Toward an integration of blockchain technology in the food supply chain

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Keywords: blockchain technology, hospitality, food chain, sharing economy, stakeholders

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Abstract

The traceability of what we eat is a lingering issue. Blockchain enables transparency across the value chain as it tracks a product's origin, location, and history. In this work we adopt a mix-method approach - experiment plus qualitative evidence - to understand why consumers consider the traceability offered by blockchain important and what are the barriers that suppliers face when considering blockchain adoption. Our findings show that, when the food is local, blockchain increases consumers' trust and, in turn, attitudes and behaviors toward the sharing experience. On the supply side, we find that, while operators see key benefits in blockchain adoption – including enhanced trust, they are still hesitant in using the technology because of a greater need for intra-organizational support and a concern in data sharing. By looking at both consumers and suppliers, we offer a complete picture on the integration of blockchain technology in the food supply chain.

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1. Introduction

When we sit at a restaurant table, it is rare to know exactly where the ingredients on our plate come from. The need for information, clarity, and traceability has never been as crucial as today (Lloyd's Register Foundation, 2020, Bray et al., 2019), especially in the sharing economy (Eckhardt et al., 2019). Consumers have been traumatized by the various scandals related to chemicals or bacteria present in food and other related diseases transmitted by the alimentation (WHO, 2022). Improving the traceability of food products is essential to respond to this growing need and to provide clear information about the origin of ingredients and their production methods. Blockchain technology seems to be able to provide an answer to this demand. This technology has been touted as a potential solution for improving food traceability, i.e., tracking the origin, location, and history of a specified item. In addition to traceability, this technology is also likely to streamline the food supply chain, reportedly saving up to $31 billion in food fraud worldwide by 2024 (Juniper Research, 2020).

Blockchain is a buzzword these days that has become fashionable recently with the major development of innovative tools such as cryptocurrencies and smart contracts (Sharma et al., 2021).

Blockchain is, indeed, the constitutive mechanism of digital currencies and bitcoins, without which these currencies cannot exist. However, it is also and more globally, the underlying principle of smart contracts based on autonomous action execution.

Blockchain technology is defined as an "open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way" (Iansiti & Lakhani, 2017, p.1). This technology has been presented as a potential solution to enhance food traceability and to streamline the food supply chain (Juniper Research, 2020).

Final consumers represent the closing actors of a chain that starts from wholesalers and farmers. Due to their evolving tastes, preferences, and habits, they play a key role along the supply chain. Consumers are increasingly demanding authentic and high-quality food (Thomas-Francois et al., 2020), but they currently do not have full transparency of the supply chain process (Cao et al., 2021). Information asymmetry issues, caused by an unequal distribution of information along the supply chain, call for more academic work on the chain-wide transparency from wholesalers to final consumers (Friedman & Ormiston, 2022; Filimonau & Naumova, 2020).

The application of blockchain technology in the specific food context represents a breakthrough solution to ensure a flow of immutable data among the supply chain actors (Cui et al., 2021; Hintze, 2019). This flow of information goes beyond the actor's physical boundaries offering clear traceability. This study explores, through the lens of Affordance Theory (Norman, 1988), the whole food chain, investigating the understudied perceptions of key stakeholders, from final consumers to food suppliers.

We adopt a mix-method approach using an experimental study and an exploratory qualitative study. First, through a scenario-based experiment, we draw causal conclusions on what are the perceptions of consumers on blockchain technology. In a recent study by Shafieizadeh & Tao (2020), the authors unveil an increased enthusiasm among tourists for the presence of a farm-to-table cuisine that arranges the delivery of food that comes directly from farms. We show that when the food offering revolves around food localness, blockchain technology enhances consumer trust. This, in turn, has a positive effect on the attitudes and behaviors. Second, by interviewing key informants (i.e., managers and food suppliers), we explore current barriers regarding blockchain adoption. Specifically, it emerges that operators are still reluctant in implementing the technology, despite acknowledging several potential beneficial effects. Two main reasons drive this hesitancy: (i) a greater need for intra organizational cross-functional effort, and (ii) the operators' reluctance in sharing information.

The adoption of this mix-method design provides a holistic perspective that combines all the viewpoints of the actors along the chain (Sharma et al., 2021), measuring the determinants of

blockchain adoption in the sharing economy food supply chain. More specifically, (i) identifying the perceptions of consumers on blockchain technology and (ii) outlining the drivers and barriers of blockchain adoption by key stakeholders (i.e., managers and food suppliers).

To-date, the challenges to blockchain technology adoption in the food supply chain have been examined adopting either the supplier or the consumer view in a mutual exclusive way. However, there are noticeable differences in the perceived blockchain's end goals. For suppliers, the ability to prevent food waste and to increase food security through tracking emerge as critical success factors (Yontar, 2023; Zhu & Li, 2021). On contrary, for consumers is important the perceived quality of food products enabled by blockchain. This greater perception of food quality can, in turn, increase consumer willingness to purchase food items (Treiblmaier & Garaus, 2023). In addition to these divergent perceptions and in further support of this mix-method design, Erol et al. (2022) emphasize the lack of collaboration and coordination along the whole food chain as an emerging challenge to blockchain adoption in the broad tourism and hospitality sector.

In the light of this, our work provides an integrated perspective from wholesalers to final consumers. First, we broaden the scope of the analysis of the potential of blockchain technology adoption in the sharing economy food supply chain. Our work stresses the importance for suppliers and consumers to work closely together toward a transparent and responsive flow of communication. Second, we contribute to the design of more collaborative business models based on a streamlined exchange of knowledge and information from suppliers to final consumers. Third, through a mix-method approach, using an experimental study and an exploratory qualitative study, we address the call for more empirical research for blockchain application in the hospitality and tourism domain (Sharma et al., 2021; Yadav et al., 2021). Our study unveils the extent to which the broad food sector, including the sharing economy, could effectively implement blockchain technology adoption. This insight is valuable as it can provide a clear understanding to the industry practitioners and decision-makers.

Our findings provide three clear theoretical implications. First, we contribute to the recent literature on blockchain adoption in the broad tourism and hospitality sector, including the sharing economy (e.g., Garaus & Treiblmaier, 2021; Rana et al., 2021; Filimonau & Naumova, 2020). Interestingly, the sharing economy has always relied on information technology advances with beneficial spillover effects (see Lehr et al., 2020). Second, this study advances the understanding of how blockchain technology can change trust in buyer-seller transactional processes (Tan & Saraniemi, 2022). Trust plays a foremost important function in the food context, traditionally dominated by asymmetric information. Third, we add to the sustainability literature (i.e., de Villiers et al., 2021; Kergoat et al., 2019), by unveiling that food localness strengthens the positive effect of

a blockchain-based traceability system on attitudes and behaviors. This contributes to prioritize a food offering that ensures freshness and preservation of nutritional elements as part of the value proposition and it is in line with an ethical marketing view in the use of blockchain (Tan & Salo, 2021). In addition, the investigation of food localness represents a novel element that has been overlooked by prior studies (Treiblmaier & Garaus, 2023; Zhou et al., 2022).

