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Human resilience and cultural change in the construction industry: communication and relationships in a time of enforced adaptation

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The construction industry will need to change to enhance performance and deliver more with less. This paper investigates how social science perspectives may help addressing challenges associated with enforced transformation. We turned to a leading construction company in Norway to study the role of human resilience and cultural understanding in the construction industry's ability to adapt to new technologies and practices. Results from a comprehensive survey with 541 respondents are analyzed and discussed against three concepts from literature: culture, resilience, and psychological safety. The results show that the consequences of enforced changes are perceived differently by different groups in the organization. Management teams found stronger impact of COVID-19, and they are more likely to carry forward changes into the future. We found confirmation that older employees and those with long experience found the effect to be stronger and more detrimental than younger. We also found that experienced individuals perceived communication and collaboration to worsen over the enforced change. However, the organizational culture represents a stabilizing force and individuals demonstrated resilience facing uncertainty. Team role affiliations also influence how people perceive the consequences. Therefore, organizations should carefully consider team dynamics and individual experience levels in their change management strategies. New technologies can enhance collaboration and communication if the organization also strengthen psychological safety, trust, and involvement. The resulting effect might be the best path for project-based organizations to adapt and reshape for the digital era.

KEYWORDS

communication, construction, culture, project based organization, psychological safety, resilience

1 Introduction

The construction industry is often criticized for its comparatively low productivity relative to other sectors. Although numerous technological advancements have been adopted to solve this productivity issue, the anticipated improvements proposed by technology proponents have not yet fully materialized. This indicates that the construction industry struggles to fully embrace and effectively utilize these new technologies. Given the future requirement to enhance performance and deliver more with less, the construction industry will need to change.

This paper examines the challenges associated with enforced transformation in the construction industry and emphasizes the significance of both human resilience and cultural understanding in addressing these challenges. We argue that the inclusion of such social science perspectives into our analysis of, and strategies for development, can be essential in changing the industry's behavior. By gaining a deeper understanding of the industry's deeply rooted culture, alongside social and organizational factors, we can design more effective strategies to encourage and facilitate successful adaptation to new technologies and practices.

To investigate these issues, we turned to a leading construction company in Norway. The case organization can be defined as a project-based organization (PBO). DeFillippi and Arthur (1998) identified project-based enterprises as organizations that manage production functions within a temporary project organization setting. PBOs refer to a variety of organizational forms that involve the creation of temporary systems for the performance of project tasks (Hobday, 2000). Most current PBO structures, and notably so in construction, are mechanistic in nature; their management approach is based on the extension of tools developed for the management of single projects and is grounded in linear relationships (Moore, 2000). This characteristic describes where most construction companies come from and is still valid for most firms in this industry. Thiry (2007) observed that PBOs must be adapted to the culture and the purpose of the existing organization; "it must take into account the political and structural circumstances and build on them, rather than fight them".

As a premise to our study, we recognize that the construction industry operates within an increasingly complex external environment marked by unprecedented challenges such as pandemics, climate change, and demands for social and economic sustainability. During periods of forced adaptation, the industry contends with a host of challenges. Uncertainty and vulnerability become prominent features of the work environment, fostering feelings of isolation and lack of belonging among team members within project-based organizations. Simultaneously, these pressures expose a deeply rooted culture that is struggling to evolve towards a more positive and adaptive stance. These complex dynamics necessitate a shift in industry practices, including a greater emphasis on regulatory compliance, adaptation to resource limitations, and a commitment to sustainable practices.

Given this starting point, this research seeks to understand the role of human resilience and cultural understanding in the construction industry's ability to adapt to new technologies and practices. The opportunity emerged during the COVID-19 pandemic–a period of enforced adaptation. Suddenly there was no way around making immediate changes, including the forced implementation of new technologies virtually overnight. This paper explores the significance of social science perspectives in shaping strategies for development, with a focus on communication and relationships within construction projects. Additionally, the research examines how the industry's deeply rooted culture, social and organizational factors influence project outcomes, productivity, and overall successful adaptation.

To help develop our understanding of the observed phenomenon we use the following concepts:

Culture: Organizational culture has been a field of study since the 1950s with anthropology and sociology as basis. The field of organizational culture research recognizes culture as a complex and multi-dimensional topic (Morrison et al., 2006). Du Plessis and Hoole (2006) refer to Deal and Kennedy's (1982) definition of organizational culture, comprising of four dimensions, i.e., project process; people in projects; project systems and structure, and project environment when they developed a descriptive project management culture framework. We will follow Du Plessis and Hoole, using their four dimensions to describe culture.

Resilience: Resilience in organizations is defined by Kuntz et al. (2017) as "system agility and robustness, essential to survival and thriving in increasingly challenging contexts". Olsson and Klakegg (2023) points to the relationship between resilience and flexibility–when these are combined, the question is not just about survival or getting back on track, but an opportunity to come back stronger after a shock to the socio-technical system. Furthermore, while resilience is not always uniform in an organization, leaders play an essential role in fostering it, as they can facilitate the process of "learning to unlearn and learn" (Giustiniano et al., 2020).

Psychological safety: Edmondson (1999) defined psychological safety at the group level as "a shared belief held by members of a team that the team is safe for interpersonal risk taking." Studies have shown the importance of psychological safety in facilitating collaborative work, particularly when workgroups face uncertainty and change and need to learn together (Edmondson and Lei, 2014).

2 Materials and methods

The research reported here utilized a survey to collect a valid picture of the development in a leading company through the changes forced upon the organization by COVID-19.

2.1 Literature review

To support the development of the survey, and to establish a theoretical framework for relevant concepts, we conducted a literature review. Key terms related to the research topic were identified. These keywords included Team, Project, COVID-19, Digitalization, Communication, Interaction, and Involvement. These keywords were then deployed in comprehensive searches of the Compendex and Scopus databases. The use of Boolean operators helped to refine the search and manage the results, aiming to achieve a collection of relevant peer-reviewed articles. Upon identifying potential sources, their relevance was assessed by reading the abstracts and examining citation counts. This ensured that the articles selected for inclusion in the literature review were both pertinent to the research and highly regarded within the field.

2.2 The research context

Our research focuses on one of Norway's leading contractors, a firm recognized for its dedication to quality and efficiency in project-based production. This organization embraces an approach called Involved Planning (IP), an adaptation of the Lean Construction

TABLE 1 Structure of the survey.

Question no.	Theme
1–4	Demographic variables (gender, age, position, and number of years of experience)
5–6	Pre Covid situation (communication and collaboration before lock-down)
7–14	Current situation (effect of infection control measures, changes in communication and collaboration, use of technology, effect on planning, and performance)
15–16	Future situation (what will be considered "normal" after the pandemic)

TABLE 2 Profile of the respondent population.

Job description	Number of respondents	Female/Male	Average age[a]	Average experience in current position[b]
Project manager	131	16/115	3.24	2.25
Design manager	54	21/33	2.72	1.81
Construction manager	152	12/140	2.95	2.02
Assistant design manager	4	3/1	1.75	1.00
Assistant construction manager	9	4/5	1.67	1.11
Operations manager	63	6/57	3.13	2.08
Project engineer	43	21/22	1.79	1.42
Trainee	76	27/49	1.05	1.00
Other	9	1/8	3.78	2.56
Sum	541	109/432	2.65	1.86

[a]1: <30 years; 2: 30–39 years; 3: 40–49 years; 4: 50–59 years; 5: >60 years.
[b]1: <5 years; 2: 5–10 years; 3: >10 years.

methodology, to drive progress in their projects. The primary aim of IP is to minimize downtime and establish a seamless workflow in production. A distinctive feature of this method is the principle of involvement - the idea that every member of the team actively participates in planning their own daily tasks. This approach has resulted in improved productivity, enhanced team collaboration, and increased job satisfaction among employees. The company plays a significant role in shaping construction practices in Norway.

