Customer involvement in technological development of smart products: empirical evidence from a coffee-machine producer

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Abstract

Purpose – This paper aims to explore how customer involvement unfolds in the development of a smart product. Smart product development poses new challenges to firms. In particular, the buyers' and users' involvement has shown novel dynamics in smart product development. These peculiarities are linked with the specific characteristics of the digital technology embedded into the smart products. This study's rationale is to analyse the frictions arising from potential divergent objectives between the focal firm and its customers when digital technologies are embedded in traditional products.

Design/methodology/approach – This study adopted an explorative and qualitative approach to investigate new emerging dynamics of customer involvement during technological development. A coffee machine producer is selected as a case study to uncover new insights and a novel perspective on the phenomenon of customer involvement in smart product development. Data analysis followed an abductive approach that allowed to identify the dimensions of friction emerging during the technological development process.

Findings – The case study analysis depicts that smart product development presents novel customer involvement dynamics. In particular, this study abductively identifies dimensions of friction emerging between the focal firm and buyers/users. Friction arises in the technological interface between the actors involved. These dimensions of friction address the complexities of developing technology in terms of smart products with customer involvement. This study suggests that embedding of technology into an existing product might change how customers are involved.

Originality/value – Even though customer involvement in product innovation has been extensively studied in management literature, this paper focused on a new type of innovation, smart products. To the best of the authors' knowledge, no previous studies have yet empirically explored customers' involvement while embedding digital technologies into existing products to create smart products. In particular, this study sheds light on the dimensions of friction emerging between the focal firm and the actors of the business network. This study unfolds novel contributions to the Industrial Marketing and Purchasing literature on technological development.

Keywords Friction, Customer involvement, Digital transformation, Technological development, Smart product

Paper type Research paper

1. Introduction

Technological development is a fundamental source of competitive advantage for firms (Chou and Zolkiewski, 2012; La Placa, 2014; Mu *et al.*, 2017; Biemans and Griffin, 2018). Resources cannot be controlled exclusively by any firm but are dispersed across the business network (Nordin *et al.*, 2018). No firm is an island; neither is it possible to develop technology in isolation (Håkansson and Snehota, 1989, 2017). In this regard, several studies have attempted to explore how technological development unfolds in relational processes in the business-to-business (B2B) setting (Takeuchi and Nonaka, 1986; Araujo *et al.*, 1999; Noteboom, 1999; Håkansson and Waluszewski, 2003; Laage-Hellman *et al.*, 2014; La Rocca *et al.*, 2016, 2019; Sabatini *et al.*, 2020). In particular, the centrality of customer involvement in the technological development process is a well-established concept in the business network literature, and it has been addressed by a plethora of academics (Håkansson and Waluszewski, 2003; Lynch *et al.*, 2016; Sundquist and Melander, 2020; Zhang and Xiao, 2020). Customer involvement is central to mobilising resources to develop new technologies (Chou and Zolkiewski, 2012; Håkansson and Waluszewski, 2003; Gressetvold and Torvatn, 2006; Aarikka-Stenroos *et al.*, 2017).

The advent of digital technology has brought a new impetus to technological development. Developing smart products –

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which embed digital technology – creates new challenges for firms (Hendler, 2019). The present study recognises that the term *smart product* encompasses different types of products (Pardo *et al.*, 2020) or archetypes (Raff *et al.*, 2020), ranging from mere *digital products* – equipped with hardware capable of processing information and supporting basic data management via its operating software – to *intelligent products* – capable of learning and acting independently, due to the embedded artificial intelligence (AI) software. However, these products' common characteristic is their physical nature combined with cyber-physical elements (Pardo *et al.*, 2020). The characteristics and materialities of concurrent digital and physical development might require different ways of managing technological development (Hendler, 2019). The digital-physical development process shows a relatively higher complexity, uncertainty, diversity and interdependence than a pure physical product (Hendler, 2021). Smart products require higher levels of multi-disciplinarity and collaboration with companies from unrelated industries; consequently, the development process becomes more unpredictable (Hendler and Boer, 2019). In other words, a smart product might call for significant shifts in the technological development process and the interactions within the network. Accordingly, the literature on this topic is increasing (Pagani and Pardo, 2017; Hendler and Boer, 2019; Pardo *et al.*, 2020; Raff *et al.*, 2020).

The present study focuses on the intersection of three research streams as it investigates the frictions emerging from technological development with customer involvement during the development of smart products, adopting the theoretical framework of the Industrial Marketing and Purchasing Group (IMP) approach. Analysing frictions is particularly relevant in the case of smart products, which can be regarded as double-faced coins (Oinonen *et al.*, 2018). On one side, they could bring new sources of business potential; on the other, they might also bring new issues that would have to be managed during their development.

