

Assessing the preparedness of the textile sector for implementing Industry 4.0: An organisational culture perspective

DOI: 10.35530/IT.076.04.2024124

ABBAS MUREED
SALEEM MUHAMMAD QAISER
MUFTI NADEEM

AMJAD HUSSAIN
KAUSAR RUKHSANA

ABSTRACT – REZUMAT

Assessing the preparedness of the textile sector for implementing Industry 4.0: An organisational culture perspective

Current research highlights the importance of an appropriate organisational culture (OC) for successfully implementing Industry 4.0 (I4.0), suggesting that overlooking OC may impede organisations from fully leveraging and maintaining the benefits of I4.0. Although there is an agreement on the characteristics of suitable OC for I4.0, methodologies to evaluate organisational readiness from an OC perspective are needed. Our study aims to assess the preparedness of organisations for implementing I4.0. Through an extensive literature review, we identified the suitable OC for I4.0, gauged the currently prevailing primary perceived OC, and evaluated the preparedness of the selected sector for implementing I4.0. Utilising data collected from Pakistan's textile sector (PTS), the research employs a cross-sectional survey utilising the Competing Values Framework (CVF). After an extensive literature review, the study found that an OC with dominant adhocracy culture profile traits is well-suited for implementing I4.0. However, the data from 162 textile organisations reveal that the perceived primary/dominant OC in PTS is the clan culture profile, with the control culture profile being the least prevalent. The results indicate that the current prevailing OC characteristics, as perceived by the respondents, are not suitable for I4.0 implementation, indicating that the selected sector is not ready to implement I4.0 from an OC perspective. This study is unique in its systematic approach, adapting the CVF to evaluate perceived OC for I4.0 readiness in a developing economy using qualitative and quantitative methods. The approach may be applied to different sectors and countries.

Keywords: Competing Values Framework, digitalisation, innovation, efficiency, supply chain management

Evaluarea pregătirii sectorului textil pentru implementarea Industriei 4.0: O perspectivă a culturii organizaționale

Cercetările actuale subliniază importanța unei culturi organizaționale (CO) adecvate pentru implementarea cu succes a Industriei 4.0 (I4.0), sugerând că neglijarea unei culturi organizaționale poate împiedica organizațiile să valorifice pe deplin și să mențină beneficiile I4.0. Deși există un consens cu privire la caracteristicile unei culturi organizaționale adecvate pentru I4.0, sunt necesare metodologii pentru a evalua pregătirea organizațională dintr-o perspectivă a culturii organizaționale. Studiul nostru își propune să evalueze gradul de pregătire al organizațiilor pentru implementarea I4.0. Printr-o analiză extinsă a literaturii de specialitate, am identificat o cultură organizațională adecvată pentru I4.0, am evaluat cultura organizațională primară percepută în prezent și am evaluat gradul de pregătire al sectorului selectat pentru implementarea I4.0. Utilizând datele colectate din sectorul textil din Pakistan (PTS), cercetarea utilizează un sondaj transversal care vizează cadrul de valori concurențiale (CVF). După o analiză extinsă a literaturii de specialitate, studiul a constatat că o cultură organizațională cu trăsături dominante ale profilului cultural adhocratic este potrivită pentru implementarea I4.0. Cu toate acestea, datele de la 162 de organizații textile relevă faptul că principala cultură organizațională percepută în sectorul textil din Pakistan este profilul culturii clanului, profilul culturii de control fiind cel mai puțin prevalent. Rezultatele indică faptul că trăsăturile culturii organizaționale predominante actuale, așa cum sunt percepute de respondenți, nu sunt potrivite pentru implementarea I4.0, ceea ce indică faptul că sectorul selectat nu este pregătit să implementeze I4.0 din perspectiva culturii organizaționale. Acest studiu este unic prin abordarea sa sistematică, adaptând cadrul de valori concurențiale pentru a evalua cultura organizațională percepută pentru pregătirea I4.0 într-o economie în curs de dezvoltare, folosind metode calitative și cantitative. Abordarea poate fi aplicată diferitelor sectoare și țări.

Cuvinte-cheie: cadrul de valori concurențiale, digitalizare, inovare, eficiență, gestionarea lanțului de aprovizionare

INTRODUCTION

It has been established that implementing Industry 4.0 (I4.0) fosters real-time connectivity and collaboration among stakeholders, including personnel, equipment, and products [1]. This integration spans production processes, distribution, and post-sales

services, enhancing productivity, efficiency, and financial performance while promoting sustainability in manufacturing facilities [2–5]. When it comes to implementing I4.0, extensive scholarly investigations consistently emphasise the important role of OC in facilitating and driving the implementation of I4.0

[6–8]. Moreover, studies have explored I4.0 maturity models, which help organisations gauge their readiness and progress in adopting I4.0 technologies. These models consider cultural aspects an integral component of readiness assessments for I4.0 [9,10]. Identifying the dominant organisational culture effectively reveals the significant compatibility between individuals and organisations. Moreover, it is an effective tool for investigating and solving disputes and misunderstandings within the workforce, ultimately differentiating employees of one organisation from their counterparts and facilitating greater success [11] and competitive advantage [11, 12]. The OC plays a significant role in successful technology adoption, promoting innovation, enabling smoother mergers, and improving employee job satisfaction, organisational success, and team effectiveness [13]. Moreover, it shapes individual behaviour, influences decision-making processes, and steers leaders and members toward achieving organisational objectives. It is instrumental in sustaining and enhancing the organisation’s mission, performance, and the competence of its members [12]. The effectiveness of an OC cannot be definitively classified as good or bad. It depends on how well it aligns with the organisation’s mission, purposes, and strategies, and if established, it can serve as an asset in achieving its goals; otherwise, it is a liability [14]. The literature on I4.0 reveals that most studies focus on technical aspects and neglect the importance of managerial approaches and OC, which play a crucial role in successfully implementing this concept [2]. Identifying OC characteristics that align with the technological and operational demands of I4.0 is crucial [2]. The intertwined relationship between social and technological dimensions is essential in organisational development and change processes [7]. I4.0 is a pivotal example recognised widely as a ‘socio-technical system’, inherently acknowledging the synchronous optimisation of social and technical aspects [15]. The authors have conducted a comprehensive review of the existing literature and have found that the investigation into I4.0 implementation concerning the role of OC within PTS remains notably deficient. The literature reveals a consensus on the ideal culture for implementing I4.0 [2, 8, 16–21]. However, how organisations should assess their readiness for implementing

I4.0 from an OC perspective needs attention. Failure to consider the suitable OC for implementing I4.0 may impede the implementation of I4.0.