2.3 Data collection

Our empirical research drew from both qualitative and quantitative data gathered from team members within one of Norway's largest contractors. A structured survey, as suggested by Blumberg, Cooper and Schindler (2014), allowed for extensive data collection from a uniquely qualified sample. This method was particularly useful given the challenges of reaching a large sample size. The survey, designed using Microsoft Forms, was organized into four logically structured segments. As Table 1 shows, the first segment sought background information via closed-ended questions, while the remaining segments employed an equal mix of open and closed questions. The completion of closed-ended questions was mandatory, while the open-ended ones were optional.

The survey was distributed via email to 1,056 potential respondents. All respondents were colleagues of the first author at that time. Contact details were obtained from the company's personnel system. After accounting for invalid emails, personnel on various types of leave, and employees no longer part of a project team, the number of valid potential respondents was adjusted to 1,025. Out of these potential respondents, 541 completed and returned the survey by the end of January 2021, achieving a response rate of 52.3 percent. A profile of the respondents is shown in Table 2. This respondent pool represented a significant fraction of the organization's project teams. Their answers enabled a comprehensive understanding of the state of the art in project-based production within the company.

The survey design ensured respondent anonymity, a one-time response per person, and protection against unauthorized access. Analysis of the quantitative data allowed us to examine sample facts, conduct hypothesis testing, analyze correlations, and compare groups. The qualitative data, collected through six open-ended questions, provided context and depth, paving the way for a rich interpretation of the empirical data collected. This approach allowed us to gain a broad understanding and situational awareness of the current state of the projects and to identify patterns that can be generalized as universally applicable facts, as suggested by Molléri, Petersen, and Mendes (2016). Furthermore, it provided us the opportunity to detect cause-effect relationships and interdependencies within the data.

2.4 Analysis

Upon the survey's completion, all data was exported to Microsoft Excel for initial cleaning and sorting. Quantitative data

were assigned numerical values and were then imported into the statistical software SPSS for advanced analysis, ensuring appropriate attributions such as Nominal, Ordinal, and Scale were assigned to each variable. Defined significance levels, $\alpha = 0.01$ and $\alpha = 0.05$, were utilized for correlation analyses, offering 99 percent and 95 percent probability respectively for the existence of the calculated correlation. Both significance levels are considered acceptable (Bond and Fox, 2015). Quantitative data, collected on a 5-point scale from "Very poor" (1) to "Very good" (5), were analyzed using frequency distribution. Furthermore, correlation analysis, chi-square tests for group comparisons, hypothesis testing, and variance analysis, provide both a factual picture of the sample and insights into potential relationships.

The first author had a unique and thorough insight into the organization, given his employment there at the time of the survey. This knowledge provided a comprehensive understanding of the organization's culture, operations, and general atmosphere across the many projects. The hypotheses for this research are therefore deeply rooted in first-hand experience and observation. To ensure that these hypotheses were robust and scientifically valid, the first author initially discussed them with an expert colleague and then discussed further with the second author. The second author, with an external and more objective position, was able to ask critical questions, challenge assumptions, and contribute to the refinement and consolidation of the hypotheses. This collaborative process helped ensure that the hypotheses not only reflected the first author's personal experiences but were also well-grounded in existing literature and theory. In this way, strong, relevant, and investigable hypotheses for the study were developed. These hypotheses were examined through various tests and the test results were subsequently analyzed.

In addition, the qualitative data were analyzed using a method of meaning condensation and coding based on Kvale and Brinkmann's approach (2015). The raw data were first exported to Microsoft Excel for preliminary cleaning before being compiled into six text documents - one for each open-ended question. The data was initially reviewed to discern the primary characteristics before being uploaded into NVivo for more in-depth analysis. Responses were organized into natural categories, and within these categories, particularly meaningful connections were identified and further divided into subcategories. Descriptive codes were then assigned to these subcategories. Central themes from the responses were explicitly expressed, and their relevance to the research problem was evaluated. Irrelevant responses were not included in the further analysis. Finally, key aspects were condensed into new descriptive statements.

3 Results

In the face of the COVID-19 pandemic, a time of enforced adaptation, our study finds that the organization is compelled to enact significant internal transformations. The pandemic, coupled with the overarching goals of environmental, social, and economic sustainability, have necessitated change across all sectors. Regulatory reforms and resource constraints will be factors driving the organization's adaptation. Data shows that the impact of these external pressures on individuals within project-based teams is profound. Prolonged absence of physical presence and face-to-face interactions has led to a significant decline in team members' wellbeing, weakening relational bonds, and undermining trust. This diminished psychological safety, combined with the erosion of the organization's culture, presents significant obstacles to productivity and the successful adaptation of the organization. To successfully transform the organization and address these challenges, our study underscores the necessity of comprehending individual attitudes and responses to change, and instigating transformation not just in organization practices, but also in the deeply entrenched culture within the organization.

3.1 How the pandemic influenced the organization

Table 3 presents the frequency analysis based on our survey. It includes six variables related to the impact of COVID-19 on the organization. Each variable has been assessed on a scale of 1–5, with higher scores indicating stronger agreement with the statement. The Table provides an overview of respondents' perceptions of the impact of COVID-19 on the organization. It helps to understand how communication and collaboration (C&C) has been impacted by the pandemic, and the degree to which it has influenced the implementation of IP and the overall outcomes of projects. It also provides insight into how digital tools have impacted collaboration and communication, and the degree to which the changes that COVID-19 has imposed will be carried forward to future projects.

In our survey, respondents rated C&C within their project teams highly before COVID-19, indicating an effective pre-existing team dynamic. However, with the onset of the pandemic, a noticeable decline in these aspects was observed, suggesting that the shift to remote working conditions posed significant challenges to the team's C&C. Interestingly, the respondents acknowledged the significant impact of digital tools on team C&C. This indicates that while digital tools were essential in maintaining some level of coordination, they did not entirely replace the pre-pandemic, in-person collaboration's effectiveness and ease.

We note that respondents gave a moderate score on the impact on outcome of the project. Still, the totality of the answers highlights the extent of the pandemic's effect on project management. This emphasizes the importance of exploring effective strategies to navigate such disruptions. Furthermore, respondents believe that many changes induced by the pandemic, such as increased remote working and digital tools usage, will persist in future projects. This points to the lasting impact of the pandemic on project management practices and the potential long-term shifts in how people work in the construction industry.

3.2 How the enforced change influenced team involvement

The correlation analysis in Table 4 presents the relationship between different variables related to the way in which the COVID-19 pandemic has influenced team involvement in the projects. Each cell in the Table indicates the correlation between two variables. The correlation coefficients range from −1 to +1. Positive coefficients indicate that as one variable increases, the other also increases, suggesting a positive relationship (Blumberg et al., 2014). Conversely, negative coefficients suggest that as one variable

TABLE 3 Results of the frequency analysis.

