 means strong disagreement and 5 means strong agreement. This design allows for a detailed and nuanced understanding of the organisation's alignment with Agile cultural principles. Within the context of this instrument, 'Manager' is the person in an immediate position of authority to the participant. 'Senior Leader' is a person who has an impact on the participant's role, but they are not a direct manager. 'Leader' refers to the overall culture of leadership in the participant's organisation.

2.3. The technology organisation in context

The organisation described in this paper is Australian and wishes to remain anonymous. For the purposes of this paper, it is referred to as "Company X". Company X manages a group of technology centres, including postal & telecommunications services, financial services/professional services, public service, commerce and utilities (water, gas, electricity), and has around 60 staff. The company worked with the ABC from 2021–2022 as part of a move towards more Agile ways of working. The directors at the organisation were keen to take their group's agility to the next level. They used the services of the ABC to help them do this.

The organisation believed that their core values were already aligned to Agile working. The CEO had been inspired by Peter Senge's 'Learning Organisation' ideas, particularly focusing on systems thinking and other elements like personal mastery and team learning. Despite progress, they felt they had reached a limit, with a sense that the company could do more but not sure where or what to focus on. They turned to the ABC and Pulse Survey for insights, particularly because of its focus on Business Agility and culture, which was crucial for their telecom business operating in a turbulent market. The focus was on getting things 'RITE' – this acronym shows a focus on:

- Respect: The focus on trust and respect necessary for an Agile culture.
- Integrity: The honesty and openness that creates the transparency Agile teams need.

Table 1
Pulse survey elements and items.
Source: Agile Business Consortium [17].

Element	Item
PR-Q1	I know, understand, and believe in the purpose of our organisation.
PR-Q2	I know, understand, and believe in our organisational values.
PR-Q3	I am clear on how my work tangibly adds value to the organisation and its customers.
PR-Q4	Our senior leaders set real, meaningful, customer-oriented goals which are relevant to the team.
PR-Q5	My manager sets real, meaningful goals which are relevant to me.
AL-Q1	Senior leaders strike a good balance between providing stability and flexibility (trying new ideas and embracing change in a supportive manner).
AL-Q2	Leaders take responsibility for their actions and admit to personal limitations and mistakes.
AL-Q3	Leaders have a good level of emotional intelligence (empathise and react effectively with others' emotions).
AL-Q4	My manager gives me ongoing coaching and appropriate supportive feedback.
AL-Q5	My manager consults with the team frequently, values the feedback they receive, and acts on it.
WF-Q1	The wellbeing of staff is a priority for my organisation.
WF-Q2	My manager is a vocal ambassador for the team.
WF-Q3	My manager pushes back when there is unreasonable pressure to deliver things too fast.
WF-Q4	My manager provides feedback, recognition, shows respect, and offers development opportunities.
WF-Q5	I derive tremendous personal fulfilment from my work.
CA-Q1	I have access to the right level of resources and training.
CA-Q2	Leaders actively facilitate the building of cooperative teams, rather than reinforcing isolated silos.
CA-Q3	Our teams are given appropriate levels of autonomy.
CA-Q4	I am encouraged to provide ideas or solutions to challenges faced by my team.
CA-Q5	In our organisation, people collaborating is standard practice.
TT-Q1	Leaders lead by example and embrace sharing of resources (including people, expertise, information).
TT-Q2	Managers contribute to a positive and productive organisational culture.
TT-Q3	Dissenting views are aired openly and honestly without any negative consequences.
TT-Q4	I feel comfortable giving upwards feedback knowing it will be heard and considered.
TT-Q5	I feel our senior leaders are open and honest, and help to develop trust across the organisation.
AC-Q1	Our organisation sees change as an opportunity and not as a threat.
AC-Q2	My team responds to changes in the business environment quickly, without compromising organisational values.
AC-Q3	Our organisation is a dynamic and entrepreneurial place.
AC-Q4	I am supported when taking appropriate risks.
AC-Q5	I feel supported during times of change.
IL-Q1	Our organisation recognises that some of our best ideas come from our people, not just from the leaders.
IL-Q2	Teams are informed about whether new ideas are going to be implemented or not.
IL-Q3	Teams see failure as an opportunity to learn, with new ideas being validated quickly.
IL-Q4	I am building my skills, confidence, and abilities to develop my full potential.
IL-Q5	I am encouraged to think creatively, and regular 'reflection time' is seen as an essential activity.

- Teamwork: The collaboration at the heart of agility.
- Excellence: In line with agility, excellence is defined in terms of meeting customer needs.

Agile governance is dependent on using appropriate information and metrics to make decisions [18]. Since in this case the organisation wanted to make a shift towards more Agile working, it was helpful for senior leaders to have access to metrics that could inform them about current weaknesses and areas for potential improvement, which was why the Pulse Survey was used. The survey was sent to the whole of the organisation in 2021. The results showed that members of the team were strongly aligned with the organisation's purpose and vision yet, there were areas that needed change if the organisation was to work in a more Agile way. These included improving levels of trust and transparency, where data showed that people did not feel able to dissent or express their genuine concerns. Innovation and learning were also shown as needing work, with more thought needed around training and developing new methods of dealing with customer issues.

The leadership team committed to change on trust and transparency by sharing these results with the whole organisation. They then made targeted changes to governance structures, policies and processes in order to provide the backbone for a more Agile culture in the organisation. Instead of strict adherence to a hierarchical decision-making process, authority was decentralised, allowing teams to develop strategies in-line with the set policies, and make decisions closer to the work being done. The transformation was influenced by the organisation's knowledge [19], which was effectively leveraged through the Agile Culture Matrix (ACM) and insights from the Pulse Survey. These tools helped to crystallise the already existing tacit knowledge into actionable insights, which were then used to drive key initiatives. The use of regular 'Town Hall' meetings and subsequent email updates ensured that all employees in Company X were engaged and informed about the ongoing changes. The open communication measures adopted were critical in aligning the staff with the leadership's vision, ensuring that the Agile initiatives were not just aspirational but also practical and actionable. The feedback and insights provided by the staff were instrumental in shaping the actions taken to enhance the organisation's effectiveness.

After four months, in early 2022, they used the Pulse Survey again with the whole staff. This time, results showed a marked improvement in trust and transparency, vital as the organisation moved towards business agility. The Pulse Survey process provided a structured framework that enabled the staff to articulate and act on their intuitions and ideas, which had been latent until then.

3. Literature review

Literature on the theoretical foundations of Agile culture has been extensively examined through Lean Thinking [20], Complexity Theory [21], Continuous Improvement [22,23] and Learning Organisations [24,25]. This section highlights the significant impact of Agile culture on organisational change and the tools employed to assess it.

3.1. Impact of agile culture on organisations

According to Ayushi et al. [26], Agile culture facilitates higher adaptability, faster response to market changes, and improved customer satisfaction. Similarly, Kuchel et al. [2] investigated the effects of Agile practices on team collaboration and autonomy, and found that Agile fosters a more collaborative, adaptive and empowered work environment. These benefits are primarily attributed to the iterative nature of Agile practices, which promote continuous feedback, adapting to change in requirements, incremental improvements and project success [27]. Further, Ebert & Avasthi [28] assert that Agile culture

fosters a collaborative environment that enhances team dynamics and increases employee engagement, which is crucial for successful organisational change. However, the shift to an Agile culture is not without challenges. Organisational inertia and resistance to change are significant barriers [29]. Mergel et al. [30] finds that the success of Agile adoption heavily depends on the organisation's readiness for change and the alignment of Agile practices with the existing organisational culture. They argue that organisations with a hierarchical culture may struggle more with Agile adoption compared to those with a more flexible and adaptive culture.

3.2. Agile culture and organisational change

The adoption of Agile culture in the technology sector has significantly influenced the values and norms within organisations' cultures. Research highlights that cultural values play a crucial role in shaping behaviour and impacting the success of Agile methodologies [31]. Specifically, Patrucco et al. [32] emphasise that Agile teams in non-software industries develop cultural values such as clan and market values. These qualities are fostered by scrum principles like courage, openness, and respect, along with practices like retrospective meetings and defining specific artifacts [33,34]. Additionally, organisational culture attributes like management control, team collaboration, market orientation, values, and creativity have been identified as key factors influencing the adoption of Agile practices, showcasing the intricate relationship between Agile methodologies and organisational culture in the technology sector. Various ways in which organisational cultures, leadership behaviours, and change management practices may need to shift to deliver sustainable value through a better balance of organisational and employee needs have been suggested by Holbeche [1]. Holbeche maintains that the role of senior leaders in committing to and enabling these shifts in culture is pivotal.

