

The effect of Organizational Culture on Top Management Support for Blockchain Technology Adoption: Evidence from the Yerba Mate Industry

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Introduction

Agrifood quality and authenticity have aroused growing interest among consumers, agrifood industries, and regulators in recent years (Kwasi Bannor, Arthur, Oppong, & Oppong-Kyeremeh, 2023). Consumers are increasingly demanding more information about the sources and methods of food production (Casino *et al.*, 2020), with an increased attention to the health properties of agrifood products, mostly in the organic markets (Annosi, Appio, Brenes, & Brunetta, 2024). In addition, agrifood companies are requested to align to the Sustainable Development Goals (SDGs) and to Environmental, Social, and Governance (ESG) regulations, ensuring sustainability attributes of their products, such as anti-deforestation (Tran, Schouteten, Gellynck, & De Steur, 2024) or combating child labor (Lafargue, Rogerson, Parr, & Allainguillaume, 2022). Furthermore, as many agrifood items cross borders worldwide, ensuring their compliance with international standards becomes essential (Khanna *et al.*, 2022).

In this context, adhering to globally recognized food standards is crucial for global market entry (Tarchi *et al.*, 2024), especially in the European Union (EU), in view of its recent regulation on Reforestation Free Product (EUDR), applicable on 30 December 2025 for large and medium companies and 30 June 2026 for micro and small enterprises, providing that the European Commission shall establish and maintain an Information System aimed to ensure that every stage of Agrifood Supply Chains (AFSCs) is monitored, documented and accountable, ensuring compliance with EU standards (European Commission, 2023).

Despite, however, some efforts to manage AFSCs efficiently, many food fraud incidents have been reported (Van Ruth, Huisman, & Luning, 2017), highlighting the urgency for better management of agrifood traceability. Traditional food traceability systems, nonetheless, are not specifically designed for fraud control (Van Ruth *et al.*, 2017). Current AFSCs, particularly those connected to large distribution platforms, have a significant number of participants dispersed along the chain, resulting in poor information exchange and potentially unreliable data among participants (Wang *et al.*, 2021). In this context, the need for effective traceability systems to improve quality and authenticity of agrifood products makes traceability a key issue in AFSCs.

The Brazilian yerba mate industry also faces similar concerns. The yerba mate (*Ilex paraguariensis*), an evergreen plant native to the subtropical South America, is found in the wild state or in plantations in Argentina, Brazil, and Paraguay, the only countries in the world that produce the yerba mate. Although it does produce flowers and fruits, only the oval-shaped leaves are picked for the “chimarrão”, a traditional beverage inherited from the indigenous culture, prepared by hot infusion of dried yerba mate leaves powder in a gourd and gently sipped with a metal straw.

For many years, the dehydrated leaves of the yerba mate have been used mainly for the “chimarrão” (Oliveira & Waquil, 2015). Over recent years, however, due to its great potential as raw material for other products, the yerba mate stirred up interest for its use in gastronomy, energy drinks, chocolates, liquors, tea infusions, among others, opening new opportunities for the sector at global markets. From 2012 to 2022, the volume of yerba mate exports in Brazil grew 32.5% (Fick, Azolin, & Haas, 2023), with the Rio Grande do Sul as the main exporting state, accounting for 73.1% of the exported volume.

Despite a promising scenario, the sector faces challenges. For decades, Brazilian yerba mate actors competed solely on price and volume, neglecting origin, harvesting, and environmental impact (Pretto, 2021). Now, with more competitive markets demanding traceability, urgent Supply Chain (SC) digitalization is crucial to avoid losing competitiveness (Pretto, 2021).

Authenticity and traceability are now central concepts (Iommi, 2021), posing a significant challenge. Industry 4.0 (Artificial Intelligence, Big Data, Internet of Things, Blockchain) has brought advancements in agrifood traceability (Hassoun *et al.*, 2023), with BT recognized as an effective "farm-to-fork" solution for AFSCs, enhancing transparency and efficiency (Dal Mas, Massaro, Ndou, & Raguseo, 2023; Galvez, Mejuto, & Simal-Gandara, 2018).

A recent review by Joshi, Tewari, Kumar, & Singh (2023) identified different uses of BT across various SC activities, increasing visibility and transparency for products and processes especially in AFSCs. Although many of these applications are just emerging or are in development, the increase in number of collaborations in many sectors indicates increasing interest in BT by many business and enterprise applications (Ahmed & Maccarthy, 2022). In this context, BT for SC traceability has received widespread research attention (Salah, Nizamuddin, Jayaraman, & Oma, 2019; Bischoff & Seuring, 2021; Centobelli *et al.*, 2021; Omar *et al.*, 2022; Varavallo *et al.*, 2022; Yiu, 2021), as food traceability can be more safely established through BT, improving transparency and enabling a robust and efficient traceability system (Galvez *et al.*, 2018).

AFSCs are required to align with increasing sustainability demands, leading organizations to seek technologies that help them achieve SDGs and ESG compliance (Agovino, Cerciello, & Gatto, 2028; Dias, Rodrigues, & Ferreira, 2019). In this regard, BT can track socio-environmental conditions (Adams, Kewell, & Parry, 2018), improving confidence in product sustainability by closely and accurately monitoring their flows in supply chains (Saber, Kouhizadeh, Sarkis, & Shen, 2018). Similarly, Friedman and Ormiston (2022) identify BT as a key factor in food sustainability. In this context, BT could be an efficient traceability solution for the Brazilian yerba mate industry, aiming for sustainability and fostering access to international markets.

Although the Blockchain Technology Adoption (BTA) offers revolutionary benefits for traceability in the agrifood supply chain, its widespread adoption is limited by a lack of awareness and the need to identify drivers and barriers (Longo *et al.*, 2019; Mirabelli & Solina, 2020). In this context, Organizational Culture (OC) emerges as a critical factor for the decision to adopt BT, especially from the perspective of Technology-Organization- Environment (TOE) theory elements (Bhattacharyya & Shah, 2021). Organizational readiness, for example, depends on internal policies and the technology's compatibility with existing practices and culture (Suwanposri, Bhatiasevi, & Thanakijombot, 2021; Boakye *et al.*, 2022; Bag *et al.*, 2020). On the other hand, Top Management Support (TMS) is crucial for BTA (Alshamsi & Al-Emran, Shaalan, 2022; Clohessy & Acton, 2019). TMS, which involves leadership direction, resources, understanding, and engagement (Queiroz & Wamba, 2019; Wong *et al.*, 2020a; Wong *et al.*, 2020b), motivates the team towards BTA, indicating that the absence of such support exacerbates the research problem in blockchain adoption.

It has been suggested in the literature on the relationship between OC and technological innovation that OC can influence an organization's decision-making processes towards technology adoption (Rahman *et al.*, 2013; Senarathna *et al.*, 2014). In the same way, Hogan and Coote (2014) proposed that OC can influence the behaviors of organizational members to support innovation because it can lead them to accept some basic values of organizations and foster their commitment to these values.

Considering this interplay between OC and the support of organizational members for technology adoption, a deeper understanding of the relationship between OC and TMS for BTA represents, therefore, a compelling research agenda. Nonetheless, academic researchers have investigated them as independent factors. As a result, the current literature on BTA lacks integrative understanding of the relationship between OC and TMS by examining, for example, how different archetypes of OC may affect TMS for BTA.