	Variable	SD	Mean	99% CI[a]	
				Lower	Upper
1	C&C in the project team before COVID-19	0.672	3,996	3,922	4,071
2	The impact of digital tools on C&C	0.738	3,769	3,687	3,851
3	The extent to which COVID-19 has influenced the project team's C&C	0.946	3,177	3,072	3,283
4	The extent to which COVID-19 has influenced the implementation of IP in the project	0.922	2,998	2,896	3,101
5	The extent to which COVID-19 has impacted the overall outcome of the project	0.925	2,732	2,629	2,835
6	The degree to which the changes imposed by COVID-19 will be carried forward to the next project	0.837	3,268	3,175	3,361

N = 541.
[a]99% Confidence Interval of the Difference (1–5).

TABLE 4 Results of correlation analysis.

	Variable	Mean	SD	1	2	3	4	5	6
1	Before COVID-19	4.10	1.71						
2	Digital tools	4.92	0.80	0.076[a]					
3	Communication and collaboration	5.97	0.80	−0.036	0.285[b]				
4	Involving planning	3.65	0.71	−0.011	0.190**	0.522[b]			
5	Total impact	5.60	1.03	−0.171[b]	0.135**	0.397[b]	0.448[b]		
6	After COVID-19	5.62	0.89	−0.041	0.184**	0.162**	0.064	0.114[b]	

N = 541.
[a]$p \leq .05$.
[b]$p \leq .01$.

increases, the other decreases, implying an inverse relationship. The coefficients marked with ** are statistically significant at the 0.01 level, meaning there is a less than 1 percent chance that these correlations occurred by chance. Coefficients marked with * are significant at the 0.05 level, meaning there is a less than 5 percent chance that these correlations are accidental.

When interpreting this Table, we're mainly interested in the strength and direction of the correlations. For example, a strong positive correlation between the impact of COVID-19 on the project team's IP and the impact on C&C within the team has been identified. This suggests that the more COVID-19 impacted IP, the more it also affected C&C. In addition, we find a strong positive correlation between the impact of COVID-19 on IP and the overall outcome of the project. This indicates that the greater the effect of COVID-19 on IP, the greater the overall impact on the project.

The correlation analysis reveals several interesting patterns in the data. It shows that there is a strong relationship between the impact of the pandemic on the team's IP and collaboration. This indicates that changes in the planning process have significant consequences for how team members communicate and collaborate. Similarly, there is a strong correlation between the impact of the pandemic on IP and the overall project outcome. This suggests that the effects of the pandemic on the planning process can significantly influence the success of the project. Considering the findings from Table 3 where respondents perceived the direct impact of COVID-19 on project outcomes as moderate, the correlation analysis suggests a deeper, more indirect influence of the pandemic. The correlations between shifts in processes and project outcomes point to a stronger, perhaps subtler, effect of COVID-19 on project success.

For organizations, this means they need to value and maintain the practice of IP planning, even in the face of the pandemic and remote work. Upholding this practice may be the key to maintaining productivity and successfully executing projects. At the same time, organizations can look towards digital tools to help them navigate these challenges, as the analysis revealed a positive correlation between the use of digital tools and several project outcomes. These tools could provide a practical solution to facilitate collaboration and planning across distances. In addition, the analysis shows a negative correlation between the situation before COVID-19 and the total impact. This suggests that organizations that were high functioning prior to the pandemic may have experienced more significant challenges. Therefore, this highlights the importance of being prepared to handle change and potentially having robust change management in place.

3.3 Different group's perception of the impacts from enforced change

The Chi-square (χ^2) test is a statistical method applied in this study for determening the relationships between categorical variables, specifically to understand the divergence in perceptions

TABLE 5 Results of the Chi-square test for group comparison.

Group differences	χ^2	$\alpha_{0.01}$
Pre-Covid-19 C&C between MT and PT.	16.75	13.28
COVID-19's impact on IP between the MT and the PT.	9.60	9.49
Post-Covid-19 change perceptions between MT and PT.	16.98	13.28
Pre-Covid-19 C&C among different age[a]	30.90	26.30
COVID-19's impact on C&C among different age[a]	27.12	26.30
COVID-19's impact on IP among different age[a]	47.20	32.00
Pre-Covid-19 C&C among respondents with varying experience[b]	17.30	15.51
Post-Covid-19 changes anticipated among respondents with varying experience[b]	15.52	15.51

$\chi^2 > \alpha_{0,01}$ ⟹ significant difference.
[a]< 30 years; 30–39 years; 40–49 years; 50–59 years; >60 years.
[b]< 5 years; 5–10 years; >10 years.

TABLE 6 Result of hypothesis testing.

H_0	T	$t_{\alpha,0.01}$	
MT did not perceive that C&C functioned better before COVID-19 compared to PT.	3,363	2,333	Rejected
MT did not perceive that COVID-19 has had a greater impact on IP compared to PT.	1,893	2,333	Supported
MT is less likely than PT to carry forward changes forced by COVID-19	2,846	2,333	Rejected
Respondents who are 50 years or older did not perceive that C&C functioned better before COVID-19 compared to the experience of respondents under 50 years old	3,337	2,333	Rejected
Respondents who are under 50 years old did not perceive a greater impact of COVID-19 on C&C compared to the experience of respondents who are 50 years or older	2,847	2,333	Rejected
Respondents who are under 50 years old did not perceive a greater impact of COVID-19 on IP compared to the experience of respondents who are 50 years or older	4,224	2,333	Rejected
Respondents with five or more years of experience in their current position did not perceive better C&C before COVID-19 compared to respondents with less than 5 years of experience	2,840	2,333	Rejected
Respondents with less than 5 years of experience in their current position are less likely to carry forward changes forced by COVID-19 compared to respondents with five or more years of experience	1,370	2,333	Supported
Respondents who are under 30 years old and have less than 5 years of experience in their current position perceived a lesser impact of digital tools on C&C compared to older respondents with more experience	2,177	2,333	Supported
Respondents who are under 30 years old and have less than 5 years of experience in their current position are less likely to carry forward changes forced by COVID-19 compared to older respondents with more experience	0.216	2,333	Supported

$T > t_{\alpha,0,01} \Rightarrow rejects\, H_0$

among different groups within the organization. Derived from the χ^2 probability distribution, the χ^2 values, listed under the χ^2 column in Table 5 represent the calculated discrepancies between the observed and expected distributions of responses. This method is especially advantageous in this context as it provides a standardized measure for assessing the significance of observed differences.

The critical value, denoted as $\alpha_{0.01}$, serves as a threshold in this analysis. Drawn from the χ^2 distribution Table, this value is used to determine whether the observed differences in perceptions among the various groups are statistically significant. If a calculated χ^2 value exceeds the corresponding critical value, it indicates that the disparity in perceptions is statistically significant, with less than a 1 percent margin of error.

Table 5 details these relationships, referring to perceptions of C&C before the pandemic and its impact on IP as pre-Covid-19 and to its impact on IP, and the effects of COVID-19 on C&C and IP, respectively. The respondents are divided into groups, designated as the Management team (MT)—comprising of project managers, design managers, and construction managers–and the Project team (PT) representing all other team members. Further divisions were made based on age and experience, providing a deeper understanding of the different perceptions within the organization. If the χ^2 value is higher than the corresponding $\alpha_{0.01}$ value, the difference is deemed significant, revealing perceptual contrasts among different demographics regarding the pandemic's impact on C&C and IP.