3.3. Longitudinal insights into agile-driven cultural change

Agile transformations influence not only workflows but deeply impact organisational culture over time. Greineder and Blohm [35] conducted a longitudinal study that spanned three years, observing cultural changes in an organisation adopting Agile practices. The study revealed that Agile adoption led to increased transparency, enhanced communication, and stronger alignment between individual and organisational goals. However, these changes required sustained leadership support to maximise the long-term cultural benefits. The study by Greineder and Blohm aligns with findings from FinOrg, a Dutch financial services organisation, which tracked Agile's influence over three distinct phases: initial team-level adoption, expansion into program and portfolio-level, and maturation at program and portfolio-level over 36 months. This case highlights improvements in productivity, time-to-market, and employee engagement, underscoring that Agile maturity leads to measurable, long-term cultural shifts. As Agile practices evolve, they deepen the organisation's ability to foster collaboration and continuous learning [36]. Additionally, Boufounou and Argyrou [37] conducted a study in the healthcare sector, emphasising the nonlinear nature of cultural transformations, where continuous adaptation and iterative learning are crucial. This finding complements the Agile transformation journey reported by Greineder and Blohm, as it shows how organisations must be flexible and responsive to feedback over extended periods to fully integrate Agile principles.

3.4. Tools for assessing agile culture in organisations

Agile Maturity Models (AMMs) and Agile Assessment Models (AAMs) are instrumental in helping organisations sustain a competitive edge, reduce costs, enhance quality, and expedite time to market [38]. AMMs offer a structured framework to evaluate the extent to which an organisation has adopted and integrated Agile practices and principles. In contrast, AAMs, the focus of this study, are tools and techniques specifically designed to assess various aspects of an organisation's Agile practices, culture, and effectiveness [39]. Evaluating Agile culture within organisations is essential for understanding the effectiveness and impact of Agile transformations. AAMs play a key role in identifying strengths, pinpointing areas needing improvement, and guiding continuous development efforts [40]. The literature indicates that over forty different models have been proposed by industry consultants, Agile experts, and academics [41]. These models serve as tools for evaluating and assessing Agile transformations within organisations, guiding improvements and measuring effectiveness. Applications of these models have been documented across various organisational contexts in [42,43]. Existing literature also provides detailed comparisons of many of these models, highlighting their diverse functionalities and approaches [39]. However, there is a notable gap in research that examines how the Agile Culture Matrix, and the accompanying Pulse Survey contribute to assessing and cultivating Agile culture within organisations. While these tools are used, there is limited independent or objective evaluation of their effectiveness in real-world settings.

3.5. Challenges in adopting and assessing agile culture

Adopting an Agile culture often encounters significant challenges due to organisational inertia and resistance to change, particularly when it involves shifting established practices in areas like Leadership and Collaboration and Autonomy [44]. Many organisations struggle with deeply rooted hierarchical structures [45,46] and cultural norms that conflict with Agile principles such as flexibility, transparency, and continuous learning [47]. Resistance often arises from fears related to the increased transparency and accountability required in Agile environments, as well as discomfort with changes in leadership dynamics and team autonomy [48]. Additionally, misalignment between existing organisational values and Agile principles can hinder the adoption of practices in areas like staff well-being and fulfilment and increasing trust and transparency, further complicating the transition [49,50].

Despite the benefits of using tools like AMMs and AAMs to assess Agile culture in organisations, they present several challenges. One major issue is the risk of oversimplification as these tools often reduce complex cultural dynamics into quantifiable metrics, which may not fully capture the nuanced, context-specific nature of organisational culture [51]. The implementation of these tools can be resource-intensive, requiring significant time, effort, and expertise, which can be a barrier for organisations with limited resources or those in the early stages of Agile adoption. Moreover, there is often a misalignment between the tool's design and the unique cultural attributes of an organisation, leading to inaccurate or misleading assessments. Resistance from employees and leadership, who may perceive these assessments as intrusive or misaligned with their daily work practices, further complicates the effective use of these tools. Finally, the dynamic nature of Agile culture means that assessments must be conducted continuously to remain relevant, which can be challenging to sustain over time [41].

4. Research methodology

4.1. Research design

In view of the research aims and questions outlined in Section 1, this paper employs a mixed research method [52] to conduct a post-hoc analysis of the datasets collected from Company X. Specifically, the study uses a quantitative approach to examine the Pulse Survey data collected by the ABC in 2021 and 2022 during the Agile transformation of Company X and a qualitative analysis of an email interview [53] with an ABC facilitator. The quantitative approach explores the cultural snapshots provided by the Pulse Survey data and illustrates the insights such data can offer about cultural changes during the transformation. The decision to use quantitative analysis is driven by its advantages

including objectivity and replicability [54], generalisability [55], statistical accuracy and precision [56]. Recent literature has also used this method to assess the impact of hybrid working on Agile principles [57], and to measure team capability and customer involvement (key Agile principles) in the success of Agile software development projects [58]. A summary of an email interview is used to contextualise the quantitative analysis, due to the context-specific nature of these datasets.

4.2. Data collection and description of datasets

In line with the aims and questions guiding this study, data were collected by the ABC, which acted as a facilitator when "Company X" was undergoing Agile transformation. The initial datasets (Datasets1) were gathered in 2021 from 36 employees, representing 60% of the organisation's staff. The second datasets (Datasets2) were collected in 2022 from 39 employees, representing 65% of the staff. In Datasets1, only employees from the Postal and Telecommunications services participated in the survey, whereas in Datasets2, there was a broader distribution of participants: Postal and Telecommunications services accounted for 50% of respondents, while Financial Services/Professional Services, Public Service, Commerce, and Utilities accounted for 6.7%, 1.7%, 2.3%, and 2.3%, respectively. We used the increased sectoral representation in Datasets2 in this study to reflect the natural expansion of Agile adoption, as over 70% of participants who took the survey in 2021 also participated in 2022, according to the response to Question 3 of the email interview, and the organisation's management remained the same during these two years. The datasets in both Datasets1 and Datasets2 was complete, with no missing values in any rows or columns, and demographic characteristics of the respondents were not present in the datasets.

Given the context-specific nature of these datasets, the study employed an email interview [53] to collect additional data from the ABC representative, who served as a facilitator during the transformation. We developed a set of nine questions (see appendix) aimed at gaining insights into the context in which the datasets was collected, e.g. what did Company X do to their governance and other structures during their transformation, how did management communicate with staff and so on. These were sent to the ABC facilitator, who responded with the answers via email. The process was asynchronous, the questions were sent on 1 July 2024 and the interviewee responded on 29 July 2024. The email response was summarised to gain insights that contextualised the specific findings from the survey data analysis. This approach ensured a comprehensive understanding of the unique organisational dynamics and the specific implementation of Agile practices.

4.3. Data analysis

This study performed four types of analysis to comprehensively evaluate and understand how agile transformation impacts different dimensions of organisational culture over time. Firstly, the reliability and validity of the Pulse survey instrument was assessed to understand how well the statements measure their corresponding Agile culture elements.

To measure the instrument's reliability, Cronbach's Alpha [59] and Composite Reliability [60] analyses were performed on the 2022 datasets. These frameworks enabled the determination of how well all the statements for each Agile culture element measured the respective construct. For instance, it assessed how statements PR-Q1 to PR-Q5 measured the PR. To measure validity, factor loadings [61] were utilised. This is to evaluate how well each individual statement correlated with the corresponding Agile culture element. For example, it measured how well PR-Q1 (I know, understand, and believe in the purpose of our organisation) relates to PR. Average Variance Extracted (AVE) [62] was also performed to understand the extent to which indicators of a specific construct actually measure that construct. Cronbach's alpha and Composite Reliability values of 0.7 were used to measure the instrument's satisfactory reliability levels, while the acceptable value of factor loadings and AVE +/− 0.5, respectively. In doing this, the instrument's reliability and validity was checked. This study employed these frameworks because they have been validated in numerous empirical studies for assessing the reliability and validity of the constructs in the survey instruments used in the research [63].

Secondly, to get the perception of the employees in areas where the organisation has embraced Agile culture and areas where it has not, the study utilised descriptive statistics, such as weighted mean [64], thereby answering questions (i) and (ii). We recognised that Likert-scale data is ordinal in nature, however, we followed established research practices [65,66] in treating the data as approximately interval-scaled to compute means for comparison. This approach provides information that is practically significant and allows for more established statistical techniques, such as t-tests and ANOVA to be applied [67]. Thirdly, the means were also subjected to t-tests at a significance level of 0.05, which is commonly chosen to indicate that the observed results are considered statistically significant, suggesting that the likelihood of obtaining such results by random chance is less than 5%.

Finally, to answer sub-question (iii), we employed inferential statistics such as correlation analysis, a statistical technique used to evaluate the strength and direction of the linear relationship between two variables. The strength of correlation is measured by the Pearson's r, with the following classifications: Very Strong: ≥ 0.90, Strong: $0.70 \leq r < 0.90$, Moderate: $0.50 \leq r < 0.70$, Weak: $0.30 \leq r < 0.50$, and Very Weak: $r < 0.30$. The aim of correlation analysis is to assess whether and how changes in one variable are associated with changes in another. We opted for inferential statistics although over 60% of the employee participated in the study, because of the small size of the datasets and we want to be able to generalise our findings beyond the organisation in context [68].