This study seeks to fill the above gap by answering the following research question: “*What effect does organizational culture have on top management support for the adoption of blockchain technology in the yerba mate industry?*” Thus, the objective of this study is to “*analyze the effect of organizational culture on top management support for the adoption of blockchain technology in the yerba mate industry.*”

Next, the study details the theoretical foundation and hypotheses, discusses the method and procedures, presents the discussion of the results, and concludes with final considerations, contributions, and limitations, followed by References and Appendix.

2 Literature Review and Research Model

This study structures its research model based on existing theories of BTA. It then reviews the literature to explore the influence of OC and TMS on BTA at the organizational level. Finally, drawing from gaps identified in prior research, the work outlines the OC perspectives used in hypothesis development and presents the proposed research model.

2.1 Theoretical Framework

Many theories have been used to explain BTA (Zhu, Bai, & Sarkis, 2022), including the Diffusion of Innovations (DOI) (Rogers, 2003), Technology-Organization-Environment (TOE) (Tornatzky & Fleisher, 1990), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morri, & Davis, 2003), and Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1977). It's important to note that while TRA and UTAUT focus on adoption at the individual level, DOI and TOE are more suited for the organizational level (Gangwar, Date, & Ramaswamy, 2015).

Behavioral theories, though useful for understanding individual adoption, are limited by a lack of organizational or environmental perspective (Ullah *et al.*, 2021). This can compromise construct validity when analyzing adoption at the organizational level (Compeau, Correia, & Thatcher, 2022). For this reason, the TOE Theory is frequently recommended for exploring technology adoption within organizational contexts (Zhang, Jun, Yang, & Wang, 2020).

Developed by Tornatzky and Fleisher (1990), TOE has been defined as a theoretical framework that describes technological innovation, adoption, and implementation within firms. It proposes that three contextual dimensions influence technology adoption decisions:

- (i) **Technological dimension:** Refers to existing, available, or developing technologies, considering their complexity and compatibility with current systems (Tornatzky & Fleisher, 1990; Chatterjee *et al.*, 2021).
- (ii) **Organizational dimension:** Encompasses the firm's formal and informal structure, internal communication processes, firm size, and slack resources. Top management's leadership is crucial for fostering innovation (Tushman & Nadler, 1986).

- (iii) **Environmental dimension:** Includes industry characteristics, market structure, technology support infrastructure, and the regulatory environment. Competition and the availability of consulting services and suppliers can encourage innovation (Mansfield *et al.*, 1977; Dwivedi, Wade, & Schneberger, 2012).

Some authors refer to TOE as a "framework" or "model" (Yadav, Shweta, & Kumar, 2022; Guan *et al.*, 2023; Jackson & Allen, 2023; Chittipaka *et al.*, 2022). However, the above TOE proposition fits better as a theory. A theory is a generalized statement that connects concepts, definitions, and propositions to explain or predict events (Glanz, Rimer, & Viswanath, 2008). Unlike a theoretical framework, perspectives from other authors (Kivunja, 2018) or a conceptual framework which addresses research design (Ravitch & Riggan, 2017), From these insights, TOE is used in this study as a standalone theory, with interconnected constructs that can be quantitatively measured within an organizational context for exploratory and predictive purposes.

TOE is widely recognized as the most robust theory for organizational-level technology adoption, contrasting with approaches that focus on the individual user (Gangwar *et al.*, 2015; Awa & Ojiabo, 2016). It serves as a fundamental theoretical underpinning for BTA by addressing adoption behavior at the organizational level. From this perspective, TOE theory was adopted as the theoretical foundation for the latent variables of our research model.

2.2 Organizational Culture and Blockchain Technology Adoption

OC is a critical factor in BTA decisions, especially from the TOE theory perspective (Bhattacharyya & Shah, 2021). An organization's readiness for BT adoption depends on its internal policies (Suwanposri, Bhatiasevi, & Thanakijombat, 2021), and OC directly influences the decision to implement BT, requiring the technology to be consistent with current practices and to fit the company's culture (Boakye *et al.*, 2022; Bag *et al.*, 2020).

Although an abstract concept (Schein, 2010), OC is generally defined as a complex set of values, beliefs, assumptions, and symbols that shape a firm's conduct. Scholars increasingly recognize OC's role in new technology adoption, influencing how organizations process information, rationalize, and make decisions (Naranjo-Valencia, Sanz-Valle, & Jiménez, 2010; Baird, Jia Hu, & Reeve, 2011; Rahman *et al.*, 2013; Senarathna, Warren, Yeoh, & Salzman, 2014). A favorable OC can foster innovative behavior and commitment to innovation (Baird *et al.*, 2011; Hogan & Coote, 2014).

In the specific context of BT, OC has a significant impact (Schuetz & Venkatesh, 2020). For SMEs, for example, OCs that promote innovation and accept technological changes lead to faster and more effective BT integration (Leong *et al.*, 2023). The absence of digital transformation as an organizational mission hinders BT implementation due to the need for cross-functional cooperation (Suwanposri *et al.*, 2021). Furthermore, BTA decisions in freight logistics firms, for instance, are based on their unique organizational characteristics (Schuetz & Venkatesh, 2020).

Therefore, OC is a key factor impacting BTA, and its integration within the organizational dimension of TOE theory is essential for a complete understanding of the organizational factors affecting BT adoption.

2.3 Organizational Culture approaches and Archetypes

OC is a multifaceted concept, defined by Schein (1985) as a collection of shared values and beliefs, encompassing actions, expectations, and interactions (Mcdermott & O'dell, 2001). There are two main approaches to OC (Burrell & Morgan, 1919):

- (i) **Functionalist:** Views culture as a "function" that promotes an organization's "adaptation" to its environment, emphasizing causality and value-driven decision-making (Leal-Rodríguez *et al.*, 2014; Sułkowski, 2014).
- (ii) **Structuralist:** Focuses on cultural "structure" as a combination of activities and conflicts, arguing there's no universally superior culture. It seeks balance and harmony, measuring cultural manifestations in daily practices (Hampden-Turner & Trompenaars, 2006; Leal-Rodríguez *et al.*, 2014; Lounsbury & Ventresca, 2003).

A recent study by Leal-Rodríguez *et al.* (2014) found similarities between these two approaches and Quinn and Rohrbaugh's (1981) cultural archetypes, based on the Competing Values Framework (CVF). Both functionalism and structuralism align with the idea that cultural systems serve an organizational purpose and can maintain power structures.

The Competing Values Framework (CVF) (Quinn & Rohrbaugh, 1981; Cameron & Quinn, 2011) is a widely used model for exploring the relationship between OC and innovation. It's based on four quadrants of cultural values – Clan, Adhocracy, Hierarchy, and Market – which coexist to varying degrees within an organization's culture (Cameron & Quinn, 2011).

The CVF is structured along two continuous dimensions, as in Figure 1: flexibility/discretion versus stability/control, and internal integration versus external differentiation.