Utilizing the χ^2 test, our study shows distinct disparities in perceptions concerning the COVID-19 pandemic's influence on communication, collaboration, and planning. Notably, MT perceived a more pronounced impact of the changes compared

to PT. The variances span both the pre-pandemic phase and expectations for the post-pandemic future. Additionally, age emerged as a defining factor: different age brackets expressed unique perspectives on how the pandemic has shaped planning. These contrasts likely stem from the diverse experiences and reactions to the pandemic based on age, subsequently impacting one's adaptability to change.

In addition, there were marked differences in the perceptions of respondents with varying experience levels. These differences pertained to both the pre-pandemic state of C&C and the anticipated changes in the post-pandemic period. This divergence implies that the impact of the pandemic might have been experienced differently depending on an individual's tenure or role within the organization. Taken together, these findings suggest that as organizations navigate the post-pandemic landscape, a considerate and inclusive approach that accommodates these diverse experiences and perceptions should be adopted.

3.4 Hypothesis testing

To further substantiate the results of the Chi-square tests, a series of independent t-tests were performed. These tests, shown in Table 6, aimed to examine differences in perceptions across various demographic groups of respondents as defined by the hypotheses. The various demographic groups are treated as independent of each other, with an assumption of normal distribution within each group. In an independent *t*-test, the calculated test statistic (T) is compared with a critical value from the student's t-distribution, corresponding to a chosen significance level. In our study, the critical value corresponds to a 1 percent significance level ($\alpha = 0.01$). If the calculated T is greater than the critical value, the null hypothesis (H_0) is rejected, suggesting that there is a significant difference between the groups.

The hypothesis tests paint a clear picture of a significant difference in perception between MT and PT. Across all the hypothesis tests, MT perceived the impact of COVID-19 to be greater than what PT perceived.

The hypothesis tests examined the relationship between the demographic groupings of age and experience. It tested whether the youngest respondents and those with the least experience in their current position had significantly different perceptions compared to the perceptions of the older respondents with more experience. The findings of these hypothesis tests indicate that respondents who are under 30 years old and have less than 5 years of experience in their current position perceived a lesser impact of digital tools on C&C. Furthermore, they are less likely to carry forward changes forced by COVID-19 compared to the older respondents with more experience.

3.5 Deeper insights into demographic influences: an analysis of variance approach

This statistical method allows for the comparison of mean perceptions across multiple groups simultaneously, providing nuanced insights beyond our initial Chi-square tests, which offered a broader overview of where significant differences lie among groups. Building upon these initial results, the ANOVA further examines these significant differences by testing hypotheses involving a combination of demographic variables and their influence on the perceived effects before, during, and after COVID-19. The hypotheses tested in the ANOVA, while thematically akin to those examined in the Chi-square tests, are not identical due to the different methodological capabilities of these two statistical analyses.

In Table 7, each row presents the null hypothesis H_0, stating that there is no significant difference in perception across groups divided by specific demographic factors. The F-value, a test statistic yielded by the ANOVA, is compared against the critical value $F_{(\alpha,0,01)}$ from the F-distribution's 0.01 quantile. When the calculated F-value surpasses the critical value, we reject the null hypothesis, indicating there is a significant difference in perception across the groups compared. Conversely, if the F-value falls below the critical value, we retain the null hypothesis, suggesting there is no significant difference.

The results of the ANOVA tests provide a nuanced understanding of how different demographic factors within the organization might affect perceptions of COVID-19's impact on communication, collaboration, and planning. While all hypotheses provide unique insights, some have more direct operational implications for the organization. Firstly, the support for the first, third, and fourth hypotheses suggests that perceptions of how C&C functioned before COVID-19 are not significantly influenced by the relative proportions of respondents in the MT *versus* the PT based on age, by respondents' age in relation to their experience, or by a combination of both team makeup and demographic factors. This implies a certain level of uniformity in the understanding of pre-pandemic conditions across the organization, regardless of age, experience, or team role affiliation. This might signal a shared cultural memory that could serve as a stable reference point when implementing changes or navigating future crises.

In contrast, the rejection of the second hypothesis indicates that there is a significant difference in perception of how C&C functioned before COVID-19 between MT and PT members, influenced by their respective experiences. This suggests that the impact of experience might differ depending on whether an individual is part of the MT or PT. The fifth hypothesis, which also was rejected, implies a significant effect of respondents' age relative to team role affiliation on the perceived impact of COVID-19 on IP. This suggests that age, in combination with team role affiliation, might affect how individuals perceive the pandemic's disruption to the planning process. This insight could be particularly valuable when considering how to tailor communication or support mechanisms to different teams and age groups in the organization. Lastly, the rejection of the sixth hypothesis suggests a significant effect of the team role affiliation relative to respondents' experience on the intention to carry forward changes after COVID-19. This might imply that individuals' openness to sustaining pandemic-induced changes could vary depending on their team's roles, as well as their individual experience. This is a critical insight for leaders looking to consolidate and build on the changes made during the pandemic, as it underscores the importance of considering both team dynamics and individual experience levels in their change management strategies.

TABLE 7 Results of the variance analysis.

H_0	F	$F_{\alpha.0.01}$	
No significant difference between MT and PT members or across age* in the perception of how C&C functioned before COVID-19	0.849	1,500	Supported
No significant difference between MT and PT members or across experience** in the perception of how C&C functioned before COVID-19	1,340	1,183	Rejected
No significant difference between age* or across experience ** in the perception of how C&C functioned before COVID-19	1,037	3,204	Supported
No significant difference between MT and PT members or across age* and experience** in the perception of how C&C functioned before COVID-19	0.500	1,325	Supported
No significant difference between MT and PT members or across age* in the perception of the impact of COVID-19 on IP.	2,641	3,967	Rejected
No significant difference between MT and PT members or across experience** in the perception on whether changes will be carried forward after COVID-19	0.597	0.817	Rejected

$F > F_{\alpha,0,01} \Rightarrow rejects\, H_0$

[a]< 30 years; 30–39 years; 40–49 years; 50–59 years; >60 years.

[b]< 5 years; 5–10 years; >10 years.

3.6 Building bridges with words: qualitative narratives on human resilience, communication, and cultural evolution in construction

The construction industry, long perceived as one rooted in tangible processes and established norms, has been thrust into an era of enforced adaptation. The pandemic not only redefined operational boundaries but also catalyzed a deeper introspection into the very ethos of the industry. At the heart of this transformation was the undeniable force of human resilience, the capacity of individuals and teams to adapt, overcome, and thrive despite adversities. This resilience was not just an innate ability; it was cultivated through revised communication frameworks and bolstered relationships. As one respondent noted, "The challenges brought about a deeper appreciation for our colleagues and the relationships we hold." It was this human-centric focus that propelled cultural shifts, encouraging more open channels of communication, prioritizing wellbeing, and fostering an environment of mutual respect and understanding. Another respondent articulated, "The way we communicate has become more intentional, more empathetic." In the face of enforced change, it was the industry's collective spirit, its commitment to its people, and a reimagined approach to communication that truly stood out, bridging gaps, and building a more resilient, culturally attuned future.