Table 2 maps the analysis methods to their respective research question and outcome. Additionally, the data collected through email interview was summarised systematically in view of keeping the organisation anonymous. The responses were thoroughly read and understood, with recurring ideas, patterns, and key points identified. When multiple ideas appeared in the responses, they were grouped together into themes. The tone of the response, whether positive, negative, neutral, or mixed was recorded to allow for in-depth interpretation. We also considered the broader implications of the response within the context of our research. Then, the main points were summarised to provide a cohesive understanding of the response.

5. Results

In view of the research questions of this study, the results are presented in four subsections: (Section 5.1) Instrument assessment, which provides the results of the analysis to answer question i. (Section 5.2) Agile culture assessment, which provides the results of the analysis to answer questions ii and iii. It is organised based on the elements of the Agile Culture Matrix. For each of the matrix elements we report the quantitative analysis for both the 2021 and 2022 datasets. (Section 5.3) Leveraging Targeted Efforts, which presents the findings for question iv. (Section 5.4) Evidence from the interview, which presents contextual insights from the transformation facilitator.

5.1. Instrument assessment

The Pulse survey instrument, as measured by Cronbach's Alpha and Composite Reliability (CR) along with the factor loadings and Average Variance Extracted (AVE), demonstrate a high level of internal consistency across the majority of the measured constructs, indicating that the Instruments' items effectively capture the underlying Agile culture elements (Table 3). All the Alpha values fall between 0.744 and 0.901, which are higher than the satisfactory value of 0.700. This

Table 2
Mapping of analysis methods to research aims and outcomes.

Research aim	Questions	Analysis	Outcome
To understand how companies can use the Pulse Survey and analyse the resulting data to help improve their Agile transformations	(i) How reliable is the Pulse survey instrument?	- Cronbach's Alpha and composite reliability analysis for reliability. - Factor loadings and Average Variance Extracted (AVE) for Validity	Reliable and valid measurement instrument confirmed for Agile culture elements
	(ii) What areas of the organisational culture are well-aligned with Agile culture, and which require improvement?	Descriptive statistics (Weighted mean)	Identification of areas with significant Agile culture change
	(iii) How have perceptions of the organisational culture changed since the last survey?	t-tests to assess significance	Nature of change
	(iv) Can targeted efforts on specific elements of the culture matrix contribute to a corresponding increase in other Agile culture elements?	Inferential statistics (Correlation analysis)	Understanding of the relationship between changes in Agile culture elements

indicates acceptable to excellent reliability. Specifically, constructs like WF and AC show strong internal consistency with Alpha values of 0.861 and 0.901, respectively. The Alpha value of 0.744 for CA, although acceptable, suggests room for improvement, as a higher value (closer to 0.80 or above) would indicate a more reliable measure. Composite reliability (CR) scores range from 0.785 (for CA) to 0.913 (for AC). These CR values demonstrate high reliability, particularly AC (0.913) and TT (0.898), indicating strong coherence among items in these scales. The CR score of 0.487 for PR construct is below the generally accepted threshold of 0.70, indicating a potential issue with the internal consistency of the items measuring this construct.

Also from the results in Table 3, AVE values range from 0.487 to 0.720. While most constructs exceed the 0.50 threshold, PR (with an AVE of 0.487) falls slightly below, indicating that this construct may not capture sufficient variance to support strong convergent validity. The AVE for AC (0.720), on the other hand, is excellent, indicating strong convergent validity for this construct. The majority of the factor loadings (FL) were greater than the acceptable value of −/+ 0.500, except for PR-Q5 and CA-Q4, which had loadings of −0.330 and −0.401, respectively. These low FL suggest that these items are weakly related to their underlying constructs and may not adequately capture the intended latent variables. The values for AVE were greater than 0.500, corroborating convergent validity, except for CA, where a slightly lower value of 0.494 was observed, indicating that this construct may not sufficiently explain the variance in its items.

5.2. Agile culture assessment

The assessment of Purpose and Results (PR) is presented in Fig. 2. Findings show increased understanding and belief in the organisation's purpose (PR-Q1: 4.58 to 4.67) and values (PR-Q2: 4.67 to 4.72), respectively in 2021 and 2022, reflecting a strengthening connection to the organisational identity. Results further indicate heightened clarity regarding the tangible value of their work to the organisation and its customers (PR-Q3: 4.58 to 4.69). Notable improvements were also observed in the perceived goal-setting practices of senior leaders (PR-Q4: 4.11 to 4.28) and managers (PR-Q5: 4.22 to 4.28), with both groups demonstrating a commitment to establishing real, meaningful, and customer-oriented goals. Results also indicate that p-values of the t-test for PR means are 0.006 and 0.011 for one-tail and two-tail, respectively are less than the specified significance level of 0.05 (Table 4), indicating that the observed difference in means is statistically significant.

The Agile Leadership (AL) results in Fig. 3 reveal that senior leaders demonstrated a commendable improvement in striking a balance between providing stability and fostering flexibility for innovation and change (AL-Q1: 4.22 to 4.36). There was an increase in leaders taking responsibility for their actions and acknowledging personal limitations and mistakes (AL-Q2: 4.05 to 4.21), indicating a culture of accountability. Findings also indicate a perceived positive shift in leaders'

Table 3
Reliability and validity of pulse survey instrument.

Constructs	Means	FL	Alpha	CR	AVE
PR-Q1	4.667	−0.932	0.798	0.487	0.558
PR-Q2	4.718	−0.720			
PR-Q3	4.692	−0.715			
PR-Q4	4.282	−0.654			
PR-Q5	4.282	−0.330			
AL-Q1	4.359	−0.739	0.842	0.864	0.613
AL-Q2	4.205	−0.858			
AL-Q3	4.308	−0.639			
AL-Q4	4.410	−0.720			
AL-Q5	4.462	−0.643			
WF-Q1	4.385	−0.734	0.861	0.900	0.648
WF-Q2	4.462	−0.657			
WF-Q3	4.333	−0.882			
WF-Q4	4.385	−0.553			
WF-Q5	3.974	−0.908			
CA-Q1	4.103	−0.735	0.744	0.785	0.494
CA-Q2	4.231	−0.631			
CA-Q3	4.436	−0.759			
CA-Q4	4.436	−0.401			
CA-Q5	4.359	−0.516			
TT-Q1	4.436	−0.641	0.876	0.898	0.671
TT-Q2	4.436	−0.791			
TT-Q3	4.103	−0.643			
TT-Q4	4.179	−0.878			
TT-Q5	4.487	−0.884			
AC-Q1	4.487	−0.617	0.901	0.913	0.720
AC-Q2	4.282	−0.804			
AC-Q3	4.256	−0.825			
AC-Q4	4.256	−0.899			
AC-Q5	4.231	−0.878			
IL-Q1	4.359	−0.602	0.851	0.894	0.627
IL-Q2	4.103	−0.836			
IL-Q3	4.026	−0.739			
IL-Q4	4.308	−0.717			
IL-Q5	4.051	−0.759			

FL = Factor Loadings, Alpha = Cronbach's Alpha, CR = Composite Reliability, AVE = Average Variance Extracted.

Table 4
T-test for PR means in 2021 and 2022.

	2021		2022
Mean	4.432		4.528
Variance	0.062		0.052
t Stat		4.496	
P(T ≤ t) one-tail		0.006	
P(T ≤ t) two-tail		0.011	

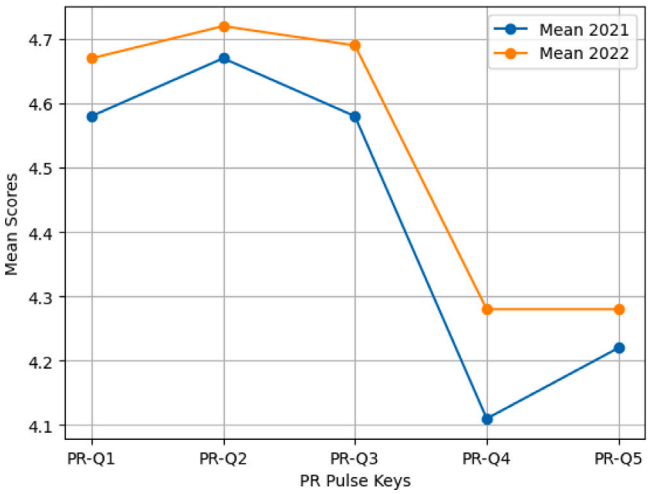

Fig. 2. Computed weighted-means for purpose and results.