Managerially, we offer actionable advice for providers working along the food chain. Stemming from the consumers' need of trust and traceability, we provide operational guidelines on how to promote blockchain adoption in the food supply chain context. Likewise, we explain how to protect users' privacy lessen the concerns of operators when it comes to sharing information.

2. The relevance of food traceability systems

To highlight the potential effect of blockchain technology on the traceability of food origin, we rely on Affordance Theory which was developed by Gibson (1977; 1979) and applied to technologies by Norman (1988).

According to the Affordance Theory, any technology or object offers individuals real and perceived possibilities for action, which may differ depending on the context of use (Norman, 1988, Maier & Fadel, 2009). A chair, for example, may be perceived as an opportunity to sit or as an improvised ladder (Volkoff & Strong, 2017). Likewise, a bicycle may be a means of travel or a healthy chance to exercise (Kewell et al., 2017). The theory has been recently adopted to understand the relationship between consumption and technology (Chen et al., 2023; De Luca et al., 2021), with a particular focus on small companies and hybrid products (El Amri, 2019; Sedalo et al., 2022).

Under the lens of Affordance Theory, technology has been presented as enabler (i.e., a potentiality to act), but also as a potential constraint (i.e., restrictions to the potentiality to act). For instance, a bicycle allows us to move, and it can be perceived as a means to travel, but not beyond a certain speed or distance, so with its limitations in terms of travel capacities. The same can be inferred for technology. It offers affordances (i.e., potentialities to act) but also constraints depending on the actor, the individual, or the context.

In the food domain, the use of Affordance Theory allows to determine the benefits of using a certain technology in a specific context as perceived by the different users. On the demand side, technology affordance theory represents a framework that trains consumers to utilize food correctly and safely, especially in the context of mobile health applications (Lu et al., 2022). For example, Bourassa et al. (2022) develop a model of engagement with a nutritional application, taking into consideration affordances, i.e., perceived possibilities for action offered by the application. On the

supply side, Morosan (2022) examines the role of redesigned restaurant technology infrastructures in streamlining menu access, ordering, and information sharing about food products.

Some researchers have highlighted the important differences that exist between perceived affordances and the end goals of technological objects. In particular, these differences have been presented in the case of mobile applications fighting food waste (e.g., Too Good To Go) (Apostolidis et al., 2021; Vo-Thanh et al., 2021). These applications are generally well perceived and may appear as catalysts for sustainable social business. However, the process of value co-creation can be challenged when there are remarkable discrepancies in perceived capabilities across user types. For example, if there is a misalignment of goals in intra- or inter-group interactions (i.e., companies, customers), a process of value co-destruction may occur.

Blockchain technology, to have an effect, must be considered richer of different affordances compared to a traditional company-owned traceability system. In sum, to answer the question "what does the adoption of blockchain technology for food traceability add to the hospitality industry?", we must first identify the potential affordances relative to blockchain technology, namely security and transparency (Hong et al., 2021). These two affordances can be perceived as enablers or constraints depending on the point of view. A constraint for the company can be considered as a potential of action for the customer and vice versa.

First, transparency is based on the blockchain affordance to allow each member of the supply chain to control the product quality without having to pass through a third party (Tessitore et al., 2022). Blockchain, therefore, allows any user to have the ability to view and access information, especially traceability information. This is particularly valuable in the case of the food supply chain where the quality of products is vulnerable due to their high perishability (Maruckeck et al., 2018). Quality may be perceived differently by different actors in the supply chain. For example, wheat quality is alternatively associated with varietal purity for producers, grain size for milling industry operators, and nutritional qualities for end consumers (Cocco et al., 2021). Therefore, the adoption of a system capable of disclosing transaction history, provenance, and quality standards of food products to any user wishing to access them represents a true revolution.

Second, blockchain ensures security in information transfer. As information does not transit through a third party, it cannot be transformed or split. Hence, it is less complex and fragmented (Cao et al., 2021). This represents an invaluable asset in the food supply chain, as the industry must make a trade-off between customer orientation and rapid responses to food incidents (Anastasiadis et al., 2022; 2021). This ultimately means gaining consumer confidence as it gives to consumers the ability to access primary information. Today consumers are more and more aware and cautious. They demand and expect their food to be safe, fresh and, often, local (Willie et al., 2019). For this

reason, they are paying increased attention to products with Protected Destination of Origin and Protected Geographical Indication (Hew et al., 2020). This is extremely valued in the hospitality context, where the one of the predominant goals is offering unique food experiences aligned with a social and cultural sense of place (Thomas-Francois et al., 2017).

Albeit potentially beneficial, the application of blockchain technology to the sharing economy food supply chain is largely unexplored. Indeed, the current literature calls for new research to explore blockchain applications in the real-life hospitality sector (Erol et al., 2022). Blockchain offers a clear accountability, i.e., what is being advertised on the product must be accurate, authentic, and reliable (Son et al., 2021). Based on Affordance Theory, we hypothesize that by providing consumers with the ability to access information that is perceived as secured and transparent, blockchain will have a positive effect on consumer attitudes and behaviors. More formally:

H1*: Compared to a food traceability system based on company self-declaration, a food traceability system based on blockchain technology improves attitudes and behaviors.*

2.1. The key role of local food in a blockchain-based traceability system

Food localness is defined as "food produced, retailed and consumed in a specific geographical area" (Bianchi & Mortimer, 2015, p. 2284). Food miles are interpreted as the main criteria to define local food as they refer to the distance that raw food ingredients travel to reach the end consumer (Pearson et al., 2011).

Despite an increased enthusiasm for the use of local food amongst tourists (Shafieizadeh & Tao, 2020), to-date little has changed in how the hospitality industry procures food as the industry mainly relies on overseas importations (Thomas-Francois et al., 2020). Potentially, the use of local food in the hotel industry can lead to an authentic touristic experience, where visitors are able to have a connection with the culture of the host destination and the places of food production (Zhang et al., 2020). However, the hotel industry rarely leverages the use of local food due to high seasonality and limited availability of food items (Kang & Rajagopal, 2014) and the complexity of commercial relations (Paciarotti & Torregiani, 2018).