This study aims to investigate the perceived prevailing characteristics of OC, determine the primary (most dominant) perceived OC, and assess organisational readiness to adopt I4.0 from the OC perspective. The study utilises empirical data collected from PTS as a case study. The textile sector is a key contributor to Pakistan’s economy. The sector’s exports account for approximately 7 to 62% of Pakistan’s national exports, contributing nearly 8.5% to the GDP and employing around 19 million people, almost 40% of the country’s workforce [22, 23]. Implementing I4.0 may boost the economy and create new opportunities for those employed in this sector. This research contributes to the existing body of literature by incorporating data from PTS through a mixed-methods approach. Our study provides a structured method for determining the prevailing perceived organisational culture and evaluating organisational readiness for deploying I4.0 from an OC’s perspective. The insights from the study may be instrumental in devising strategies to align the OC for implementing I4.0. The study is organised into six main sections: Section 2 begins with a literature review. Section 3 explains the methodology and data collection process, and Section 4 presents the findings. Section 5 provides a discussion, and Section 6 summarises the findings and the study’s limitations.

LITERATURE REVIEW

Industry 4.0

The Industrial Revolution (IR) was an era of substantial technological and economic development that began in Europe in the eighteenth century and revolutionised the production and distribution of products. It led to the shift from manual *labour* to machine-based production, resulting in the emergence of new technologies, industries, and economic systems. The IR significantly changed working conditions, *urbanisation*, and the economy, tremendously impacting society. Four industrial revolutions, each building upon the preceding one and delivering technological and manufacturing process breakthroughs, are presented in figure 1 [2, 24–26].

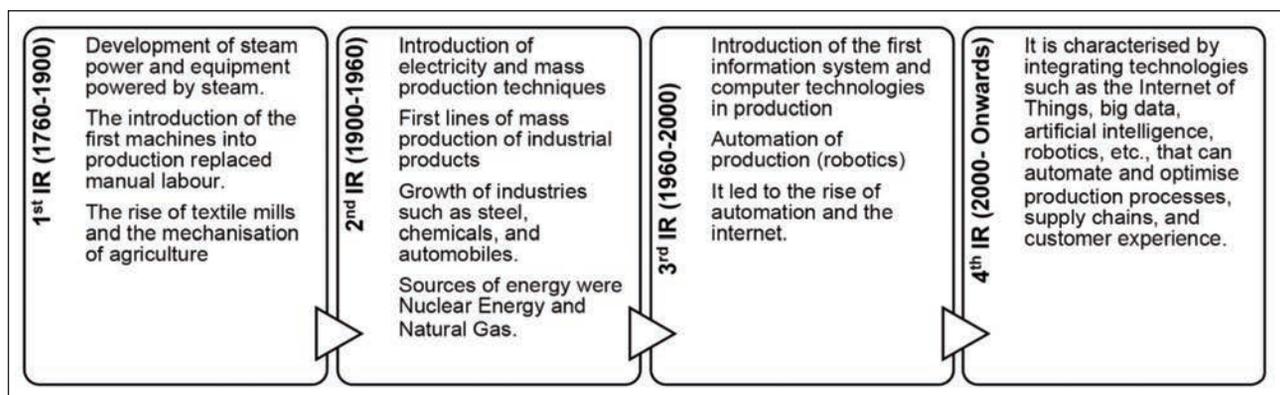


Fig. 1. Industrial Revolutions [2, 24–26]

The term “Industry 4.0 (I4.0)” was coined from German ‘Industrie 4.0,’ an initiative of the German Federal Government in 2011 [24]. I4.0 enables autonomous data collection, analysis, and interaction between products, processes, suppliers, and customers through the Internet using cutting-edge technologies [27]. I4.0 includes various technologies such as additive manufacturing or 3D printing, cloud computing, cyber-physical systems manufacturing execution system, big data, sensors, RFID, e-value chain, autonomous robots, augmented reality, simulations or an analysis of virtual models, and cyber security, etc.; however, there is a disagreement over the specific types of technologies that make up I4.0 [5, 27–33]. For the past few years, the business and research communities have paid close attention to the initiative of I4.0 [5]. It is rising to the top of the industrial sector’s priorities [34].

Organisational culture

“On Studying Organisational Cultures”, a 1979 publication in US academic literature, coined the term “Organisation Culture (OC)” [35, 36]. Several interpretations of OC have emerged over time due to its various definitions [37]. The academic literature has documented over a hundred different dimensions of an OC [38]. Hence, defining and interpreting OC is challenging [36]. During the 1980s and 1990s, an increasing emphasis was observed on studying OC and developing its measurement tools [11]. Some of the frequently referenced definitions of OC are:

“The culture is a socially constructed attribute of organisations that acts as the social glue holding an organisation together [39].”

“The group culture is a pattern of shared basic assumptions learned by a group as it solved its problems of external adaptation and internal integration, which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel about those problems [40, 41].”

“Culture is related to an organisation’s shared language, beliefs, symbols, and values, and a measure of culture’s strength is the extent to which all the organisation’s members understand these things [42].”

“Culture is the collective programming of the mind, which distinguishes the members of one category of people from another [43].”

The Competing Values Framework (CVF)

The CVF developed by Cameron et al. (1999) was used to meet the research objectives. The CVF has been empirically driven and extensively used in quantitative studies to diagnose and change OC [39, 44–48]. Moreover, this framework helps to identify the dominant perceived OC and subcultures in organisations [49, 50]. The CVF classifies OC into four categories, as illustrated in figure 2 and summarised below [51].