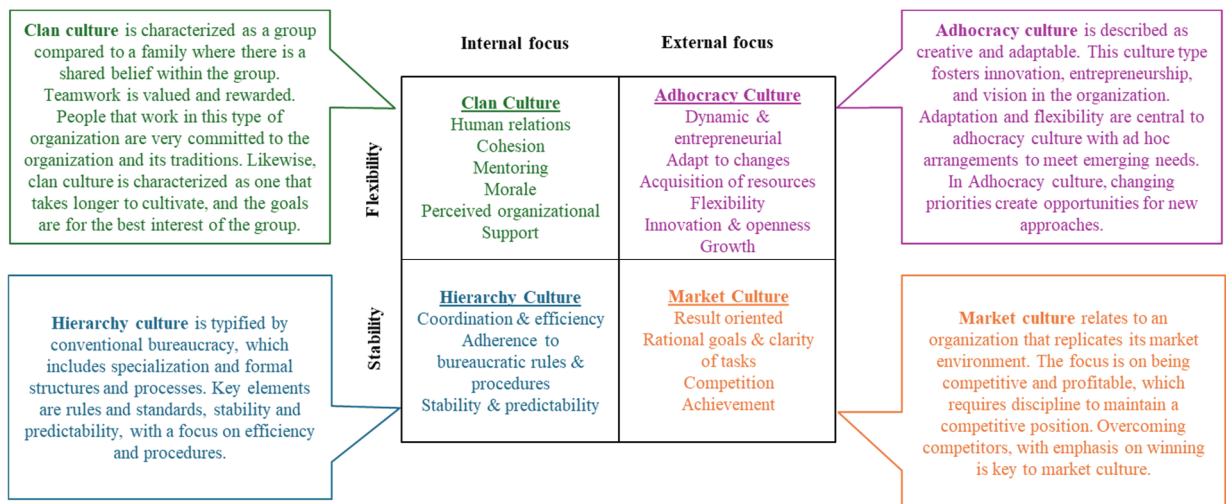


Figure 1. Organizational Culture, types and definitions according to CVF quadrants

Source: Adapted from Cameron and Quinn (2011).

In this study, we adopt Quinn and Rohrbaugh's (1981) OC archetypes, further developed by Cameron and Quinn (2011), namely adhocracy, clan, hierarchy, and market cultures, which integrate both functionalist and structuralist elements of OC (Leal-Rodríguez *et al.*, 2014).

2.4 Top Management Support for Blockchain Technology Adoption

Recent studies indicate that TMS is crucial for the BTA in organizations (Alshamsi & Al-Emran, Shaalan, 2022; Clohessy & Acton, 2019). TMS encompasses managerial beliefs about technological initiatives, their participation, and the degree of technological advancement (Kulkarni, Robles-Flores, & Popovič, 2017), reflecting management's understanding and involvement in the adoption process (Clohessy & Acton, 2019).

In the BT context, TMS is defined as top managers' ability to provide direction and resources during and after BTA (Queiroz & Wamba, 2019), as well as their understanding and involvement in adoption (Wong *et al.*, 2020a; Wong *et al.*, 2020b). TMS can, for example, motivate employees towards BTA (Wong *et al.*, 2020a).

Considering that BTA may involve new resources and regulations, TMS is vital because they create a favorable environment (Lin, 2023) and allocate resources (Malik, Chadhar, Vatanasakdakul, & Chetty, 2021). The absence of TMS reduces the likelihood of adoption (Chittipaka *et al.*, 2022). Top management's willingness to take risks and provide support drives the adoption of new technologies (Tasnim *et al.*, 2023).

However, top management needs to be aware of BT's benefits for organizational transformation (Chittipaka *et al.*, 2022), as knowledge about BT is still limited, as observed in a study with Spanish firms (Hashimy, Jain, & Grifell-Tatjé, 2022).

TMS also has a significantly positive influence on BTA, especially in Small and Medium-sized Enterprises (SMEs). SMEs with a favorable attitude from top management are more likely to adopt BT (Bhardwaj, Garg, & Gajpal, 2021). Conversely, a lack of conviction or experience among SME owners regarding BTA reduces the intention to adopt it (Wong *et al.*, 2020b). Thus, top management, including directors and SME owners, should consider BT a strategic priority to drive BTA.

2.5 Relationship between Organizational Culture and Top Management Support for Blockchain Adoption

Despite OC being a prominent organizational factor affecting BTA, its influence on TMS has been insufficiently explored in the literature, possibly due to the difficulty in measuring OC. However, investigating this relationship within the TOE organizational dimension is crucial, as OC traits like internal practices and shared values are essential for predicting BTA. Therefore, analyzing the interaction between OC and TMS for BTA in the yerba mate industry context presents a relevant research objective.

Existing literature suggests that OC can influence an organization's ability to process information and make technology adoption decisions (Rahman *et al.*, 2013; Senarathna *et al.*, 2014). It can also stimulate innovative behavior and members' commitment to innovation (Baird *et al.*, 2011; Hogan & Coote, 2014).

Despite this interplay, BTA research often treats OC and TMS as independent factors, leading to a lack of integrative understanding of how different types of OC might affect TMS for BTA. Furthermore, most studies on OC's influence on BTA emphasize it as a unidimensional construct, overlooking that distinct cultural values can impact BTA in varied ways (Leal-Rodríguez *et al.*, 2023).

To our knowledge, no empirical studies currently examine the direct relationship between OC and TMS for BTA.

2.6 Hypothesis development and Research Model

Adhocracy culture emphasizes future orientation, risk taking (Ahmed, 1998) and flexibility (Kitchell, 1995). Flexibility-oriented culture emphasizes creativity, providing discretion for employees (Shao, 2019). Moreover, flexibility-oriented culture creates an open environment for informal communications among organizational members (Somech & Drach-Zahavy, 2013). These cultural characteristics are supportive of firms adapting to the new environment and bring critical resources together to engage in innovative and creative ventures. The organization with the adhocracy culture is more responsive to innovation (Brettel & Cleven, 2011). In the same way, adhocracy actively promotes change, adaptation, and it is a powerful catalyst for digitalization (Hartl & Hess, 2017). Under such circumstances, we propose the following hypothesis for the relationship between adhocracy culture and TMS for BTA.

H1. Adhocracy culture impacts top management support for blockchain adoption in the mate industry.

Clan culture is typically featured as a friendly place to work. An organization with a clan culture normally emphasizes the long-term benefit, high cohesion and human development and participation (Cameron & Quinn, 2006). A study by Felipe, Roldán, and Leal-Rodríguez (2017) established a positive and statistically significant correlation between clan culture and organizational agility, which can favor innovation. In this way, Hartl and Hess (2017) suggest that a combination of culture types from the CVF, emphasizing values that promote care for people, provide optimal outcomes in digitalization. From these insights, this paper proposes the following hypothesis for the relationship between clan culture (CLA) and TMS for BTA:

H2. Clan culture impacts top management support for blockchain adoption in the mate industry.

