The Development of Quality Capabilities in Brazilian Breweries:
A Co-evolutionary Approach

Abstract

Small and medium-sized enterprises (SMEs) have few internal resources compared to large firms. They may rely more on external partners to access the resources needed for developing their quality capabilities. How do the interactions between internal and external environments affect a firm's ability to develop its quality capabilities? This paper explores how firms that differ in size and have different characteristics regarding their internal resources interact with the external environment to develop their quality capabilities by adopting a co-evolutionary approach. A multiple case study was employed in four high-quality breweries in Brazil, including one plant belonging to a multinational firm and three SMEs. The findings suggest that internal resources play an important role in determining the co-evolutionary paths of firms when it comes to developing their quality capabilities. The large firm takes advantage of past corporate decisions and challenges in its plants worldwide to develop its capabilities mainly internally. On the other hand, SME breweries actively engage with the environment based on higher levels of multi-directional causalities, non-linearity, and feedback, which affect the co-evolutionary paths of these firms. This study also provides managers with guidance on how to implement strategies that help firms develop their quality capabilities.

Keywords: quality capability; co-evolution; external environment; internal resources; SMEs; breweries; case study.

1. Introduction

The idea of co-evolution dates from "On the Origin of Species" by Charles Darwin (1859), which introduced the idea of a mutual evolutionary process between insects and flowering plants. Insects attracted to the nectar in flowers help plants by cross-pollinating them and are positively influenced by this new source of food. Insects and plants co-evolve together, which also changes the landscape of their environment (Ehrlich and Raven, 1964). The co-evolutionary theory was developed in the management field to understand how firms select and adapt their strategies to fit a competitive environment that is shaped by a large and complex process of joint development (Braguinsky and Hounshell, 2016; Duarte and Rodrigues, 2017; Lewin and Volberda, 1999; McKelvey, 1997). It also includes the interaction between managerial decisions, supply chain partners, industry competitors, and institutions (Lewin and Volberda, 1999; McKelvey, 1997). Operations and supply chain management (OSCM) literature has recognised supply chains as complex networks embedded in a larger set of inter-organisational relationships (Dmitrijeva *et al*. 2020; Liu *et al*. 2019; Macdonald *et al*. 2018; Nair and Reed-Tsochas, 2019). However, it has paid limited attention to understanding how firms access other agents in the external environment to help develop their capabilities (Linder, 2019; Zaridis *et al*. 2020).

OSCM literature has explored the operational capabilities of high-performance firms, including those based on quality management routines (Xu *et al*. 2020; Zaridis *et al*. 2020; Zhou and Li, 2020). The emergence of new technologies and current disruptions have highlighted the need to better understand quality in the OSCM field (Gunasekaran *et al*. 2019; Xu *et al*. 2020; Zhou and Li, 2020). Quality capabilities can be understood as a set of heterogeneous quality management routines, which are the foundation for firms to remain operationally competitive in their markets (Ancarani *et al*. 2019; Ramanathan *et al*. 2021; Xu *et al*. 2020). We need to understand, therefore, the mechanisms involved in developing quality capabilities in firms with different characteristics (Xu *et al*. 2020; Zaridis *et al*. 2020; Zhou and Li, 2020), including their internal resources.

Previous OSCM literature has assumed that firms, regardless of their characteristics, exert similar efforts in managing their quality issues (Xu *et al*. 2020; Sila, 2018). It is also understandable, however, that SMEs possess limited resources for quality management when compared with larger firms (Linder, 2019; Matthews *et al*. 2017; Zaridis *et al*. 2020). This can lead

them to actively seek resources from other agents externally instead of relying solely on their internal resources. On the other hand, large firms may not need to interact with their environment since they possess a higher level of internal resources. It is unclear, however, how scarce organisational resources affect the dynamics of firms with the environment for developing their quality capabilities (Linder, 2019; Xu *et al*. 2020; Zaridis *et al*. 2020), which can result in different co-evolutionary paths (Lewin and Volberda, 1999). The co-evolutionary approach is a suitable research framework for understanding how firms adapt to a complex environment (Braguinsky and Hounshell, 2016; Duarte and Rodrigues, 2017; Lewin and Volberda, 1999) based on *"the joint outcome of managerial intentionality, environment, and institutional effects"* (Lewin and Volberda, 1999, p. 526). This can shed light on how firms develop their capabilities using five co-evolutionary properties: path and historical dependence; multi-levelness/embeddedness; multi-directional causalities; non-linearity; and feedback (Lewin and Volberda, 1999).

This research was guided by the following research questions: *(RQ1) How do firms simultaneously engage with internal and external resources to develop their quality capabilities? (RQ2) How do scarce internal resources affect the co-evolutionary paths of companies?* The study's objective was to investigate how firms with different characteristics in terms of their internal resources interact with the external environment to develop their quality capabilities using the five properties of co-evolution. To address those questions, we employed a multiple case study in four high-quality breweries in Brazil (Eisenhardt, 1989; Ketokivi and Choi, 2014): one plant belonging to a global producer, and three SMEs.

This study expands on existing OSCM literature by suggesting that internal resources play an important role in developing the quality capabilities of companies, thereby affecting their co-evolutionary path with the environment. Greater internal resources lead large firms to develop their quality capabilities internally, mainly by co-evolving their quality standards through internal practices and technologies that have already been tested in their plant network. Not only do the plant's path and history matter when developing quality capabilities, but so do the paths and history of other plants in the network, with the headquarters actively sharing information and knowledge with them. SME breweries, however, are more embedded in their environment and engage more with internal and external networks since they lack internal resources. They need to access external resources, actively share information, exchange knowledge, and join in collaborative endeavours with personal and inter-organisational ties, which include suppliers, customers, industry

associations, and competitors. Their dynamic interactions with their external environment is, therefore, based on higher levels of multi-levelness/embeddedness, multi-directional causalities, non-linearity, and feedback, which together affect the firms' co-evolutionary paths.

The following section presents a literature review of the development of capabilities in SMEs, quality capabilities, and co-evolution. The third section describes the methodological steps we used in our multiple case study, including case selection and data analysis. The fourth section presents the findings of the within-case and cross-case analyses, followed by a discussion of our findings and a synthesis of the literature. Finally, we present the main conclusions and suggestions for future studies in the last section.

2. Theoretical background

2.1 The development of capabilities in SMEs

Previous OSCM literature has extensively studied quality management issues (Ancarani *et al*. 2019; Ramanathan *et al*. 2021; Xu *et al*. 2020), although few studies have addressed them by comparing firms with different characteristics in terms of their internal resources, such as business size, structure, and context (Sila, 2018 Xu *et al*. 2020). For example, Sahoo and Yadav (2017) discussed the role of entrepreneurial orientation in SMEs for developing successful TQM strategies and achieving better performance. McAdam *et al*. (2019) discussed the role of quality management in improving the strategic alignment of SMEs rather than adopting the best practices used by leading firms. Those papers suggested opportunities for future studies that are still underexplored regarding how internal resources may affect the development of a quality capability.

Large firms possess great internal resources that enable them to overcome the deficiencies suffered by their smaller competitors (Linder, 2019). Since they lack internal resources, SMEs need to find ways to compete with large companies while they develop their own capabilities. Capability is a *"firm's ability to integrate, build and reconfigure internal and external competencies to address rapidly changing environments"* (Teece *et al*. 1997, p. 516). In other words, capable firms configure and reconfigure their resources and assets to identify and seize market opportunities (Teece, 2007). SMEs are characterised by *"low economies of scale, higher*

capital, transaction and spill-over costs, and limited resources and capabilities, which generally makes them more vulnerable to larger enterprises, especially in uncertain and volatile industries" (Zaridis *et al*. 2020, p. 3). Due to their lack of internal resources, SMEs actively seek resources in the external environment to improve their existing capabilities (Linder, 2019) or develop new ones.

Although there is almost a consensus that the external environment can be a source of information and knowledge for firms, past literature has mainly focused on the perspective of multinational companies (MNCs) (Duarte and Rodrigues, 2017; Liu *et al*. 2021). However, approximately 72% of the jobs in Brazil are in SMEs, representing 27% of the Brazilian GNP (Brazilian Service for Micro and Small Enterprise, 2021), which provides new insights into their interactions with the external environment. SMEs are also relevant in developed countries, like Germany (Simon, 2009; Audretsch *et al*., 2018), where firms classified as '*hidden champions'* are highly competitive in international markets because of their high quality, innovative products. At the same time, because SMEs usually lack resources (Linder, 2019; Matthews *et al*., 2017), they may rely more on partners from their own environment, although their external environment can be a source of important resources for these firms since they can establish strong ties with other organisations (Fu *et al*. 2020; Huang *et al*. 2020; Salimian *et al*. 2021), such as supply chain partners, competitors, non-government organisations, and government institutions. So collaboration can be beneficial for firms that lack internal resources to develop their capabilities (Zaridis et al. 2020; Zhou and Li, 2020) and influence their entire environment in the process (Lewin and Volberda, 1999).

2.2 Quality capabilities

Quality management controls the processes, routines, and tasks for achieving the desired level of excellence in the products and services that are delivered to clients (Ancarani *et al*. 2019; Ramanathan *et al*. 2021; Xu et *al*. 2020). OSCM literature has highlighted that quality practices reduce variability and errors in different processes, such as standardization (Transchel *et al*. 2016) and Six Sigma (Wang *et al*. 2019). Digital transformation can improve the reliability and quality of firms by reducing any weaknesses in their quality systems. Apell and Hidefjäll (2022) argue that digital simulators can ensure quality requirements in healthcare systems through evidence-based training programmes with surgical teams. Quality has also been discussed on different levels

of analysis, including the organisational (Scarpin and Brito, 2018), buyer-supplier (Huang *et al*. 2020; Salimian *et al*. 2021), and supply chain levels (Fu et al. 2020; Zhou and Li, 2020). Little attention has been paid, however, as to how relationships beyond supply chains can improve quality. The Quality 4.0 concept has expanded the traditional quality management approach by including modern technologies for achieving new performance levels in design quality, standardisation, and performance quality (Sony *et al*. 2020; Chiarini and Kumar, 2022; Gremyr *et al*. 2022). This new quality approach encompasses diverse viewpoints, including using data for developing a deeper understanding of the business context, different ways for dealing with uncertainty, recognition of the importance of high-quality data, investments in trusted sources, and making improvements (Zonnenshain and Kenett, 2020). Our research considers that establishing relationships with other agents in the environment may improve quality, thus leading firms to develop or strengthen their quality capabilities.

Quality capabilities refer to how proficient firms are in managing the quality of their products, processes, and services by way of the tangible and intangible resources they have for meeting customers' specifications (Chang *et al*. 2003). These capabilities have also been considered a type of manufacturing capability, competitive capability, or the basis of other capabilities (Bortolotti *et al*. 2015; Chavez *et al*. 2017). Guo *et al*. (2020), for example, point out that quality control mechanisms in real-time enable the continuous improvement of products and processes, thus enabling firms to achieve better performance. Pozzi *et al*. (2021, p. 14) consider continuous improvement as '*fundamental for guaranteeing process performance'* for meeting and exceeding customer requirements on quality, which is only possible because of the organisational culture and worker commitment. Quality can also be considered to be those operational capabilities that focus on achieving the desired quality standards (Bortolotti *et al*. 2015; Chavez *et al*. 2017): they are the '*secret ingredient'* for achieving a competitive advantage (Wu *et al*. 2010) in terms of quality.