The Clan Culture Profile (CCP): The upper left quadrant of the CVF corresponds to the characteristics

typical of a Clan Culture within an organisation, distinguished by its internal orientation and flexibility. The foundational values of this culture prioritise employee involvement initiatives, teamwork, and a commitment to the holistic growth and welfare of employees. They also perceive customers as integral partners in the organisational process. This culture prioritises empowering employees, thus fostering a high level of engagement and promoting organisational loyalty. Leadership within this framework predominantly assumes a guiding and mentoring role, where harmony and collaboration are highly esteemed. Organisational success is measured by the degree of collaboration, participatory engagement, and stakeholder consensus. *Control Culture Profile (CoCP)* is characterised by an internal focus alongside control and stability (lower left quadrant). This culture values clear authority in decision-making, standardised processes, and accountability measures, fostering a formal and structured workplace. Organisations adopting this profile aim for efficiency and stability, employing hierarchical organisational structures and decision-making to achieve these objectives. Responsibilities are organised in a consistent setting to sustain consistency in process outputs. Long-term goals focus on maintaining stability, predictability, and efficiency, all supported by clear and established guidelines. *Adhocracy Culture Profile (ACP)* combines an external focus with flexibility (upper right quadrant). Work environments with this OC type emphasise adaptability, creativity, and innovation. Leaders are viewed as innovators and are willing to take risks. These organisations prioritise experimentation and innovation, fostering cohesion through a shared commitment to these values. Their long-term goals centre on growth and securing new resources, with success driven by developing unique products or services. This culture encourages individual creativity, autonomy, and decentralised decision-making. *Market Culture Profile (MCP)* combines an external focus with an emphasis on control and stability (lower right quadrant). The core values of organisations with stronger MCPs are competitiveness and productivity. Organisations with this culture perceive the external environment as competitive and challenging, viewing customers as discerning and focused on value. Leaders’ main responsibility is to lead organisations toward productivity, results, and profits. The business success indicators are market penetration and market shares. Such organisations perceive an aggressive approach as improving productivity and profit [39]. Organisations with this OC are dedicated to understanding and meeting customers’ needs. They foresee emerging market patterns and respond to these challenges proactively with agility and innovation [39, 52]. According to the CVF, a company can possess four unique organisational culture profiles simultaneously. However, one of these cultures may have a greater influence on the company’s values, behaviours, and social interactions and can be regarded as the primary culture profile [53]. To assess organisations’ preparedness from

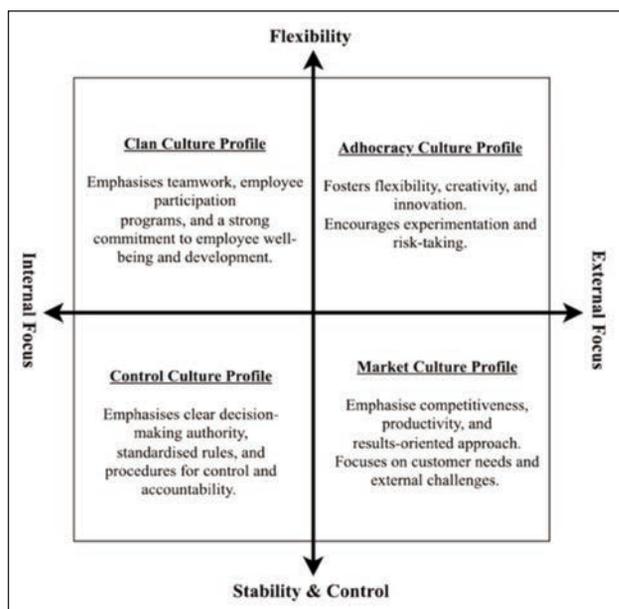


Fig. 2. The Competing Values Framework adapted from Cameron et al. [39]

an OC perspective, it is important to understand the prevailing (Primary) OC for implementing I4.0. The authors needed help finding a single study examining the characteristics of current OC within PTS. Consequently, this situation necessitates identifying the existing primary (most dominant) organisational culture profile. To achieve this, employing the CVF, our RQ1 is formulated as follows:

RQ1. Which OCP is perceived as the primary culture within the textile sector of Pakistan?

Based on the research question, we propose the following hypothesis:

H₀₁: No significant difference exists in the prevalence of four types of OCPs.

Suitable OC for implementing Industry 4.0

Organisation Culture (OC) is a multifaceted and dynamic concept shaped by several factors, including national culture, styles of leadership, vision, employee behaviour, organisational structures, environment, rituals, hiring practices, narratives, external factors, values, communication, and reward systems, among others [14, 54–57]. OC significantly shapes individual behaviours, impacts decision-making processes, directs leaders and team members towards the attainment of organisational objectives, and plays an important role in sustaining and improving employee competence. It plays a critical role in integrating an organisation's vision, mission, and performance, determining whether it serves as an asset or a liability to its objectives [12, 14]. Additionally, demographic diversity may significantly impact cultural perspectives within a workplace, leading to the emergence of subcultures [58]. By studying thousands of organisations through the lens of the CVF, researchers have also concluded that more than 80% of them have one or more clear dominant organisational culture profiles. Moreover, they found that organisations that don't have a dominant OCP either

lack clarity about their OC or balance all four types of OCPs (Hierarchy, market, clan, and adhocracy) equally. Each category of the OC in CVF has unique characteristics [39]. With this in mind, the literature review in this section, through the lens of CVF, aims to identify the characteristics of OC most suitable for implementing I4.0. A systematic literature review (SLR) concluded that specific OC characteristics, such as continuous learning for innovation adaptation, knowledge sharing and transfer, and entrepreneurship traits of risk-taking and flexibility, creativity, and innovation, align with I4.0 [16]. Another SLR revealed that organisational agility, the capacity for rapid adaptation to a changing external environment, is critical for the early adoption and successful implementation of I4.0 [8]. Another study has highlighted the importance of aligning OC with the principles and requirements of I4.0, advocating for an OC that promotes innovation, adaptability, and a willingness to embrace technological change [17]. In a study, authors concluded that 13 organisations implementing I4.0 have observed that they require an entrepreneurial mindset, openness, a desire to learn, and a willingness to embrace change [21].