Hierarchy culture places significant emphasis on adhering to norms, formal procedures, and control (Sanz-Valle, Naranjo-Valencia, Jiménez-Jiménez, & Perez-Caballero, 2011). In contrast to adhocracy culture, the hierarchical culture is characterized by a formalized and structured place to work, emphasizing stability, predictability, and efficiency (Cameron & Quinn, 2006). The existence of rules, regulations, and explicit goals for responsiveness and productivity in a control-oriented culture provides low discretion for organizational members and high level of uncertainty avoidance (Lewis & Boyer, 2002; Sarooghi, Libaers, & Burkemper, 2015). In the hierarchical culture, a company stresses internal control, which may reduce information gathering, organizational learning, and thus be detrimental to innovation (Büschgens, Bausch, & Balkin, 2013; Lemon & Sahota, 2004; Naranjo-Valencia *et al.*, 2010). Under these conditions, we propose the following hypothesis for the relationship between hierarchy culture and TMS for BTA:

H3. Hierarchy culture impacts top management support for blockchain adoption in the mate industry.

Market culture emphasizes competitiveness, goal achievement, and environment exchange. Market culture can be perceived, therefore, as a driver of competitive success with clear objectives and an assertive approach to increase output and revenue (Grover, Tseng, & Pu, 2022). However, previous research suggests that cultural values such as tight deadlines and team efficiency within organizations may inhibit processes such as organizational learning or innovation (Sanz-Valle *et al.*, 2011). According to these authors, the market culture's focus on

control and stability (rather than flexibility) has an adverse impact on innovation. Consequently, we propose the following hypothesis for the relationship between market culture and TMS for BTA:

H4. *Market culture impacts top management support for blockchain adoption in the mate industry.*

The theoretical proposition is that the four perspectives of OC are related to the TMS for BTA. **Figure 2** presents the research model and its hypotheses.

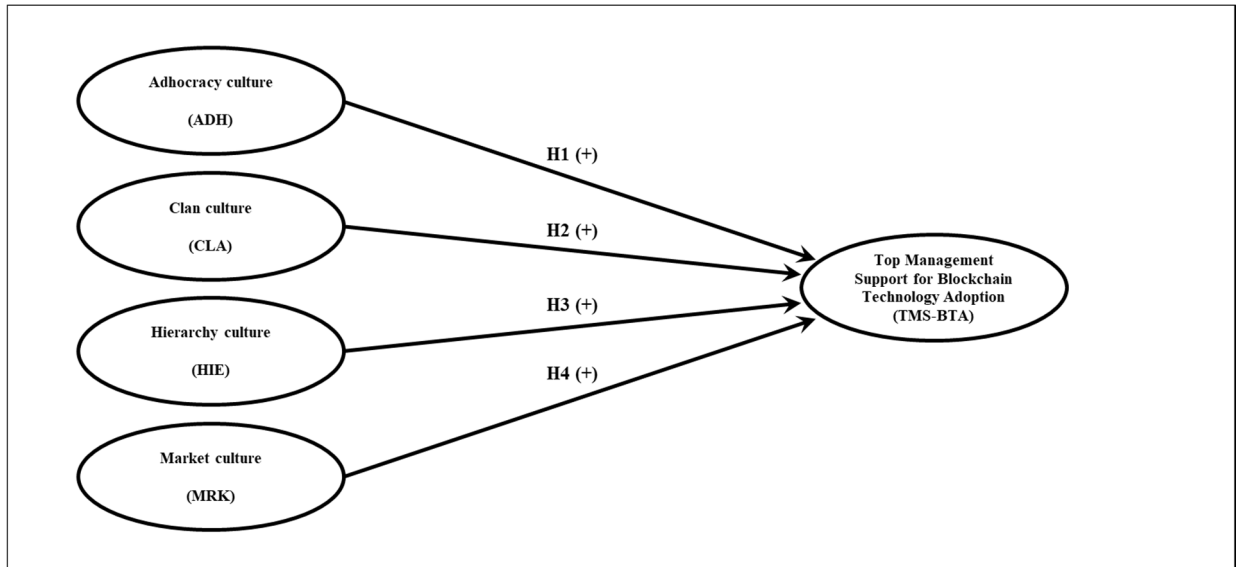


Figure 2. Research model.

3 Method

This study particularly focused on predicting BTA in the mate industry, considering four types of OC as exogenous constructs (independent variables) and TMS as endogenous constructs (dependent variable). According to [Hair et al., \(2022\)](#), there is not a definite answer to when to measure a construct reflectively or formatively, because constructs are not inherently reflective or formative. Instead, the specification depends on the construct development and the objective of the study. Since the indicators of the five constructs in our research model were described as manifestations of each underlying construct, all constructs in our study were measured reflectively.

3.1 Measurement instrument development

A semi-structured questionnaire survey was used to collect data and to test the hypotheses. The questionnaire comprises three groups of points regarding, respectively, (a) demographic characteristics, (b) OC constructs, and (c) TMS constructs.

The group of points related to OC was adapted from the copyrighted Organizational Culture Assessment Instrument (OCAI) developed by [Cameron and Quinn \(2006\)](#) based on the four CVF quadrants, widely employed and validated in many prior studies ([Heritage, Pollock, & Roberts, 2014](#); [Naranjo-Valencia et al., 2010](#); [Pakdil & Leonard, 2015](#)). Approval for the OCAI use was obtained by the instrument's authors. The original OCAI consists of 24 items divided into six groups of four statements (one for each culture type), comprising the following

dimensions of OC: dominant characteristics, organizational leadership, management of employees, organizational glue, strategic emphasis, and criteria for success. For this study purpose, the OCAI items were adapted to a five-point Likert scale with 24 reflective statements (indicators) provided without numbering, divided into four groups (one for each OC construct) of six statements.

TMS was measured using a five-point Likert with five reflective statements (indicators) provided without numbering, adapted from Wong *et al.* (2020a) and from Badi *et al.*, (2020) studies on BTA.

The initial questionnaire draft was translated into Portuguese and underwent a proofreading by an expert from the mate industry, and an academic with a PhD on BTA in the agrifood sector to ensure the survey items were clear, meaningful, and understandable. Their feedback contributed to the final version of the questionnaire with minor adjustments.

3.2 Data setting

This study was conducted among mate industries in the Brazilian State of Rio Grande do Sul. The distinctiveness of the Rio Grande do Sul as the main Brazilian exporting State, accounting for 73,1% of the exported volume, justified its choice as the geographical focus of our study.

We have targeted for data collection a list of 149 registered mate industries provided by the Yerba Mate Committee of the Secretary of Agriculture of Rio Grande do Sul. Our decision for registered mate industries considered that they provide a more reliable picture of the sector than a data sample also including informal productive structures.

Managers and owners who were directly responsible for the companies' activities have been chosen as respondents. These key respondents were considered appropriate for the survey because they have a broader perspective of the daily operations and the internal environment of the firm and play an active role in making strategic decisions.

3.3 Sample size

Research design and the unity of analysis are important factors when deciding on sampling size. As put by Memom *et al.*, (2020), a complex model with numerous variables requires a larger sampling than a simple model with few variables. In the same way, research at the organization level using top managers as respondents may have a smaller sample size than research at the individual level using, for example, employees and clients (Memom *et al.*, 2020).

Considering our research comprises a simple model with five variables using top managers as respondents in a population of 149 industries, a smaller sample size is appropriate for our research objectives. The next step was to estimate the minimum required sample size.