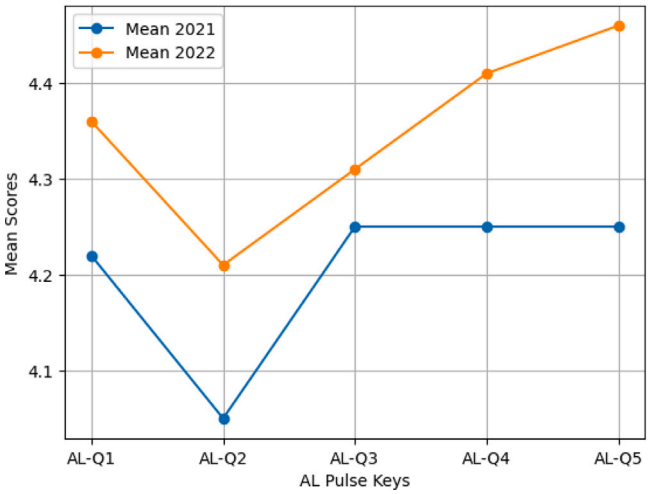

Fig. 3. Computed weighted-means for Agile leadership.

Table 5
T-test for AL means in 2021 and 2022.

	2021		2022
Mean	4.204		4.350
Variance	0.008		0.009
t Stat		−5.980	
P(T ≤ t) one-tail		0.002	
P(T ≤ t) two-tail		0.004	

emotional intelligence, with a modest increase in their ability to empathise and react effectively to others' emotions (AL-Q3: 4.25 to 4.31). The results also highlight the effectiveness of managerial support, as evidenced by improved scores in ongoing coaching and appropriate feedback from managers (AL-Q4: 4.25 to 4.41) and increased consultation with teams, valuing and acting on their feedback (AL-Q5: 4.25 to 4.46). Findings also reveal that the t-test p-values for AL means (one-tail: 0.002, two-tail: 0.004) are below the specified significance level of 0.05 (Table 5), indicating that the observed difference in means is statistically significant.

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The findings of Well-being and Fulfilment (WF) in Fig. 4 show a slight positive increase in the prioritisation of staff wellbeing by the organisation (WF-Q1: 4.36 to 4.39), indicating a continued commitment to fostering a healthy work environment. The results also

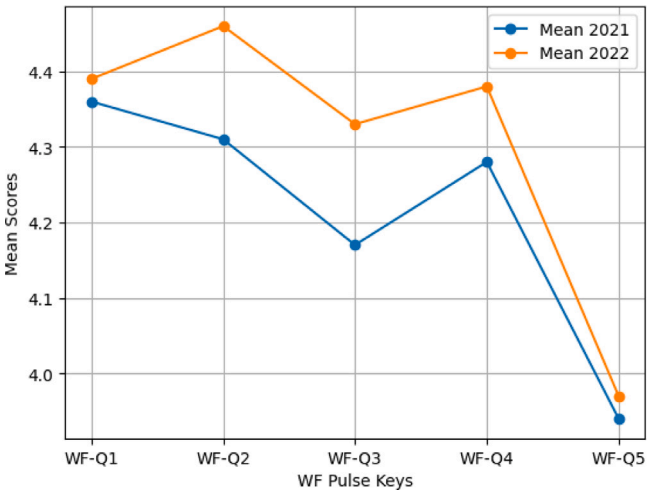

Fig. 4. Computed weighted-means for well-being and fulfilment.

Table 6
T-test for WF means in 2021 and 2022.

	2021		2022
Mean	4.212		4.306
Variance	0.028		0.037
t Stat		3.353	
P(T ≤ t) one-tail		0.014	
P(T ≤ t) two-tail		0.029	

indicate an improvement in managers acting as vocal ambassadors for their teams, with a notable increase in scores (WF-Q2: 4.31 to 4.46). Results further reveal a constructive shift in managerial behaviour, with managers pushing back against unreasonable pressure to deliver tasks too quickly (WF-Q3: 4.17 to 4.33). Additionally, managers were recognised for providing feedback, recognition, showing respect, and offering development opportunities, as reflected in the positive increase in scores (WF-Q4: 4.28 to 4.38). The personal fulfilment from work remained the lowest (WF-Q4: 3.94 to 3.97) among the Pulse items in this element. The t-test p-values for WF means (one-tail: 0.014, two-tail: 0.029) are below the specified significance level of 0.05 (Table 6), indicating that the observed difference in means is statistically significant.

The results of Collaboration and Autonomy (CA) in Fig. 5 show a decrease in the perception of having access to the right level of resources and training (CA-Q1: 3.94 to 3.67), indicating a potential concern that warrants attention. Findings further revealed positive trends in other aspects with leaders demonstrating a slight improvement in actively facilitating the building of cooperative teams instead of reinforcing isolated silos (CA-Q2: 3.94 to 3.97), contributing to a more cohesive organisational structure. Teams were perceived to be given appropriate levels of autonomy, with a modest increase in scores (CA-Q3: 4.28 to 4.36), fostering a balance between control and empowerment. Results indicate a substantial improvement in feeling encouraged to provide ideas or solutions to team challenges (CA-Q4: 4.28 to 4.77), highlighting a positive shift towards a culture that values employee input. There is an increase in the perception that collaboration is standard practice (CA-Q5: 4.12 to 4.72), suggesting a commendable advancement in fostering a collaborative work environment. The t-test result in Table 7 shows p-values for CA means (one-tail: 0.154, two-tail: 0.308) greater than the significance level, indicating that the observed difference in means is not statistically significant.

From the Trust and Transparency (TT) results in Fig. 6, there was a decrease in the perception of leaders leading by example and embracing resource sharing (TT-Q1: 4.22 to 4.10), suggesting a potential area for improvement. However, the results demonstrate a remarkable

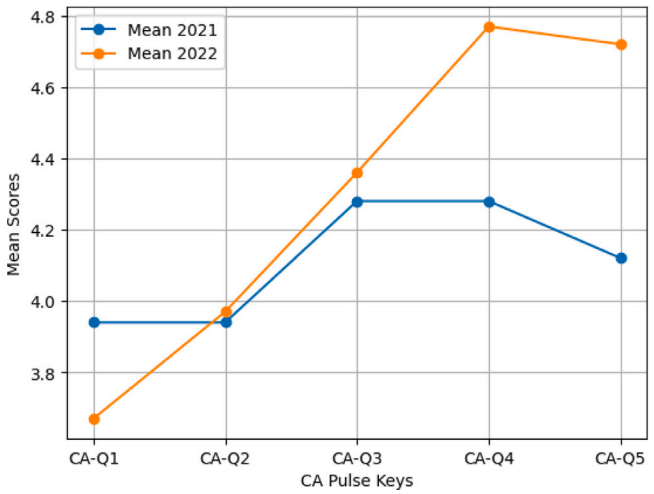

Fig. 5. Computed weighted-means for collaboration and autonomy.

Table 7
T-test for CA means in 2021 and 2022.

	2021		2022
Mean	4.112		4.298
Variance	0.029		0.227
t Stat		−1.168	
P(T ≤ t) one-tail		0.154	
P(T ≤ t) two-tail		0.308	

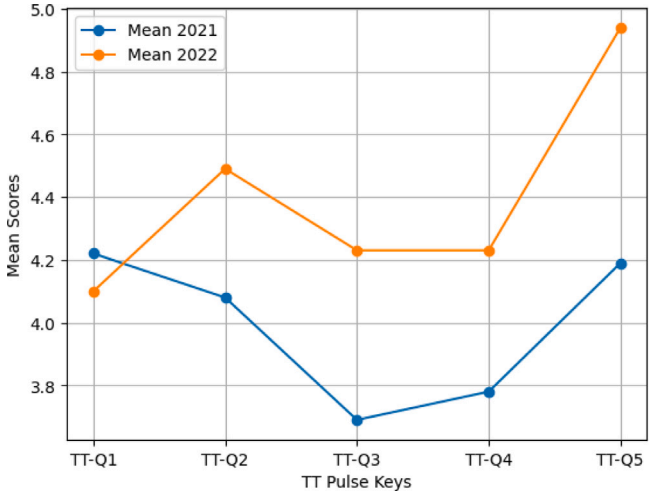

Fig. 6. Computed weighted-means for trust and transparency.

improvement in managers' contributions to a positive and productive organisational culture (TT-Q2: 4.08 to 4.49), indicating a strengthened cultural environment. The organisation exhibited substantial progress in fostering an open and honest culture, with marked increases in the expression of dissenting views without negative consequences (TT-Q3: 3.69 to 4.23) and in employees feeling comfortable giving upwards feedback that is heard and considered (TT-Q4: 3.78 to 4.23). The findings also indicate a strong increase in the perception that senior leaders are open, honest, and contribute to trust development across the organisation (TT-Q5: 4.19 to 4.94). Results also reveal that the t-test p-values for TT means (one-tail: 0.024, two-tail: 0.048) are below the specified significance level (Table 8), indicating that the observed difference in means is statistically significant.

From the findings of Adaptability to Change (AC) in Fig. 7, the organisation demonstrated a substantial increase in the belief that change

Table 8
T-test for TT means in 2021 and 2022.