Furthermore, another study concludes that a culture that promotes continuous learning is vital for adapting to new technologies and fostering innovation within the I4.0 framework [18]. Adopting I4.0 requires constant innovation and education, not only to enhance individual skills but also to evolve OC. So, the innovative culture (defined by Wallach) is more suitable for implementing I4.0 [2]. Encouraging employees to innovate their processes and explore new technologies helps organisations adapt to the rapidly evolving landscape of I4.0. Ongoing education keeps employees updated on the latest technological advancements and best practices, which helps organisations make informed decisions about technology adoption. Moreover, the literature suggests that the characteristics of Innovative Culture defined by E. Wallach closely resemble those of the Adhocracy/Developmental Culture Profile proposed by Cameron and Quinn [39]. Subsequently, we conclude after a comprehensive review of existing literature that the characteristics of a prerequisite OC conducive to successfully implementing I4.0 are focused on promoting innovation, entrepreneurial risk-taking, adaptability, agility, continuous learning, knowledge-sharing, willingness to accept change, openness to new ideas, and the encouragement of employee-driven process development [2, 8, 16–21]. These OC characteristics are closely related to the Adhocracy Culture Profile (ACP); hence, it can be argued that organisations implementing I4.0 should focus more on developing an ACP while considering OC characteristics from other cultural profiles to meet their specific needs. Our argument is further strengthened by an SLR that has concluded the unanimous agreement in the existing literature about the characteristics of OC required for implementing I4.0. The SLR concludes that ACP, characterised by a tendency to accept change, creativity, ambiguity, and adaptability,

is suitable for implementing I4 [16]. Given that the dominant culture profile for implementing I4.0 is ACP, the following research question is formulated to assess the preparedness of PTS from an OC perspective:

RQ2: Does the perceived OC in the textile sector of Pakistan align with the dominant OC profile required to implement Industry 4.0 successfully?

RESEARCH METHODOLOGY AND DATA COLLECTION

The research objectives drove the research methodology. A structured questionnaire-based survey following a cross-sectional approach was conducted to achieve the objectives.

Development of questionnaire

To measure the construct of “Organisational Culture”, we used an already validated questionnaire designed by Naor et al. (2014), which aligns well with the study’s objectives [60]. This questionnaire is grounded in the CVF, a widely recognised model for assessing perceived organisational cultural profiles, with proven face and empirical validity. This model is useful in diagnosing and transforming OC [39]. The CVF facilitates an in-depth examination of OC from unitarist and pluralist viewpoints. It helps to identify the dominant cultures and reveals concealed subcultures [49]. This model covers most of OC’s dimensions [46]. It has gained popularity and has been used in several modern quantitative studies [47–51]. A five-point Likert scale was used, with 1 indicating strong disagreement and 5 indicating strong agreement.

Target population and sampling strategy

Organisations were included in the study based on their active membership in reputable industry bodies, such as the All-Pakistan Textile Mills Association and the Chambers of Commerce of major cities. To ensure random sampling and avoid convenience sampling, we created a list of all 512 eligible organisations [23]. An Excel-based random number generator was then used to assign random numbers to these organisations, giving each an equal chance of selection. Data collection involved multiple follow-ups, including emails and phone calls, to ensure that even less responsive organisations were included, contributing to a more balanced and representative sample. The target participants were managerial-level employees from departments likely to be directly involved in I4.0 implementation, ensuring they could understand and accurately complete the questionnaire. We opted for a single respondent per organisation to streamline data collection while maintaining the credibility and representativeness of the responses within the constraints of available resources.

Pilot study

A pilot study was carried out by collecting data from thirty textile units to evaluate the reliability of the construct dimensions. The internal consistency of items

was assessed using Cronbach’s Alpha (CA), a widely recognised test [61, 62]. The α values met the accepted threshold, confirming the reliability of the construct dimensions. The standard deviation ($s = 0.57$) was also estimated to calculate the sample size using equation 1.

Sample size (n)

We used equation 1 for sample size calculation as the construct’s dimensions are measured using a Likert scale, which may be considered a continuous variable, and the N is also finite [63, 64].

$$n = \frac{(Z^2)(N)(\sigma_p^2)}{[(N - 1)(e^2) + (Z^2)(\sigma_p^2)]} \approx 110 \quad (1)$$

where N (Population Size) = 514; e (acceptable error) = 0.03 for continuous data, $\sigma_p = \text{StDev}$, $z = 1.96$ at α of 5%.

Data collection and sample descriptive statistics

The survey questionnaire was distributed via email. 162 textile units in Pakistan participated in the research. Process improvement/industrial engineers account for 43.83%, QA/QC comprises 24.69%, others constitute 15.43%, production contributes 12.96%, and product development makes up 3.09%. The age distribution reveals that 74.69% of participants are aged 20 to 35, with 5.56% above 45 and 19.75% between 36 to 45. Regarding experience, 38.27% have 1–5 years of experience, 30.25% have 6–10 years, 14.20% have 11–15 years, and 17.28% have over 15 years. Gender distribution shows 91.98% male and 8.02% female participants. Job roles vary, with 5.56% as first-level supervisors, 66.05% in middle management, and 28.40% in top management. Organisation sizes range from 85.80% having over 500 employees, 9.26% with 250 to 500 employees, to 4.94% having less than 250 employees. Data on business models indicate that 56.79% follow B2B, 28.40% are exclusively B2C, and 14.81% engage in both. Ownership distribution reveals that 58.02% are family-owned, and 41.98% are corporate-owned. Regarding textile sector categories, Composite Textile Companies (13.58%), Yarn Manufacturing Units (8.02%), Garment Manufacturing Units (39.51%), Chemical Treatments and Coloration Units (3.09%), Apparel (34.57%), Technical Textiles Manufacturing (4.94%), and Accessories and Gear Items (21.60%) are covered, offering a comprehensive overview. The research encompasses demographic and organisational characteristics within the textile sector.

Validity and reliability of the constructs

It is important to ensure that the instrument accurately assesses the variables as intended while preserving precision. It is ensured by evaluating the validity and reliability indicators of the constructs [61, 62]. The questionnaire used for measuring OC already demonstrates a strong psychometric quality, so face validity is not required. Still, the consistency of items of the four dimensions of the construct OC has been

evaluated using Cronbach's alpha (CA) values. An acceptable value for research purposes is 0.70 or above [61]. The associated CA values (table 1) have reached or surpassed the required level.

Procedure used to evaluate the organisational preparedness

The following steps were taken to achieve the study's objectives.

Step 1: Identification of the primary perceived OCP

To determine the primary perceived OC, four types of OC profiles were compared using the descriptive statistics, Friedman Test, followed by Wilcoxon Signed Ranked Tests for pairwise comparisons [64,65]. Mohelska and Sokolova employed a comparable methodology to determine the prevailing OC in the Czech Republic [2].