Operational capabilities can be conceptualised as '*firm-specific sets of skills, processes, and routines, developed within the operations management system, that are regularly used in solving its problems through configuring its operational resources'* (Wu *et al*. 2010, p. 726). The tangible approach to the development of quality capabilities includes best practices, equipment, and lean manufacturing applications (Su *et al*. 2014; Wu and Zhang, 2013), while the intangible approach includes organisational culture and managerial philosophy (Chen *et al*. 2017; Wiengarten

et al. 2015). Tangible resources have frequently been overemphasised compared to intangible resources (Dangol *et al*. 2015), and there is little literature exploring the combination of the two. This research, therefore, considers quality capabilities to be a type of operational capability, which enables firms to manage the quality of their products or services better than their competitors (Chang *et al*. 2003; Wu *et al*. 2010). Firms with a high level of quality capabilities are able to achieve excellence in their products and services (Ancarani *et al*. 2019; Ramanathan *et al*. 2021; Xu *et al*. 2020), thereby increasing their competitive advantage (Wu *et al*. 2010).

OSCM researchers consider quality a multidimensional concept (Escrig-Tena *et al*. 2018; Parast and Golmohammadi, 2019; Xu *et al*. 2020), including aspects such as customer focus, leadership, quality analysis, and managing supplier quality, among others. Although these researchers suggested that multiple agents should become involved in quality improvement (Xu *et al*. 2020), they limited their analysis to supply chain members, especially those in buyer-supplier relationships. The involvement of a larger group of supply chain partners can expand quality capabilities, improve supply chain practices (Wu and Zhang, 2013), sustain competitive advantage (Su *et al*. 2014), and improve manufacturing performance (Power, 2014). Information sharing with supply chain partners enables firms to enhance quality through joint control by combining inter-organisational efforts to reduce quality issues (Zhou and Li, 2020).

Even competitors may influence firms to adapt their quality capabilities as they seek to become strong rivals in their environment. A firm's ability to exploit a competitor's moves can help it achieve and sustain innovation relative to its competitors (Vilkas *et al*. 2021), thus improving its quality performance. Since supply chains are embedded in an external environment with a large number of agents (Dmitrijeva *et al*. 2020; Liu *et al*., 2019; Nair and Reed-Tsochas, 2019), prior studies have provided limited insights into how the external environment can shape the development of quality capabilities or how firms can actively influence quality standards in their environment.

2.3 Co-evolutionary approach

Co-evolution refers to joint progress that is supported by multi-directional interactions between management actions, industry, and the environment (Duarte and Rodrigues, 2017; Lewin and Volberda, 1999). This phenomenon happens between individual organisations or groups

comprising a large number of agents from the environment, including supply chain partners, competitors, non-government organisations, and government institutions (Duarte and Rodrigues, 2017; Liu *et al*. 2021). The co-evolutionary approach proposes that different agents in the environment adopt a mutual process of evolution, which differs from other types of approach (Lewin Volberda, 2009), such as the evolutionary approach, the micro foundation perspective, and the resource-based view, all of which are limited in their scope. For example, these approaches do not deal with multiple levels of analysis, such as micro and macro environments. They are also restricted by the directional causalities arising from the different agents. On the other hand, the co-evolutionary approach considers organisations as active agents in their environment, which they simultaneously adapt to and influence in terms of introducing changes in it that align with their own goals and actions. The co-evolutionary path, therefore, is highly dependent on other agents from the environment.

Lewin and Volberda (1999) suggest that the co-evolutionary approach is based on five properties that distinguish it from other evolutionary processes: multi-levelness/embeddedness; multi-directional causalities; non-linearity; feedback; and path and historical dependence. First, the multi-levelness/embeddedness property considers the firms' engagement with their environment by way of micro (intra-firm) and macro (industry and country) levels of analysis (Abatecola *et al*. 2020; Lewin and Volberda, 1999). Firms may need to engage with their workers, managers, plants, and supply chain partners to meet the quality specifications required by government regulation. Second, multi-directional causalities refer to the complex dynamic between multiple agents in the environment over time, in which the change of one agent is the result of other agents changing (Abatecola *et al*. 2020; Lewin and Volberda, 1999). In other words, although firms influence the environment, they are influenced by other agents. For example, a firm may introduce a new production process that reduces pollution following pressure from a competitor that introduced a better marketing strategy in the industry. Third, non-linearity means that one influence may not be understood as being the outcome of a direct, linear and logical relationship, which produces different effects in agents in the environment (Abatecola *et al*. 2020; Lewin and Volberda, 1999). The same technology can improve quality in one firm, for example, but have a limited impact on another. Fourth, feedback is the result of the interdependence and circular causality that exists between firms and their environment (Abatecola *et al*. 2020; Lewin and Volberda, 1999). For example, a firm with high quality standards may motivate other agents

to seek a similar performance. Last, path and history dependence are related to all the decisions taken and the challenges faced by firms over time (Abatecola *et al*. 2020; Lewin and Volberda, 1999). For example, firms may require years to structure their quality standards. In short, the properties of co-evolution can shed light on the development of quality capabilities, as shown in Table 1.

Table 1. Properties of co-evolution

Properties	Description
Multi-levelness/embeddedness	Company engagement occurs at multiple levels of analysis in its environment
Multi-directional causalities	Multiple influences that have come from different agents over time (e.g. A and B can influence C, and D, while E may be influenced by all of them)
Non-linearity	Influences between agents differ over time (e.g. A may influence B, while B may influence A at another time)
Feedback	Each adaptation in a firm might provoke a feedback effect on markets and other firms
Path and history dependence	The current position of a firm can be explained by the decisions it takes over time

Source: adapted from Lewin and Volberda (1999).

Past empirical studies have underlined a co-evolutionary process that focuses on different levels of analysis (Duarte and Rodrigues, 2017; Liu *et al*. 2021). They have addressed issues such as collective evolution between firms and their partners (Chen *et al*. 2017), their subsidiaries, their industry (Duarte and Rodrigues, 2017), and their institutional environment (Childlow *et al*. 2021; Liu *et al*. 2021). Although prior studies have described quality as a complex phenomenon that involves multiple agents (Duhaylongsod and De Giovanni, 2019; Salimian *et al*. 2021), few studies have highlighted the role of the external environment in the development of capabilities.

2.4 Research gaps

Based on the discussions above, this research considers the external environment to be an important driver when it comes to firms defining their evolutionary path in the process of developing their quality capabilities. Previous literature has already established the importance of supply chain partners in improving quality standards (Transchel *et al*. 2016, Wang *et al*. 2019). Supply chains, however, are embedded in a larger set of inter-organisational relationships, which include not only customers and suppliers, but competitors, industry associations, informal

networks, and others (Dmitrijeva *et al*. 2020; Liu *et al*. 2019; Nair and Reed-Tsochas, 2019), and so firms may access the resources they need for developing their quality capabilities from these relationships. This leads us to our first research question: *(RQ1) How do firms simultaneously engage internal and external resources to develop their quality capabilities?*

Since SMEs lack internal resources when compared to large firms, they may need to engage deeply with their formal and informal networks to achieve the quality specifications they are aiming for. There is still much to learn regarding how a company's size has an influence on its interactions with the environment, and consequently its co-evolution in terms of quality (Sahoo and Yadav; 2017; McAdam *et al*. 2019). A company's own improvement can also be seen as an important influence on other competitors in the environment. We, therefore, use the co-evolutionary approach to better understand the mutual relationships between the breweries and their environment by way of their five properties: multi-levelness/embeddedness; multi-directional causalities; non-linearity; positive feedback; and path and history dependence (Lewin and Volberda, 1999, 2009; Olsen, 2017). This leads us to our second research question: *(RQ2) How do a company's scarce internal resources affect its co-evolutionary paths?*

Since the OSCM literature talks little about this, our research employed a multiple case study approach (Eisenhardt, 1989; Ketokivi and Choi, 2014). We need to understand better the development of quality capabilities in a complex set of inter-organisational relationships between the case breweries and other agents in their environment.

3. Research Method

This study investigates the development of quality capabilities by way of a large set of relationships in the environment. Since our research investigates a contextually rich phenomenon, we employ a multiple case study approach involving four breweries in Brazil (Eisenhardt, 1989; Ketokivi and Choi, 2014). We formulated our research questions based on the co-evolutionary approach in order to better understand the dynamic between breweries and their environment. A multiple case study approach allows us to develop more precise theoretical insights into the development of quality capabilities. We used a theory elaboration approach because '*the context is not known well enough to obtain sufficiently detailed premises that could be used in conjunction with the general theory to deduce testable hypotheses'* (Ketokivi and Choi, 2014, p. 236). This

section is structured by the five stages of a case study proposed by Eisenhardt (1989). They include developing the research questions (presented in the introduction), case selection, data gathering, data analysis, and replication.

3.1 Case selection

This research took a theoretical sampling approach to select its cases (Eisenhardt,1989; Ketokivi and Choi, 2014), which employed three criteria to find suitable companies. First, we selected the brewery industry based on its need for higher quality standards, including: (1) short production times, which can be challenging for quality control when it comes to sustaining low variability and avoiding errors; (2) greater control over quality practices since the process of brewing involves biological and chemical steps, which have an influence on shelf-life and the stability of taste over time (Poveda, 2019). For example, the fermentation step produces many volatile compounds that impart several characteristics to beer; and (3) its consumption expansion rate of over 700% in the last ten years in Brazil (Brazilian Ministry of Agriculture, 2021), all of which require efforts for maintaining quality standards in new breweries. Second, we selected a cluster of breweries that are based in the most traditional beer-producing region in Brazil, which is known as Brazil's beer capital, and which has the only training centre that focuses on this product in Latin America. We expected that breweries located in this region would have higher quality standards and greater interaction with the external environment, including with suppliers, customers, competitors and learning centres.

Lastly, from the breweries located in this traditional beer-producing region, we selected plants with top-quality practices based on exploratory interviews with managers and experts from the brewing industry. We believed that information derived from top-quality plants would provide suitable responses to our research questions. The literature review helped the authors to develop an interview protocol (we call it quality-diagnostic protocol), which was pilot-tested and validated by four key respondents: two brew masters and two experts from the brewing industry. These respondents suggested a few changes in the wording of the questions but in general, agreed with the interview protocol. The final version of the protocol is presented in Appendix A. The quality-diagnostic protocol was then used with eleven managers from eleven breweries to evaluate their own plants using eighteen elements of quality performance. The scores for each plant were then

validated by two experts from the brewing industry, who considered it to be aligned with the practices of the best-known, top-quality breweries. We then ranked the eleven plants on the basis of their quality scores and on the sum of the managers' scores for each element of quality performance (Table A1). Finally, we selected the four top-quality breweries, as presented in Appendix B. This includes one plant, which has a premium brand of beer and is owned by a large global producer, and three SME plants.

3.2 Data gathering

Data were collected between March and December 2017 in two stages. In the exploratory stage, we interviewed thirteen regional managers from representative breweries, two specialists, an academic on beer production and the head of the training centre that specialises in beer. This step focused on gaining a better understanding of the industry, building the interview protocol (Appendix C), and selecting the best quality breweries based on their products and processes. In the second stage, we conducted twenty-five interviews between May 2017 and December 2017 that focused on the case breweries, as presented in Table 2. We conducted six or seven interviews in each brewery. Besides the managers from the four breweries, and in order to better understand their production processes, we also interviewed four partners and stakeholders who were suggested by the informants: two suppliers (B), one competitor (B), and one client (C). Interviews lasted approximately 40 minutes on average, with the time ranging between 30 and 75 minutes. They were conducted in Portuguese, recorded, and transcribed before data analysis. As we conducted the interviews on-site, we made observations on the production process to confirm the information we collected during the interviews.