	2021		2022
Mean	3.992		4.398
Variance	0.059		0.112
t Stat		−2.819	
P(T ≤ t) one-tail		0.024	
P(T ≤ t) two-tail		0.048	

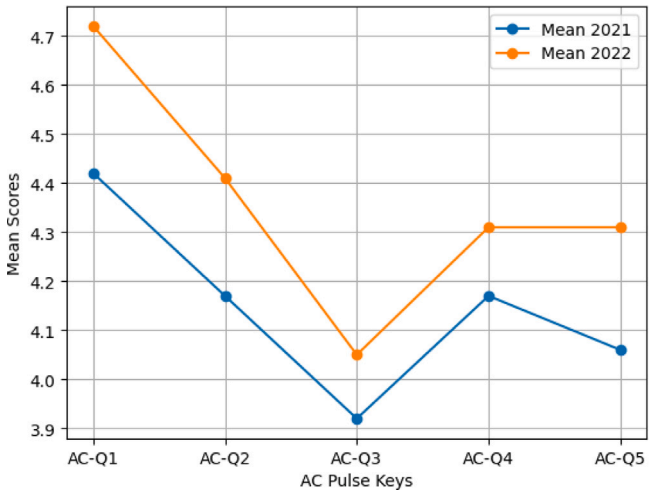

Fig. 7. Computed weighted-mean for adaptability to change.

Table 9
T-test for AC means in 2021 and 2022.

	2021		2022
Mean	4.148		4.360
Variance	0.034		0.058
t Stat		−6.410	
P(T ≤ t) one-tail		0.002	
P(T ≤ t) two-tail		0.003	

is viewed as an opportunity (AC-Q1: 4.42 to 4.72), indicating a positive organisational mindset towards change initiatives. Findings also reveal that there was a commendable improvement in teams responding quickly to changes in the business environment without compromising organisational values (AC-Q2: 4.17 to 4.41), emphasising a balance between adaptability and adherence to core values. Results further indicated that the organisation is perceived to be becoming more dynamic and entrepreneurial (AC-Q3: 3.92 to 4.05), reflecting a positive cultural shift towards innovation and agility. Employees reported increased support when taking appropriate risks (AC-Q4: 4.17 to 4.31), indicating a fostering of a risk-tolerant environment. An improvement was noted in feeling supported during times of change (AC-Q5: 4.06 to 4.31), underscoring the organisation's commitment to providing a supportive environment during periods of transition. Results also indicate that the t-test p-values for AC means (one-tail: 0.002, two-tail: 0.003) are below the significance level (Table 9), indicating that the observed difference in means is statistically significant.

The findings of Innovation and Learning (IL) in Fig. 8 show a substantial increase in the recognition that some of the best ideas come from employees, not just leaders (IL-Q1: 3.89 to 4.36), signalling a shift towards a more inclusive and idea-driven culture. Teams experienced improved communication regarding the implementation status of new ideas (IL-Q2: 3.83 to 4.10), contributing to transparency and accountability in the innovation process. Results also show that although perception of failure as an opportunity to learn remained relatively stable, there was a slight increase in teams validating new ideas quickly (IL-Q3: 4.00 to 4.02). Employees reported growth in building their

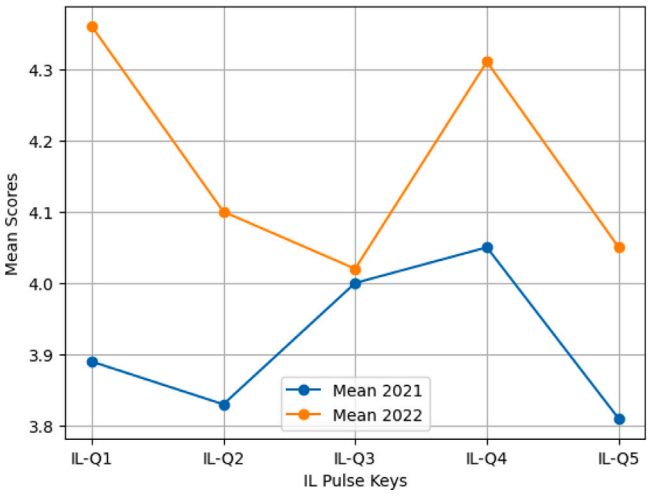

Fig. 8. Computed weighted-means for innovation and learning.

Table 10
T-test for IL means in 2021 and 2022.

	2021		2022
Mean	3.916		4.168
Variance	0.011		0.024
t Stat		−3.531	
P(T ≤ t) one-tail		0.012	
P(T ≤ t) two-tail		0.024	

skills, confidence, and abilities to reach their full potential (IL-Q4: 4.05 to 4.31), suggesting a commitment to professional development. There was a promising increase in the encouragement of creative thinking and the recognition of regular 'reflection time' as an essential activity (IL-Q5: 3.81 to 4.05), reflecting a positive shift towards fostering a creative and reflective work environment. The p-values of the t-test for IL means are 0.012 and 0.024 for one-tail and two-tail, respectively which is less than the specified significance level of 0.05 (Table 10), indicating that the observed difference in means is statistically significant.

5.3. Leveraging targeted efforts

The results of the correlation analysis are presented in this subsection. It assesses how Company X's efforts to enhance Trust and Transparency influenced other elements of its culture. Findings indicate a notable improvement in the overall Agile culture resulting from targeted effort leveraged in 2022 (Fig. 10). In 2021, the majority of correlation coefficients, 605 out of 630 (96%), were positive, indicating mostly weak and moderate relationships between elements of the Agile Culture Matrix. Twenty-three (3.68%) were negative, signalling potential areas of concern, and two instances of zero correlation were observed. Referencing the case study above, the organisation dedicated efforts to enhance "Trust and Transparency" within its structure. The targeted effort on this specific aspect of the culture matrix yielded corresponding improvements in other Agile culture elements, as shown by our analysis. The effort led to moving the overall Agile culture of the organisation to strong and very strong positive relationships among elements of the organisation's culture as indicated in the Agile Culture Matrix. This is evidenced from the computed coefficients in 2022 (Fig. 10), where a notable 628 out of 630 (99.7%) coefficients were positive, with only 2 (0.32%) being negative, and no instances of zero correlation being recorded.

In 2021, 3 very strong positive correlations were identified, indicating the direction and magnitude of the cultural efforts in the organisation (Fig. 9). "My Manager pushes back when there is unreasonable pressure to deliver things too fast (WF-Q4) and My Manager consults with the team frequently, values the feedback they receive and acts on it (AL-Q5) correlate with a coefficient of 0.877". There is also a substantial correlation between "My Manager sets real, meaningful goals which are relevant to me (PR-Q5) and Our senior Leaders set real, meaningful, customer-oriented goals which are relevant to the team (PR-Q4) with a coefficient of 0.836". "Managers contribute to a positive and productive organisational culture (TT-Q2), and My Manager provides feedback, recognition, shows respect and offers development opportunities (WF-Q4) correlate with a coefficient of 0.804".

In 2022 (Fig. 10), the coefficients of these specific culture elements were reduced to 0.552, 0.665 and 0.618, respectively, indicating a transformation into four new very strong relationships with a more team-oriented focus. These include "I feel our Senior Leaders are open and honest and help to develop trust across the organisation" (TT-Q5) and I feel comfortable giving upwards feedback knowing it will be heard and considered (TT-Q4) with a coefficient of 0.823. "Leaders take responsibility for their actions and admit to personal limitations and mistakes (AC-Q2) and My Manager pushes back when there is unreasonable pressure to deliver things too fast (WF-Q3) with a coefficient of 0.810". "I am supported when taking appropriate risks (AC-Q4) and My team responds to changes in the business environment quickly, without compromising organisational values' (AC-Q2) with a coefficient of 0.806" and, "I am encouraged to think creatively and regular 'reflection time' is seen as an essential activity (IL-Q5) and I am building my skills, confidence, and abilities to develop my full potential (TT-Q3) with a coefficient of 0.816".

In 2021, 23 negative correlations were observed, suggesting areas where improvements or attention may be needed (Fig. 9). The negative associations include mostly the relationship between "Teams see failure as an opportunity to learn with new ideas being validated quickly (IL-Q3) and I feel supported during times of change (AC-Q5)", implying a potential disconnect in support during change initiatives. "I am encouraged to think creatively and regular 'reflection time' is seen as an essential activity (IL-Q5) displayed negative correlations with several items related to organisational purpose and emotional intelligence", indicating potential misalignments in these aspects. Two culture elements, Teams see failure as an opportunity to learn with new ideas being validated quickly (IL-Q3), and Our teams are given appropriate levels of autonomy (CA-Q3) with I am encouraged to think creatively and regular 'reflection time' is seen as an essential activity (IL-Q5) showed no correlation with each other, suggesting that autonomy and creative thinking/regular-reflection time may not directly impact the perception of failure as a learning opportunity.

In 2022, only two negative correlations are observed (Fig. 10). These are: My Manager sets real, meaningful goals which are relevant to me (PR-Q5) and I am clear on how my work tangibly adds value to the organisation, and its customers (PR-Q3) with a coefficient of −0.039; and, My Manager provides feedback, recognition, shows respect and offers development opportunities (WF-Q4) and I am clear on how my work tangibly adds value to the organisation, and its customers (PR-Q3) have a coefficient of −0.179.