Step 2: Evaluation of the Preparedness for Implementing Industry 4.0

The primary perceived OC and the most suitable organisational culture identified through the literature review were compared qualitatively.

RESEARCH FINDINGS

Identification of the most dominant (Primary) perceived OCP

Descriptive statistics of the perceived OCPs are presented in table 1. The CCP has the highest average (3.62) and median scores (3.50), whereas the CoCP received the lowest average (3.20) and median (3.00) scores. The MCP stands as the second most prevalent perceived OCP. The ACP has an average score of 3.39 and a median of 3.20, respectively. Consequently, in PTS, the order of prevalence of organisational culture profiles based on descriptive statistics (average and median scores) may be ranked as CCP > MCP > ACP > CoCP. Statistics

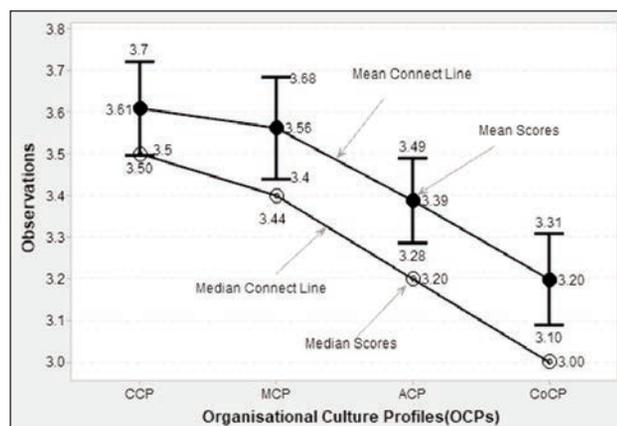


Fig. 3. The interval plot (95% CI of Average) shows the hierarchy of perceived dominance of OCPs

reveal that CCP is perceived as the most prevalent perceived OCP, while CoCP is the least prevalent. In figure 3, the CCP is the most dominant, and CoCP is the least prevailing. It is important to note that overlapping CIs can occur even with significant differences in distributions, particularly with non-normal data.

Data normality tests

Table 2 presents the results of normality tests for four types of perceived OCPs using the Kolmogorov-Smirnov and Shapiro-Wilk tests, the most commonly used in the research [65]. The p-values for both tests are less than 0.01 for all four types of perceived OCPs, suggesting a deviation from normal distribution.

Friedman Test for verification of H01

The non-normality of the data implies that parametric statistical tests, which assume normality, are inappropriate for analysing OCPs. Consequently, to test the dominance hierarchy obtained from descriptive statistics, the Friedman Test, the results of which are presented in table 3, followed by Wilcoxon Signed

Table 1

DESCRIPTIVE STATISTICS OF PARTICIPANTS' PERCEPTION OF FOUR TYPES OF PERCEIVED OCPs AND CRONBACH'S ALPHA						
OCPs	N	Average	StDev	95% CI of Average	Median	CA
CCP	162	3.62	0.73	(3.50, 3.72)	3.50	0.83
MCP	162	3.56	0.79	(3.45, 3.67)	3.40	0.88
ACP	162	3.39	0.66	(3.28, 3.50)	3.20	0.78
CoCP	162	3.20	0.71	(3.09, 3.31)	3.00	0.70

Table 2

RESULTS OF NORMALITY TESTS FOR FOUR TYPES OF PERCEIVED OCPs						
OCPs	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
CCP	0.18	162	0.00	0.92	162	0.00
MCP	0.23	162	0.00	0.88	162	0.00
ACP	0.22	162	0.00	0.90	162	0.00
CoCP	0.17	162	0.00	0.95	162	0.00

Ranked Tests for pairwise comparisons, the results of which are summarised in table 4, are employed [64, 65]. We reject the null hypothesis (H_01) ($P < 0.01$), implying that at least one OCP significantly differs from others (table 3). However, this test fails to identify which group has the highest or lowest statistically significant median scores.

Table 3

FRIEDMAN TEST RESULTS INDICATE THAT THE PREVALENCE OF PERCEIVED OCPs DIFFERS SIGNIFICANTLY				
OCPs	Mean Rank	Chi-Square	DF	P-Value
CCP	2.84	27.88	3	0.00
MCP	2.59			
ACP	2.38			
CoCP	2.19			

Wilcoxon Signed Ranked Tests for pairwise comparison of perceived OCPs

To identify the primary perceived OCP, we developed null hypotheses (H_02-H_07) based on median scores, used Wilcoxon Signed Ranked Tests and made pairwise comparisons of the perceived OCPs. The results of Wilcoxon Signed Ranked Tests, presented in table 4, revealed that perceived CCP has a significantly higher prevalence than ACP ($p < 0.01$). Although CCP (median = 3.62) tends to be more prevalent than MCP (Median = 3.56), the difference is not statistically significant ($p = 0.07$). The MCP exhibits a significantly higher prevalence than ACP ($p < 0.01$). The MCP also surpasses CoCP significantly ($p < 0.01$). Finally, the ACP is significantly more prevalent than the CoCP ($p < 0.05$). The findings from the pairwise comparisons show that the CCP has been perceived as the primary OC and revealed a significant difference in median scores compared to ACP and CoCP. The MCP is the second most prevalent OCP compared based on median scores. Conversely, CoCP is the least dominant OCP within PTS. The dominance hierarchy, ranking Organisational

Culture Profiles from the most to the least dominant, is presented in figure 3.

DISCUSSION

The findings reveal that the Clan Culture Profile (CCP) is the primary *perceived* OC within PTS (RQ1). At the same time, Adhocracy Culture Profile (ACP) is identified as the most suitable organisational culture Profile for implementing Industry 4.0 (RQ2). This prevalence of the *perceived* CCP can be attributed to several factors. Firstly, the labour-intensive processes in the textile sector require close coordination and cooperation among workers, which a clan culture emphasising group cohesion and shared values can facilitate [23]. Effective communication and task execution are essential in such environments, making CCP a natural fit. Secondly, Hofstede's research on employee values, undertaken by IBM in the late 1960s, indicated that Pakistani society prioritises "collectivism". This cultural trait prioritises cooperation, communal values, and the welfare of the community or family over personal interests [66, 67]. National cultural traits significantly influence organisational culture, and in Pakistan, collectivism likely contributes to the dominance of the CCP [11, 68].