Table 2. Case and interview overview

Case	Firm size	Revenue (US dollars) *	Employees in the plant	Approx. plant capacity (litres per month)	Code of the informant	Informant(s)	Location of the informant	Interviews
A	Large	Over 20 billion	50-100	300,000	A1	Production Manager	Plant	1
					A2	Administration Analyst	Plant	1
					A3	Brewmaster	Headquarters	1
					A4	Logistics Manager	Headquarters	1
					A5	Financial Manager	Headquarters	1
					A6	Planning Manager	Headquarters	1
					A7	Laboratory Manager	Plant	1
B	SME	0-10 million	10-50	120,000	B1	Owner	Plant	1
					B2	Production Manager	Plant	1
					B3	Brewer	Plant	2
					B4-supplier	CEO	Equipment supplier	1
					B5-supplier	Sales Manager	Raw materials supplier	1
					B6-competitor	Administrative Manager	Competitor	1
C	SME	0-10 million	10-50	100,000	C1	Production Manager	Plant	2
					C2	Lab Expert	Plant	1
					C3	Brewer	Plant	1
					C4	Owner	Plant	1
D	SME	0-10 million	0-10	40,000	D1	Production Manager	Plant	2
					D2	Commercial Manager	Plant	2
					D3-client	Purchasing Manager	Client	2

Note. * Considering the whole enterprise in each case.

3.3 Data analysis

Data were analysed in accordance with the within-case and cross-case analysis process (Eisenhardt, 1989). While within-case is usually used for analysing cases individually, the cross-case analysis compares case pairs by contrasting similarities and differences between them to identify broader dimensions (Eisenhardt, 1989; Yin, 2008). As the interviews were recorded and transcribed, we employed the NVivo software for data codification. First, we identified codes based on information language in seventeen first-order categories, grouped them into six second-order categories, and then into three dimensions. The data were coded by one of the researchers and validated by the co-authors. Evidence of the coding process is shown in Appendix D. The citations we present in this paper were translated from Portuguese into English by one of the researchers and then checked by the other authors.

3.4 Robustness

Meredith (1998) highlighted the fact that case studies require the same level of rigour as statistical approaches, although they are presented in distinct ways. In seeking to enhance the accuracy of this study, we paid attention to quality criteria for dealing with case studies, according to Yin (2008): construct validity, internal validity, external validity, and reliability. First, to ensure construct validity our research employed multiple sources of evidence, including interviews with key informants, an exploratory phase, and validation of the interview protocol by experts. Second, we addressed internal validity by way of the coding process shown in Figure 1. Third, for external validity, we present the interview questionaries in Appendices A and C. Future studies can apply them in other industries for evaluating the quality capabilities described in our study. Lastly, we ensured reliability by way of the interview questionaries for use in future studies.

4. Findings

The findings presented in this section emerged from our within-case and cross-case analyses (Eisenhardt, 1989). The following sub-section presents the within-case analysis, which explores each of the four unique case contexts in detail. It includes different levels of analysis,

such as individual, company, supply chain and market. The cross-case analysis grouped the information for each case into larger categories, as presented in Figure 1. The representative quotes are presented in Appendix D.

4.1 Within-case analysis

4.1.1 Case A

Case A was founded as a family brewery in 2002 and later sold to larger beer groups until a prominent global producer acquired it in 2017. It started producing craft beer according to a German purity law dating from 1516, strengthening its brand and reputation. Since the beginning quality has always been a concern and was seen as a competitive priority (A1; A2). Over time, Case A has also received quality improvements from the headquarters of its larger MNC (A2; A3; A7) *[path and history dependence]*. For example, the brewery always focused on the quality control of all raw materials in its laboratory in the plant. After the first acquisition in 2008, the headquarters invested approximately one million dollars in improving quality control, which included better equipment, hiring more employees and establishing additional procedures to ensure quality, which was already being tested in other plants in this group (A7). This process led to an evolution in its quality standards through information and procedure sharing throughout the network of breweries, which increased after the global producer acquired this particular brewery in Brazil.

The global producer established stricter quality standards through operational control and by analysing raw materials in the laboratory (A3). New equipment was also acquired to reduce variability in the brewing and carbonation phases of production, such as equipment for measuring must extract and for measuring the inclusion of carbon dioxide in the end product (A7). This increase in quality standards has enabled the Case A brewery to become the benchmark for the group's other plants worldwide (A6), with which it shares best practices (A4; A7). Since A developed high-quality standards based on brewing technologies, its regional competitors have started their own operations based on the former's standards *[*feedback*]*. This meant that these competitors acquired advanced equipment right at the start of their production (A1):

> '*…quality was defined on the basis of strict production controls carried out by the laboratory that controls all stages in manufacturing, from the arrival of the inputs to the beer that's ready for delivery. They [the company] built a physical-chemical and microbiological laboratory, so it goes far beyond the sensory levels that most microbreweries have, and this helps control the desired quality control levels of the beer'* (A1).

Even though Case A had influenced regional competitors to decide on their own operational processes, the former's quality is still higher. Since Case A belongs to a larger global producer, it has benefited from this structure. For example, its headquarters introduced new information that came from its global operations that covered aspects such as new equipment, technology, practices, and market trends for quality *[path and history dependence]*. Case A adapted its quality system based on this knowledge, and this played an important role in the local industry by spreading knowledge of new technologies and practices.

4.2 Case B

After seven years selling beer, the owner decided to start his own brewery supported by its supply chain networks. Case B started its manufacturing activities in 2015 with advanced technology processes compared with other local breweries. It developed high-quality proficiency based on joint efforts with its staff, equipment, and raw material suppliers *[multi-levelness/embeddedness]*. For example, its plant was built in partnership with an equipment supplier and based on the highest technology standards. This supplier used to focus on soft drinks equipment but sought new opportunities in the growing Brazilian brewing industry. Case B was the first to operate this equipment in Brazil (B3), and it sought to improve its processes while using it. It made several suggestions about the equipment during the initial manufacturing phases (B2, B3; B4-supplier) and used the supplier's expertise for developing new machinery (B4-supplier): *'they developed and built our equipment. They have the know-how, and we were talking about some adaptations…'* (B2). As a result, the equipment supplier acquired expertise in brewing, and Case B became the most technologically advanced brewery in the region (B1; B2; B3; B4-supplier) *[feedback]*. Both the brewery and the supplier benefited from the collaborative co-evolution process by sharing essential information [*multi-levelness/embeddedness*].

Case B also improved its quality process by acquiring centrifugal equipment to accelerate liquid homogeneity after the fermentation process (B2). This equipment removes some of the remaining yeast from the beer, while maintaining the same taste and appearance over time (B2):

> *Our company has improved its equipment over the last two years. We used to work with inadequate equipment and suffered large losses in the process… for example, we bought a German malt grinder, which maintained the same grain standard. This was perfect. This helps us improve our process performance'* (B3).

Based on Case B's results, local competitors sought to upgrade their own brewing equipment and improve their quality process, including Case A (B6-competitor; A1) *[feedback; multi-directional causalities; non-linearity]*. Another local brewery visited Case B, for example, to understand how this equipment worked. This local competitor subsequently invested in more advanced technological equipment in its own brewery (B2; B6-competitor).

These collaborative relationships were extended to include other beer production phases. For example, brewers from different local companies created a standardised routine to run sensorial tests jointly (B2 and B3) *[multi-levelness/embeddedness]*. These brewers decided on the changes together and updated the technical procedure to be incorporated into the production phase (B2; B3). This knowledge and information sharing between brewers have helped improve the quality of local beers and achieved better results for local companies *[feedback; multi-directional causalities; non-linearity]*.

4.1.3 Case C

Founded in 2014, Case C has received several national and international awards for its beers. To ensure consistent quality over time, this brewery has invested in manufacturing and laboratory technologies, standardised processes, hired managers with expertise in running breweries, and improved worker qualifications (C1; C2; C4). It developed quality management proficiency by improving its processes based on competitors' best practices, including exchanging knowledge about sensorial analysis, sharing information with its external network, and exchanging knowledge with raw material suppliers *[multi-levelness/embeddedness; feedback]*.

In seeking to match or exceed its competitors' quality standards, Case C adopted a strategy of hiring employees with expertise *[path and history dependence]*. For example, it hired a

production manager with expertise in quality (C4). He introduced several changes, including mitigating contamination risks during manufacturing, process standardisation by defining operational procedures, enhanced quality control at each stage in the process, and equipment upgrading to reach similar productivity and quality standards as reached by its competitors (C1; C3). Case C also installed a laboratory to measure and reduce variability during the manufacturing processes (C1; C2; C4). The brewery's laboratory established a rigorous process that evaluated each manufacturing batch before moving on to cellaring (C2). Case C hired a chemical expert to run this laboratory and better evaluate the beer quality by analysing both products and processes. This has enabled the brewers to receive constant formal feedback about their production batches (C3). If there is an unexpected result, they can identify the previous batches and correct the next ones to reduce variations in the processes (C2; C1). This co-evolution between brewer and lab has minimised variations in brewing processes (C3) and upgraded product stability (C1; C3). These internal changes in the manufacturing phases have helped them catch up with their competitors *[feedback]*.

As a fast-growing industry in the Brazilian market, breweries are trying to innovate by using different manufacturing methods to achieve superior results, for example, in flavour and aroma, and by using a combination of exotic ingredients (C4). Although this brewery tried to focus on continuous improvement in the brewing area, it exchanged information with an informal network to learn from external experiences *[multi-directional causalities; multi-levelness/embeddedness; feedback]*. This network comprises non-commercial relationships via inter-organisational and personal ties with other practitioners in the local industry. For example, this external network has introduced new methods for dealing with raw materials, especially hops (C1; C3). Managers from Case C seek external experts' opinions regarding a new product before releasing it on the market or at a trade fair. Its operations manager believes that sharing knowledge and information with external agents from the environment is important for strengthening this network (C1):

> *'...we share information with other breweries and other brewers. I really like to work in this way. Sometimes, for example, when I need hops for a test, before I make the beer I ask my network if they know something about it. If it has been tested before, we exchange information. So, if they come close to my target, I test it as well. If not, I leave it.'* (C1).

Collaborative inter-organisational relationships have also been established with raw material suppliers, which have often provided technical workshops to explain how to effectively use materials in the brewing process *[multi-levelness/embeddedness; multi-directional causalities]*. Improving the understanding of how to better use raw materials means companies can improve their processes and quality issues. It also helps raw material suppliers benefit from long-term customer loyalty and service satisfaction (C1).

4.1.4 Case D

This brewery was founded in 2003 as a microbrewery, producing from six to eight thousand litres per month. After being sold in 2015, it established a strategy that engaged manufacturing and marketing departments, and managers with expertise in these areas were hired to support its strategy. While the brewing department was responsible for increasing the quality standards of its beers, the marketing department built a close relationship with customers, which included having a regular presence in their strategic customer's store (D2) and establishing customer training (D3-client) *[multi-levelness/embeddedness; feedback]*. This close relationship helped create customer credibility and improve trust (D2). Trust-building was also enabled by opening its plant to customers, who could learn about its production process and product quality (D1; D2): *'according to our Commercial Director, our sales increased by around 30%. It was joint work between marketing and production; because we're making a quality product… we embraced our public…'* (D1).

The brewery grew fast, going from eight thousand litres a month to around forty thousand (D1), and increasing its number of clients by over ten times in two years (D2). To maintain this result, beer quality became critical for the managers. They adhered to standardised procedures to achieve the same beer quality and thus offered a consistent quality product over time (D1). Externally, this brewery provided its customers with guidelines and instructions on how to maintain product quality longer (D1; D2) *[multi-levelness/embeddedness]*. Quality management has been supported by elements such as assimilating brewing processes to match or exceed the competitor's capabilities *[feedback; non-linearity]*, improving the relationship between the manufacturing and commercial departments, and encouraging the joint evolution of staff and the

informal network, comprising mainly customers *[multi-levelness/embeddedness*; *multi-directional causalities]*.