5.4. Evidence from the interview data

In terms of governance adaptation, the interviewee explained that Company X's governance structures, policies, and processes were initially designed to comply with the country's regulatory demands while operating as a value-added services provider in a specific market sector. The Agile transformation was internally driven by the leadership of Company X and its Organisational Development (OD) specialist, who believed in creating a better workplace through the principles of a Learning Organisation and Continuous Improvement. As noted by the interviewee, "At the end of the day, this was more about believing in the concepts of Learning Organisation and Continuous Improvement". This shift was further sharpened by the Agile Business perspective,

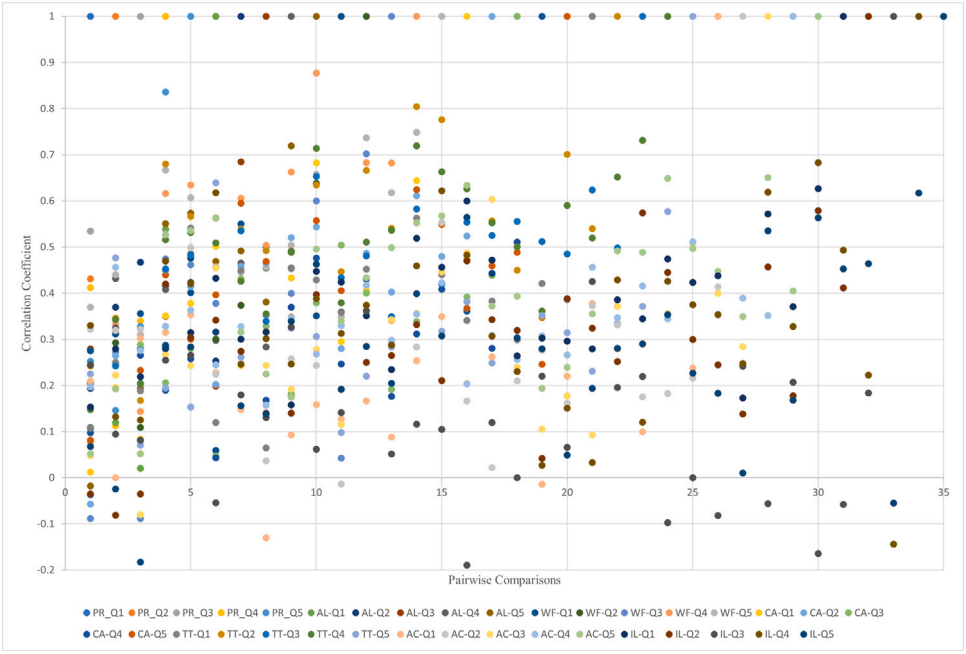

Fig. 9. Correlation coefficients for pulse survey responses (2021): Understanding relationships between agile culture elements.
This figure presents the correlation coefficients for responses in 2021, illustrating the relationships between different Agile culture elements. The legend colours indicate the strength and direction of these correlations, ranging from −1 (strong negative correlation) to +1 (strong positive correlation). Stronger correlations highlight key interdependencies between Agile culture dimensions.

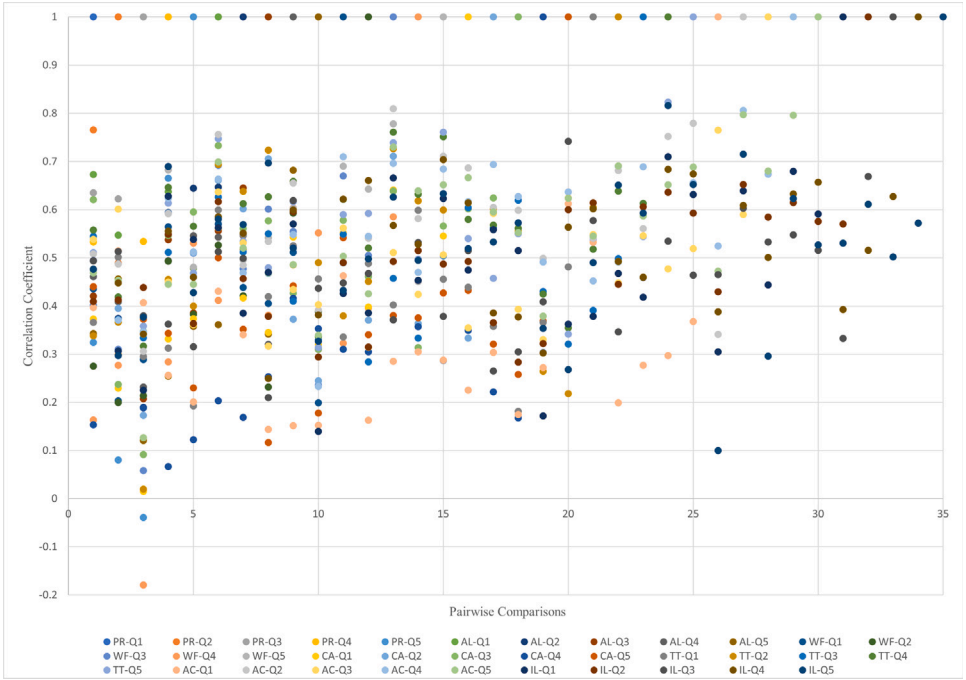

Fig. 10. Correlation coefficients for pulse survey responses (2022): Changes in agile culture relationships over time.
This figure presents the correlation coefficients for responses in 2022, providing insights into how relationships between Agile culture elements evolved. The legend colours indicate the correlation coefficient's position on a scale from −1 to +1. Comparing this with Fig. 9 allows for an assessment of cultural shifts over time.

which underscored the importance of adaptability in response to market volatility and strategic changes from their partners. The interviewee highlighted, "The Agile Business Consortium perspective brought into sharper focus the need to be adaptable as well". Despite these challenges, Company X successfully restructured and won several awards, validating its ability to navigate market disruptions while maintaining organisational viability. Their governance adaptations were integral in fostering an Agile culture focused on adaptability and long-term sustainability.

When it comes to foundation for Agile implementation, the interviewee explained that other organisations can follow what Company X did only at a generic level, as much of their success relied on tacit knowledge, which is not directly codifiable. As the interviewee noted, "It is the difference between Tacit knowledge and Explicit knowledge. The latter is codifiable, the former not". While some frameworks were

in use, the introduction of the Agile Culture Matrix (ACM) through the Pulse Survey allowed Company X to build on its existing tacit knowledge of a Learning Organisation and Continuous Improvement. For other organisations, the transferable aspect lies in recognising when there is a good foundation but also sensing the potential for further improvement. The interviewee emphasised the importance of deploying approaches that create alternative perspectives and comparing these with the organisation's tacit knowledge through open feedback sessions. By combining these insights, Company X's leadership devised three key initiatives that resonated with the staff and were informed, rather than dictated to, by the ACM review. The hypothesis behind this approach was that they would be both understood by the staff and aligned with the ACM, enhancing the organisation's effectiveness. While frameworks such as ACM can guide Agile transformations, the unique, uncodified knowledge embedded in an organisation's culture is crucial and must be tapped into for successful adaptation.

In terms of communication, Company X's leadership played a pivotal role in the Agile transformation by fostering open communication and transparency. The use of regular 'Town Hall' meetings and subsequent email updates ensured that all employees were engaged and informed about the ongoing changes. This transparency and inclusivity in communication were critical in aligning the staff with the leadership's vision, ensuring that the Agile initiatives were not just aspirational but also practical and actionable. The staff's deep insights, brought to light through structured reflection and learning, further reinforced the importance of leadership in guiding and nurturing an Agile culture.

The interview underscores the importance of employee involvement in the Agile transformation process. The insights provided by the staff were instrumental in shaping the actions taken to enhance the organisation's effectiveness. The Pulse Survey process provided a structured framework that enabled the staff to articulate and act on their intuitions and ideas, which had been latent until then. This indicates that successful Agile transformations require not only top-down leadership but also bottom-up engagement, where employees are empowered to contribute their knowledge and insights, thus fostering a sense of ownership and commitment to the change process.

6. Discussion

This study presents an analysis framework to support companies using or seeking to use the Pulse survey instrument in their efforts to transform culture. The research aim is to understand how companies can use the Pulse Survey and analyse the resulting data to help improve their Agile transformations. The answers to the four research questions that guided this study are discussed in the following sub-sections:

6.1. How reliable is the pulse survey instrument?

The analysis of the first research question, which seeks to evaluate the internal reliability and validity of the Pulse survey instrument, demonstrates strong consistency, with Cronbach's Alpha values between 0.744 and 0.901, indicating acceptable to excellent reliability. Constructs like WF (0.861) and AC (0.901) show high reliability, while CA (0.744) suggests room for improvement. Composite Reliability (CR) scores range from 0.785 to 0.913, confirming good reliability, except for PR (0.487), which requires further investigation. Most Average Variance Extracted (AVE) values exceed the 0.50 threshold, but PR (0.487) and CA (0.494) fall below, indicating weaker convergent validity. Factor loadings mostly surpass −/+ 0.500, except for PR-Q5 and CA-Q4, whose low loadings (−0.330 and −0.401) suggest these items are weakly associated with their constructs. This calls for a review of these items. These findings agree with [63], who demonstrated that reliability and validity can be effectively assessed using these frameworks. Overall, while the Pulse survey instrument performs well, this paper suggests that targeted refinements in PR and CA constructs will enhance its internal reliability and validity, ensuring a more robust tool.