Furthermore, the PTS is well known for its team-oriented work culture, in which the leaders leave or join the organisation with the entire team, highlighting the group cohesion prevalent in CCP. However, the dominance of CCP poses challenges for implementing I4.0, which requires a culture that values innovation, experimentation, risk-taking, and openness to change – traits not typically associated with CCP. Consequently, from an OC perspective, PTS is not well-equipped for I4.0 implementation. As this is the first study in the selected sector, further research using different OC frameworks is needed to compare and validate these findings.

Table 4

PAIRWISE COMPARISONS OF PERCEIVED OCPs USING WILCOXON SIGNED RANKED TESTS				
Null Hypotheses	Z-score	P-Values	Significant?	Pairwise comparison
H₀₂ : The prevalence of CCP is not significantly different from ACP.	- 4.11	0.00	Yes	CCP > ACP
H₀₃ : The prevalence of CCP is not significantly different from CoCP.	- 4.89	0.00	Yes	CCP > CoCP
H₀₄ : The prevalence of CCP is not significantly different from MCP.	-1.85	0.07	No	CCP = MCP
H₀₅ : The prevalence of MCP is not significantly different from ACP.	-3.10	0.00	Yes	MCP > ACP
H₀₆ : The prevalence of MCP is not significantly different from CoCP.	-3.80	0.00	Yes	MCP > CoCP
H₀₇ : The prevalence of ACP is not significantly different from CoCP.	-2.77	0.01	Yes	ACP > CoCP

CONCLUSION

To successfully implement Industry 4.0, an adhocracy culture profile (ACP) should ideally be the dominant organisational culture. However, the clan culture profile (CCP) is currently perceived as the most prevailing OC in PTS, while the control culture profile (CoCP) is the least prevalent. This indicates that Pakistan's textile industry is not yet well-prepared for Industry 4.0 implementation from an organisational culture perspective.

Future research

Future research may incorporate the perceptions of OCPs across various demographics, such as gender, education, departments, organisation size, and experience, to gain a deeper understanding of subcultures within organisations and assess the consistency in opinions across different groups. Additionally, collecting more responses from the same organisations could further enhance findings and present more accurate perceptions of OC.

REFERENCES

- [1] Kerin, M., Pham, D.T., *A review of emerging industry 4.0 technologies in remanufacturing*, In: J Clean Prod, 2019, 237, 117805, <https://doi.org/10.1016/j.jclepro.2019.117805>
- [2] Mohelska, H., Sokolova, M., *Management approaches for Industry 4.0—the organisational culture perspective*, In: Technological and Economic Development of Economy, 2018, 24, 2018, 2225–2240
- [3] Rosin, F., Forget, P., Lamouri, S., Pellerin, R., *Impacts of Industry 4.0 technologies on Lean principles*, In: Int J Prod Res, 2020, 58, 1644–1661, <https://doi.org/10.1080/00207543.2019.1672902>
- [4] Vaidya, S., Ambad, P., Bhosle, S., *Industry 4.0 – A Glimpse*, In: Procedia Manuf, 2018, 20, 233–238, <https://doi.org/10.1016/j.promfg.2018.02.034>
- [5] Oztemel, E., Gursev, S., *Literature review of Industry 4.0 and related technologies*, In: J Intell Manuf, 2020, 31, 127–182, <https://doi.org/10.1007/s10845-018-1433-8>
- [6] Silvestri, L., *Which tools are needed to implement Lean Production in an Industry literature review Industry 4*, In: 0 environment? A literature review, 2022, 00
- [7] Davies, R., Coole, T., Smith, A., *Review of Socio-technical Considerations to Ensure Successful Implementation of Industry 4.0*, In: Procedia Manuf, 2017, 11, 1288–1295, <https://doi.org/10.1016/j.promfg.2017.07.256>
- [8] Mrugalska, B., Ahmed, J., *Organizational agility in industry 4.0: A systematic literature review*, In: Sustainability (Switzerland), 2021, 13, 1–23, <https://doi.org/10.3390/su13158272>
- [9] Häring, K., Pimentel, C., *Industry 4.0 Implementation in Small- and Medium-Sized Enterprises: Recommendations Extracted from a Systematic Literature Review with a Focus on Maturity Models*, 2023
- [10] Santos, R.C., Martinho, J.L., *An Industry 4.0 maturity model proposal*, In: Journal of Manufacturing Technology Management, 2020, 31, 1023–1043, <https://doi.org/10.1108/JMTM-09-2018-0284>
- [11] Demir, C., Unnu, N.A.A., Erturk, E., *Diagnosing the organizational culture of a Turkish pharmaceutical company based on the competing values framework*, In: Journal of Business Economics and Management, 2011, 12, 197–217, <https://doi.org/10.3846/16111699.2011.555451>
- [12] Tama, K.M., *Organizational culture mapping analysis through Organizational Culture Assessment (OCA)*, In: Masyarakat, Kebudayaan Dan Politik, 2019, 32, 186, <https://doi.org/10.20473/mkp.v32i22019.186-195>
- [13] Reigle, R.F., *Measuring organic and mechanistic cultures*, In: EMJ - Engineering Management Journal, 2001, 13, 3–8, <https://doi.org/10.1080/10429247.2001.11415132>
- [14] Wallach, E.J., *Individuals and Organizations: The cultural match*, In: Train Dev J, 1983, 37, 28-36
- [15] Sony, M., Naik, S., *Industry 4.0 integration with socio-technical system theory: A systematic review and proposed theoretical model*, In: Technol Soc, 2020, 8, 353–355, [https://doi.org/10.1016/0160-791x\(86\)90029-1](https://doi.org/10.1016/0160-791x(86)90029-1)
- [16] de Camargo, R.Q., da Silva, M.T., Facin, A.L.F., Gonçalves, R.F., *The Role of Organizational Culture in the Transformation to Industry 4.0*, In: IFIP International Conference on Advances in Production Management Systems, Springer, 2023, 487–500
- [17] Liu, S.F., Fan, Y.J., Luh, D.B., Teng, P.S., *Organizational Culture: The Key to Improving Service Management in Industry 4.0*, In: Applied Sciences (Switzerland), 2022, 12, 1–23, <https://doi.org/10.3390/app12010437>
- [18] Piccarozzi, M., Aquilani, B., Gatti, C., *Industry 4.0 in management studies: A systematic literature review*, In: Sustainability (Switzerland), 2018, 10, 1–24, <https://doi.org/10.3390/su10103821>
- [19] Ort, R., Stolwijk, C., Punter, M., *Implementing Industry 4.0: assessing the current state*, In: Journal of Manufacturing Technology Management, 2020, 31, 825–836, <https://doi.org/10.1108/JMTM-07-2020-0284>
- [20] Nafchi, M.Z., Mohelská, H., *Organizational culture as an indication of readiness to implement industry 4.0*, In: Information (Switzerland), 2020, 11, <https://doi.org/10.3390/INFO11030174>
- [21] Veile, J.W., Kiel, D., Müller, J.M., Voigt, K.I., *Lessons learned from Industry 4.0 implementation in the German manufacturing industry*, In: Journal of Manufacturing Technology Management, 2020, 31, 977–997, <https://doi.org/10.1108/JMTM-08-2018-0270>
- [22] Memon, J.A., Qayyum, M., *The Rise and Fall of Pakistan's Textile Industry: An Analytical View*, In: European Journal of Business and Management, 2020, 135–142, <https://doi.org/10.7176/ejbm/12-12-12>
- [23] TCO, Commissioner T, Textile Commissioner's Organization, *Annual Report on Textile Industry of Pakistan 2020–2021*, 2021