Based on previous experiences *[path and history dependence]*, the operations manager introduced new quality practices in the brewing process to meet or exceed their competitor's standards *[non-linearity]*. For example, he developed standards for brewers to analyse the raw materials and/or manufacturing processes, improved asepsis using mechanical rather than manual handling, implemented new manufacturing practices, and introduced an inventory control method (D1). Despite significant improvements in product and process quality, the marketing department was still receiving customer complaints about the quality of the beer (D2). After investigation, the manufacturing department concluded that customers used the wrong process to store, handle and clean the beer barrels (D1). The commercial area, therefore, gave customers better guidance (D2; D3-client), which soon reduced customer complaints (D1). Finally, the manufacturing and marketing areas worked together in relation to quality concerns and the brewery's outputs, including new product development and delivery (D1; D2) *[multi-levelness/embeddedness]*.

Beer production also creates a mutual internal evolution of the brewery's staff. First, a brewmaster with more than fifty years of experience came into the brewery to check their batches of beer each month. He helps the brewers understand the critical issues affecting beer quality (D1). Second, the brewery's directors look for opportunities to improve the efficiency and effectiveness of the manufacturing department, including new technologies for improving product and process quality (D1; D2). Finally, Case D employs an informal network comprising experts, supply chain members and competitors to share information that can be applied to successfully implement or upgrade the quality process, including procedures to measure carbonation levels in beer without using sophisticated equipment or internal labs (D1) *[multi-levelness/embeddedness]*.

4.2 Cross-case analysis

After analysing the cases individually, a final model grouped this information into seventeen first-order categories, six second-order categories, and three dimensions, as presented in Figure 1. The first dimension, *'Adapting quality to adjust to internal and external influences'*, consists of some obligatory adaptations in the internal structure of breweries because of internal or external threats, such as changes in the market and competition, respectively. The second

dimension, *'Engaging partners in the development of quality capabilities'*, refers to a joint evolution involving breweries and their external agents, including suppliers, the informal network, and internal departments. Lastly, *'Influencing changes in the environment through quality improvement'* describes how the case breweries influence the market, the industry, and/or other external agents in their environment.

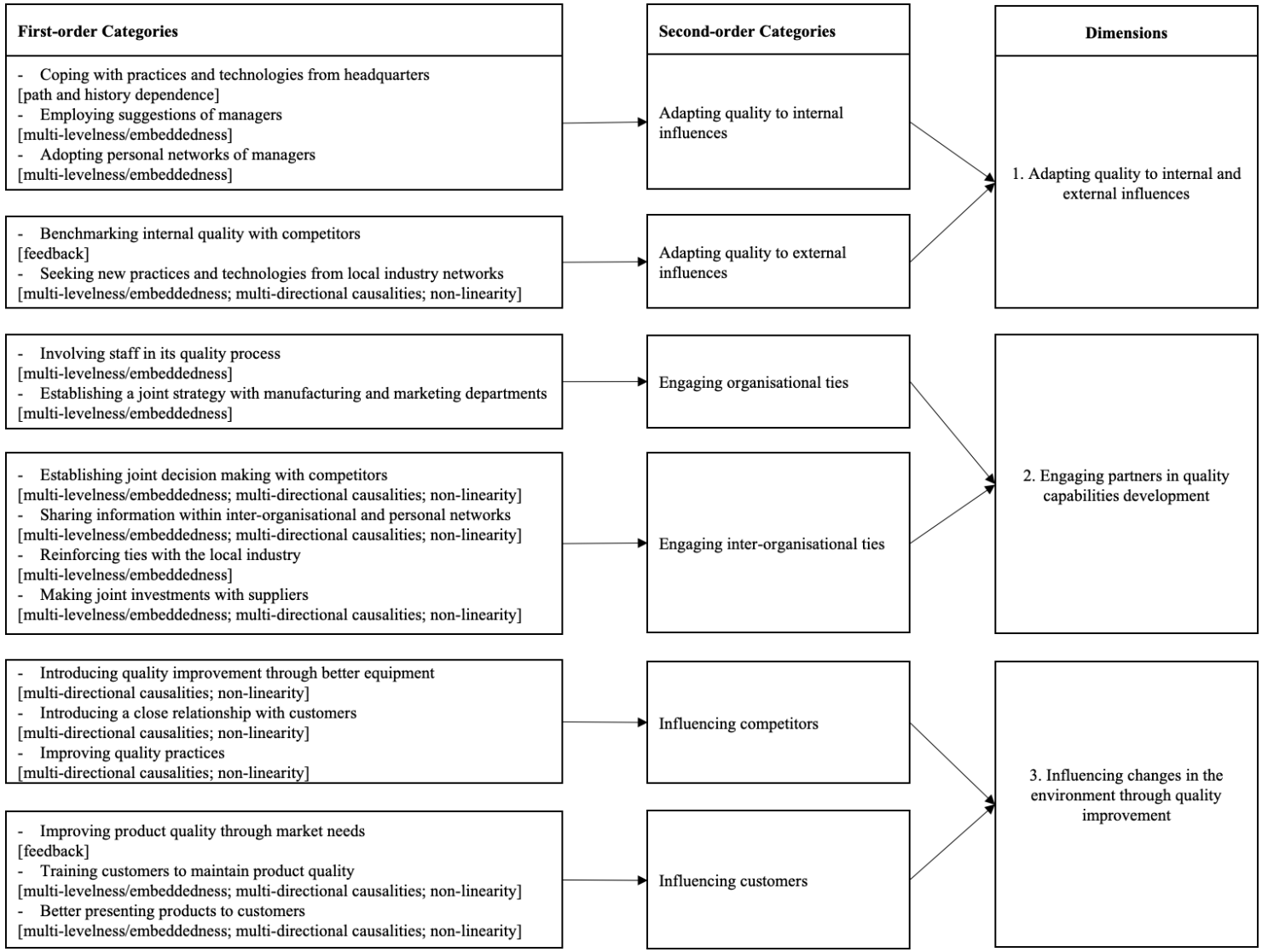

Figure 1. Data structure

(2-column fitting image)

From our cross-case analysis, the firms' resources emerged as an important factor in defining the development of their quality capabilities, as presented in Table 3. Case A is a brewery that belongs to a large MNC and embedded in a worldwide brewing network. Its strategy focuses mainly on the Brazilian market with quality standards that are defined by its headquarters and already applied in other plants: *'all of the quality concerns developed at the corporate level are rolled out to the subsidiaries immediately…"* (A3) *[path and history dependence]*.

Table 3. Cross-case comparison

	Case A	**Case B**	**Case C**	**Case D**
Characteristics				
Brewery type	MNC	Local	Local	Local
Firm size	Large	SME	SME	SME
Internal resources	High	Low	Low	Low
Approx. plant capacity (litres)	300.000	120.000	100.000	40.000
Market focus	Brazil-wide	Local	Local	Local
Adapting quality to internal and external influences				
Adapting to managers' suggestions	Low	High	High	High
Adapting to requirements from its headquarters	High	Low	Low	Low
Adapting to competitors	High	Low	High	High
Engaging partners in the development of quality capabilities				
Employees	Low	High	High	High
Internal departments	Low	Low	Low	High
Suppliers	Low	High	High	High
Informal network	Not identified	Not identified	High	High
Influencing changes in the environment through quality improvement				
Influencing competitors' strategies	High	High	Low	Low
Influencing customers' behaviour	Low	Low	Low	High
Influencing the entire industry	High	Low	Low	Low

On the other hand, cases B, C, and D are SMEs with fewer internal resources, which means they rely more on partners from the local industry. This includes engaging partners to access needed resources from employees, internal departments, suppliers, and informal networks resulting from their personal ties *[multi-levelness/embeddedness]*. For example, Case B followed its employees' suggestions in order to improve the taste of its beer:

'...we started correcting the minerals in the water used for our beer; it was a big change for us. So, we meet on a daily basis – John, Mark, James, and I. We drink the beer… so let's change something in it, but as the market knows our product, we can't change it suddenly" (B2).

The need for external resources deeply influences how the case breweries develop their quality capabilities and interact with other agents in the environment.

All these case breweries have adapted their quality standards because of internal and/or external changes *[feedback]*, such as those demanded by their headquarters, or coming from competitors, or employees. Case A, for example, had to cope with additional requirements from its headquarters to reduce variability. As a result, it invested in new equipment for its laboratory and standardised its quality procedures in line with those already tried and tested by other plants in its global network *[path and history dependence]*. The headquarters made these investments obligatory, aiming to improve quality to support brand growth and protect the brewery's reputation in the market. Case A has also suffered pressure due to the advanced equipment acquired by its competitors, to which this brewery has responded by renewing its manufacturing technology to ensure similar production levels and costs. Cases C and D, on the other hand, hired production managers with expertise in their attempt to increase quality and productivity levels *[path and history dependence]*. They conducted benchmark analyses with other breweries to improve quality practices and respond to market demands *[feedback]*. Managers from SMEs have played an important role in enhancing the quality processes and products based on their prior experience and personal ties.

Cases B, C and D tend to rely on partners to access the resources they need while also engaging employees, internal departments, suppliers, clients, and informal networks that are made up of their personal links *[multi-levelness/embeddedness]*. For example, based on a reciprocal learning process between employees from the laboratory, sensory tests, laboratory experts and brewers, the quality of the flavour of the beer produced by the different companies in this network improved. A close relationship between its marketing and manufacturing departments also allowed Case D to understand its customers' needs *[feedback]*. It engaged customers in training dealing with beer conservation methods, reinforcing their ties with Case D. These SMEs have also benefited from external collaboration with supply chain partners, such as raw material and equipment suppliers *[multi-levelness/embeddedness; multi-directional causalities]*. Raw material suppliers, for example, have provided technical support for materials and reduced the costs of long-range procurement contracts:

> *'For example, we go there [main supplier], and they offer us seminars about hops, malted barley and their characteristics, then we can implement and improve our processes,*

> *such as the performance of the materials, and the calculations. By understanding more about our materials, we can use them better, and then we can add a lot more quality'* (C1).

An equipment supplier built a plant jointly with Case B: *'The mill was the first equipment manufactured by them… They came here, did a study, and hired a professional to develop it following our advice… Today they've evolved a lot in terms of equipment development…'* (B1). This supplier was also responsible for advanced equipment that enabled automated quality control. Lastly, these breweries collaborate in an informal network by sharing experiences and exchanging knowledge between those participating. Since SMEs lack resources, they are more likely to engage with other agents in the environment, and share information and resources with them *[multi-levelness/embeddedness; multi-directional causalities; non-linearity]*.

These case breweries are not passive agents in their environment; they also influence other agents by pursuing best quality practices. Case A, for example, is considered by other breweries as the regional benchmark in quality standards. Its procedures and equipment influence quality standards regionally, leading to new entrants in this market considering it to be a minimum level in terms of quality *[feedback]*. Like Case A, Case B introduced advanced new equipment in its beer production process, thus improving product quality. Its competitors then acquired new equipment to improve their processes. On the other hand, Case D strengthened its ties with its clients, and provided them with training on preserving beer quality for their consumers. As it improved the end customers' level of satisfaction, Case D introduced a way to establish a closer brewery-client relationship, thereby becoming a benchmark for its competitors. These case breweries have introduced new practices and technologies in their operations that have changed quality standards for the entire local brewing industry *[feedback; non-linearity]*.