6.2. What areas of the organisation's culture are well-aligned with agile culture, and which require improvement?

The analysis for the second question, which explores areas of organisational culture aligned with Agile practices and those needing improvement, reveals a positive shift in Company X's Agile culture from 2021 to 2022. In the 'Purpose and Results' element, all item scores improved, with mean scores ranging from 4.10 to 4.65 in 2021 and 4.28 to 4.71 in 2022, demonstrating the company's active engagement in Agile practices. The use of the ACM helped to identify these improvements, supported by targeted efforts in 2021. This aligns with the initial report and is similar to the interview insights, which indicate that Company X had a strong foundation but sought further workplace enhancement. A similar upward trend was observed in 'Agile Leadership', with mean scores increasing from 4.02 to 4.25 in 2021, and 4.21 to 4.48 in 2022. The trajectory is also the same for Adaptability to Change, with mean scores increasing from 3.91 to 4.71 in 2021 and 4.02 to 4.71 in 2022. These results are the same as the interview finding, which reveals that the Leadership of Company X was committed to creating a better workplace with acceptance to the change in culture that the transformation brings. For 'Well-being and Fulfilment' (WF), most items exceeded 4.0 in both years, except for personal fulfilment from work (WF-Q4), which remained the lowest (3.94 in 2021, slightly increasing to 3.97 in 2022), highlighting a need for improvement. In 'Collaboration and Autonomy' (CA), three out of five items exceeded 4.0 in both years, but CA-Q1 and CA-Q2 remained below 4.0. Although CA-Q2 showed a slight increase (3.94 to 3.97), CA-Q1 decreased (3.94 to 3.67), signalling a potential area requiring further attention.

Company X believes in the importance of being a learning organisation and engaging in continuous improvement, according to the interview findings. This is echoed in the mean scores of 'Innovation and Learning', which increase from 3.89 to 4.50 in 2021 and 4.10 to 4.38 in 2022. This suggests a commitment to professional development. In 2021, while the mean scores of other items of 'Trust and Transparency' were above 4.0, two elements, TT-Q3 (Dissenting views are aired openly and honestly without any negative consequences) and TT-Q4 (I feel comfortable giving upwards feedback knowing it will be heard and considered) items were below the mark. This suggests a potential opportunity for improvement. This finding confirms the initial report mentioned in section 1.3, which implicated 'Trust and Transparency' as the main element needing improvement. The efforts made by Company X were mainly targeted at improving 'Trust and Transparency'. These included creating alternative perspectives and comparing them with the organisation's tacit knowledge through feedback sessions to ensure they resonated with staff. This is evidenced in the 2022 results where mean scores of TT-Q3 and TT-Q4 increased to 4.23 each, with noticeable increases across other items in this element. Although there was a decrease in TT-Q1, the mean score remained above 4.0 which is not of great concern. The study has also revealed that statistical analysis can provide insights into Agile culture transformation in an organisation, by highlighting aspects requiring enhancement, and discerning the potential influence of targeted efforts to become more Agile. This is similar to [57], who employed quantitative analysis to determine the extent that hybrid working influences Agile principles, and to Barros et al. [58], who measured the success of Agile software development projects using a quantitative analysis.

6.3. How have perceptions of the organisation's culture changed since the last survey?

The t-test results which address the third research question, provide significant insights into the perceptions of changes in Company X's culture since the previous survey in 2021. They highlight meaningful improvements in the culture elements, supporting the effectiveness of targeted efforts or interventions. For elements like PR, AL, WF, TT, AC, and IL, where the p-values for both one-tail and two-tail tests are

below the conventional 0.05 threshold, we can conclude with statistical confidence that the observed changes are not due to random chance. This confirms comments made in the interview that the change in strategy made by Company X enabled them to continue in a viable manner and even win awards. Specifically, the p-values for PR (0.005 and 0.010), AL (0.002 and 0.004), and AC (0.002 and 0.003) indicate strong statistical significance, suggesting that the targeted shifts in these areas are consistent and substantial. This points to successful enhancement in organisational alignment with Agile practices in these categories.

On the other hand, the CA construct, with p-values of 0.153 (one-tail) and 0.307 (two-tail), does not exhibit a statistically significant change. This indicates that despite any targeted efforts, the changes in the CA means are likely attributable to random fluctuations, highlighting a potential area for further investigation and intervention. These results, combined with p-values for WF (0.014 and 0.028), TT (0.024 and 0.048), and IL (0.012 and 0.024), reinforce the notion that while many elements of the organisational culture improved, the lack of significance in the CA construct warrants attention for future strategies. As this paper supports the findings of [2,26,28], who maintain that Agile culture fosters a collaborative environment that enhances team dynamics and increases employee engagement, which is crucial for successful organisational change, it is important to improve CA culture in Company X.

Our findings validate the importance of statistical analysis in not only monitoring Agile transformations but also suggesting areas for targeted refinement to enhance overall cultural alignment.

6.4. Can targeted efforts on specific elements of the culture matrix contribute to a corresponding increase in other agile culture elements?

On the fourth question that explores whether targeted efforts on a specific element of the culture can contribute to increase in other Agile culture elements, the correlation analysis reveals significant improvements in the overall Agile culture of the organisation between 2021 and 2022, driven by targeted interventions on Trust and Transparency. In 2021, while the majority of correlation coefficients (96%) were positive, indicating that Company X has a good Agile foundation, they are mostly weak to moderate relationships existing between culture elements. The 23 (3.68%) negative correlations suggest some misalignment within the organisation's culture. This agrees with the interview findings that reveal Company X sensed things could be even more effective, which implies that what is being done in terms of organisational culture could be impacting negatively on some other culture elements. The presence of zero correlation in the two cases further underscored possible disconnects in the organisation's ability to foster CA within teams.

By 2022, after the implementation of targeted efforts, a remarkable shift was observed, with 99.7% of correlation coefficients turning positive, and only two negative correlations remaining. This stark reduction in negative associations indicates a significant strengthening of the organisation's Agile culture. The improved positive correlations, including the development of four new very strong relationships among key elements of 'Trust and Transparency', and 'Agile leadership', reflect a more cohesive and aligned culture. The introduction of new correlations, such as between senior leadership honesty and team feedback (TT-Q5 and TT-Q4, 0.823), highlights a shift towards a more open work environment. The 2022 correlations point to a culture that is increasingly team-oriented, focusing on shared leadership and collective accountability. The new strong correlations, such as between risk-taking and adaptability (AC-Q4 and AC-Q2, 0.806), demonstrate the organisation's evolving ability to respond swiftly to change without compromising values, reinforcing a deeper cultural alignment with Agile principles. The few remaining negative correlations in 2022, such as the weak negative relationship between goal setting and work value (PR-Q5 and PR-Q3, −0.039), suggest that while substantial progress has been made, there are still areas where Company X can further refine its practices.

Research limitations

- The study focuses on specific elements of Agile culture highlighted in the ACM, potentially overlooking other relevant culture dimensions such as diversity and sustainability which could affect Agile transformations.
- External variables such as market conditions, economic factors, or organisational changes outside of the Agile initiatives could have impacted on the results but were not accounted for in the analysis.
- The use of datasets from a single organisation limits the generalisability of the findings to other companies or industries with different structures, cultures, and challenges.
- While in-person interviews, specially with the organisation in context could have provided richer qualitative insights, participant availability limited data collection to email-based interview only with the ABC representative who supported the transformation.
- The dual role of the ABC representatives, who both facilitated the Agile transformation and provided qualitative reflections via email interviews. While their insights offer valuable practitioner perspectives, their involvement in the transformation process may have influenced the reporting.
- While reliability measures were adequate, the validity of the Pulse survey instrument, particularly for certain elements like PR and CA, showed inconsistencies, suggesting a need for refinement of some elements of the measurement tool.
- While the study provides reliability and convergent validity evidence of the instrument, additional validation techniques such as expert review, or cross-validation with external measures are necessary to confirm the theoretical alignment of the constructs.
- Refinement of the instrument through academic validation, such as Delphi studies with Agile scholars, could enhance the construct validity.
- Although data was collected at two time points, the study still lacks a longitudinal approach that could provide deeper insights into the long-term effects of Agile transformations on organisational culture.