The present study acknowledges that despite the manifold benefits of customer involvement in technological development (Laage-Hellman *et al.*, 2018), smart product development might present new challenges yet to be uncovered (Cantù *et al.*, 2012). New complexities emerge when developing new solutions to old problems by adopting digital technologies (Björkdahl, 2020). Hence, this study posits that combining digital and physical components within the interaction among several actors from different backgrounds may lead to friction (Belingheri and Neirotti, 2019).

Thus, this study takes the opportunity to contribute to IMP's extant empirically explorative studies of how firms manage customer involvement while embedding digital technologies in existing products and developing smart products. How a firm involves customers in developing smart products is still an underexplored issue and needs more studies (Aarikka-Stenroos *et al.*, 2014; La Rocca *et al.*, 2016; Pagani and Pardo, 2017); in particular, more research is needed to shed light on emerging frictions when developing smart products. The research follows the calls of La Rocca *et al.* (2016) and Laage-Hellman *et al.* (2018), drawing on Håkansson and Waluszewski's (2003) concept of friction in technological development and scrutinising previous research on industrial network approaches (Håkansson and Snehota, 1995; Håkansson and Waluszewski, 2003; Sundquist and Melander, 2020). This paper aims to shed light on how the development of smart products influences customer involvement during technological development and how frictions unfold in the process. Hence, the paper tries to answer the following two research questions:

RQ1. How do smart products influence customer involvement during technological development?

RQ2. How do frictions emerge from customer involvement during smart products' technological development?

Considering the explorative aim of this study, it adopts a qualitative approach based on a single case study of an Italian professional coffee-machine manufacturer. It focuses on analysing smart product development at the focal firm's network level, aiming to provide a new understanding of customer interactions.

This paper is organised as follows: Section 2 encompasses the literature background of the study. Section 3 provides the methodological background, while Section 4 presents information about the context and the case firm. Section 5 covers the case findings. Section 6 discusses the theoretical and managerial implications. Finally, Section 7 concludes the study.

2. Literature background

2.1 Frictions and tensions in technological development and customer involvement

The present study builds on three research streams in the IMP literature. These are related to technological development and the focus on frictions and tensions; customer involvement in technological development; and smart products.

Innovation has been linked to technological development (Håkansson and Waluszewski, 2001; Baraldi, 2008). The IMP tradition conceives technological development as the result of interactions through direct and indirect relationships (Håkansson and Snehota, 1995). Thus, technological development stems as solution(s) created from the combination of existing resources brought by different actors within the business network through interactions (La Rocca and Snehota, 2014; Ylimäki, 2014; La Rocca *et al.*, 2016). Innovation pertains to the relational process that occurs when technological change, embedded in products, services or new businesses, becomes established and diffused across the business network (La Rocca and Snehota, 2014; Aarikka-Stenroos *et al.*, 2017). This has become particularly relevant in B2B markets, where developing solutions entails extensive interactions in buyer-supplier relationships (Baraldi, 2008; Håkansson *et al.*, 2009; Harrison and Finch, 2009). Interactions are needed because the complex solutions offered are enacted jointly between the user/customer and producer/supplier organisations (Read *et al.*, 2009). Consequently, a relational perspective is required to study technological development (La Rocca *et al.*, 2016). Therefore, developing technologies within the business network increasingly entails suppliers' and customers' involvement (von Hippel, 1989; Oinonen *et al.*, 2018).

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Customers, identified in the *market-as-network* setting as buyers and users, have represented valuable sources of information and knowledge for developing new products since the beginning. Buyers' and users' involvement supports the focal firm in a number of ways. The major benefits are addressed to recognise new business opportunities (Zhang and Xiao, 2020): enhancing the understanding of customers' needs (Munksgaard *et al.*, 2012; Laage-Hellman *et al.*, 2014), expanding the firm's resource base and supporting the combination of new resources (Araujo *et al.*, 1999), gathering information to adapt products' features to users' preferences (Gressetvold and Torvatn, 2006), increasing the speed of development and reducing innovation lead time (Rubera *et al.*, 2016), educating the users about the new products' features and establishing the firm's credibility to support the innovation commercialisation (Aarikka-Stenroos and Sandberg, 2012; Sabatini *et al.*, 2021).

Customer involvement remains paramount for firms, considering the efforts needed to adapt any new offering to its use context and the high risk of developing unsuccessful products (Skarp and Gadde, 2008). However, the degree of involvement might differ, considering the role of technology and the subsequent activities needed to develop the resources engaged (Skarp and Gadde, 2008). Moreover, as stated by La Rocca *et al.* (2016), under certain circumstances, there may be drawbacks and risks related to customer participation in technological development, such as limiting radical product innovation, leakage of sensitive information and exposure to opportunistic exploitation.