3.6.1 Dynamic shifts: agility, resilience, and the role of technology in project practices

The pandemic-induced remote work structure meant the role of technology evolved from being auxiliary to essential. Organizations realized that the shift was more than just replacing physical presence with virtual meetings. "We have leveraged technology to facilitate virtual meetings, document sharing, and real-time collaboration." Yet, the newfound dependence on technology was not without its challenges. Many respondents missed the nuances of face-to-face interactions, especially for IP activities. "The pandemic has challenged involved planning as a methodology since a significant portion of the project team has been less physically present." However, it became evident that while digital tools offer numerous benefits, they cannot completely replicate the rich context and nuances of in-person dialogues.

The dearth of casual interactions drastically shifted the dynamics within project environments. Once taken-for-granted moments like coffee machine conversations or hallway chats became conspicuous by their absence. "Our interactions have taken a digital turn, but it is the spontaneous and organic conversations we miss the most." This change was not merely social. It impacted the very fabric of how information and expertise flowed within teams. "In the past, we could easily share insights, troubleshoot issues, and learn from one another by being physically present. Now, the experience feels more fragmented, and it is harder to tap into the collective wisdom of the team." In addition to the external challenges, internal challenges like stress, anxiety, and overall mental wellbeing loomed large. The organization had to adopt a proactive approach in addressing these. "We have implemented employee assistance programs, provided access to mental health resources, and encouraged open conversations about wellbeing."

Respondents consistently conveyed a profound sense of resilience. They emphasized a cultural shift towards continuous improvement, adaptability, and innovation. In a time where facing uncertainties became a daily routine, this resilience proved crucial. One respondent noted, "The challenges we faced were not just technological, they were deeply human. We had to relearn how to collaborate, prioritize, and drive innovation in the face of adversity." In this altered landscape, the commitment to evolving project practices, nurturing employee wellbeing, and maintaining a steadfast focus on organizational objectives defined the trajectory for many in their quest to navigate the challenges of the pandemic.

3.6.2 Human connections: trust, cultural evolution, and digital dynamics in teams

The pandemic's disruption of traditional work routines forced the organization to confront an unprecedented challenge: maintaining a cohesive team dynamic amid geographic separation and virtual interactions. A major takeaway was the loss of those fleeting yet significant moments of casual interactions. As one respondent elaborated, "The lack of face-to-face interactions has made it difficult to establish meaningful connections with colleagues, especially as a new team member." This highlights a profound disruption in the fabric of team building. The physical separation created by remote work meant that the fundamental act of gathering team members in one room, sharing ideas, and building rapport became a rarity. This physical disconnection, according to another respondent, has been particularly

challenging for IP processes, where "the digital tools available do not fully replace the interaction that can occur in a physical meeting."

In the absence of physical proximity, trust became an ever more critical component of team dynamics. The foundation of trust was shaken as teams grappled with the new normal. Traditional oversight methods were rendered impractical, and a new trust dynamic was required. Managers and leaders had to believe in their team members' commitment and integrity without the usual visual validations. The importance of trust extended beyond mere work responsibilities. With the blurred lines between personal and professional realms causing stress for many, trust in team members' capability to voice their challenges was paramount. One respondent insightfully shared, "While we've adapted to this new digital realm, the absence of those impromptu office chats and face-to-face moments can not be replaced." This reinforces the idea that despite technology's facilitation, genuine human connections, built on trust, remain irreplaceable.

Amidst this landscape of change, cultural evolution took center stage in many organizational transformations. While the technical aspects of projects persisted, it was the human facets that stood out most prominently. Values surrounding open communication, trust-building across digital boundaries, and an emphasis on the wellbeing of team members began to shape the core culture of many project teams. Echoing this sentiment, one respondent observed, "The essence of our interactions might have shifted, but the human need for genuine connection remains stronger than ever." This not only indicates a transformation in day-to-day operations but also reveals a profound cultural transition towards recognizing the value of genuine human connections amidst digital landscapes. Moreover, the importance of technology in maintaining and fostering these team dynamics was undeniable. As one respondent noted, "The use of innovative digital tools has become an essential aspect of our project workflow, ensuring seamless communication and collaboration." More than just facilitating tasks, technology played a vital role in replicating, to the best possible extent, the human element of work. Virtual team-building activities and informal catch-up sessions were integral in sustaining team spirit and camaraderie in this digital age.

Despite these challenges, there was an evident resilience in the way teams adapted. The respondents' narratives painted a picture of an adaptable, learning-driven workforce. As one respondent succinctly put it, fostering "a mindset of resilience" enabled teams to navigate the challenges, drawing from their experiences to fuel innovation and continuous growth. However, the silver lining in this era of remote work was the re-emphasis on human connections, the value of trust, and the adaptability of teams. Through the turbulence, the human spirit's resilience was evident.

3.6.3 Expanding safety: physical, digital, and psychological dimensions in the project environment

Historically, safety within projects was often tethered to tangible concerns: physical hazards in construction sites or security protocols in IT infrastructures. However, the dispersed nature of modern work has expanded this scope considerably. Reflecting on the expanded definition of safety, one respondent mentioned the following, "Our notion of safety now encompasses not just the physical workspace, but also the digital environment and mental wellbeing of our team members." Safety has been reconceptualized, with attention now given to digital data integrity and the ergonomic health of remote workers. This was paralleled by shifts in project processes, which became more agile, emphasizing flexibility to navigate the unpredictability of the current era.

The move towards remote projects not only blurs office boundaries but also intensified the challenge of maintaining the essential human connection. A palpable sense of nostalgia is evident in the words of a participant: "The informal moments where we could 'pop by' someone's office or ask a quick question were invaluable for fostering relationships." The absence of these moments meant teams had to be deliberate in nurturing connections. Another respondent highlighted their innovative strategies, noting, "We have implemented regular virtual team-building activities and informal catch-up sessions to maintain a sense of connection."

From a structural perspective, traditional hierarchies and systems underwent significant re-evaluation. The PBOs recognized that an era demanding rapid adaptation required fluid structures. One team member emphasized, "The constant challenge was to ensure the team felt united, even though we were all physically apart." Adaptability was now not merely an operational choice but a necessity for mental health and trust cultivation. Prominent in this reshaping was the increased recognition of mental health's significance. While remote work offered flexibility, it also blurred the lines between personal and professional spheres, causing stress for many. One respondent shared their perspective: "The wellbeing of our team members became a forefront concern. It was not just about project deadlines but ensuring everyone felt supported and heard." Such statements reveal a broader shift from viewing projects as mere operational entities to ecosystems that care for their members' holistic wellbeing.

Embedded in these narratives is an undercurrent emphasizing resilience and adaptability. When one respondent stated, "We have encouraged team members to embrace new technologies, learn new skills, and find creative solutions," it was not just about process efficiency. It reflected a broader cultural shift within PBOs towards cultivating resilience and a growth mindset. This commitment to resilience and adaptability was seen as fundamental in navigating the myriad challenges presented by a changing project environment. As we delve deeper into the dimensions of safety in the modern project environment, it becomes evident how physical, digital, and psychological aspects are interwoven within the fabric of PBOs. The quotations from professionals on the ground bring forth their lived experiences. The tales not only shed light on the struggles faced but also highlight the inherent resilience and adaptability that characterize today's project teams.