To assess the minimum required sample size for PLS-SEM, Hair *et al.* (2021) suggest researchers can consider Cohen's (1992) table, which shows the minimum samples required to obtain minimum R^2 values for any of the endogenous constructs in the structural model at significance levels of 1%, 5%, and 10% with statistical power of 0.80, standard values used in social sciences, as depicted in Table 3.

Following these guidelines, we considered a minimum R^2 of 0.250 at 5% of significance level. Accordingly, since there are four arrows pointing at the TMS construct in our model, the recommended sample size was 65. Therefore, the collected number of 69 samples, reported in the next topic, is an adequate sample size for our study aims.

3.4 Data collection

The survey questionnaire was transferred to an online platform for data collection (SurveyMonkey). The questionnaire was accompanied by an introductory letter informing the respondents about the researcher and the purpose of the study. Adherence to ethical considerations was ensured, including informing the participants that their participation was voluntary, that responses were anonymous and that results will only be reported in aggregate form.

The data collection period spanned from January to March 2024. The questionnaire link was initially distributed to participants via e-mail obtained from the target industries websites. The initial e-mail was followed by phone calls and reminders two weeks later. The final sample contains 69 respondents, with a response rate of 47%.

3.5 Sample profile

Sample profiles were assessed by asking respondents about their management level, enterprise size and information technology (IT) structure. We obtained 68 samples of these items from the total of 69 survey questionnaires returned, just one of them, therefore, with missing values regarding this section. This survey section's results are summarized in **Figure 3**.

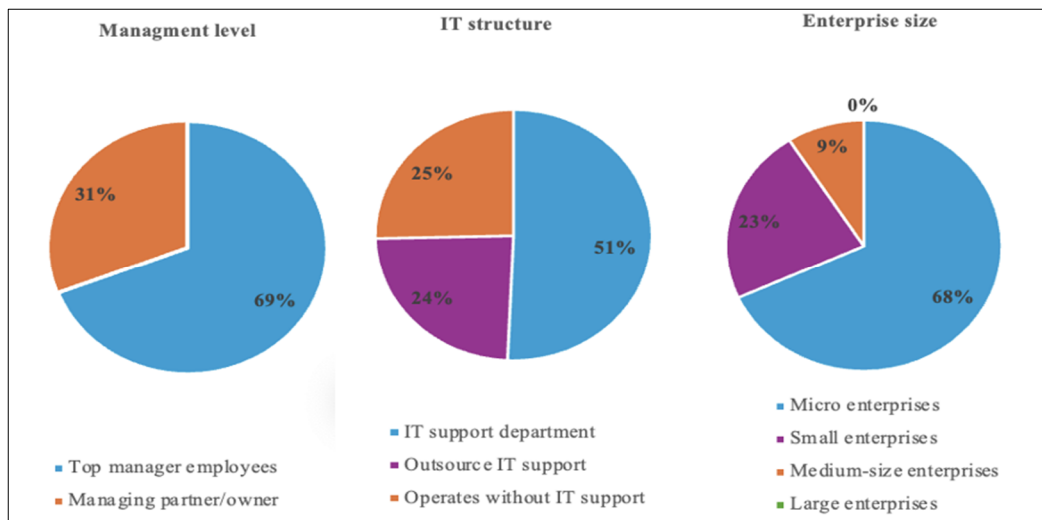


Figure 3. Sample profile.

Of the respondents, 69.12% were managing partners or owners, while 30.88% held top management positions. And for information about enterprise size, we used the industries classification system of the Brazilian Institute of the Geography and Statistics (IBGE), which classifies enterprises size by the number of persons employed: 1 to 19 persons employed (micro enterprises), 20 to 99 (small enterprises), 100 to 499 persons employed (medium-sized enterprises), and 500 or more persons employed (large enterprises). According to the respondents' answers, 68.18% have, 22.73% have small enterprises, and 9.09% have medium-size enterprises. Finally, regarding Information Technology (IT) structure, 48.53% have an IT support department, 25% outsource IT support, and 26.47% fully operate without IT support.

3.6 Data analysis technique

Data collected was analyzed using SmartPLS 4 software and the PLS-SEM method. PLS-SEM is a quantitative method widely used in the social sciences, particularly in management,

marketing, and economics (Hair *et al.*, 2012). It is well-suited for exploring relationships between latent constructs such as attitudes, beliefs, and behaviors in complex systems (Hair *et al.*, 2014). Given the predictive aims of this study, the small size of our data setting, the use of reflective measurement model and the research focus on recommendation for managerial practices, we considered the PLS-SEM as the most appropriate method for our data analysis (Hair, Sarstedt, & Ringle, 2019).

4 Results and Discussion

The PLS-SEM technique was chosen to evaluate both the measurement model of the constructs and the structural model for exploratory analysis of the hypothesized relationships. The PLS-SEM model results provide empirical measures of the relationship between the indicators and the constructs (measurement model) as well between the constructs (structural model). The results enable the evaluation of the quality of the indicators and if the model delivers satisfactory results in explaining and predicting the target construct. Thus, the PLS-SEM results assessment consists of two stages: (1) The evaluation of the measurement model, and (2) The evaluation of the structural model.

4.1 Evaluation of the measurement model

In the measurement-model analysis, the following quality criteria were considered, as recommended by Hair *et al.* (2022): (i) Outer loadings of observable variables > 0.70 ; (ii) Cronbach's alpha (α) and Composite Reliability (CR) of constructs > 0.70 ; (iii) Average Variance Extracted (AVE) for convergent validity of constructs > 0.50 ; and (iv) Discriminant validity, assessed via HTMT < 0.85 .

Step 1. Indicator reliability

The recommended value for the indicator loadings should be more than 0.70. However, indicators with outer loadings between 0.40 and 0.70 should be considered for removal only when deleting the indicator leads to an increase in the internal consistency reliability or convergent validity above suggested threshold values (Hair *et al.*, 2022). After deleting these indicators from the survey, all remaining 20 indicators meet the acceptable threshold value, most of them with outer loads more 0.70 and just one (HIE2<HIE) with 0.53, ensuring, therefore, construct indicator reliability. Following these guidelines, two indicators from each construct of our path model have been removed with a new sequence from 1 to 4 in the construct indicators (**Appendix A**).

Step 2. Construct internal consistency reliability

Internal consistency reliability means the extent to which indicators measuring the same construct are associated with each other. A widely used criterion for measuring internal consistency reliability is Cronbach's alpha. While Cronbach's alpha is rather conservative, the composite reliability rho_c may be too liberal, and the construct's true reliability is typically viewed as within these two extreme values (Hair *et al.*, 2022). As an alternative, subsequent research has proposed the coefficient rho_a for composite reliability (Hair *et al.*, 2022). Since the reliability coefficient rho_a usually lies between the conservative Cronbach's alpha and the liberal composite reliability rho_c, it is therefore considered an acceptable compromise between these two measures (Hair *et al.*, 2021). Taking the composite reliability rho_a as the more appropriate measure, our model shows good composite reliability values ensuring, therefore, construct internal consistent validity.