- [24] Atik, H., Ünlü, F., *The Measurement of Industry 4.0 Performance through Industry 4.0 Index: An Empirical Investigation for Turkey and European Countries*, In: *Procedia Comput Sci*, 2019, 158, 852–860, <https://doi.org/10.1016/j.procs.2019.09.123>
- [25] Petrovic, V., Pesic, M., Joksimovic, D., Milosavljevic, A., *Digitization in the Textile Industry - 4.0 Industrial Revolution in Clothing Production*, In: *International Joint Conference on Environmental and Light Industry Technologies*, 2019, 11–21
- [26] Xu, M., David, J.M., Kim, S.H., *The fourth industrial revolution: Opportunities and challenges*, In: *International Journal of Financial Research*, 2018, 9, 90–95, <https://doi.org/10.5430/ijfr.v9n2p90>
- [27] Buer, S.V., Strandhagen, J.O., Chan, F.T.S., *The link between industry 4.0 and lean manufacturing: Mapping current research and establishing a research agenda*, In: *Int J Prod Res*, 2018, 56, 2924–2940, <https://doi.org/10.1080/00207543.2018.1442945>
- [28] Deepthi, B., Bansal, V., *Industry 4.0 in Textile and Apparel Industry: A Systematic Literature Review and Bibliometric Analysis of Global Research Trends*, In: *Vision: The Journal of Business Perspective*, 2022, 097226292211302, <https://doi.org/10.1177/09722629221130233>
- [29] Kumar, R., Singh, R.K., Dwivedi, Y.K., *Application of industry 4.0 technologies in SMEs for ethical and sustainable operations: Analysis of challenges*, In: *J Clean Prod*, 2020, 275, 124063, <https://doi.org/10.1016/j.jclepro.2020.124063>
- [30] Bai, C., Dallasega, P., Orzes, G., Sarkis, J., *Industry 4.0 technologies assessment: A sustainability perspective*, In: *Int J Prod Econ*, 2020, 229, 107776, <https://doi.org/10.1016/j.ijpe.2020.107776>
- [31] Bibby, L., Dehe, B., *Defining and assessing industry 4.0 maturity levels—case of the defence sector*, In: *Production Planning and Control*, 2018, 29, 1030-1043, <https://doi.org/10.1080/09537287.2018.1503355>
- [32] Rossini, M., Costa, F., Tortorella, G.L., Portioli-Staudacher, A., *The interrelation between Industry 4.0 and lean production: an empirical study on European manufacturers*, In: *International Journal of Advanced Manufacturing Technology*, 2019, 102, 3963–3976, <https://doi.org/10.1007/s00170-019-03441-7>
- [33] Tortorella, G.L., Fettermann, D., *Implementation of industry 4.0 and lean production in Brazilian manufacturing companies*, In: *Int J Prod Res*, 2018, 56, 2975–2987, <https://doi.org/10.1080/00207543.2017.1391420>
- [34] Erro-Garcés, A., *Industry 4.0: defining the research agenda*, In: *Benchmarking*, 2019, 28, 1858–1882, <https://doi.org/10.1108/BIJ-12-2018-0444>
- [35] Pettigrew, A.M., *On Studying Organizational Cultures*, In: *Adm Sci Q*, 1979, 24, 570-581
- [36] Hofstede, G., Neuijen, B., Ohayv, D.D., Sanders, G., *Measuring Organizational Cultures: A Qualitative and Quantitative Study Across Twenty Cases*, In: *Adm Sci Q*, 1990, 35, 286–316
- [37] Sun, S., *Organisational Culture and Its Themes*, In: *International Journal of Business and Management*, 2009, 3, 137–141, <https://doi.org/10.5539/ijbm.v3n12p137>
- [38] Jung, T., Scott, T., Davies, H.T.O., Bower, P., Whalley, D., McNally, R., et al., *Instruments for exploring organizational culture: A review of the literature*, In: *Public Adm Rev*, 2009, 69, 1087–1096, <https://doi.org/10.1111/j.1540-6210.2009.02066.x>
- [39] Cameron, K.S., Quinn, R.E., *Diagnosing and changing organizational culture: Based on the competing values framework*, Third Edition. John Wiley and Sons, 2011
- [40] Schein E.H., *Coming To a New Awareness of Organizational Culture*, In: *Sloan Manage Rev*, 1984, 25, 3–16
- [41] Schein E.H., *Organizational Culture and Leadership*, third. San Francisco, California: Jossey-Bass, 2004
- [42] Liker, J.K., Morgan, J.M., *The Toyota Way in Services: The Case of Lean Product Development*, 2006, 20, 5–20
- [43] Hofstede, G., Hofstede, G.J., Minkov, M., *Cultures and organizations: Software of the mind*, vol. 2. McGraw-Hill, New York, 2005
- [44] Quinn, R.E., Rohrbaugh, J., *A Spatial Model of Effectiveness Criteria: Towards a Competing Values Approach to Organizational Analysis*, In: *Manage Sci*, 1983, 29, 363–377
- [45] Losonci, D., Kása, R., Demeter, K., Heidrich, B., Jenei, I., *The impact of shop floor culture and subculture on lean production practices*, In: *International Journal of Operations and Production Management*, 2017, 37, 205–225, <https://doi.org/10.1108/IJOPM-11-2014-0524>
- [46] Yu, T., Wu, N., *A Review of Study on the Competing Values Framework*, In: *International Journal of Business and Management*, 2009, 4, 37–42, <https://doi.org/10.5539/ijbm.v4n7p37>
- [47] Igo, T., Skitmore, M., *Diagnosing the organizational culture of an Australian engineering consultancy using the competing values framework*, In: *Construction Innovation*, 2006, 6, 121–139, <https://doi.org/10.1108/14714170610710659>
- [48] Jacobs, R., Mannion, R., Davies, H.T.O., Harrison, S., Konteh, F., Walshe, K., *The relationship between organizational culture and performance in acute hospitals*, In: *Soc Sci Med*, 2013, 76, 115–125, <https://doi.org/10.1016/j.socscimed.2012.10.014>
- [49] Naranjo-Valencia, J.C., Jiménez-Jiménez, D., Sanz-Valle, R., *Innovation or imitation? The role of organizational culture*, In: *Management Decision*, 2011, 49, 55–72, <https://doi.org/10.1108/00251741111094437>
- [50] Zu, X., Robbins, T.L., Fredendall, L.D., *Mapping the critical links between organizational culture and TQM/Six Sigma practices*, In: *Int J Prod Econ*, 2010, 123, 86–106, <https://doi.org/10.1016/j.ijpe.2009.07.009>
- [51] Prajogo, D.I., McDermott, C.M., *The relationship between multidimensional organizational culture and performance*, In: *International Journal of Operations and Production Management*, 2011, 31, 712–735, <https://doi.org/10.1108/01443571111144823>