4 Discussion

4.1 Project process

The results from our study indicated a significant transformation in project processes due to the COVID-19 pandemic. It is crucial to delve deeper into this transformation, how organizations navigated it, and the potential implications for

future project management practices. This discourse finds its roots in traditional project management theory and practice and extends to the shift towards agile and flexible methodologies.

The traditional approach to project management has been challenged by the uncertainties and rapid changes brought about by the pandemic. This is consistent with previous research suggesting that conventional project management approaches might not be suited to uncertain, dynamic environments (Shenhar and Dvir, 2007). The pandemic, by its nature, presented an uncertain, volatile, and highly complex situation for projects. Our respondents highlighted that they needed to shift from established project management methods towards greater flexibility and adaptability. The necessity of this shift reinforces the growing recognition of agile project management (Highsmith, 2010). Agile project management emphasizes flexibility, responsiveness to change, and continuos realignment of project goals as circumstances change. In the face of a crisis like the pandemic, this agility becomes even more critical.

Looking at the pandemic through the lens of Duchek's (2020) framework of resilience, we see that the initial stage of anticipation entailed a reconsideration of survival. While our empirical data did not indicate projects being paused or terminated, the focus seemed to be on strategic adaptation considering the impending challenges. Drawing parallels from Cinner and Barnes (2019), this strategic adaptation can be linked to key social factors that foster resilience, such as flexibility, social organization, and agency. In the coping stage, as identified in our empirical data, projects demonstrated resilience by navigating challenges rather than halting. Here, the emphasis shifted from the anticipation of disruption to finding ways to continue delivering amidst it. Elements like flexibility in project goals, and adaptive strategies were evident in our findings. Finally, the adaptation stage, as outlined by Duchek (2020), emphasizes long-term survival or outcomes. This aligns with our empirical findings where organizations were not merely reacting to the pandemic; they were strategizing for potential future disruptions. While some reported a shift towards more digital collaboration tools and altered stakeholder engagement processes, the core objective was clear: to enhance resilience by learning from the current crisis and adapting their processes accordingly.

The interplay between organizational structure and resilience, as shown in our findings, paints a picture of a nuanced relationship. Drawing insights from Cinner and Barnes (2019), one can argue that elements like social organization and agency played a pivotal role in this dynamic. While decentralized organizations showed adaptability, the balance between flexibility and accountability remained crucial. By integrating Edson's (2012) insights on complex adaptive systems, our findings suggest that project teams displayed resilience by tapping into adaptive capacities. The environment of continuous feedback, seen through the usage of digital collaboration tools and frequent stakeholder check-ins, can be seen as an adaptive response strategy.

We found that organizational structure significantly influences an organization's resilience. Decentralized organizations demonstrated greater adaptability, suggesting a higher level of resilience. However, as Olsson et al. (2023) point out, a more fragmented structure may also limit flexibility and resilience, as each unit must be able to "prove its accountability." This implies that the relationship between organizational structure and resilience is complex and nuanced. In addition to organizational structure, building resilience within project processes is a multi-dimensional endeavor. Steen, Haakonsen and Patriarca (2022) underscore the importance of not solely relying on standard procedures, but also having the ability to improvise in the face of escalating uncertainty. This aligns with our own findings, where we saw instances of creative problem-solving beyond standard procedures. Communication and interaction, which Steen, Haakonsen and Patriarca (2022) identify as key components of resilience capacities, were particularly prominent in our empirical findings. The pandemic has shown the importance of network building and regular training to maintain and enhance these capacities.

The concept of psychological safety, as defined by Edmondson (1999), pertains to a group-level climate characterized by interpersonal trust and mutual respect in which people feel comfortable being themselves. In essence, it captures the degree to which people perceive their work environment as conducive to taking interpersonal risks, such as asking questions, seeking feedback, reporting mistakes, or proposing new ideas. In the context of our discussion on project processes amidst the pandemic, this definition adds further depth. As teams shifted to remote work due to COVID-19, they were thrown into an environment of heightened uncertainty and stress. This environment potentially hindered interpersonal risk-taking as individuals may have been more hesitant to voice their ideas or concerns for fear of repercussions. The shared belief in the safety of doing so, or psychological safety, may have been compromised.

Our research suggests that the shift to remote work may have unsettled established norms, impacting psychological safety in project teams. Fyhn et al. (2023a) introduced "team emergent states" as properties arising during team interactions, representing members' attitudes like cohesion. Many studies have overlooked the evolving nature of these states, focusing instead on their static aspects. This highlights the need to understand how these team states develop, especially during challenges like the pandemic. Understanding and bolstering psychological safety is critical, especially as teams face disruptions and uncertainties.

Promoting interpersonal risk-taking through open communication and mutual respect can enhance psychological safety, aiding project teams in navigating challenges. According to Edmondson (1999), such environments help teams address uncertainties collaboratively. Fyhn et al. (2023b) stress the need to delve deeper into the nuances of psychological safety's emergence and sustenance during tough times. As we move ahead, it is essential for organizations to reflect on pandemic learnings and anticipate future challenges, be it climate change, tech disruptions, or geopolitical shifts. Organizations will be guided by embracing principles of psychological safety and understanding team dynamics. Cultivating an atmosphere of trust and dialogue prepares them for forthcoming complexities, ensuring enduring success.

4.2 People in projects

When examining the pandemic's effects on projects, it is crucial to consider the human aspect. People are the lifeblood of projects,

and their experiences, behaviors, and responses to crisis can significantly impact project outcomes. In the context of the COVID-19 pandemic, our research unveiled profound implications for team members, their interactions, wellbeing, and the shifting nature of work within project environments. The pandemic has compelled a significant portion of the workforce to adapt to remote work, fundamentally altering the dynamics within project teams. Existing research on remote work has posited both advantages, such as flexibility and increased autonomy, and challenges, including isolation, communication issues, and blurred boundaries between work and personal life (Gajendran and Harrison, 2007). Our findings echo these complexities.

The shift to remote work indeed underscored the importance of effective communication in projects. Digital tools and platforms have undoubtedly served to bridge some of the physical distance; however, based on our respondents' feedback, these tools could not fully replicate the richness of face-to-face interactions. This aligns with Morrison-Smith and Ruiz's (2020) analysis of the challenges faced by virtual teams, which revealed that geographical distance is closely linked with cognitive, social, and emotional challenges. Furthermore, our findings indicated reduced opportunities for spontaneous interactions and the casual exchange of ideas, reflecting another category identified by Morrison-Smith and Ruiz (2020) - the configuration of dispersed teams. The lack of informal and unplanned interactions at the workplace, which play a crucial role in knowledge transfer, points to the challenges associated with recreating these dynamics in a remote work setting effectively. Thus, the transition to remote work during the pandemic underscores the need to better understand the challenges faced by virtual teams, as outlined by Morrison-Smith and Ruiz (2020) and develop strategies to overcome these obstacles.

The transition to remote work during the COVID-19 pandemic highlighted the pivotal role of leadership in projects. Leaders had to steer teams through uncertainties, adapt to novel working methods, and manage emotional wellbeing. This echoes Yukl and Mahsud's (2010) perspective on the critical role of leadership during crises, emphasizing direction and emotional management. Our findings further emphasize a "people-oriented" leadership style, aligning with Drouin et al.'s (2021) balanced leadership concept, which promotes a fluid leadership authority exchange between managers and team members. Projects that excelled during the pandemic were often exhibited by flexible leadership and a decentralized power structure, fostering adaptability and rapid response. Drouin et al. (2021) stress empowering team members to decide "who leads", optimizing responsiveness to unforeseen challenges. However, remote leadership brought challenges like reduced direct supervision. These can be mitigated by implementing balanced leadership principles, emphasizing role clarity and expectations, ensuring smoother coordination in remote settings.