Theoretically, local food emerges as a key aspect of the hotel value proposition. First, by allowing guests to visit local food suppliers, hosts let visitors experience *the taste of place* (Cozzio et al., 2020; Thomas-Francois et al., 2017). Second, a farm-to-table cuisine ensures freshness and genuineness of the cooking ingredients, supporting the healthy eating lifestyle (Kergoat et al., 2019). This effect of local food can generate more trust. The goal of trust is to decrease uncertainty

in situations where individuals do not have adequate indications to guide their choices (Montecchi et al., 2019; Khare & Pandey, 2017). Food consumption often falls into this situation as consumers are subject to credence attributes that are difficult to be verified (Lo et al., 2017). For instance, if we consider the consumption of an organic product, a common consumer may not determine with certainty whether it has been produced and processed organically or whether it contains the ingredients mentioned on the label.

The adoption of blockchain technology to the food supply chain enhances the traceability of the process or, at least, makes it possible for the consumer to access the information if they wish. Traceability leads to information transparency that guarantees product quality by minimizing concerns on product safety (Treiblmaier & Garaus, 2023). Therefore, the creation of swift trust along the value chain is encouraged and sustained (Tang and Saraniemi, 2022; Centobelli et al., 2021, Dubey et al., 2020). Traceability and transparency, as inherited characteristics of the blockchain, enable supply chain stakeholders who do not know each other to trust counterparts (Boukis, 2019; Abeyratne & Monfared, 2016). Following this logic, it is reasonable to expect that consumers will show positive attitudes and behaviors towards food products due to the enhanced trustworthiness in the exchange relationships.

Furthermore, we argue that - specifically in the case of local food – blockchain enhances the trust among all the actors as they can directly assess where the local food comes from and where it has been processed (Zhou et al., 2022; Garaus & Treiblmaier, 2021). This is particularly relevant in the food industry, where many scandals, including greenwashing trends (Nygaard & Silkoset, 2022), food frauds and adulterations (Galvez et al., 2018), health- and allergen-awareness of food service provisions (Filimonau & Naumova, 2020), have increased consumers' skepticism (Ladwein et al, 2021). On this note, blockchain technology can really improve consumer confidence and trust in the food system. This is essential in hedonic contexts such as the hospitality industry where tourists tend to avoid effortful cognition in the aim to pursue happiness and carefree, while being easily distracted by extraneous interferences (Lu & Chi, 2018).

Therefore, we expect the impact of blockchain technology to be considerable in the case of high food localness. Hence, we postulate that a high food localness strengthens the positive effect of the blockchain technology on attitudes and behaviors through trust. Thus, we propose the following:

***H2a**: High (versus low) food localness increases (decreases) the positive effect of blockchain-based traceability system on trust.*

***H2b:** High (versus low) food localness increases (decreases) the positive effect of a blockchain-based traceability system on attitudes and behaviors.*

H2c: *The positive effect of a blockchain-based food traceability system on attitudes and behaviors is strengthened (weakened) when a high (low) food localness is disclosed.*

Figure 1 presents an overview of the studies conducted. In Study 1 we test our research hypotheses quantitatively through an experiment. In Study 2 we explore, through a qualitative approach, the point of view of suppliers on potential hiccups in the adoption of blockchain technology. Figure 2 shows the empirical model for the experimental study.

Figure 1: Overview of the studies

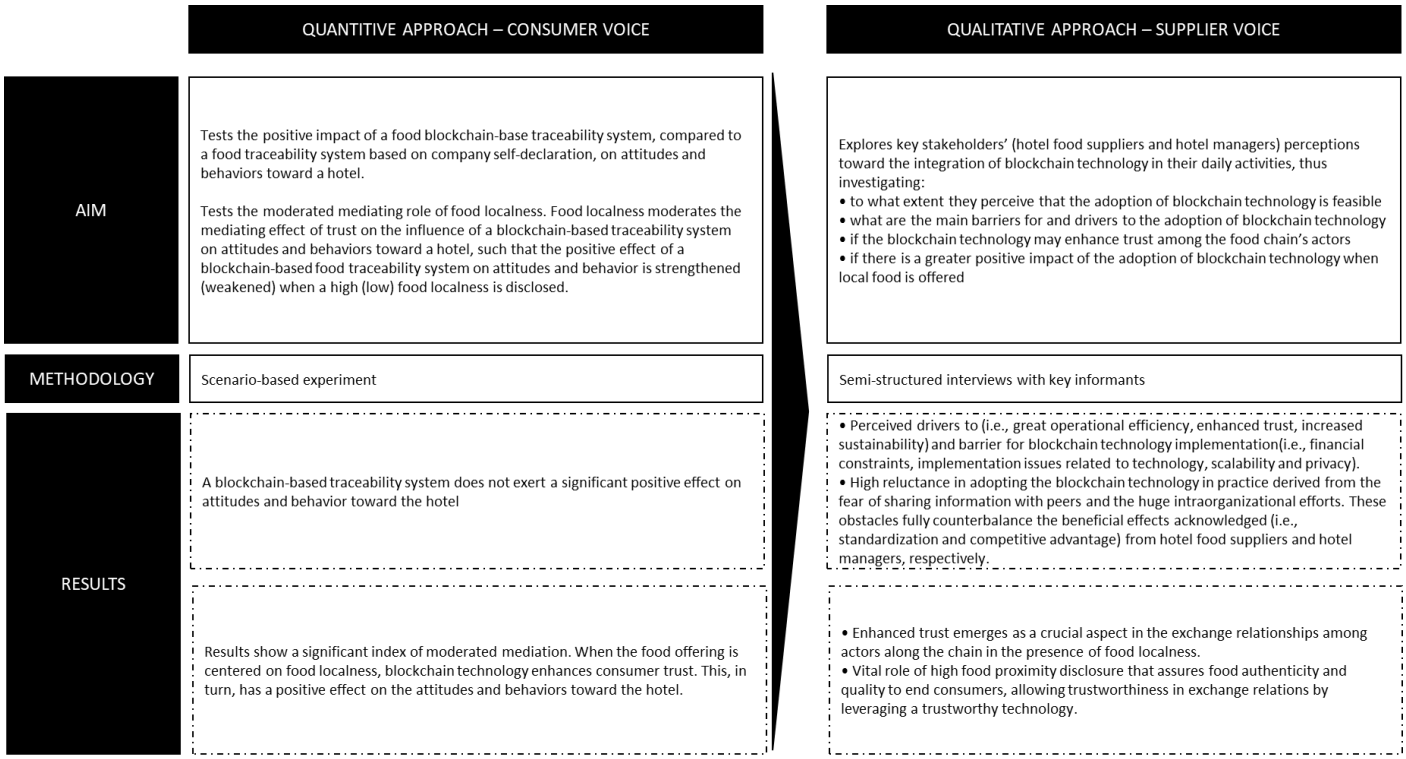
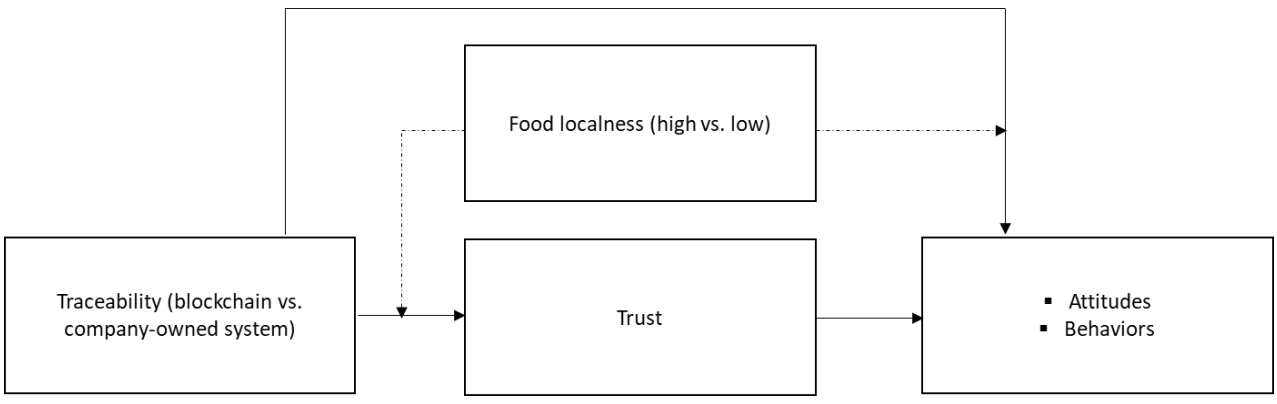