Technological change causes disturbance to the actors' interactions and might lead to frictions and tensions (Chou and Zolkiewski, 2012; Munksgaard *et al.*, 2012) or, more strongly stated, often results in friction (Waluszewski *et al.*, 2019). Frictions and tensions emerge when developing new digital technologies as the degree of uncertainty is linked to actors' ex-ante and ex-post expectations (Dwyer *et al.*, 1987; Hadjikhani and Lindh, 2020). The concept of friction explains how radical changes, such as introducing innovations and new technologies, might be difficult due to resistance at the roots of the established relationships (Håkansson and Waluszewski, 2001). Friction influences technological development and the flow of the resources needed to develop new products (Håkansson and Waluszewski, 2003). Tensions are described as complications in resource interactions (Håkansson and Waluszewski, 2001). Frictions and tensions might arise because some actors could be against those new technologies and try to produce destructive or destabilising effects (Håkansson and Waluszewski, 2003; Rubach *et al.*, 2017). However, frictions are not negative *per se*; they might also lead to positive outcomes and nudge the actors to improve the use of their resources (Håkansson and Waluszewski, 2001). Managing frictions is a firm's crucial challenge in coping with the emerging complexities required for developing new technological solutions that fulfil the needs of buyers and users (La Rocca *et al.*, 2016).

2.2 Digital technologies and smart products

The mainstream diffusion of digital technologies for industrial purposes is related to the Industry 4.0 paradigm (Kagermann *et al.*, 2013). In particular, embedding digital technologies in products (digital transformation) leads to *smart products*, which can be monitored, optimised and controlled remotely (Lyytinen *et al.*, 2016).

Hoffman and Novak (2015, p. 14) define smart products as those that:

> [. . .] interact and communicate with themselves and each other – and with humans – on an ongoing basis by sending and receiving data through the Internet that is stored and organised in a database.

Consistent with the Industry 4.0 paradigm, smart products are usually embedded in these three types of components (Porter and Heppelmann, 2014):

1. sensors that collect data about the environment;
2. actuators that activate action and are controlled by some other entity; and
3. network connectivity that can take several forms, including WiFi, Bluetooth or RFID.

Other authors call this technological development different names: intelligent products (Meyer *et al.*, 2009), remote monitoring technology (Davies, 2004) and smart technology (Ostrom *et al.*, 2010). However, the phenomenon's principle is the same: collect real-time data to determine the status of a product and to optimise its usage and performance.

Many examples of smart products are already available, ranging from simple digital cameras to more complex products, like driverless vehicles. Smart products are essentially made of a physical part (the hardware) and a digital part (the software) (Pardo *et al.*, 2020). In this regard, Raff *et al.* (2020) distinguish four different archetypes of smart products, depending on their capabilities and the technologies embedded in them:

1. digital products – equipped with only basic hardware;
2. connected products – equipped with basic hardware and connectors;
3. responsive products – also equipped with sensors and actuators; and
4. intelligent products – equipped with AI software for learning, improving and anticipating actions.

Pardo *et al.* (2020) developed a typology of smart products based on two dimensions:

1. the degree to which the smart transformation of the product results in its additional functions; and
2. the degree of "systemness", that is, the range of stakeholders interconnected through the smart product and the resulting system that is created.

They identified four types of smart products in the B2B context:

1. more efficient products;
2. augmented products;
3. products as a node; and
4. products as a hub.

However, all these categories of smart products share a common characteristic: their material nature; smart products are first and foremost physical and combine cyber-physical elements. Thanks to technological transformation, a physical product can be repositioned within a larger ecosystem, although it remains a physical object with its usage (Pardo *et al.*, 2020). Based on the definition of Pardo *et al.* (2020), when this present study mentions smart products, it refers to those designed and manufactured by one company and used by another.

There is a broader consensus about the higher complexities generated by embedding digital technologies in existing products as they require a fundamental transformation of a firm's competencies, practices and relationships (Björkdahl, 2020). Tomiyama *et al.* (2019) identified two types of complexities: the software complexity and the process complexity of product development. In particular, the second type is related to smart product multi-disciplinarity and multi-actor nature and to the difficulties in capturing user requirements. Smart product development combines traditional product development practices with software development practices, which significantly differ from each other (Hendler, 2019). This aspect poses some challenges to firms trying to develop smart products.

Additionally, adopting digital technologies and developing new smart products might require a renovation of a firm's business model to seize emerging business opportunities (Hess *et al.*, 2016; Kreutzer *et al.*, 2017). Previous studies recognised the challenges in translating the benefits of smart products into tangible value propositions to customers (Brax and Jonsson, 2009; Westergren, 2011). Thus, Grubic and Peppard (2016) point out the need to collaborate with customers in developing smart products, arguing that only by working together is it possible to deploy the business potential of smart products, in terms of both new services and new offerings. The identification of new business models unfolds through new ways of creating value within the business network (Chesbrough and Rosenbloom, 2002; Bankvall *et al.*, 2017). The development of smart products is also related to the development of new business relationships, enabling new ways of engaging with the actors of the business network (Yaqub *et al.*, 2020).