Our four cases have developed quality capabilities based on internal and external factors that have led them to changes *[feedback]*, including those that emerged intra- and inter-departmentally, from their suppliers, customers and competitors, and from informal networks. Personal and inter-organisational relationships have played an important role for these SMEs on their evolutionary path. Due to their lack of internal resources, these breweries were more likely to engage with local networks to improve their quality standards *[multi-levelness/embeddedness]*. On the other hand, the large company's brewery mostly followed a path whereby it has adapted its quality standards to meet its headquarters' requirements by introducing new practices and acquiring assets that have become a benchmark for other local breweries *[path and history*

dependence]. The SMEs also introduced new practices and assets that influence other breweries and the entire local industry *[multi-directional causalities; non-linearity]*. The development of quality capabilities differed in each company regarding their resources, history, and relationships.

The following section discusses how the findings contribute to OSCM literature and practice.

5. Discussion

5.1 Theoretical contributions

Although capabilities (Linder, 2019; Teece *et al*. 1997) and quality management (Ancarani *et al*. 2019; Ramanathan *et al*. 2021; Xu *et al*. 2020) have been extensively studied in OSCM literature, the role of the external environment in developing quality capabilities still requires more attention (Bortolotti *et al*. 2015; Chavez *et al*. 2017). While previous literature has overemphasised the role of internal resources in developing capabilities (Linder, 2019), our framework extends it by incorporating internal *and* external resources that interplay simultaneously, supported by a co-evolutionary approach. The findings suggest that the case breweries we studied have created and developed their capabilities by adopting a series of main standards, which include adapting their quality to reflect internal and external influences, engaging partners in developing quality capabilities, and influencing changes in the environment by improving their quality. These standards have encouraged breweries to improve their quality procedures, control, technology and standards. This study discusses how the co-evolutionary approach contributes to understanding these findings.

As the co-evolutionary approach suggests, the case breweries evolved their quality capabilities in line with internal and external factors, following a co-evolutionary path based on past decisions and challenges relating to quality within their plants and its headquarters, multi-levelness/embeddedness in the external environment, multi-directional causalities, non-linearity, and feedback emerging from their relationships with other agents in their environment (Lewin and Volberda, 1999, 2009; Olsen, 2017). This research contributes to previous literature on co-evolution by highlighting the role of internal resources in setting out how firms define their co-

evolutionary paths, which could focus internally on their plant networks, or actively seek resources from other firms in the environment to build collaborative, inter-organisational relationships.

Prior studies have highlighted that MNCs might actively change their environment, influence public policies and introduce new practices and technologies into the environment (García-Cabrera and Durán-Herrera, 2016). Our findings support this by presenting how the plant that belongs to an MNC introduces new practices and technologies into the local industry and becomes a benchmark for quality standards. It follows ambitious corporate goals and adapts to best practices emanating from its headquarters. Co-evolutionary research has already emphasised that path and history dependence are important for explaining a firm's current competitive position in its market (Lewin and Volberda, 1999). Our findings, however, suggest that plants belonging to an MNC improve their quality capabilities by way of practices that have already been tested in other plants worldwide. In other words, they take advantage of past decisions and challenges in the quality of other plants in the MNC's network over time, which include those challenges that involve global suppliers, customers, and competitors, as presented in Figure 2. This enables us to understand co-evolution as part of a broader set of relationships (Duarte and Rodrigues, 2017; Liu *et al*. 2021). On the other hand, SME breweries allow their managers to have greater autonomy to enhance their manufacturing processes and product features because of scarce resources. Managers use their past experiences in other breweries to improve quality standards in their current employer. We put forward, therefore, the following propositions:

Proposition 1a – The past decisions of MNCs and challenges related to quality are associated with greater quality capabilities in the plant network

Proposition 1b – Managers' past decisions and challenges related to quality are associated with greater quality capabilities in their current SME

OSCM researchers have indicated that capability development is the result of: a collaborative process in buyer-supplier relationships (Huang *et al*. 2020; Salimian *et al*. 2021); informal networks composed of personal and inter-organisational ties (Zhang *et al*. 2016); collective staff evolution (Su *et al*. 2014; Zhang *et al*. 2016); and manufacturing and marketing integration (Su *et al*. 2014). Our findings show that there is an interplay in the efforts of internal and external agents that helps breweries develop their quality capabilities. However, the level of multi-levelness/embeddedness in the external environment seems to be associated with the need

for breweries to access resources from this environment. Previous studies addressed that co-evolution can emerge from inter-organisational networks (Duarte and Rodrigues, 2017; Liu *et al*. 2021), but this assumes that the process is unevenly distributed between firms in the environment (Lampel and Shasie, 2003). Our findings suggest that SME breweries engage more with a wider network in macro environments (suppliers, customers, competitors, and informal networks) because they lack internal resources. They are also more likely to share resources with partners in their environment, which includes information sharing, knowledge exchange, and joint decision-making with other agents. By engaging in personal and inter-organisational ties, SME breweries are more likely to collaborate with relationships outside supply chain boundaries. Although previous literature has recognised that collaboration is an important factor for companies and supply chains in developing their quality system (Fu *et al*. 2020; Huang *et al*. 2020; Salimian *et al*. 2021), evidence from our research highlights the importance of collaboration that goes beyond supply chain relationships. Our second proposition, therefore, is:

> *Proposition 2 – Multi-levelness/embeddedness in macro environments is associated with a greater need for access to resources from external agents for developing quality capabilities.*

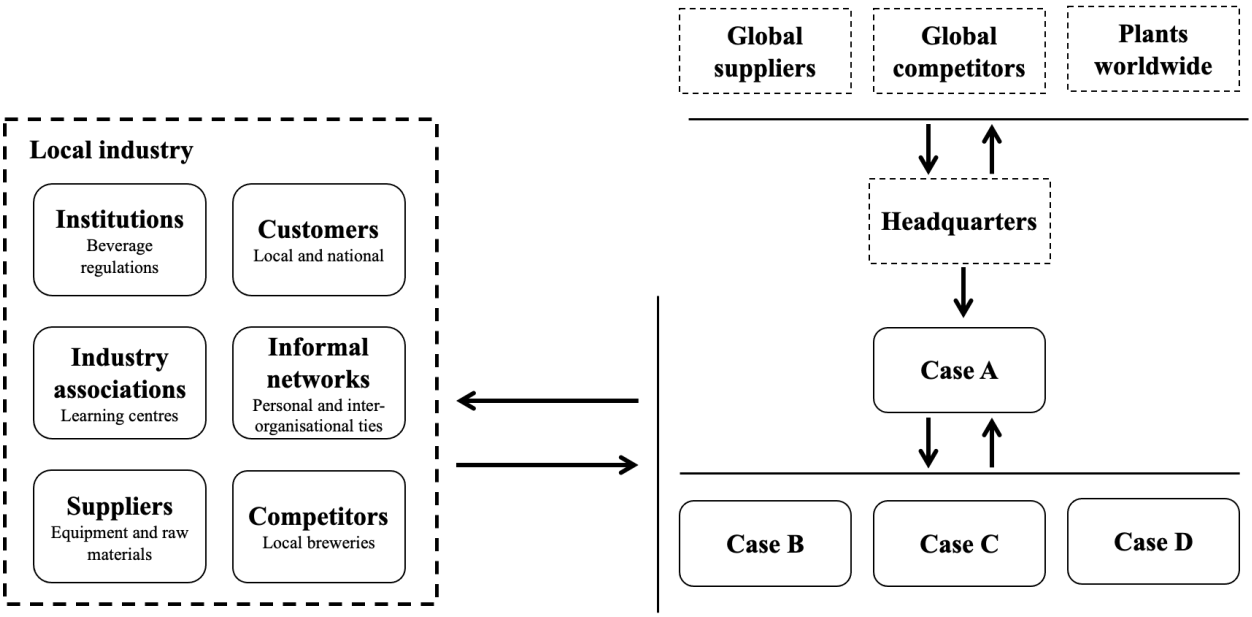

Figure 2. Influences of the case breweries on the environment

(2-column fitting image)

Firms cannot be seen as passive agents in their environment (Duarte and Rodrigues, 2017; Liu *et al*. 2021), influencing changes while improving their quality capabilities. For example, the case breweries benefited from innovations while influencing changes in the local market, stimulating adaptations in other breweries' operations (Zaridis *et al*. 2020). This encourages companies to continuously improve their capabilities over time to remain competitive in the market (Braguinsky and Hounshell, 2016). Anticipating changes makes firms more resilient to potential disruptions and improves quality (Su *et al*. 2014). For example, Wu and Zhang's (2013) study found that exploration-oriented quality practices are more effective in achieving performance goals than exploitative practices. Previous literature indicated that seeking continuous improvement is an essential internal practice for developing quality capabilities (Guo *et al*. 2020; Pozzi *et al*. 2021). Our findings suggest that firms are embedded in a dynamic environment composed of multiple non-linear influences from different agents over time, which is a source for disseminating information and resources throughout the industry. In other words, the dynamic between agents in the environment comprises multi-directional causalities, feedback, and non-linearity. Case A invested in equipment to reduce variability, increase its quality standards and become the benchmark for the industry. This provoked a feedback effect in other breweries and some of its quality standards became the minimum requirement for its competitors and motivated them to seek a similar performance. On the other hand, Case D invested in providing customer training, which can result in the entire industry has a closer relationship with customers over time. Our case breweries, therefore, must pay attention to multiple agents while they seek to improve their quality processes and products. Based on these arguments, we present our third proposition:

> *Proposition 3 – Greater multi-directional causalities, feedback, and non-linearity are associated with a greater dissemination of information and resources, thus enabling breweries to develop their quality capabilities.*

5.2 Managerial implications

This study has useful implications for managers. Quality is an important factor for increasing or maintaining the competitiveness of companies and managers should be concerned with how firms use the external environment for developing their quality capabilities, although there is no unique path to effectively evolving such capabilities. Different strategies are based on

company characteristics, including the extent of their internal resources and their embeddedness in the local industry. These research implications can also be useful for managers in their decision to actively engage in informal networks involving inter-organisational and personal links with local industry.

This research first pointed out that the MNC's local brewery evolved its quality standard to adapt its practices and technologies to match the quality standards that had already been tested in other breweries in Brazil and worldwide. This company is more exposed to different competitors, which makes it more likely to absorb advances quickly and move towards following market trends. Managers in large firms should engage more in corporate committees that focus on sharing information and knowledge from other plants. They can introduce new practices and technologies in their plant, thereby underlining their benchmarking role in the local industry. They should also seek to strengthen their ties with local industry by engaging suppliers and customers in developing their quality capabilities.

Second, managers from SMEs are more likely to engage in formal and/or informal local networks, and actively seek resources from the external environment. Inter-organisational relationships with internal and external agents seem to be a quick way of acquiring complementary resources for improving product and process quality. These managers can use their network to search for innovations and compensate for their lack of internal resources through joint strategies. They should also look for innovation in the large company by using their ties with their employees to explore new practices and technologies they can adopt in their plant. Working closely with customers and acting on their feedback can also improve their understanding of customers' needs, and engender mutual trust and cooperation that may lead to innovation in products and processes.

5.3 Limitations and future research directions

This study has its limitations that indicate new directions for future research. Although this paper contributes to our understanding of the role of the external environment in developing quality capabilities, it focuses primarily on industry and market agents. The brewing industry is highly regulated by a complex system, which includes food and beverage controls, tax benefits, and other aspects. The role of the government and its potential influences on the brewing industry,

however, was limited in our case studies. It would be interesting to understand how regulations affect quality in Brazilian breweries and how they can cope, adapt, or influence institutions.