Figure 2: The role of blockchain technology in improving attitudes and behaviors toward a hotel through enhanced trust



3. Study 1: Data collection, design, and procedures

The Study 1 assesses consumers' attitudes and behaviors through a scenario-based experiment, testing the empirical model presented in Figure 2. We recruited participants from a consumer panel (i.e., not students) of a large European university. Specifically, the subject pool is comprised of individuals – excluding students - who wish to participate in research studies that are being conducted at the university.

We adopted the study design of Liu et al. (2019) in a retailing context by exposing participants to two hospitality situations, one implementing a blockchain-based traceability system and the other employing a company-owned traceability system. This distinction represents the experimental manipulation. More specifically, in the treatment group we mentioned participants that the company was using a *blockchain-based traceability system for food products which tracks the supply chain. This system is based on a certified information flow that can be directly verified by the recipients through a QR code.* In the control group we mentioned that *all food products are tracked by the company-owned information system. This system is based on the host self-declaration.* Because respondents in online experiments must be asked to imagine a hypothetical situation (Viglia & Dolnicar, 2020), we manipulated food localness (high vs. low), by including (excluding) the presence of local food offering. The respondents were randomly assigned to one of the four conditions.

We measured trust using a three-item seven-point scale, drawn from Lafferty et al., (2002). We asked respondents to express their level of agreement with the following statements: 1) I think that they make truthful claims, 2) I think that they are honest, and 3) I think that they are trustworthy (1 = Strongly disagree, 7 = Strongly agree; $\alpha = 0.82$). A specific instruction recommended that respondents consider the adoption of blockchain (or not) to trace the food chain when answering this question.

We measured attitudes by adapting the semantic seven-point scale of Araujo (2018) (i.e., good/bad, favorable/unfavorable, satisfactory/unsatisfactory, negative/positive, disliked/liked). We also assessed behavioral responses by asking participants whether they were happy to actually use 2 Euros of their current 5 Euros remuneration to have the chance of winning a voucher for a hospitality stay (Viglia et al., 2021). Participants' behavioral choices were registered and coded 0 in case of no and 1 in case of yes. Finally, we asked the respondents to report their ages and genders.

3.1. Results

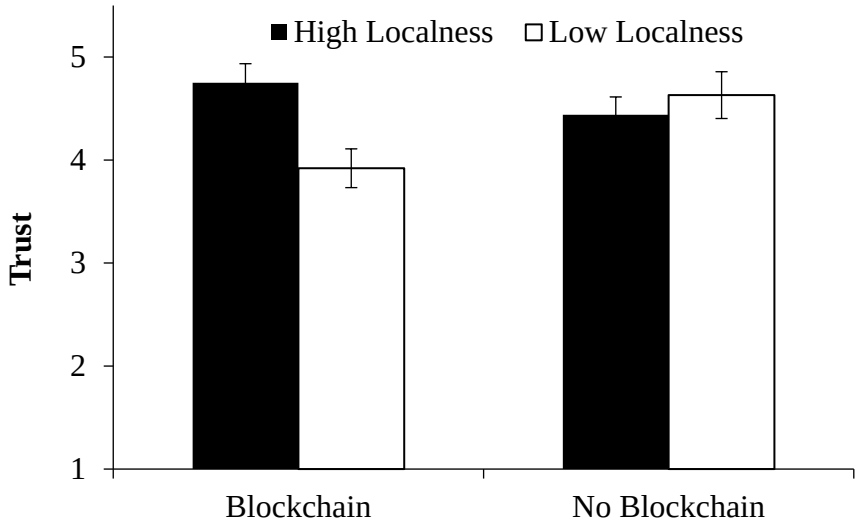
One hundred thirty-nine participants were included in Study 1 (M_{age}=36; *SE*=5.4, 55% male). Approximately the same proportion of consumers was included in the blockchain-based

traceability scenario (53%) and in the company-based traceability system (47%) conditions. Nearly half of the consumers each were assigned to the high food localness (46%) and low food localness (54%) conditions.

First, we assessed the direct effect of a blockchain-based traceability system on attitudes and behaviors. We conducted a one-way ANOVA to assess the direct effect of blockchain on attitudes [$F(1, 137)=0.05$, $p=0.82$]. We also ran one linear regression model to test the direct impact of blockchain on behavioral responses ($\beta=0.165$, $SE=0.34$, $p=0.636$). Both direct effects are not statistically significant, thus not supporting H1.