7. Agile transformation and data-driven agility: Past, present and future

This section presents a set of reflections on the broader implications of Agile Assessment Models (AAMs) and other frameworks for Agile culture transformation. Rather than drawing directly from research data, these insights are based on expert judgment and an interpretation of industry trends. Agile methodologies have evolved significantly, shifting from a human-centric focus on flexibility, collaboration, and feedback to increasingly incorporating data-driven practices [69]. This shift has enhanced decision-making and performance metrics, but also raised concerns about maintaining Agile's core values amid growing reliance on analytics. Balancing these two aspects is crucial for organisations aiming to sustain agility while benefiting from data insights. In this section, we reflect on the key cultural shifts, the progress of Agile transformations, the challenges in adopting data-driven approaches, and present a vision for the future of Agile in an era of advanced technologies.

7.1. Shifts in agile culture

Agile methodologies, which centred around principles such as collaboration, self-organisation, and customer-centricity, have undergone a profound transformation in response to the rise of data-driven practices [70]. Early Agile practices, such as Scrum and Extreme Programming (XP), emphasised human interactions and flexible responses to change, with less reliance on quantitative measures [71]. However, over the past decade, the adoption of data analytics and statistical measures have significantly influenced Agile practices [72]. Today,

data-driven approaches are often embedded in Agile workflows, with metrics and key performance indicators (KPIs) playing a central role in decision-making, organisation performance assessment, and process optimisation [69]. For instance, metrics such as velocity, cycle time, and lead time provide actionable insights into team efficiency and help organisations make informed decisions about resource allocation and timelines [73]. Furthermore, tools like Jira and Azure DevOps have enabled teams to collect and analyse data on project progress and bottlenecks in real-time, fostering a culture of continuous improvement that relies heavily on data [36]. This evolution signifies a shift from qualitative judgment to quantitative insights, where data-driven agility has become essential for organisations seeking to improve their products and their ways of working [74].

7.2. Shifts in agile transformation

In the early 2000s, Agile adoption predominantly focused on introducing Agile methods within the software development sphere, introducing specific practices such as team structures, incremental development and enhanced customer engagement. It was not until the early-2010s that it became more widely understood that becoming Agile involved more than simple method adoption. The term 'transformation' became more widely used, acknowledging that these often involved a long journey encompassing culture change as well as strategy change and operational change [6], extending beyond IT departments. During the same period many IT organisations were heavily focused on operational Agile scaling, using frameworks such as SAFe that do not focus on culture. Since the early-2020s, there has been a growing emphasis on business agility, reflecting the need for cultural shifts across the entire organisation rather than focusing solely on the software development teams [75].

Since the mid-2010's numerous Agile Maturity Models (AMMs) and Agile Assessment Models (AAMs) have been published. These provide frameworks, assessment criteria and roadmaps that help organisations understand their level of Agile adoption and performance [39]. While some worry they encourage assessment as a tick-box exercise, they have been useful in helping to open up the debate about what Agile is, and what characteristics are most important for organisations to embrace. Since all organisations are different and Agility is fundamentally about responding to change, there is no one-size-fits-all, but there is still a need for pointers. Data visualisation tools and dashboards are becoming more widely used by organisations to continuously monitor and identify areas for improvement [69]. The feedback mechanisms embedded in Agile processes, such as sprint retrospectives and iterative planning, have been enhanced by data-driven insights. The increasing use of data-driven approaches means AMMs and AAMs, such as the Agile Culture Matrix and the Pulse survey, can not only be used to gain insights into team performance but also to help organisations track their transformation progress [40]. The inclusion of analytics allows for more objective and frequent assessments of team performance and helps organisations refine their Agile transformation strategies with greater precision [76].

7.3. Challenges in adoption

Despite the advantages offered by data-driven Agile practices, the adoption of such approaches has introduced significant challenges. One of the most prominent is the cultural tension between maintaining Agile's human-centric values and the growing reliance on quantitative metrics [77]. Agile's core principles emphasise flexibility, communication, and collaboration, but the emphasis on data can sometimes lead to a mechanistic view of Agile, where metrics overshadow qualitative factors such as team morale and creativity [78]. Another critical challenge is the integration of new technologies with Agile practices. While data analytics tools offer valuable insights, many organisations struggle to adopt these tools without undermining the collaborative ethos that Agile promotes [79]. For example, over-reliance on data can lead to metric fixation, where teams become focused on achieving specific numbers (e.g., velocity or throughput) rather than maintaining the adaptability and creativity that Agile encourages [80]. This challenge highlights the need for organisations to balance the use of data with Agile's human-centred philosophy, ensuring that data complements, rather than replaces, team judgment and collaboration [70].

7.4. Vision for the future

Looking ahead, the future of Agile culture and transformations will likely see even deeper integration of advanced analytics, artificial intelligence (AI), and machine learning (ML) to assess and identify areas of improvement in organisation's culture. Access to organisational data could enable organisations to make more predictive decisions about flexibility, adaptability and innovation abilities [36]. For instance, AI-driven tools could help organisations predict potential culture challenges, allowing them to proactively adjust their culture before issues arise [81]. In addition, adaptive Agile methodologies could emerge, where organisations dynamically adjust their Agile processes based on real-time data inputs. Such methodologies would leverage AI-powered analytics to continuously refine Agile practices, enabling organisations to become more responsive to changing market conditions and internal dynamics [82]. This future vision positions data-driven agility as the next frontier in Agile transformations, where organisations use data not only to react to changes but also to anticipate and prepare for future challenges. Ultimately, the future of Agile lies in harmonising the human-centred values of Agile with the power of data and technology, fostering a culture where organisations are empowered by data to make better decisions while still maintaining the flexibility and creativity that define Agile [76].

8. Conclusions and future work

This study presents an analysis framework that supports organisations in using the Pulse Survey instrument to guide Agile transformations. The findings show that Agile transformations significantly influence various dimensions of organisational culture over time, and validate the use of statistical analysis and data-driven approaches to track these shifts. The study concludes that targeted efforts on culture elements can lead to corresponding improvements in other areas, emphasising the interconnectedness of Agile culture elements. The results highlight the practical impact of initiatives such as managerial support and goal-setting, which show strong alignment within the Agile Culture Matrix.

While the Pulse Survey instrument demonstrates strong internal consistency, refinement in constructs like PR and CA may enhance measurement reliability. The positive correlations observed in 2022 reinforce the effectiveness of Agile principles within Company X, fostering a cohesive and aligned culture. For organisations seeking to enhance Agile transformation, this study recommends using the Pulse Survey to crystallise cultural states into actionable insights. These insights should be contrasted with the organisation's tacit knowledge to guide initiatives that are relevant and supported by the team. This approach ensures that transformations are collaborative, fostering both relevance and buy-in. While frameworks like the Agile Culture Matrix guide transformation efforts, it is essential for organisations to leverage their unique, uncodified knowledge for successful adaptation. Organisations should carefully tailor their transformation efforts, ensuring that improvements in one area do not hinder others.

A balanced approach, using both data-driven insights and cultural understanding, is essential for maximising Agile transformation benefits. Reflecting on the Agile culture assessment, the integration of data-driven approaches has fundamentally reshaped the landscape, shifting the focus from solely human-centric principles to a more metrics-based, analytically enhanced methodology. As organisations continue to adopt

advanced analytics and AI-driven tools, Agile transformations will increasingly rely on predictive insights, fostering a future where data and agility coexist to drive both innovation and continuous improvement. Future research should broaden the scope to include multiple organisations to enhance the generalisability of findings. Refinements to the Pulse Survey instrument, particularly in PR and CA, should be explored to improve reliability. Further investigation of the instrument through methods such as Confirmatory Factor Analysis (CFA), discriminant validity testing, and external validation against established Agile culture elements is recommended for future studies. Longitudinal studies could provide further insights into the long-term effects of Agile transformation on organisational culture. While we acknowledge sectoral differences in the datasets, we recommend conducting a subgroup analysis in a future research to further explore their impact. Future research should also explore broader qualitative data such as in-person interview methods to enhance depth in qualitative data collection.

CRediT authorship contribution statement

Chukwudi Uwasomba: Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Advait Deshpande:** Supervision, Resources. **Helen Sharp:** Writing – review & editing. **Peggy Gregory:** Writing – review & editing. **Rod Willis:** Writing – review & editing. **Leonor Barroca:** Supervision. **Maduka Uwadi:** Validation. **Katie Taylor:** Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix. Email interview questions

1. What exactly did Company X do to their governance structures, policies, and processes to provide the backbone for a more Agile culture in the organisation?
2. Can other organisations follow exactly what Company X did to achieve the same results? If yes, give details.
3. Were the staff who took the Pulse survey in 2021 the same as those in 2022?
4. How were the leadership efforts communicated to the employees?
5. Were these efforts merely a leadership aspiration?
6. How much insight did the staff have about the issue at hand?
7. Did the managers stay the same for these two years?
8. Did you play a role during the Company X Agile transformation? If yes, what was your role?
9. What is the history of what happened in the organisation before they started the transformation?

Data availability

Data will be made available on request.

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