Furthermore, Tvedt et al. (2023) shed light on the importance of organizational values in choosing suitable leadership styles to support employees during a crisis. In their study, they found that the organizational values influenced the selection of transformational or transactional leadership styles, both of which played critical roles in the resilience of the project-based organization. Our empirical findings resonate with these insights. Notably, projects that demonstrated resilience during the pandemic were often those whose leaders aligned their styles with the organization's core values. For example, in projects where the organization's values prioritized employee autonomy and innovation, a transformational leadership style was often employed. We argue that this style leverages relationships, passion, and trust to foster an environment conducive to adaptation and resilience. On the other hand, in projects where stability and excellence were valued, a transactional leadership style was more prevalent. This aligns with Tvedt et al.'s (2023) findings that these values facilitate a transactional style, which provides structure and consistency, critical elements during times of crisis. This interplay between leadership style and organizational values is a key facet of project resilience. Leaders need to not only be flexible and adaptable but also deeply aware of the organizational values and how they can be leveraged to guide their leadership approach.

The pandemic underscored the essential role of project leaders in fostering psychological safety. Beyond task management, leaders can instill a sense of security by showing empathy, promoting open communication, and offering reassurance. Activities such as frequent check-ins and addressing team concerns reinforce this sentiment. Research by Fyhn et al. (2023a) highlights that psychological safety dynamics are complex. It is not just the overall team sentiment that matters but also the alignment on that sentiment, termed as the team psychological safety climate strength. Varied perceptions within a team can affect performance, yet even a single member's positive perception can uplift the entire team. Thus, emphasizing psychological safety is not just about productivity but is vital for individual wellbeing. By prioritizing their team's mental wellbeing, leaders fortify their projects against unforeseen challenges.

The emphasis on learning and adaptability aligns with the concept of the "learning organization" (Senge, 1990), emphasizing continual learning, flexibility, and adaptability. Moreover, our findings align with Sutcliffe et al. (2003), emphasizing the importance of team resilience–the collective capacity of team members to cope with adversity–is critical in uncertain and challenging situations. Tvedt et al. (2023) highlight the role of a learning environment in promoting organizational resilience. Our findings support this, as projects that embraced a learning mindset–where mistakes were viewed as opportunities for growth, and adaptability was prized–were more likely to weather the challenges of the pandemic. Our study's respondents noted a significant shift towards employee assistance programs, mental health resources, and open conversations about wellbeing, emphasizing the importance of mental health in the project context. Most research on employee wellbeing has focused on the organizational level (Wright and Cropanzano, 2000). However, our findings suggest that employee wellbeing should be a critical concern at the project level, given the unique pressures and challenges associated with project work.

4.3 Project systems and structure

The COVID-19 pandemic's extensive implications forced project systems and structures to adapt rapidly, necessitating more agility and flexibility. This shift was not a strategic choice but a response to the disruptive external environment, as highlighted by our respondents. This aligns with Söderlund and Sydow's (2019)

proposition that project systems and structures must evolve to meet changing environmental demands.

Our research highlighted that organizations swiftly incorporated new protocols not just to adhere to health guidelines but also to reshape project structures considering remote work. These quick shifts to digital platforms ensured project continuity, which aligns with Klakegg et al.'s (2008) emphasis on the importance of solid governance frameworks, especially during uncertain times. Amidst the pandemic, this need for robust governance and flexible adaptations became even more pronounced. Although this rapid digital transition, highlighted in our findings, presented challenges like communication barriers, it also revealed opportunities. Benefits included improved efficiency and flexibility, suggesting a potential for a blended approach to project management after the pandemic.

The transition to remote work challenged the traditional practices of IP, which emphasized face-to-face stakeholder involvement (Ballard, 2000). While Ballard and Tommelein (2021) stress the significance of involving all stakeholders in the planning process, the remote context challenges this, as digital tools cannot entirely replace the richness of in-person interactions. Still, our findings suggest that some teams effectively leveraged these tools, echoing Benghi (2019), who argue that digital avenues can enhance collaboration. Though the pandemic disrupted traditional IP mechanics by reducing in-person dialogue, the essence of IP remains unchanged: active stakeholder participation. Thus, while the pandemic altered how IP functions, its fundamental principles remained constant. Digital collaboration tools, while different from in-person dynamics, offer new avenues for stakeholder participation. Virtual meetings and digital platforms maintain a space for discussions and consensus-building. This shift underscores the need for adaptability in project planning. The pandemic may have driven project teams to deepen their IP commitment to navigate uncertainties. By ensuring stakeholder involvement, teams harness diverse perspectives, share challenges, and collaboratively create adaptive strategies. Despite the pandemic's disruption to traditional IP methods, it also presents an opportunity to adapt and reshape it for the current digital era.

The extent of the pandemic's influence on the implementation of IP may be viewed not so much as a limitation, but rather as a catalyst for innovation and adaptation in project planning processes. This perspective may explain why the impact of COVID-19 on the implementation of IP did not score as high as anticipated in the empirical data (as presented in Table 3). Interestingly, the findings from our variance analysis (as presented in Table 7) lend empirical support to this perspective. Specifically, the hypotheses that focus on the effect of team role affiliation, age, and experience on the perception of how C&C functioned before COVID-19 reveal a complex picture. For example, the significant rejection of the null hypothesis concerning team role affiliations compared to experience indicates that experience levels within the team significantly affected the perception of C&C during the pandemic. Similarly, the fact that the null hypotheses regarding age and the impact of COVID-19 on IP were rejected, further underscores the role of demographic factors in shaping perceptions. These quantitative insights align with the notion that the pandemic has not only challenged traditional methodologies of IP but has also spurred new ways of thinking and adapting to change. The varying perceptions across different demographic segments of the organization provide tangible evidence of how the impact of COVID-19 has been multifaceted, influencing not only the practicalities of project planning but also the very philosophy underpinning collaboration and engagement.

Given the COVID-19 pandemic's effects, resilience has emerged as a key element of project management, allowing projects to navigate through uncertainties and recover from setbacks. Yang et al.'s (2022) findings highlight the importance of prior ties among stakeholders in fostering readiness, response, and recovery for resilience. This could be particularly relevant in the context of enforced adaption, for example, where pre-existing relationships played a crucial role in how effectively project teams could adapt to the new challenges and uncertainties brought about by the pandemic. Additionally, Yang et al.'s (2022) emphasis on the role of contractual and relational governance in clarifying stakeholders' roles and responsibilities and forming collective cognition also aligns well with the reconfigurations of project systems and structures observed during the pandemic. The move to remote work and the changes in project timelines and protocols necessitated clear communication about roles, responsibilities, and expectations, underlining the importance of effective governance.