Subsequently, we conducted a 2X2 two-way ANOVA to evaluate the interaction effect of food localness x blockchain-based traceability system on trust, which indicated a significant positive effect [$F(1, 133)=6.84$, $p=0.009$; $\eta 2=0.047$]. Specifically, when respondents were exposed to the blockchain-based traceability scenario, a high food localness led to greater trust compared to low food localness ($M_{\text{high localness}}=4.75$, $M_{\text{low localness}}=3.91$, $p=0.002$). We present this result graphically in Figure 3. This fully supports H2a

Figure 3: The interaction effect of blockchain and food localness on trust



Finally, we employed a moderated mediation test employing a bias-corrected bootstrap procedure (Hayes's Model 8; n = 10,000). We used Hayes' PROCESS macro featuring blockchain-based traceability system as the independent variable, food localness as the moderator, trust as the mediator, and attitudes and behaviors as the dependent variables. The analysis showed a significant index of moderated mediation ($c'_{\text{attidudes}}$: $\beta=0.63$; *CI* 95% [0.15; 1.18]; $c'_{\text{behaviors}}$: $\beta=0.50$; *CI* 95% [0.09; 1.09]), thus confirming H2c. In particular, the interaction effect of blockchain-based

traceability system and food localness had a significant and positive effect on trust (β=1.01, *SE*=0.38, *t*=2.61, *p*=0.009). In turn, trust had a significant and positive effect on the attitudes (β=0.62, *SE*=0.95, *t*=6.62, *p*=0.000) and on the behavioral responses (β=0.49, *SE*=0.17, *z*=2.82, *p*=0.004). The moderated direct effect of food localness on the effect of a blockchain-based traceability system on the dependent variables is not significant for attitudes (β=0.44, *SE*=0.43, *t*=1.01, *p*=0.31), while it is barely significant for behaviors (β=1.22, *SE*=0.76, *t*=1.60, *p*=0.09). Hence, H2b which postulates that food localness moderates the impact of a food traceability system on attitudes and behaviors receives partial support. Table 1 reports the full regression results.

Table 1: Moderated mediated regression results

	M_1 Trust				**Y_1 Attitude**				**Y_2 Behavior**			
	Coeff	SE	t	p	Coeff	SE	t	p	Coeff	SE	z	p
Block	-0,68*	0.28	-2.40	0.017	-0.08	0.32	-0.26	0.789	-0,35	0.55	-0.62	0.531
FoodL	-0,15	0.28	-0.55	0.582	-0.39	0.31	-1.26	0.207	-0.55	0.54	-1.01	0.308
*Block*FoodL*	1.01*	0.38	2.61	0.009	0.44	0.43	1.01	0.311	1.22	0.76	1.60	0.098
Trust					0.62*	0.09	6.62	0.000	0.49*	0.17	2.82	0.004
Female	0.09	0.19	0.47	0.633	-0.20	0.21	-0.95	0.348	-0.36	0.37	-0.96	0.336
Age	-0.01	0.01	-0.78	0.484	0.00	0.01	0.43	0.663	0.01	0.03	0.33	0.738
Constant	4.91*	0.47	10.25	0.431	1.68*	0.70	2.40	0.017	-1.64	1.23	-1.32	0.183
	R^2 = 0.08 F(5,133)=2.43, p<0.05				R^2 = 0.27 F(6,132)=8.48, p<0.001				McFadden = 0.08 p<0.05			

Indirect effects	**Coeff , CI**	**Coeff , CI**
Index of moderated mediation	0.63, [0.15, 1.18]	0.50, [0.09, 1.09]
Low food localness (0)	-0.43, [0.83, -0.05]	-0.34, [-0.82, -0.03]
High food localness (1)	0.20, [-0.13, 0.52]	0.16, [-0.11, 0.48]

4. Study 2: Theoretical backdrop

While prior research highlights opportunities and barriers to the adoption of a blockchain-based food traceability system (e.g., Friedman & Ormiston, 2022; Srivastava & Dashora, 2022), there is a paucity of studies that consider the main stakeholders' perceptions in the hospitality food

context (i.e., managers and food suppliers). Blockchain technology may consolidate the relationship between the key actors in the food supply chain, allowing the verification of third-party documentation and the rapid acquisition of key information (Rana et al., 2021).

Table 2 summarizes the findings on the opportunities for and the barriers to the adoption of the blockchain technology in the food supply chain.

Table 2: Main contributions on the adoption of the blockchain technology in the food supply chain

Themes	Authors	Key findings	Theoretical definition
Enhanced trust	Friedman & Ormiston (2022); Anastasiadis et al. (2021); Hong et al. (2021); Rana et al. (2021); Son et al. (2021), Willie (2019)	Blockchain technology assures accountability of information and generates a distributed trust along the chain, thus increasing consumer confidence.	Trust: The degree to which supply chain stakeholders who do not know each other well believe in their counterparts.
Great operational efficiency	David (2022); Rana et al. (2021), Son et al. (2021)	It allows a real-time information flow that generates an automated and highly resilient system. It also increases coordination and control along the chain.	Speed: The rapidity to which stakeholders can retrieve all information about origin, location and history of an item.
	Srivastava & Dashora (2022); Anastasiadis et al. (2021); Garaus & Treiblmaier (2021); Hong et al. (2021); Saurabh & Dey (2021), Son et al. (2021)	It enables immediate reactions to potential safety hazards and it protects the production from fraud and contamination. In turn, product quality is higher and consumer health protection is achieved.	Safety: Control of product quality, considering hygiene and consumer's health
	Friedman & Ormiston (2022); Anastasiadis et al. (2021); Rana et al., (2021); Son et al. (2021)	It permits an increased market knowledge, thus allowing the visibility of producers' efforts and the legitimacy of best practices.	Transparency: Shared information concerning all manufacturing phases of food for the whole supply chain
Increased sustainability	Friedman & Ormiston (2022); Garaus & Treiblmaier (2021); Rana et al. (2021); Son et al. (2021); Tsolakis et al. (2021)	It supports a responsible resources management (e.g., identify wastage along the chain). It also avoids costly data collection for environmental sustainability assessment.	Environmental sustainability: Protection of the environment and correct information about environmental impacts, including safeguard of animal welfare
	Anastasiadis et al. (2022); Friedman & Ormiston (2022); Rana et al. (2021);	It assures the commitment of producers to guarantee the origin and authenticity of their products, thus	Social sustainability: Respect of fair-trade criteria for producers and