Future research could explore government influences and compare similarities and differences in the development of capabilities in different institutional environments. First, well-established institutions can reduce the uncertainty felt by firms, but because of food and beverage security rules, they can also restrict innovation in brewing practices. It would also be interesting to explore how informal networks are developed in countries with different national cultures. Second, the co-evolutionary approach presupposes that resource mobilisation and competencies are unevenly distributed (Lampel and Shasie, 2003). The opportunities a firm chooses to explore will depend on the associated outcomes and capabilities. This allows the co-evolutionary approach to be employed along with different theories to better understand a complex set of relationships, such as the ambidexterity, institutional, network, social, and dynamic capabilities' theories. Lastly, future quantitative studies could also test our suggestions.

6. Conclusions

This paper investigated the process of developing quality capabilities with other agents in their environment by adopting a co-evolutionary approach. Past OSCM literature explored the process of developing capabilities (Linder, 2019; Teece *et al*. 1997; Zaridis *et al*. 2020), but it did not consider the role of agents from the external environment. This research expands this literature by suggesting that internal resources define the embeddedness of firms in the local industry and, consequently, their co-evolutionary path for developing quality capabilities. Due to their lack of internal resources, SMEs seem more likely to establish joint solutions for improving quality with their suppliers, customers, and even competitors. The headquarters, however, has had a more profound effect on driving the development of large firms' plants and their capabilities. We believe this paper and its findings can make important contributions to the work of OSCM scholars and practitioners.

References

Ancarani, A., Di Mauro, C., & Mascali, F. (2019). Backshoring strategy and the adoption of Industry 4.0: Evidence from Europe. *Journal of World Business*, *54*(4), 360–371. https://doi.org/10.1016/J.JWB.2019.04.003

Audretsch, D., Lehmann, E., & Schenkenhofer, J. (2018). Internationalization strategies of hidden champions: lessons from Germany. *Multinational Business Review*, *26*(1), 2–24, https://doi.org/10.1108/MBR-01-2018-0006

Apell, P., & Hidefjäll, P. (2022). Quality improvement: understanding the adoption and diffusion of digital technologies related to surgical performance. I*nternational Journal of Quality & Reliability Management*, Vol. ahead-of-print No. ahead-of-print.

Bortolotti, T., Danese, P., Flynn, B. B., & Romano, P. (2015). Leveraging fitness and lean bundles to build the cumulative performance sand cone model. *International Journal of Production Economics*, *162*, 227–241. https://doi.org/10.1016/j.ijpe.2014.09.014

Braguinsky, S., & Hounshell, D. A. (2016). History and nanoeconomics in strategy and industry evolution research: Lessons from the Meiji-Era Japanese cotton spinning industry. *Strategic Management Journal*, *37*(1), 45–65. https://doi.org/10.1002/smj.2452

Brazilian Ministry of Agriculture. (2021). A Cerveja no Brasil [Beer in Brazil]. Retrieved from: <http://www.agricultura.gov.br/assuntos/inspecao/produtos-vegetal/a-cerveja-no-brasil>

Brazilian Service for Micro and Small Enterprise. (2021). Pequenos negócios em números [Small business in numbers]. Retrieved from: < https://www.sebrae.com.br/sites/PortalSebrae/ufs/sp/sebraeaz/pequenos-negocios-em-numeros,12e8794363447510VgnVCM1000004c00210aRCRD>

Chang, S. C., Lin, N. P., Yang, C. L., & Sheu, C. (2003). Quality dimensions, capabilities and business strategy: An empirical study in high-tech industry. *Total Quality Management and Business Excellence*, *14*(4), 407–421. https://doi.org/10.1080/1478336032000047228

Chavez, R., Yu, W., Jacobs, M. A., & Feng, M. (2017). Manufacturing capability and organizational performance: The role of entrepreneurial orientation. *International Journal of Production Economics*, *184*(1), 33–46. https://doi.org/10.1016/j.ijpe.2016.10.028

Chen, Y., Su, H., & Ro, Y. K. (2017). The co-evolution of supplier relationship quality and product quality in the U.S. auto industry: A cultural perspective. *International Journal of Production Economics*, *184*(1), 245–255. https://doi.org/10.1016/j.ijpe.2016.12.020

Chidlow, A., Wang, J., Liu, X., & Wei, Y. (2021). A co-evolution perspective of EMNE internationalization and institutions: An integrative framework of 5Cs. *International Business Review*, *30*(4), 101843. https://doi.org/10.1016/j.ibusrev.2021.101843

Chiarini, A. & Kumar, M. 2022. What is Quality 4.0? An exploratory sequential mixed methods study of Italian manufacturing companies. *International Journal of Production Research*, 60(16), 4890-4910. https://doi.org/10.1080/00207543.2021.1942285

Dangol, R., Bahl, M., & Karpak, B. (2015). Timing cooperative relationships with sequential capability development process to reduce capability development trade-offs. *International Journal of Production Economics*, *169*(1), 179–189. https://doi.org/10.1016/j.ijpe.2015.07.014

Darwin, C. (1859). *On the origin of species by means of natural selection, or preservation of favoured races in the struggle for life*. London: John Murray.

Dmitrijeva, J., Schroeder, A., Bigdeli, A., & Baines, T. (2020). Context matters: how internal and external factors impact servitization. *Production Planning & Control*, *31*(13), 1077-1097. https://doi.org/10.1080/09537287.2019.1699195

Duarte, R., & Rodrigues, S. (2017). Co-evolution of industry strategies and government policies: The case of the Brazilian automotive industry. *Brazilian Administration Review*, *14*(2), 1-28. https://doi.org/10.1590/1807-7692bar2017160100

Duhaylongsod, J. & De Giovanni, P. (2019). The Impact of Innovation Strategies on the Relationship between Supplier Integration and Operational Performance. *International Journal of Physical Distribution & Logistics Management*, *49*(2), 156–177. doi:10. 1108/IJPDLM-09-2017-0269.

Ehrlich, P., & Raven, P. (1964). Butterflies and Plants: A Study in Coevolution. *International Journal of Organic Evolution*, *18*(1), 586-608.

Eisenhardt, K. M. (1989). Building theories from case study. *Academy of Management Review*, *14*(4), 532–550. https://doi.org/10.5465/AMR.1989.4308385

Escrig-Tena, A. B., Segarra-Ciprés, M., García-Juan, B. & Beltrán-Martín, I. (2018). The impact of hard and soft quality management and proactive behaviour in determining innovation performance. *International Journal of Production Economics*, *200*(1), 1-14. https://doi.org/10.1016/j.ijpe.2018.03.011

Fu, S., Zhan, Y., Ouyang, J., Ding, Y., Tan, K. & Fu, L. (2020). Power, Supply Chain Integration and Quality Performance of Agricultural Products: Evidence from Contract Farming in China. P*roduction Planning and Control*, *32*(13), 1119–1135. doi:10.1080/09537287.2020.1794074.

García-Cabrera, A. M. & Durán-Herrera, J. J. (2016). MNEs as institutional entrepreneurs: A dynamic model of the co-evolutionary process. *European Management Journal*, *34*(5), 550–563. https://doi.org/10.1016/j.emj.2016.02.002

Gligor, D., Esmark, C. & Gölgeci, I. (2016). Building international business theory: A grounded theory approach. *Journal of International Business Studies*, *47*(1), 93–111 (2016). https://doi.org/10.1057/jibs.2015.35

Gremyr, I., Birch-Jensen, A., Kumar, M. & Löfberg, N. 2022. Quality functions' use of customer feedback as activation triggers for absorptive capacity and value co-creation. *International Journal of Operations & Production Management*, 42(13), 218-242. https://doi.org/ 10.1108/IJOPM-11-2021-0692

Guo, H., Zhang, R., Zhu, Y., Qu, T., Zou, M., Chen, X., Ren, Y. & He, Z. (2020). Sustainable quality control mechanism of heavy truck production process for Plant-wide production process. *International Journal of Production Research*, *58*(24), 7548-7564. DOI: 10.1080/00207543.2020.1844918

Gunasekaran, A., Subramanian, N. & Ngai, W. T. E. (2019). Quality management in the 21st century enterprises: Research pathway towards Industry 4.0. *International Journal of Production Economics*, *207*(1), 125–129. https://doi.org/10.1016/j.ijpe.2018.09.005

Huang, Y., Han, W. & Macbeth, D. (2020). The Complexity of Collaboration in Supply Chain Networks. *Supply Chain Management: An International Journal*, *25*(3), 393–410. doi:10.1108/ SCM-11-2018-0382.

Ketokivi, M. & Choi, T. (2014). Renaissance of case research as a scientific method. *Journal of Operations Management*, *32*(5), 232-240. https://doi.org/10.1016/j.jom.2014.03.004

Jacobides, M. G. & Winter, S. G. (2005). The co-evolution of capabilities and transaction costs: Explaining the institutional structure of production. *Strategic Management Journal*, *26*(5), 395–413. https://doi.org/10.1002/smj.460

Lampel, J., & Shamsie, J. (2003). Capabilities in motion: New organizational forms and the reshaping of the Hollywood movie industry. *Journal of Management Studies*, *40*(8), 2189-2210. 10.1046/j.1467-6486.2003.00417.x

Lewin, A. Y., Long, C. P. & Carroll, T. N. (1999). *The Coevolution of New Organizational Forms*. *10*(5), 535–550. https://doi.org/10.1287/orsc.10.5.535

Lewin, A. Y. & Volberda, H. (1999). Prolegomena on for Coevolution: A Framework for Research on Strategy and New Organizational Forms. *Organization Science*, *10*(5), 519–534. https://doi.org/10.1287/orsc.10.5.519

Lewin, A. Y. & Volberda, H. W. (2009). The Future of Organization Studies: Beyond the Selection-Adaptation Debate. In *The Oxford Handbook of Organization Theory* (Issue May, pp. 1–672). https://doi.org/10.1093/oxfordhb/9780199275250.003.0022

Linder, C. (2019). Customer orientation and operations: The role of manufacturing capabilities in small-and medium-sized enterprises. *International Journal of Production Economics*, *216*(1), 105-117. https://doi.org/10.1016/j.ijpe.2019.04.030

Liu, G., Aroean, L. & Ko, W. (2019). A business ecosystem perspective of supply chain justice practices: A study of a marina resort supply chain ecosystem in Indonesia. *International Journal of Operations & Production Management*, *39*(9), 1122-1143. https://doi.org/10.1108/IJOPM-09-2018-0578

Liu, X., Yang, N., Li, L. & Liu, Y. (2021). Co-evolution of emerging economy MNEs and institutions: A literature review. *International Business Review*, *30*(4), 101828. https://doi.org/10.1016/j.ibusrev.2021.101828

Macdonald, J., Zobel, C., Melnyk, S. & Griffis, S. (2018). Supply chain risk and resilience: theory building through structured experiments and simulation. *International Journal of Production Research*, *56*(12), 4337-4355. https://doi.org/10.1080/00207543.2017.1421787

Matthews, R. L., MacCarthy, B. L. & Braziotis, C. (2017). Organisational learning in SMEs: a process improvement perspective. *International Journal of Operations & Production Management*, *37*(7), 970-1006. https://doi.org/10.1108/IJOPM-09-2015-0580

McAdam, R., Miller, K. & McSorley, C. (2019). Towards a contingency theory perspective of quality management in enabling strategic alignment. *International Journal of Production Economics*, *207*(1), 195–209. https://doi.org/10.1016/j.ijpe.2016.07.003

Meredith, J. (1998). Building operations management theory through case and field research. *Journal of Operations Management*, *16*(4), 441–454. https://doi.org/10.1016/S0272-6963(98)00023-0

Nair, A. & Reed-Tsochas, F. (2019). Revisiting the complex adaptive systems paradigm: Leading perspectives for researching operations and supply chain management issues. *Journal of Operations Management*, *65*(1), 80-92. https://doi.org/10.1002/joom.1022

Olsen, T. D. (2017). Rethinking collective action: The co-evolution of the state and institutional entrepreneurs in emerging economies. *Organization Studies*, *38*(1), 31-52. https://doi.org/10.1177/0170840616670440

Parast, M. M. & Golmohammadi, D. (2019). Quality management in healthcare organizations: empirical evidence from the Baldrige data. *International Journal of Production Economics*, 216(1), 133-144. https://doi.org/10.1016/j.ijpe.2019.04.011

Poveda, J. (2019). Biogenic amines and free amino acids in craft beers from the Spanish market: A statistical approach. *Food Control*, *96*(1), 227–233. https://linkinghub.elsevier.com/retrieve/pii/S0956713518304651.