Step 3. Construct convergent validity

A common measure to establish convergent validity is the average variance extracted (AVE). As we can see in **Table 2**, most AVE values are above the acceptable threshold of 0.50, except for HIE. However, as the AVE value for HIE (0.497) is very close to 0.50, we conclude that our model sufficiently establishes convergent validity.

Step 4. Discriminant validity

Recent research suggests as a criterion for discriminant validity the Heterotrait-Monotrait Ratio (HTMT). As we can see from **Table 2**, all HTMT results are lower than the conservative threshold value of 0.85.

Table 2 presents the results for these quality and validation criteria.

Table 2. Measurement model evaluation.

Construct	ADH	CLA	HIE	MRK	TMS-BTA
ADH	-				
CLA	0.790	-			
HIE	0.659	0.782	-		
MRK	0.835	0.484	0.641	-	
TMS-BTA	0.614	0.280	0.317	0.425	-
αC	0.723	0.799	0.683	0.731	0.825
CR (rho_a)	0.822	0.780	0.712	0.792	0.854
CR (rho_c)	0.818	0.854	0.794	0.823	0.886
AVE	0.533	0.598	0.497	0.541	0.664

Construct legend: Clan Culture (CLA); Adhocracy Culture (ADH); Hierarchy Culture (HIE); Market Culture (MRK); Top Management Support for Blockchain Technology Adoption (TMS-BTA).

Criterion legend: Cronbach's alpha (α); Composite Reliability (CR); Average Variance Extracted (AVE).

Note: Discriminant validity assessed by the HTMT criterion.

After confirming the construct indicators are reliable and valid, next we evaluate the structural model results.

4.2 Evaluation of the Structural model

The second stage in applying PLS-SEM is to evaluate the relationship between the constructs (structural model), which involve four steps in which we assess (1) collinearity issues in the structural model; (2) the significance and relevance of the structural model; (3) the model's explanatory power; and (4) the model's predictive power.

Step 1. Collinearity

All *VIF* values in our structural model are lower than 3, meeting, therefore, the preferable threshold value for collinearity (Hair *et al.*, 2022).

Step 2. Significance of the structural model relationships

Structural model path coefficients (the arrows towards TMS in Fig. 17), represent the hypothesized relationships among the constructs. Path coefficients have standardized values approximately between -1 and $+1$, $+1$ represent strong positive relationships and vice versa for negative values (Hair *et al.*, 2022). The arrows from the exogenous constructs ADH, CLA, MRK and HIE pointing at the endogenous construct TMS-BTA in **Figure 4** demonstrate the strength of the relationship among them.

Looking at the results, we find that the ADH has the highest path coefficient (0.585). In contrast, CLA (0.129), MRK (0.054) and HIE (0.010) display very low values. These results reveal that there is a positive relationship between adhocracy culture and TMS-BTA. The path coefficient 0.585 indicates a strong relationship between them, suggesting that adhocracy culture positively impacts TMS for BTA in the mate industry. The results also show a negative relationship between clan culture and TMS-BTA. The low path coefficient for clan culture (0.129) indicates, however, a weak relationship between them. Finally, as the results for market culture (0,129) and hierarchy culture (0.010) are very close to 0, we consider the relationship between each of these two constructs and TMS for BTA is not statistically significant.

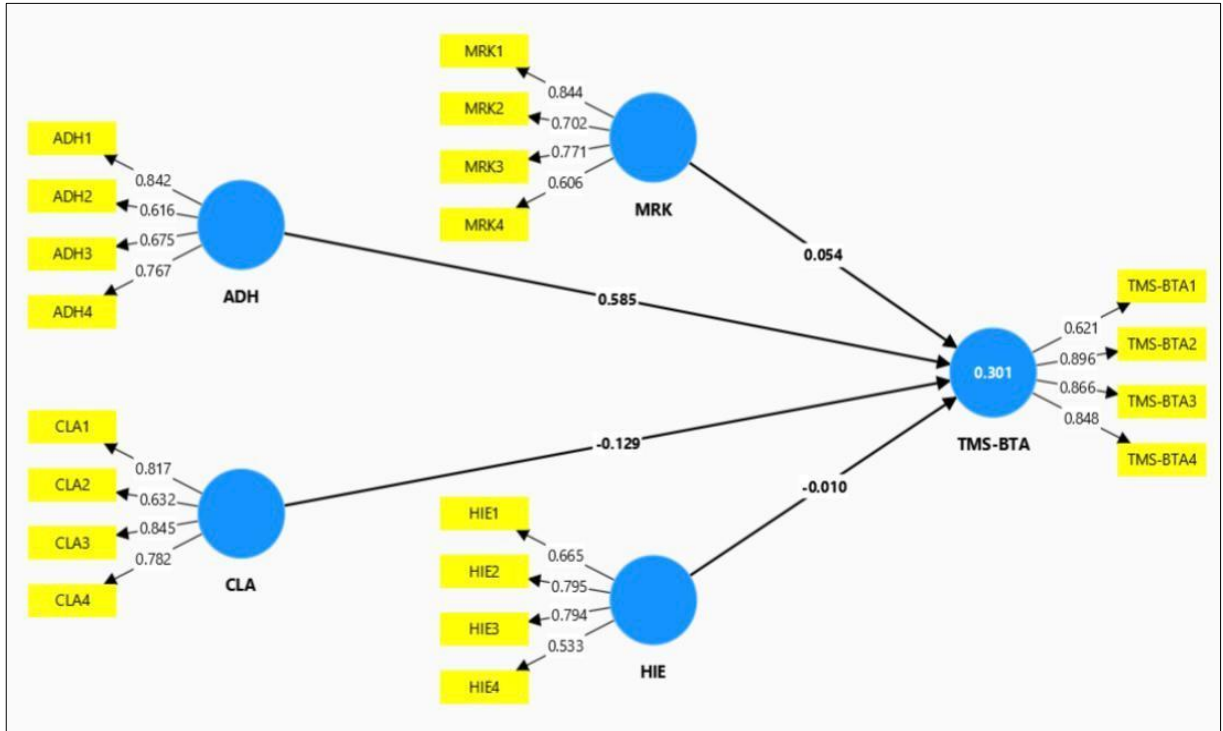


Figure 4. PLS-SEM Path Model Results.

By going to the bootstrapping results (**Table 3**), we get a more detailed overview of the path model coefficients and significance.

Table 3. Hypothesis test.

Path	Coefficient	P values	f ²	Empirical evidence
H1: ADH → TMS-BTA	0.585	0.000	0.229	Supported, medium effect size
H2: CLA → TMS-BTA	-0.129	0.467	0.014	Not supported
H3: HIE → TMS- BTA	-0.010	0.945	0.000	Not supported
H4: MRK → TMS-BTA	0.054	0.703	0.003	Not supported

Looking at these results, we have the following findings regarding the proposed hypotheses for this study.

With **H1**, we have predicted a positive impact of Adhocracy Culture on TMS-BTA. The results show that Adhocracy Culture has a strong and significant positive impact on TMS-BTA ($\beta = 0.585$, $P < 0.05$). Therefore, the proposed hypothesis has been accepted.

With **H2**, we have predicted a positive impact of Clan Culture on TMS-BTA. The results demonstrate, however, that the relationship between Clan Culture and TMS-BTA is not statistically significant ($\beta = -0.129$, $P > 0.05$). Thus, the proposed hypothesis has been rejected.