	Saurabh & Dey (2021); Tsolakis et al. (2021)	ensuring chain integrity and producers' empowerment. It also allows to identify inequalities along the chain.	fair working conditions in the supply chain
	Anastasiadis et al. (2022); Friedman & Ormiston (2022); Srivastava & Dashora (2022); Rana et al. (2021); Saurabh & Dey (2021)	It eliminates the need of intermediaries, thus reducing transaction costs. Financial returns boost either due to an increased customer loyalty or to transaction costs saving. Hence, it allows companies to obtain a competitive advantage.	Economic sustainability: Better economic performances due to customer loyalty and reduced transaction costs
Financial constraints	Hong et al. (2021); Rana et al. (2021); Saurabh & Dey (2021)	It requires high initial costs for technology development, adoption, and maintenance.	Costs: High initial costs for blockchain technology's adoption and implementation
Implementation issues	David (2022); Srivastava & Dashora (2022); Hong et al. (2021)	Due to the immature technology, there is lack of skilled personnel (e-skills) and limited technical expertise and knowledge, without any possibility to attend training courses to better understand the technology.	Hard skills: Lack of high degree computational skills required for blockchain
	Friedman & Ormiston (2022); Srivastava & Dashora (2022); Hong et al., (2021); Rana et al. (2021); Saurabh & Dey (2021)	The insufficient regulatory mechanism for blockchain and the complexity in data management undermine the technology's applicability at a wide scale. Further barriers are value barriers (lack of diffusion), communicability barriers (benefits beyond hype) and usage barriers (digitalization along the chain).	Scalability: The adoption of blockchain technology at a wide scale is challenging
	Friedman & Ormiston (2022); Srivastava & Dashora (2022); Rana et al. (2021)	It rises privacy leakages that make collaboration even more difficult.	Privacy: The protection of users' privacy is not guaranteed due to data visibility through the blockchain

All in all, there are multiple benefits and obstacles associated with the adoption of the blockchain technology in the broader food context. Against that background, Study 2 explores the

perceptions of key stakeholders (i.e., managers and food suppliers) about the adoption of blockchain technology in the understudied context of food hospitality.

4.1 Data collection, design, and procedures

To explore the perceptions of the hotel food supply side on the integration of blockchain technology in its operations, we conducted semi-structured face-to-face interviews with n. 20 key stakeholders (i.e., managers and food suppliers) between August and September 2022. We started with a set of general questions such as "What is your current position and your professional background?", "What kind of experience do you have from blockchain in the broad tourism context?". Then, we asked more specific questions that relate to the adoption of blockchain technology in the hospitality food context such as "What are the main barriers and drivers toward blockchain adoption in the hospitality supply chain?", "Do you think that the adoption of the blockchain technology may enhance the final customer's trust?", "Do you think that the benefits from the adoption of the blockchain technology may be amplified in the context of local food offering?".

The interviews lasted between 10 and 30 minutes, with an average length of 16.2 minutes. To strengthen the exploratory power of the qualitative analysis, we purposively involved information-rich participants (Patton, 2002) and we stopped collecting data when theoretical saturation has been reached (Saunders et al., 2018). We present a brief description of each informant in Table 3.

Table 3: Informants details

Interviewee	Job Position / Initials of name	Age	Gender	Years of Professional Experience
1	Food supplier C.Q.	46	Male	11
2	Manager, R.B.	38	Male	6
3	Manager, R.C.	50	Male	26
4	Food supplier, A.I.	36	Female	13
5	Food supplier, R.P.	32	Male	11
6	Manager, B.V.	28	Male	6
7	Food supplier, M.N.	48	Male	23
8	Manager, G.B.	28	Male	6
9	Manager, A.C.	37	Male	14

10	Food supplier, K.R.	27	Male	3
11	Food supplier, R.L.	43	Male	9
12	Food supplier, L.T.	50	Male	18
13	Manager, M.N.	40	Female	10
14	Food supplier, S.M.	61	Male	32
15	Manager, G.S.	47	Male	11
16	Manager, R.F.	55	Female	30
17	Food supplier, M.M.	45	Male	7
18	Manager, A.P.	52	Female	22
19	Food supplier, D.M.	66	Male	31
20	Manager, D.F.	39	Male	8

The process of data coding includes looking for themes as in DeSantis and Ugarizza (2000), looking at abstract entities that bring meaning and identity to a recurrent experience. We used an open coding procedure that includes comparing quotations and grouping the similar quotations to form categories (Miles & Huberman, 1994).

4.2. Explanatory findings

The categories emerged from the interviews are aligned with the literature review findings. We aggregated key themes and formed the following four categories: *(i) Trust, (ii) Efficiency, (iii) Sustainability, (iv) Financial and technological constraints.*

Informants emphasize that blockchain technology allows trust to flow along the chain, enabling supply chain stakeholders who do not know each other to trust counterparts: *"I can better connect with all the stakeholders involved. Enhanced relationships are key in this industry" (Interviewee #7). "Often food information flows stop at the hotel managers' level. Blockchain technology facilitates communication and trust between hosts and guests" (Interviewee #20). "After the COVID pandemic, communication strategies in the food sector are increasingly leveraging end consumers' centricity. Trustworthy relations between food producers and final consumers are vital to pursue." (Interviewee #12).* From the interviews' evidence, our study proposes that:

P1 (Trust): Operators perceive that blockchain technology enables trustworthiness in the exchange relationships at several touchpoints along the chain.

Findings substantiate informants' agreement on the great operational efficiency associated with the adoption of the blockchain technology. We observe an overall emphasis about the speed, security, and transparency of information: *"Blockchain is efficient. We can get fast and reliable*

information at a reduced cost" (Interviewee #3). "Blockchain allows a clear and transparent flow of information about product's quality, from raw materials to potential health alerts" (Interviewee #14). "In the context of increased food allergies, a transparent sharing of all food information may lower the sense of responsibility of a host toward its clients" (Interviewee #18). Building on the preceding declarations, the second proposition is that:

P2 (Efficiency): Blockchain technology allows a real-time information flow that guarantees the product's quality and preserves consumer health.

We observe that informants are willing to consider the adoption of blockchain technology to achieve sustainability in their operations. Environmental sustainability is pursued through transparent information about products' environmental impacts: *"People brag about sustainability in these days. Often it is only greenwashing. With blockchain it is possible to see the real green value of the products" (Interviewee #5). "Due to the current regulations, the concept of made in Italy is often greenwashed. Blockchain technology allows to better communicate assortment choices grounded on food localness" (Interviewee #17) "It is important to communicate food authenticity in a reliable way, especially in Italy where local food specialities may generate memorable touristic experiences" (Interviewee #13).* We also observe certain informants pointing out social sustainability as a beneficial effect of blockchain technology adoption: *"In a globalized world where consumers are increasingly curious to taste food references from abroad, blockchain technology allows to share information about the fairness of working conditions in the supply chain" (Interviewee #12).* This can be summarized with our third proposition:

P3 (Sustainability): Operators feel that protection of the environment and the respect of fair working conditions along the supply chain might be facilitated through the adoption of blockchain technology. Blockchain technology eases the sustainability assessment.