Power, D. J. (2014). Competence and capability in quality in the high-tech sector: an international comparison. *International Journal of Operations & Production Management*, *34*(9), 1184–1209. https://doi.org/10.1108/IJOPM-06-2012-0232

Pozzi, R., Rossi, T. & Secchi, R. (2021). Industry 4.0 technologies: critical success factors for implementation and improvements in manufacturing companies. *Production Planning & Control*, DOI: 10.1080/09537287.2021.1891481

Raddats, C., Zolkiewski, J., Story, V. M., Burton, J., Baines, T. & Ziaee Bigdeli, A. (2017). Interactively developed capabilities: evidence from dyadic servitization relationships. *International Journal of Operations and Production Management*, *37*(3). https://doi.org/10.1108/IJOPM-08-2015-0512

Ramanathan, U., Mazzola, E., Mohan, U., Bruccoleri, M., Awasthi, A. & Garza-Reyes, J. (2021). How Selection of Collaborating Partners Impact on the Green Performance of Global Businesses? An Empirical Study of Green Sustainability. *Production Planning and Control*, *32*(14), 1207-1222, DOI: 10.1080/09537287.2020.1796133

Sahoo, S. & Yadav, S. (2017). Entrepreneurial orientation of SMEs, total quality management and firm performance. *Journal of Manufacturing Technology Management*, *28*(7), 892–912. https://doi.org/10.1108/JMTM-04-2017-0064

Salimian, H., Rashidirad, M. & and Soltani, E. (2021). Supplier Quality Management and Performance: The Effect of Supply Chain Oriented Culture. *Production Planning & Control*, *32*(11), 942–917. doi:10.1080/09537287.2020.1777478.

Scarpin, M. R. S., & Brito, L. A. L. (2018). Operational capabilities in an emerging country: Quality and the cost trade-off effect. *International Journal of Quality & Reliability Management*, *35*(8), 1617-1638. https://doi.org/10.1108/IJQRM-04-2017-0061

Schroeder, R. G., Shah, R. & Peng, D. X. (2010). The cumulative capability 'sand cone' model revisited: a new perspective for manufacturing strategy. *International Journal of Production Research*, *49*(16), 4879–4901. https://doi.org/10.1080/00207543.2010.509116

Sila, I. (2018). Linking quality with social and financial performance: A contextual, ethics-based approach. *Production and Operations Management*, *27*(6), 1102-1123. https://doi.org/10.1111/poms.12857

Simon, H. (2009). *Hidden Champions of the 21st Century: Success Strategies of Unknown Market Leaders*, Springer-Verlag, Heidelberg.

Sony, M., Antony, J., & Douglas, J. A. (2020). Essential ingredients for the implementation of Quality 4.0: A narrative review of literature and future directions for research. *The TQM Journal*, *32*(4), 779-793. https://doi.org/10.1108/TQM-12-2019-0275

Su, H. C., Linderman, K., Schroeder, R. G. & Van De Ven, A. H. (2014). A comparative case study of sustaining quality as a competitive advantage. *Journal of Operations Management*, *32*(7–8), 429–445. https://doi.org/10.1016/j.jom.2014.09.003

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal, 28*(13), 1319–1350. https://doi.org/10.1002/smj.640

Teece, D. J., Pisano, G. & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533. https://doi.org/10.1002/(SICI)1097-0266(199708)18:7<509::AID-SMJ882>3.0.CO;2-Z

Transchel, S., Bansal, S. & Deb, M. (2016). Managing Production of High-Tech Products with High Production Quality Variability. *International Journal of Production Research*, *54*(6), 1689–1707. doi:10.1080/00207543.2015.1053579.

Vilkas, M., Bikfalvi, A., Rauleckas, R., & Marcinkevicius, G. (2022). The interplay between product innovation and servitization: the mediating role of digitalization. *Journal of Business & Industrial Marketing*, Vol. ahead-of-print No. ahead-of-print

Voss, C., Tsikriktsis, N. & Frohlich, M. (2002). Case research in operations management. *International Journal of Operations & Management Production Management*, *22*(2), 195–219. https://doi.org/10.1108/01443570210414329

Wang, C., Chen, K. & Tan, K. (2019). Lean Six Sigma Applied to Process Performance and Improvement Model for the Development of Electric Scooter Water-Cooling Green Motor Assembly. *Production Planning & Control*, *30*(5), 400–412. doi:10.1080/09537287.2018.1501810.

Wiengarten, F., Gimenez, C., Fynes, B. & Ferdows, K. (2015). Exploring the importance of cultural collectivism on the efficacy of lean practices. *International Journal of Operations & Production Management*, *35*(3), 370–391. https://doi.org/10.1108/IJOPM-09-2012-0357

Wu, S. J. & Zhang, D. (2013). Analyzing the effectiveness of quality management practices in China. *International Journal of Production Economics*, *144*(1), 281–289. https://doi.org/10.1016/j.ijpe.2013.02.015

Wu, S. J., Melnyk, S. A., & Flynn, B. B. (2010). Operational capabilities: The secret ingredient. *Decision Sciences*, 41(4), 721-754. https://doi.org/10.1111/j.1540-5915.2010.00294.x

Xu, L., Peng, X., Pavur, R. & Prybutok, V. (2020). Quality management theory development via meta-analysis. International Journal of Production Economics, 229(1). https://doi.org/10.1016/j.ijpe.2020.107759

Yin, R. K. (2008). Case study research: Design and method. In *Sage Publications, Inc.* (4th ed.). Sage Publications.

Zaridis, A., Vlachos, I., & Bourlakis, M. (2021). SMEs strategy and scale constraints impact on agri-food supply chain collaboration and firm performance. *Production Planning & Control*, *32*(14), 1165-1178. https://doi.org/10.1080/09537287.2020.1796136

Zhang, Y., Gregory, M., & Neely, A. (2016). Global engineering services: Shedding light on network capabilities. *Journal of Operations Management*, *42*(1), 80–94. https://doi.org/10.1016/j.jom.2016.03.006

Zhou, H., & Li, L. (2020). The impact of supply chain practices and quality management on firm performance: Evidence from China's small and medium manufacturing enterprises. *International Journal of Production Economics*, *230*(1), 107816. https://doi.org/10.1016/J.IJPE.2020.107816

Zonnenshain, A., & Kenett, R. S. (2020). Quality 4.0—the challenging future of quality engineering. *Quality Engineering*, *32*(4), 614-626. DOI: 10.1080/08982112.2019.1706744

Appendices

Appendix A
Exploratory questionnaire

Company
Name
Position and experience
Production volume per month

Please answer the questions below (Table A1) indicating any evolution in your brewery over the last five years and how it happened (if there was any influence from internal and/or external players).

Table A1

Quality-diagnostic protocol

	Maturity level		
Item	***Low (1)***	***Intermediate (2)***	***High (3)***
How do you manage variations in the raw materials acquired (malted barley, hops and yeast)?			
1. Malted Barley	Do not perform tests or make changes in the datasheet	Change datasheet according to the suppliers' technical report	Change datasheet according to sensory, microbiological, physical and chemical tests
2. Hops	Do not perform tests or make changes in the datasheet	Change datasheet according to the suppliers' technical report	Change datasheet according to sensory, microbiological, physical and chemical tests
3. Yeast	Do not perform tests or make changes in the datasheet	Change datasheet according to the suppliers' technical report	Change datasheet according to sensory, microbiological, physical and chemical tests
How do you manage variations in the water components?			
4. Water	Do not perform tests	Change datasheet according to the suppliers' technical report, and test for the existence of chlorine in the water	Perform periodic tests of pH and make mineral adjustments
How do you manage variations in the milling of the grain?			
5. Milling the grain	Do not perform tests	Do sensory tests	Conduct grading, powder content and granulometry tests
How do you manage temperature and time variations in the mash conversion process?			
6. Mash conversion	Manual control of temperature ramp-up and time	Automatic control of temperature ramp-up and time	Check mash conversion speed and time, pH.
How do you manage variations in the lautering process?			
7. Lautering	Do not perform tests	Lautering time control, final wash extract	Wash water's pH, the turbidity of the wort, delta pressure in the lautering bed
How do you manage variations in the boiling process?			
8. Boiling	Do not perform tests	Realize evaporated volume test, and complete and final tub extract	pH, chemical bitterness, the volume of losses (trub)
How do you control variations in temperature, pressure and cooling time?			
9. Wort separation and cooling	Manual control of temperature and time	Automatic control of temperature and time	Quantification of spent refrigerant and quantification of the thermal load used
How do you control variations in the fermentation process?			
10. Fermentation	Do not perform tests	Realize sensory tests and daily density	Perform pH tests and daily cell counts
How do you manage variations in the maturation, filtration or centrifuge, carbonation, cellaring, pasteurisation, and process transfer?			

Item	Maturity level		
	Low (1)	***Intermediate (2)***	***High (3)***
11. Maturation	Do not perform tests	Monitoring temperature and pressure – registration for statistical process control (SPC)	Perform microbiological contamination tests, incorporation of dissolved oxygen, and other chemical tests
12. Filtration or centrifuge	Do sensory tests	Perform turbidity input and output tests	Perform microbiological contamination tests and incorporation of dissolved oxygen
13. Carbonatation	Do sensory tests	Tank pressure and temperature test	Bottle pressure and temperature test (carbonation test cylinder)
14. Cellaring	Do sensory tests	Perform cellaring tests	Perform microbiological contamination tests and incorporation of dissolved oxygen
15. Pasteurization	Do sensory tests	Conduct pasteurization efficiency test (glycophytic test)	Perform microbiological contamination tests
16. Process transfer	Do not perform tests	Do sensory tests	Perform microbiological contamination tests and incorporation of dissolved oxygen
What kind of tests are performed to guarantee the final product quality?			
17. Final product	Do not perform tests	Do sensory tests	Conduct shelf-life tests, cap pressure tests, and incorporation of dissolved oxygen
What kind of tests are performed to guarantee sterilization and asepsis quality?			
18. Sterilisation and asepsis	Do not perform tests	Periodically perform microbiological tests	Perform daily microbiological tests

Appendix B

Table A2

Each brewery's quality score in the exploratory phase

Breweries / **Processes**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Malted barley	3	2	2	2	2	2	2	2	1	2	2
Hops	3	2	2	2	2	2	2	2	1	2	2
Yeast	3	2	3	2	2	2	2	1	1	1	2
Water	2	3	2	3	3	2	2	1	1	1	1
Grain milling	3	3	2	3	2	3	1	2	2	2	1
Mash conversion	3	3	3	1	1	2	1	2	1	1	1
Lautering	2	3	3	2	2	2	2	2	2	1	2
Boiling	3	2	2	2	2	1	1	1	1	1	1
Wort separation and cooling	3	2	2	1	1	2	2	2	1	2	1
Fermentation	3	2	3	2	2	1	2	1	2	2	2
Maturation	3	2	2	2	2	1	1	1	1	1	1
Filtration or centrifuge	3	2	2	1	1	1	1	1	1	1	1
Carbonatation	3	2	2	2	2	1	1	1	1	1	1
Cellaring	3	2	2	2	1	1	1	1	1	1	1
Pasteurisation	3	2	2	2	1	1	1	1	1	1	1
Process transfer	3	2	2	2	1	1	1	1	1	1	1
Final product	3	3	3	2	2	2	1	1	2	2	1
Sterilisation and asepsis	3	3	3	3	1	2	2	2	2	1	1
Total Score	**52**	**42**	**42**	**36**	**30**	**29**	**26**	**25**	**23**	**24**	**23**

Appendix C

Interview questionnaire

Company

Name

Position and experience

Production volume per month

1. What manufacturing practices support process quality (5S, best manufacturing practices, standard operational procedure, six sigma, total quality management)? How have they been implemented?
2. How have your manufacturing technologies helped reduce any variability during the process (manual vs. automatic, lab)?
3. How has your brewery's output supported improvements in the manufacturing process, practices, and technology?
4. How do you perceive your brewery influencing other firms (suppliers, customers, competitors, institutions, or entities)?
5. How have external agents influenced adaptations in your company's processes, practices, or technology (suppliers, customers, competitors, institutions, or entities)?