With **H3**, we have predicted a negative impact of Hierarchy Culture on TMS-BTA. The results show the relationship between Hierarchy Culture and TMS-BTA is not statistically significant ($\beta = -0.010, P > 0.05$). Hence, the proposed hypothesis has been rejected.

With **H4**, we have predicted a negative impact of Market Culture on TMS-BTA. The results show that the relationship between Hierarchy Culture and TMS-BTA is not statistically significant ($\beta = 0.054, P > 0.05$). Consequently, the proposed hypothesis has been rejected.

Step 3. Model Explanatory power

The most used measure to evaluate the structural model's explanatory power is the coefficient of determination (R^2). R^2 values above 0.60 are considered as high, between 0.30 and 0.60 as moderate and below 0.30 as low. We find a moderate R^2 value of 0.301 for TMS-BTA, indicating that approximately 30,1% of the variability in TMS-BTA was explained by ADH, as the relationship among TMS-BTA and the variables CLA, HIE and MRK in the path model is not statistically significant (**Figure 4**). Therefore, we can conclude that the R^2 for TMS-BTA in our model is enough to draw important conclusions about the relationship between ADH and TMS-BTA. In reporting and interpreting studies, both the statistical significance (P value) and substantive significance (effect size) are essential results to be reported (Sullivan & Feinn, 2012), as it enables academics and practitioners to understand their practical implications in the real-world. As a guideline, Cohen (1988) values of 0.02, 0.15 and 0.35 respectively represent small, medium and large effect size (Hair *et al.*, 2022). The results show that ADH has a medium effect size (0.229) on TMS-BTA. On the other hand, CLA (0.014), HIE (0.000) and MRK (0.003), with values close or equal to 0, have no effect on TMS-BTA.

Step 4. Predictive power

For a PLS path model to be useful for managerial decision-making, the model needs to produce generalizable results (Hair & Sarstedt, 2021). Producing generalizable findings requires assessing whether the results not only apply to the data that have been used in the model estimation process but also to other data sets not included in the estimation process. The researchers need, therefore, to assess their model's out-of-sample predictive power, or simply its predictive power (Hair *et al.*, 2022). The primary approach for assessing the predictive power of a PLS path model is by running the PLS-Predict procedure available in the SmartPls 4 software. When using PLS-Predict it is necessary to make the following key choices (Hair *et al.*, 2022): (i) the number of folds; (ii) the number of repetitions; and (iii) the prediction statistics.

Step 4.1 Number of Folds

PLS-Predict is based on the concept of k-fold cross-validation, in which the overall data set is split into k equally sized subsets of data. For example, a 5-fold cross-validation splits the total sample into 5 equally sized subsets (groups) of data. PLS-Predict then combines k-1 subsets (i.e., 4) into a single training sample to predict the remaining subset, which represents the holdout sample for the first cross-validation run. Hair *et al.*, (2022) suggest when choosing a value for k, researchers need to ensure that the training sample in a single fold still meets the model's minimum sample size requirements. They recommend predictive studies to set k to 10 if the minimum sample size requirements are met. As the overall data in our study is equal to 69, we set k to 17 subsets of 4 samples, so the single training sample (69-4) is equal 65, meeting, therefore, the minimum sample size requirement we have specified in Section 3.

Step 4.2 Number of Repetitions

Although choosing a high value for r increases the estimates' precision, setting r to 10 generally provides a good trade-off between increase in precision and runtime (Witten, Frank, & Hall, 2011). Following these guidelines, we set r to 10.

Step 4.3 Prediction statistic

To assess the model's predictive power, one of the following prediction statistics should be adopted (Hair *et al.*, 2022): the mean absolute error (*MAE*) or the root mean square error (*RMSE*). Since *RMSE* often applies to predictive modelling, Hair *et al.*, (2012) recommend its routine for prediction statistics.

Step 4.4 PLS-Predict Results

When interpreting PLS-Predict results, researchers should generally focus on their model's key endogenous construct. Once the key target construct has been identified, researchers should first interpret the Q^2 Statistic to ensure that the PLS-SEM-based predictions outperform the most naïve benchmark. A value of 0 or less suggests the predictive power of the PLS-SEM analysis for that indicator does not even outperform the most naïve benchmark. On the other hand, for those indicators with $Q^2 > 0$, the next step is to compare the *RMSE* (or the *MAE*) values with the naïve *LM* benchmark. Following Hair's guidelines, we focus the analysis on the target construct TMS-BTA and consider the *RMSE* metric for interpreting the model predictive power.

As we can see in **Table 4**, all TMS indicators show $Q^2 > 0$, which suggests the predictive power of the PLS-SEM analysis outperforms the most naïve benchmark.

Table 4. Model predictive power.

Indicator	Q^2 predict	PLS-SEM (RMSE)	LM (MSE)
TMS-BTA1	0.101	0.939	1.138
TMS-BTA2	0.132	0.950	1.008
TMS-BTA3	0.159	1.081	1.211
TMS-BTA4	0.005	0.967	1.007

Legend: Top Management Support for Blockchain Adoption (TMS-BTA).

The last step in the PLS-Predict results analysis requires comparing the *RMSE* values with those produced by the naïve *LM* benchmark model. Looking at **Table 4**, we can see that the PLS-SEM *RMSE* analysis produces smaller values than the *LM* *RMSE* for all TMS-BTA indicators. These results indicate, therefore, a high predictive power of this study results for BTA in the mate industry.

5 Final Considerations

This study aimed to investigate the magnitude and predictive power of the relationship between OC and TMS for BTA in the yerba mate industry towards sustainable competitiveness with a focus on new market opportunities. The paper's results demonstrated, with high predictive power, that adhocracy culture has a positive and significant impact on TMS for BTA in the mate industry, confirming the first hypothesis of this study.

On the other hand, the study results show that the relationship between the remaining OC constructs explored in our research model and TMS is statistically insignificant and, therefore, neither promote nor hinder BTA in the yerba mate industry.

The findings reinforce the need for organizations to foster specific traits of culture that supports and encourages innovation. A core message from the study results is that a strong alignment between adhocracy culture and innovation objectives is crucial for the yerba mate

industry to thrive in today's dynamic and competitive business, especially for accessing international markets.

From this perspective, the main challenge in the research context would be to reconcile the traditionalism of the yerba mate industry, largely characterized by small family business, with the adhocracy culture, which emphasizes innovation and flexibility to meet emerging needs. A further concern deriving from the research findings could be possible resistance in the sector to change their OC.

Regarding these concerns, it is important to observe that the results also show that the relationship between the remaining culture types and TMS is statistically insignificant, neither promoting nor hindering blockchain adoption by yerba mate industries. Regardless, therefore, of their prevailing culture types, there is no need for substantial change in their current culture, which suggests lower resistance towards digital transformation.

Furthermore, 68% of the surveyed industries are micro enterprises, with 1 to 19 persons employed, 51% of them have an IT support department (Fig. 14), which indicates the existence of supportive infrastructure that facilitates organizational change towards blockchain adoption.

5.1 Theoretical and practical implications

By exploring the influence of OC on TMS as key factors affecting BTA, this study has some noteworthy theoretical and practical implications.