Despite the acknowledged benefits, there is some reluctance on the actual adoption of the technology. The main issues revolve around to the limited knowledge about technology and a lack of skilled personnel: *"There is a steep learning curve that slows down the blockchain adoption. The implementation is feasible, but it requires a corporate cultural change" (Interviewee #4). "The food context is very fragmented and there are many small suppliers that lack personnel with technical expertise" (Interviewee #19).* The adoption of blockchain technology at a wide range is also prevented by the high initial investment required: *"Blockchain technology may cause the disappearance of the small food suppliers that would not have the financial resources to sustain the initial investment for the technology adoption" (Interviewee #11).*We also note that the demand for food traceability in the hospitality sector it is still in its infancy: *"We implemented the pilot project PIA (product information automatic) that is based on blockchain technology. To date it is very little*

used by hotel managers compared to public food service providers" (Interviewee #14). In the private sector the need of shared information about nutritional values, ingredients, allergens seems still at an embryonic stage compared to the public sector. Basing on the preceding discussion, we can conclude that:

P4 (Financial and technological constraints): Operators' resistance toward the adoption of blockchain technology is mainly due to the initial investment, the lack of skilled personnel, and the relatively feeble demand for food traceability by managers.

Additional themes emerge from the interviews and enrich the literature review findings. They have been generated through data saturation in qualitative research (Fusch & Ness, 2015). Following this approach, data saturation is reached when (i) there is enough information to repeat the study, (ii) no additional new information can be obtained, (iii) further coding is no longer achievable. The extra themes belong to two different macro dimensions: the operational and the organizational one (Figure 4).

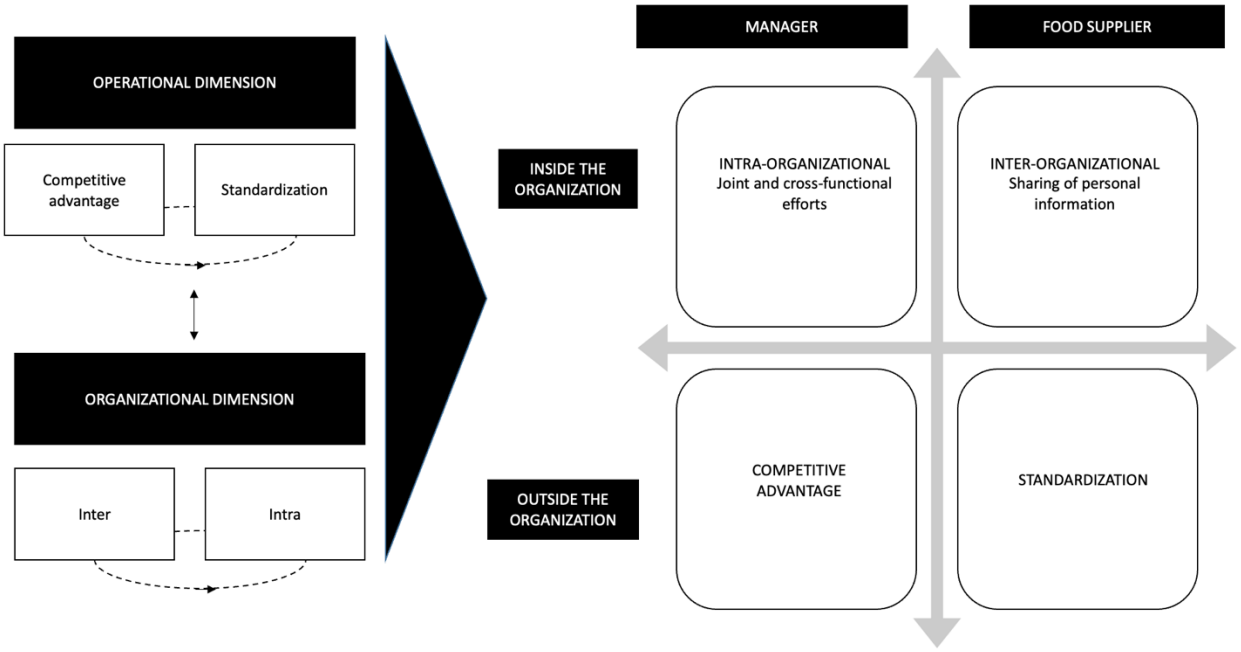
Focusing on the operational dimension, the adoption of blockchain technology provides an added-value service that, from the company's perspective, entails a competitive advantage: *"Consumers are keen on premium products as they can really see the provenance of those products and deter frauds" (Interviewee #10). "Blockchain technology assures crucial additional value for the final customer. In a menu that proposes fillet, it is essential to know the specific characteristics of the meat". (Interviewee #15). "Offering a certified product in terms of hygiene and processing methods - HACCP protocol - is key in the hotel industry. Hosts mainly offer buffet style-settings where dishes are not prepared in an open kitchen right in front of guests. Blockchain technology informs guests about food quality" (Interviewee #16).* Furthermore, interview findings evidence that blockchain technology enables the standardization of fine-grained information about products along the chain: "*The technical product information is directly visible to all key actors in the chain. This guarantees a homogeneity of the way in which the information is presented – product image, characteristics, short video, minimizing differences in the information display. Today each supplier has its own way to display key product information" (Interviewee #14).*

Concerning the organizational dimension, informants emphasize that the actual implementation of blockchain technology in the food supply chain is not feasible, especially in the short time, as it requires a common effort within the organization: *"Blockchain technology requires strong intraorganizational energies as it relies on a joint effort between two departments: the procurement and the IT" (Interviewee #17).* In addition, the blockchain implementation is challenging as operators are reluctant to share their own information: *"I would not be willing to share information about my suppliers as it is my know-how. I personally do not trust that this*

technology may preserve information such as ingredients or receipts that can be used by competitors" (Interviewee #11).

All in all, the emerging beneficial effects are counterbalanced by obstacles that hinder blockchain's adoption and spread. Figure 4 outlines the newly emerged viewpoints about blockchain adoption according to the group of stakeholders (i.e., hotel food suppliers and hotel managers).

Figure 4: New knowledge generated by Study 2



5. General discussion and conclusion

The application of blockchain technology represents a breakthrough solution to ensure a flow of immutable data among the supply chain actors (Cui et al., 2021; Kouhizadeh et al., 2019; Saberi et al., 2019). To offer a comprehensive understanding of the key stakeholders' perceptions about blockchain technology's adoption in the hospitality food supply chain, we collected multiple sources of data through a mixed-method approach. We integrated two studies, a quantitative and a qualitative one. First, based on Affordance Theory, we developed and designed an experiment to examine the potential impact of blockchain technology adoption on consumer trust and on attitudes and behaviors. Second, through a qualitative study based on in-depth interviews, we explored the affordances perceived by key stakeholders (i.e., managers and food suppliers) related to blockchain

technology. Across the integration of these two studies, we holistically explore the whole food chain, from food suppliers to final consumers.