Reflecting on our empirical results, the shift to adaptability in project structures during the pandemic mirrors Laine, Korhonen and Suomala (2020) emphasis on flexible project governance. Traditional models were ill-suited for the evolving challenges, but this push for adaptability, as revealed by our findings, also became an opportunity for project teams to grow and learn. Rather than seeing these shifts as mere disruptions, they can be viewed as challenging established project management norms. This evolution presented opportunities for innovation, but also brought forward challenges like maintaining team cohesion and balancing work-life dynamics. It underscores that even with the imperative for adaptability, as seen from both our empirical observations and theoretical constructs, the path is fraught with complexities. This pivotal period prompts a re-evaluation, encouraging researchers and practitioners to redefine project systems for better resilience against future disruptions.

4.4 Project environment

The turbulence caused by COVID-19 has led to profound shifts, not just within the confinements of organizations but also in the broader environment that encompasses projects. Tvedt et al. (2023) underscore the importance of organizational values in bolstering resilience during crises. Such resilience, as per our findings, is not merely an internal organizational phenomenon but has ramifications for the entire project landscape, influenced by industry shifts, societal changes, and evolving organizational cultures. The pandemic influenced the environment in which projects operate, affecting industry standards, societal expectations, and organizational values. In line with Tvedt et al.'s (2023) study conducted during this crisis, it is evident that organizational values play a pivotal role in directing leadership responses, particularly when navigating uncharted territories like those induced by the pandemic.

A significant outcome of the pandemic's influence on the project environment has been the shift from physical workplaces to virtual platforms. Yet, this move is not merely about a change in the location of work. It heralds a radical transformation in how

projects are approached, communicated, and realized. While Allen (1977) highlighted the significance of spontaneous interactions for creativity within physical project settings, the new virtual paradigm has changed this dynamic. The research of Hinds and Bailey (2003) resonates with our findings, indicating that the essence of in-person interactions is hard to replicate virtually, especially in the absence of non-verbal cues and shared physical context.

The respondents also indicated a conscious effort to cultivate a project environment that values mental health and wellbeing. The pandemic brought into sharp focus the mental health implications of remote work, including feelings of isolation, burnout, and stress (Kniffin et al., 2021). Organizations responded to these challenges by implementing employee assistance programs and facilitating open conversations about mental health, indicative of the shift towards a more holistic conception of employee wellbeing. Our findings suggest that the project environment is no longer merely about facilitating project tasks, but also about nurturing the physical and mental health of team members, which has been identified as a key factor in enhancing project success (Fyhn et al., 2023a; Fyhn et al., 2023b). In response to the disruptive impact of the pandemic, project-based organizations adopted a culture of adaptability, learning, and continuous improvement. Our findings highlighted the encouragement of a growth mindset, learning from failures, and embracing innovation. This reflects a critical shift towards a learning orientation in project environments, as described by Clegg et al. (2023), with resilience and adaptability becoming critical in navigating the uncertainties induced by the pandemic (Olsson et al., 2023). Clegg et al. (2023) discuss the concept of toxic project cultures and underline the importance of change at all levels of culture. They emphasize that attention from project leadership is required daily; inter-organizational strategic change projects can serve as "temporary trading zones", fostering experimentation, knowledge exchange, and behavioral change. Relating these insights to our study, the importance of adaptability, continuous learning, and unlearning of ingrained routines becomes evident. Our respondents' accounts underline the significance of cultivating a project environment that fosters resilience, encourages innovation, and supports continuous learning are key strategies for surviving and thriving amidst disruption.

5 Concluding remarks

The onset of the COVID-19 pandemic revealed the intrinsic interplay between human resilience, cultural understanding, and technological adaptation in the construction industry. Our research illuminates this intricate relationship, offering key insights and drawing important implications for future practices.

A key finding from our investigation is the vital role of human resilience in adopting new technologies within the construction sector. Although the pandemic accelerated technological innovation, individual adaptability was the true driver of success. This highlights an essential link in the construction industry between technology investments and supporting human adaptability. Our study affirms that cultural understanding is not merely significant for day-to-day operations but is pivotal in steering through substantial shifts and adopting novel practices. Given the diverse stakeholders in the construction industry, there lies both a challenge and opportunity in fostering a culture that encourages innovation and adaptability. Human resilience and cultural understanding are not just side considerations; they are at the heart of the industry's ability to adapt and thrive. Organizations should not only prioritize technology and processes but also enhance team resilience and foster a culture of openness, adaptability, and continuous learning.

Restoring trust within project teams, rebuilding disrupted interpersonal dynamics, and fostering human resilience is vital. Building robust communication networks and relationships in construction projects will play a pivotal role in addressing these challenges and promoting sustainable growth. Our study demonstrates that strengthening human resilience and fostering cultural change enables the industry to meet the demands of forced adaptation. By focusing on the human elements within the construction industry, our research offers valuable insights for improving productivity and facilitating the industry's successful adaptation during this unprecedented era and beyond.

Throughout the course of our study, it became increasingly evident that the human aspect of projects has become paramount. The COVID-19 pandemic imposed transformative changes on conventional project systems and structures. A recurrent theme from respondents emphasized the abrupt need for flexibility and adaptability in their approach. The transition to remote work has not only introduced a myriad of new challenges but has also illuminated unforeseen opportunities. It has compelled project teams to refine and sometimes redefine their strategies for communication, collaboration, and leadership. A salient conclusion from our research is the heightened significance of mental health and wellbeing in projects. This has catalyzed a shift towards a more people-centric project management approach. In navigating these unprecedented times, the values of learning, adaptability, and resilience have emerged as cornerstones for project teams, offering a robust foundation to ensure sustained project performance, even in the face of potential future uncertainties.

Our investigation concludes on a note of optimism. By reinforcing human resilience and instigating cultural change, the construction industry can effectively adapt to its rapidly evolving environment. We hope that our study serves as a springboard for further research, providing valuable insights to policymakers, industry practitioners, and academics alike. Our vision is of a construction industry that is not only an exemplar of productivity and sustainability but also a champion of its workforce, emphasizing human wellbeing at the forefront of its transformative journey.

5.1 Limitations and generalization

The findings are representative for one company, not the whole industry. The research is done in one country–so it has the cultural, judicial, and economic flavors of Norway, but it may be representative of the Nordic and western European region. The COVID-19 pandemic hit all countries in similar ways, but it was met by different strategies from Governments; therefore, some effects

may differ. Human beings and their individual responses, however, are pretty much the same everywhere.

5.2 Future research

Our research underscores the deep interplay of human resilience, cultural dynamics, and technological adaptation in the construction sector. We've identified key areas warranting further exploration. Firstly, beyond highlighting human resilience, there's a need to delve deeper into what factors bolster resilience at both individual and team levels. Additionally, as we've touched upon culture's role in technological adoption, further investigation is needed to understand how new technologies influence organizational culture and the subsequent effects on team interactions for peak performance. External events, like pandemics or economic crises, can significantly shape organizational culture. Hence, it is vital to analyze how organizations can proactively manage such changes to ensure continued efficiency.

The pivot to remote work brings both challenges and opportunities for collaboration. A closer look at tools and processes that optimize virtual collaboration is crucial for enhancing team productivity and wellbeing. Finally, as safety and wellbeing become paramount in the construction sector, a holistic exploration of both physical safety measures and psychological supports, as well as their collective impact on team perception, can guide future best practices.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: Datasets are available on request: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation. Requests to access these datasets should be directed to aaasen@systra.com.

Ethics statement

The studies involving humans were approved by Norwegian centre for research data. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

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Author AA was employed by Veidekke Entreprenør AS in which the data was collected.

The remaining author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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