As a first theoretical implication, this study contributes to the debate on BTA at organizational level through the perspective of the TOE theory by exploring the relationship between OC and TMS, as prevalent OFs affecting BTA. This approach differs from previous studies which examine them as single constructs. Furthermore, by clarifying the interconnection between key TOE organizational constructs, we enhanced the TOE theory providing new directions for future studies in the field.

Second, our research combines functionalist and structuralist perspectives of OC for investigating the impact of different types of OC on TMS, hence contributing to the literature on measuring culture based on archetypes, rather than the traditional approach based on OC as a single construct. By measuring culture based on archetypes, we can gain profound insights into different cultural patterns that shape technology's adoption.

Third, prior research has identified significant impact of adhocracy culture, clan culture, hierarchy culture, and market culture on technological innovation in different contexts. The results of this study reveal, however, that clan, hierarchy and market culture neither promote nor hinder BTA in the yerba mate industry. This reinforces the theoretical perspectives that not all cultural values may have an equal impact on fostering innovation as each organization has its own distinctive culture, and that cultural values cannot be treated prescriptively, as there is no such thing as a universally better culture.

As a first practical implication, managers will be better informed on the influence of different types of OC towards the adoption of new technology, which may help to overcome the lack of TMS for BT as an effective tool for agrifood traceability. In the yerba mate industry context, our research findings indicate top managers should encourage employees to think innovatively and pursue new ideas, in line with the adhocracy culture as a key factor affecting BTA in the sector.

Second, by identifying adhocracy culture as a crucial factor for BTA in the yerba mate industry, this study provides practitioners in the sector with a target culture upon which they are advised to build their cultural change. These insights can help yerba mate industries more effectively to adapt to the evolving digital transformation era of Industry 4.0, including BT, pointing to the need for deliberate efforts to shape their OC in a way that facilitates the development of digital solutions for the sector.

Third, BTA in the yerba mate SC involves multiple stakeholders, including industries from other sectors which utilize the yerba mate as raw material for new products such as chocolate, energy drinks, liquors, and infusions. Considering the importance of BT as an effective traceability system ensuring compliance with globally accepted agrifood standards, these industries, especially public companies with responsibility and commitment to the global sustainability agenda, can play a leading role in digital innovation throughout the value chain.

Four, given the high predictive power of this study results, they are relevant to administrators and policymakers seeking to foster the use of BT towards sustainability in line with SDGs, an important step for the yerba mate industry for accessing international markets. As a first step towards this purpose, it is advisable to reinforce ongoing initiatives in the sector such as training and qualifying yerba mate producers to adhere to organic certification, considering the increased demand for organic products both at national and international markets.

Five, next step could be the implementation of the SIBRAAR in the sector, a traceability system developed by Embrapa in 2022, which uses BT to trace agrifood products (Embrapa, 2022), recently employed, for the first time, in the brown sugar sector from a partnership between Embrapa, the Cooperative of Sugarcane Producers of São Paulo State, and Usina Granelli (SNA, 2023). Similar partnerships could be developed, for example, between Embrapa and the yerba mate industry, considering the promising opportunities for new yerba mate products and the need for an effective traceability system for the sector.

5.2 Limitations and future research

Despite the underlying implications of this study, it has some limitations that may offer opportunities for future research.

First, this study was conducted on a limited sample size of 69 yerba mate industries in the Brazilian state of Rio Grande do Sul state. The use of convenience sampling may restrict the generalizability of the results exclusively to the yerba mate industry into this specific geographic area. Future studies can overcome regionalism and sample size limitations by including other economic sectors.

Second, this study relies on a quantitative method to gather the perceptions of top managers. The perception of senior managers may, however, be biased by personal features and external environment. Future research may combine quantitative and qualitative methods to capture a wider picture of the research setting. Exploring alternative methodologies could unveil additional insights that contribute to a deeper understanding of the relationship between OC and TMS.

Third, the use of cross-sectional data in this study also may limit the predictability of its findings. To overcome this, future research may explore different stages of organizations' digital transformation for more reliable results.

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Appendix A – Indicators of the Measurement Model

Variable	Indicators
Clan Culture	
*	The organization is a very personal place. It is like an extended family. People seem to share a lot of themselves.
*	The leadership in the organization is generally considered to exemplify mentoring, facilitating, or nurturing.
CLA1	The management style in the organization is characterized by teamwork, consensus, and participation.
CLA2	The glue that holds the organization together is loyalty and mutual trust. Commitment to this organization runs high.
CLA3	The organization emphasizes human development. High trust, openness, and participation persist.
CLA4	The organization defines success based on the development of human resources, teamwork, employee commitment, and concern for people.
Adhocracy Culture	
ADH1	The organization is a dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.
*	The leadership in the organization is generally considered to exemplify entrepreneurship, innovation, or risk taking
ADH2	The management style in the organization is characterized by individual risk taking, innovation, freedom, and uniqueness.
ADH3	The glue that holds the organization together is commitment to innovation and development. There is an emphasis on being on the cutting edge
ADH4	The organization emphasizes acquiring new resources and creating new challenges. Trying new things and prospecting for opportunities are valued.
*	The organization defines success based on having unique or the newest products. It is a product leader and innovator.
Market Culture	
MRK1	The organization is very results oriented. A major concern is with getting the job done. People are very competitive and achievement oriented.
MRK2	The leadership in the organization is generally considered to exemplify a no - nonsense, aggressive, results - oriented focus.
*	The management style in the organization is characterized by hard - driving competitiveness, high demands, and achievement.
*	The glue that holds the organization together is the emphasis on achievement and goal accomplishment.
MRK3	The organization emphasizes competitive actions and achievement. Hitting stretch targets and winning in the marketplace are dominant.
MRK4	The organization defines success based on winning in the marketplace and outpacing the competition. Competitive market leadership is key.
Hierarchy Culture	
HIE1	The organization is a very controlled and structured place. Formal procedures generally govern what people do.
HIE2	The leadership in the organization is generally considered to exemplify a no - nonsense, aggressive, results - oriented focus.
HIE3	The management style in the organization is characterized by security of employment, conformity, predictability, and stability in relationships.
*	The glue that holds the organization together is formal rules and policies. Maintaining a smoothly running organization is important.
HIE4	The organization emphasizes permanence and stability. Efficiency, control, and smooth operations are important.
*	The organization defines success based on efficiency. Dependable delivery, smooth scheduling, and low - cost production is critical.
Top Management Support	
TMS1	Our company's upper manager is aware of blockchain technology and its potential as a tool for tracking goods.
TMS2	Our company's upper manager would be willing to invest in blockchain technology to track its products to ensure their authenticity and origin, with a focus on competitiveness.
TMS3	Our company's upper manager would be willing to promote internal restructuring, including employee training, for possible adoption of blockchain technology as an innovation strategy.
*	Our company's upper manager would support the exchange of information between employees and other levels of management about blockchain technology and its potential contribution as a competitiveness strategy.
TMS4	Our company's upper manager would be prepared to accept the risks associated with blockchain technology adoption, considering that it is still a relatively new technology.

* Removed due to low outer loadings according to HAIR *et al.* (2022) guidelines.