In Study 1, we provide evidence about the strategic role played by food localness. While the adoption of blockchain technology does not appear beneficial *per se*, we demonstrate that when this technology is used to ensure that the food offering is local, blockchain technology enhances consumer trust. Trust, in turn, has a positive effect on the attitudes and behaviors. This can be linked to the increased enthusiasm for a farm-to-table cuisine that is developing among consumers (Shafieizadeh & Tao, 2020). In Study 2 we present an overview of key stakeholders' affordances (i.e., perceptions) concerning blockchain adoption to further understand drivers and obstacles to its implementation. In this way, we offer a complete view of the different stakeholders which are consumers, suppliers and producers. Our findings emphasize that operators are still reluctant to implement this technology, despite acknowledging several potential beneficial effects. Operators' reluctance is mainly due to the intra organizational effort required for blockchain implementation and a fear of sharing company information with peers.

This article provides three theoretical contributions. First, we contribute to the recent literature on blockchain adoption in tourism and hospitality (e.g., Filimonau & Naumova, 2022; Garaus & Treiblmaier, 2021; Rana et al., 2021), holistically investigating the perceptions of key stakeholders along the whole hotel food supply chain. In terms of applicability, our contribution broadens the traditional boundaries of the tourism and hospitality industry, focusing on tourism businesses in the sharing economy. Second, we address the call for deepen understandings on how blockchain technology relates to the notion of trust (Tan & Saraniemi, 2022). Importantly we find that trust is perceived as a main determinant both by consumers (**Study 1 – experimental study**) and by producers (**Study 2 – exploratory qualitative study**). The trust literature encompasses two different dimensions, which are acknowledged in the business-to-business marketing literature. The calculative approach is grounded on minimizing risks in exchange relations by increasing confidence in the business party (Beckert, 2006). The relational dimension defines trust as "a psychological state characterized by the acceptance of vulnerability based on positive expectations about the intentions or behaviour of others" (Rousseau et al., 1998, p. 395), thus leveraging the willingness to rely on the partner (Latunek & Vlaar, 2018). Indeed, Tang and Saraniemi (2022) show that blockchain enables trust both in actions (i.e., calculative dimension) in terms of lasting business relationships, and in actors (i.e., relational dimensions) that means a great commitment between partners. Following Abeyratne and Monfared (2016) who state that "the inherited characteristics of the blockchain enhance trust through transparency and traceability within any transaction of data, goods, and financial resources" (Abeyratne & Monfared, 2016, p.1), our study

findings show that blockchain technology allows distributed trust to flow along the chain in the presence of local food offering. In fact, blockchain technology enables supply chain stakeholders who do not know each other to trust counterparts (Boukis, 2019; Hughes et al., 2019). The theory of transfer of trust (Zhao et al., 2019) postulates that trust in one person or entity can be transferred to another person or entity when there is a trustworthy relationship between them. For instance, consumers' previous experience with a food producer would allow them to infer the extent to which they can trust the retailer. Third, our study adds to the literature on sustainable tourism (e.g., de Villiers et al., 2021; Kergoat et al., 2019), by unveiling that food localness strengthens the positive effect of a blockchain-based traceability system on attitudes and behaviors. Our results show that the key role of food localness is twofold. It is a crucial constituting element of the value proposition, in line with a food proposal that assures freshness and preservation of nutritional properties (Shafieizadeh & Tao, 2020). In addition, it is a condition that amplifies the need for traceability and transparency, thus reinforcing the power of blockchain technology.

Beyond its theoretical significance, our study offers four clear managerial implications for hospitality stakeholders. First, our qualitative study shows that operators acknowledge the beneficial effects of blockchain adoption (i.e., excellent operational efficiency, enhanced trust, increased sustainability). These are aligned with the findings that emerge from the literature (Table 2) and from recent evidence on the need of personalized marketing (Chandra et al., 2022). Additionally, we provide several obstacles that need to be overcome for full blockchain adoption (i.e., financial constraints, implementation issues related to technology, scalability, and privacy). These obstacles are mainly perceived by operators (i.e., managers and food suppliers) but not by consumers. This pose a fundamental question on a gap that needs to be closed to enhance consumers' wants. Second, our study provides clear operational guidelines on how to promote blockchain adoption in the specific context of the food supply chain. Specifically, for managers, the main beneficial effect is the competitive advantage derived from proposing a value-added service to end-consumers. Given the current scant adoption, this would offer a unique selling proposition for first movers. For food suppliers, the fact that blockchain technology allows standardization of product information represents a major advantage that protects the quality of the value chain and prevents possible brand dilution and legal fights. Thus, our study outlines linkages that are "both highly influential and highly dependent" (Erol et al., 2022, p. 11) with respect to blockchain adoption. Third, as barriers hinder the blockchain technology's diffusion, our study unveils a fundamental implication for practice rooted on the need to generate more confidence about the protection of users' privacy through the blockchain technology. This may represent a way to inhibit the operators' fear of sharing information. Likewise, it is also essential to offer and develop training

courses for the technology's implementation to favor cross-functional collaboration within the organization. In doing so, the integration of blockchain technology will result in win-win situations for all actors involved. Fourth, our study poses the managerial question about how to communicate the adoption of blockchain technology to consumers in a straightforward and understandable way. Consumers are bombarded with technological advances, and this leads to stress and satiation (Kumar et al., 2022; Pala et al., 2022). For this reason, hospitality operators may proactively play the role of facilitators in informing the public about the benefits of blockchain. The more the parties become aware and confident on blockchain adoption, the more business enterprises - in the food context and beyond - will benefit from signaling the use of blockchain technology by easy-to-implement communication cues (i.e., product labels).

The paper provides a rich research agenda that can address some of our limitations. It is important to assess if the new elements that emerge from our qualitative study (i.e., standardization, competitive advantage, inter and intra organizational actions) can similarly act as drivers for and barriers to the blockchain technology adoption in the broad food context and beyond. We also suggest that further studies might consider if food localness plays a primary role (i.e., moderated mediated effect) in other tourism contexts such as accommodations (from peer-to-peer accommodations to five-star hotels), transportation industry (from planes to cruises), and cultural sightseeing such as museum and historical places. Following Tan & Saraniemi (2022) who theorize different dimensions of trust (i.e., calculative and relational dimension), it would be interesting to explore more comprehensively the trust dimension as this study focuses on the relational dimension only. Likewise, future studies should replicate our research in non-Western countries, as factors related to traditions, history and culture might influence the perceived effect of food proximity (Lee & Lee, 2009). Finally, future studies should look at cost-benefit analyses. In particular, blockchain adoption in new business models can become more cost-effective through disintermediation (see Tan et al., 2021).

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