- [52] Jackson, S., *Organizational culture and information systems adoption: A three-perspective approach*, In: Information and Organization, 2011, 21, 57–83, <https://doi.org/10.1016/j.infoandorg.2011.03.003>
- [53] Quinn, R.E., Spreitzer, G.M., *The psychometrics of the competing values culture instrument and an analysis of the impact of organizational culture on quality of life*, Emerald, 1991
- [54] Harrison, J.R., Harrison, R., *Understanding your organization's character*, In: Harv Bus Rev, 1972, 50, 119–128
- [55] Hofstede, G., *The cultural relativity of organizational practices and theories*, In: J Int Bus Stud, 1983, 75–89
- [56] Burns, T., Stalker, G.M., *The management of innovation*, Oxford University Press, 1994
- [57] Parry, K., Proctor-Thomson, S., *Leadership, culture and performance: The case of the New Zealand public sector*, In: Journal of Change Management, 2002, 3, 376–399, <https://doi.org/10.1080/714023843>
- [58] Sürücü, D., Sürücü, L., *Organizational Culture and Demographic Characteristics of Employees*, In: Journal of Business Research – Turk, 2020, 12, 1046–1057, <https://doi.org/10.20491/isarder.2020.894>
- [59] Dubkevics, L., Barbars, A., *The Role of Organizational Culture in Human Resource Management*, In: Human Resources Management & Ergonomics, 2010, IV, 1–10
- [60] Hardcopf, R., Liu, G. (Jason), Shah, R., *Lean production and operational performance: The influence of organizational culture*, In: Int J Prod Econ, 2021, 235, 108060, <https://doi.org/10.1016/j.ijpe.2021.108060>
- [61] Sekaran, U., Bougie, R., *Research methods for business: A skill building approach*, John Wiley & Sons, 2016
- [62] Taber, K.S., *The use of Cronbach's alpha when developing and reporting research instruments in science education*, In: Res Sci Educ, 2018, 48, 1273–1296
- [63] Bartlett, J.E., Kotrlik, J.W., Higgins, C.C., *Organizational Research: Determining Appropriate Sample Size in Survey Research*, In: Information Technology, Learning, and Performance Journal, 2001, 19, 43–50
- [64] Kothari, C.R., *Research methodology: Methods and techniques*, Second. New Age International, 2004
- [65] Ghasemi, A., Zahediasl, S., *Normality tests for statistical analysis: A guide for non-statisticians*, In: Int J Endocrinol Metab, 2012, 10, 486–489, <https://doi.org/10.5812/ijem.3505>
- [66] Hofstede, G., *Culture's consequences: International differences in work-related values*, vol. 5. Sage, 1984
- [67] Bashir, M., *The organization's cultural values: A study of public sector universities in Pakistan*, In: African Journal of Business Management, 2012, 6, 3686–3693, <https://doi.org/10.5897/ajbm11.2677>
- [68] Barry, G., *How much does national culture constrain organizational culture?*, In: Management and Organization Review, 2009, 5, 241–259, <https://doi.org/10.1111/j.1740-8784.2008.00117.x>

Authors:

ABBAS MUREED¹, SALEEM MUHAMMAD QAISER¹, MUFTI NADEEM¹, AMJAD HUSSAIN²,
KAUSAR RUKHSANA³

¹University of Engineering and Technology, Faculty of Mechanical Engineering, Department of Industrial and Manufacturing Engineering, Grand Trunk (G.T.) Road, 54890, Lahore, Pakistan
e-mail: qaiser@uet.edu.pk, namufti@uet.edu.pk

²University of Engineering and Technology, Faculty of Mechanical Engineering, Department of Mechanical Engineering, Grand Trunk (G.T.) Road, 54890, Lahore, Pakistan
e-mail: chamjad@uet.edu.pk

³Kaizen Quest Institute of Professional Development, Training and Development Department, Q-33 Lahore Motorway Society, Lahore, Pakistan
e-mail: rukhsana.kausar@kaizenquest.net

Corresponding author:

ABBAS MUREED
e-mail: mureed.abbas@uet.edu.pk