Appendix D

Table A3

Representative quotes by coding categories

Coding category	Representative quotes
Adapting quality to internal and external influences	
Adapting quality to internal influences	'One of the most import evolutions in our plant came after the acquisition when they required an improvement in our process quality… our plant had a small laboratory with just one professional…after the acquisition, they hired another three to cover the quality control processes 24 hours a day. They required a new procedure for a technical assessment of each batch we made before moving on to the packaging department…they brought microbiological, chemical and physical controls into this plant for line checking. They invested more than a million in the plant lab' (A7). '...he has no experience with industrial brewing. He had a lot of old habits in his job, and so I fired him. In fact, I fired many of the original guys and hired new workers and, because I like to work, I've trained them in my ways: prioritizing cleanliness, tank cleaning, floor cleaning, internal cleaning, equipment disassembly and cleaning, cleaning, cleaning...' (C1). '…the company's competitive differential, I think, is that we have a master brewer who graduated in Germany…He's old, really old, but he's transferring his knowledge to me. He comes in once a month to taste our beer, and then we exchange a lot of information about his extensive experience in the brewing industry' (D1).
Adapting quality to external influences	'Our technology is at the same level or lower than our regional competitors, even those producing less volume than us…' (A1). 'We were adjusting, improving our recipes, changing equipment…we had a bad wort separation and cooling process because we removed too much of the grain husk. So, then we changed that equipment, improved its chimney because of weak evaporation…' (B2). 'When I arrived here we didn't analyse our raw materials… another thing we changed was focusing on fresh materials, because they came from Germany, the United States… another thing was asepsis, which is fundamental for maintaining a good end product…the same process, standardisation…' (D1).
Engaging partners in developing quality capabilities	
Engaging organisational ties	'I called him [production manager] and said 'Come on. Let's visit a client: one of the new ones. That's a competitive differential we have; it's hard to see a brewery allowing visits from its brewmaster' (D2). '…we also analyse the beer tank by drinking a sip of beer everyday from each batch when it's ready, and we discuss if it's a little bitter or something is missing. That will influence the next production batches of this kind of beer. We'll improve something' (B3). 'For example, sometimes when I taste a beer it's sweet, so sweet I don't like it because it's very heavy….. Then, the laboratory results come up with details about extracts, which are higher than our limit, and we need to reduce it to 3, 3.5. That's how we correct it. We analyse the sensory and laboratory tests jointly' (C1).
Engaging in inter-organisational ties	. '..because hops may suffer from a lot of variability, we've asked for better quality raw materials from our supplier…we have a formal contract with a hops supplier that ensures quality, and with delivery on time, which is another important thing. Hops differ from harvest to harvest…so, they ensure supply when we need it under contract' (B3).

Coding category	Representative quotes
	'…ensuring supply for our client is the biggest gain because we have a contract. Besides, we give a discount. Both of us gain, because I supply hops to them when necessary, and it's good for me in terms of managing our inventory' (B5-supplier). 'Today brewers exchange information…suppose they identify a problem that you're facing, but I've never noticed. So, I can learn from their experience, and solve a problem rather than wasting time on it. However, if I kept that information to myself, then no one would help me later…I have some experienced colleagues who have spent around 40 or 50 years working in breweries. I have a colleague who graduated in Germany and is now 72, and retired, …' (D1).
Influencing changes in the environment through quality improvement	
Influencing competitors	'…I suppose that our main competitor will not see the market turnaround to a high-quality product, but they'll not be comfortable losing market share… As they are a big player in the market, any adaptation has a big impact on the market [when mentioning a mass production company]'(A6). '…a competitor visited our plant to see our technology. We own a centrifuge that removes yeast from the beer – I'll show you later. They were interested and bought better equipment than ours, so it's something that should be made cooperatively to develop the region…' (B2).
Influencing customers	'…they're recognized as one of the most important in perceived quality…we had small issues regarding quality, but now this is something distant…we have direct contact, and they provide us with good assistance'(D3-client). '…I provide training for all the breweries and make myself available for their team…if they need training for their team…what are my duties? I deliver the products, check storage, give them product validity' (D2).

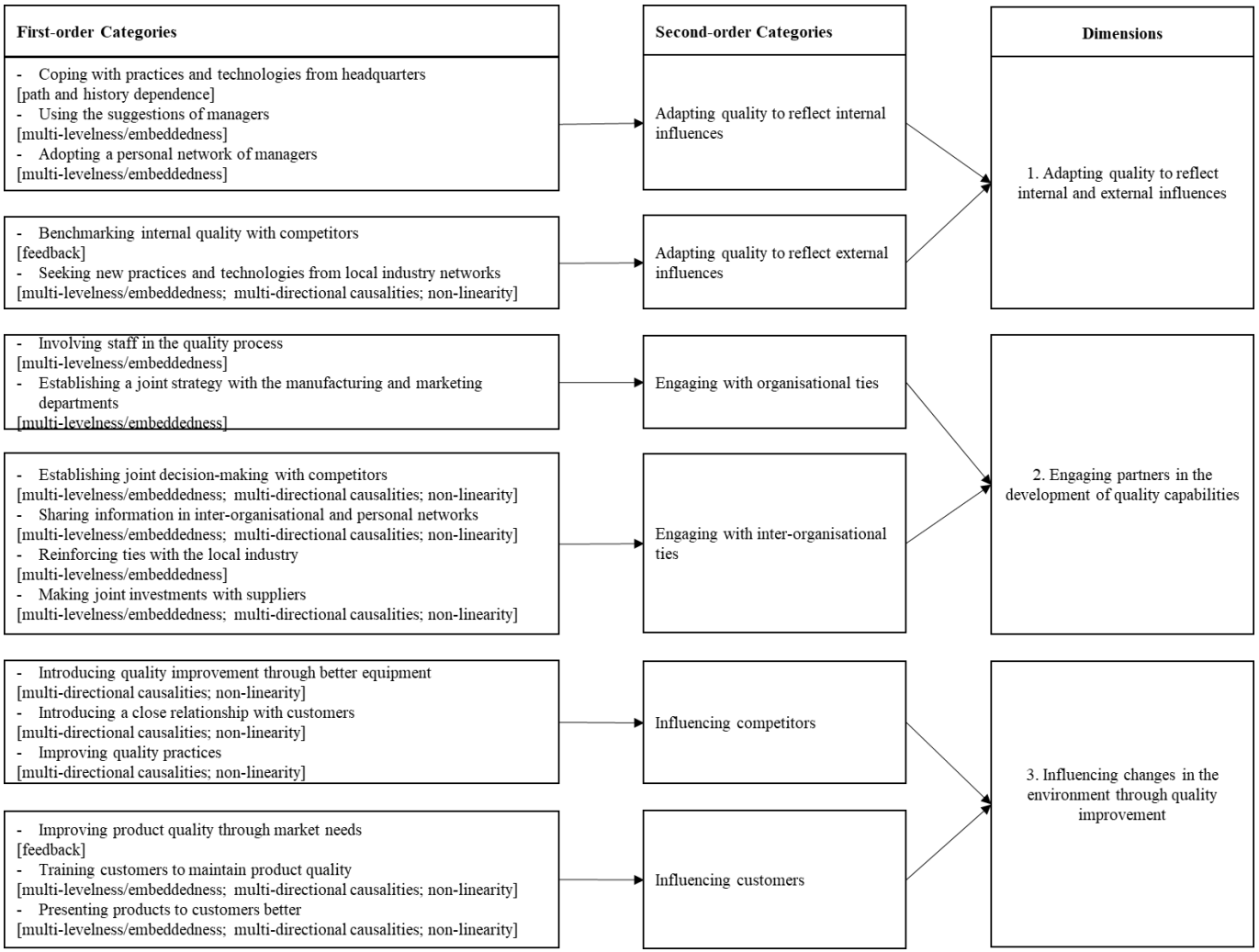

Figure 1. Data Structure

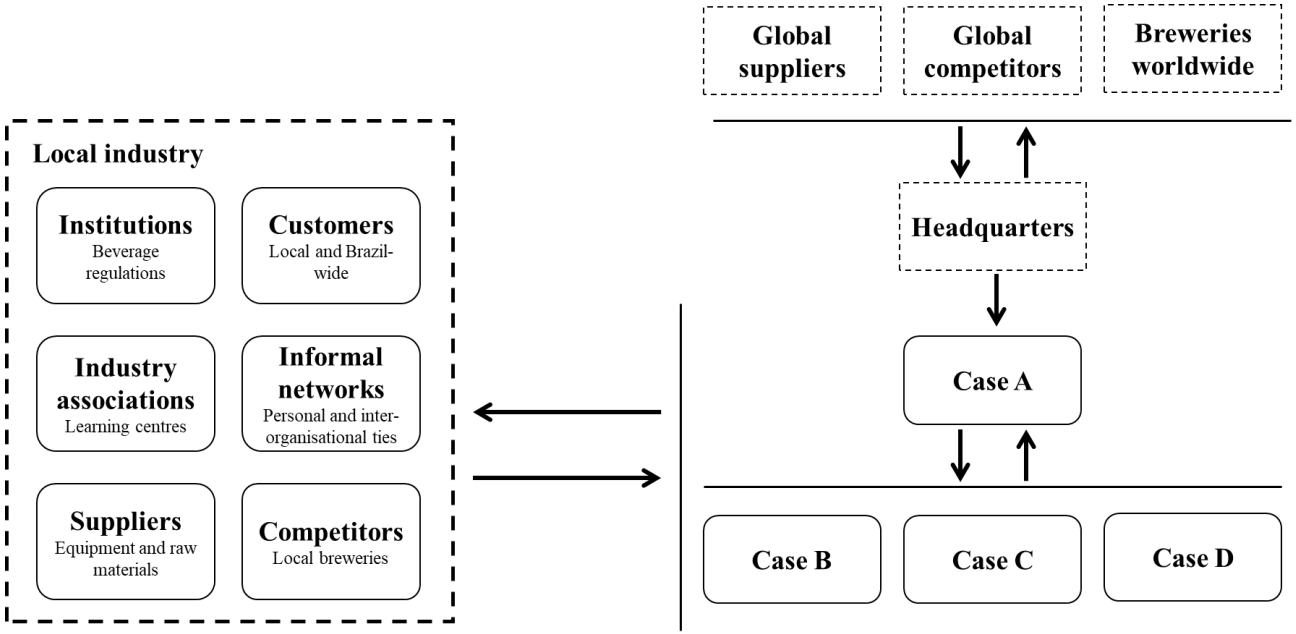

Figure 2. Influences of the case breweries on the environment