Customer commitment and involvement seem to be fundamental enabling factors, while the best way to implement them is by educating the customers from the beginning of the process and convincing them of the benefits. In fact, customers are still sceptical about the services of new technologies (Westergren, 2011). Customers fear that data generated from smart products might be used to gain insights into their key processes. They also fear that losing control over information might lead to losing control over production (Klein *et al.*, 2018).

2.3 Framework to understand frictions in customer involvement during smart product development

Based on the presented literature, this study posits that customer involvement in smart product development might present some peculiarities as frictions might emerge among the focal firm and the network actors. The principal reasons for the emergence of frictions and tensions during smart product development could be addressed in five main areas: the technology (Aarikka-Stenroos and Sandberg, 2012), data and information sharing (Oinonen *et al.*, 2018), the typology of the relationships (Athaide *et al.*, 2019), the nature of the involvement (Forbord, 2015) and the development of a new business model (Hess *et al.*, 2016; Bankvall *et al.*, 2017).

Firstly, technology changes the nature of a firm's relationships with the actors of the business network (Pagani and Pardo, 2017). It is also well known that innovation is rarely only "technology push" (Cooper, 1983); therefore, how the firm organises technological development in collaboration with the actors might support reducing uncertainty (Lind and Melander, 2019).

Secondly, regarding data and information sharing, the seller who aims to involve buyers is advised to ensure adequate protection and disclosure of all information, data and knowledge shared by buyers and users in the technological development process (Athaide *et al.*, 2019). Moreover, as digital technologies enhance data management, the focal firm might find an unwillingness to share ideas and knowhow, a lack of mutual insights into the business scope, a lack of communication and incompatible cooperation among all partners Håkansson and Waluszewski, 2001; Munksgaard *et al.*, 2012; La Rocca *et al.*, 2016). When digital technology is embedded, customers and other actors might be keen on protecting their knowledge by not sharing relevant information (Klein *et al.*, 2018; Oinonen *et al.*, 2018). They might believe their proprietary knowledge is of particular importance, as they fear opportunism and information and knowledge leakage to competitors or other actors of the business network (Athaide *et al.*, 2019). The friction arising from data management might provide a new understanding of how digital technologies embedded in smart products might influence the interactions between the focal firm and its customers.

Thirdly, regarding the typology of relationships emerging during buyer-seller interactions for technological development, two groups emerged based on the classification of collaboration practices in innovation: development-centric and commercialisation-centric relationships (Rubera *et al.*, 2016; Athaide *et al.*, 2019). In a development-centric relationship, buyers and sellers actively aim to co-develop new products. In a *commercialisation-centric relationship*, buyers and sellers begin to interact mainly at the end of the technological development, during market launch; this type of relationship is characterised by a firm's attempts to reduce customer barriers to new product adoption and to facilitate the product's diffusion in the marketplace (Rubera *et al.*, 2016; Athaide *et al.*, 2019).

Fourthly, in line with Pardo *et al.* (2020), the present study argues that digital technology (e.g. Internet of Things [IoT]) repositions traditional products and therefore changes the involvement of customers. In line with Filieri (2013) and La Rocca *et al.* (2016), Forbord (2015) then suggested involving buyers and users later in the process, such as in the testing and commercialisation stages, to overcome the aforementioned frictions. Forbord (2015) also suggested that not involving customers could be a better solution when commercialising new products if users do not welcome certain technological features.

Fifthly, the business model concept raises new issues in technological development. Business models are frameworks that convert technological inputs into economic outputs (Ancillai *et al.*, 2023). They are shaped by the interactions among the technology, the market offering and the network architecture (Bankvall *et al.*, 2017). Digital technologies can bring changes in products, organisations and processes (Hess *et al.*, 2016). The innovation of the business model depicts the changes in how buyers and suppliers do business with each other. Digital technologies have highlighted a shift towards service innovation (Bankvall *et al.*, 2017). Physical goods are no longer enough as new value sources are found in services. Changing a business model raises several challenges, such as

changing a firm's orientation, needing new capabilities, transforming procedures and processes and addressing customers' preferences and needs (Brax and Jonsson, 2009). Based on the above discussion, this paper tries to answer the following two research questions:

RQ1. How do smart products influence customer involvement during technological development?

RQ2. How do frictions emerge from customer involvement during smart products' technological development?

3. Methodology

Considering the empirical and explorative nature of this research that aims to shed light on an underdeveloped perspective of the IMP literature dealing with customer involvement, a case study methodology is adopted, which allows an in-depth and detailed examination of the topic under analysis in its real-life context (Eisenhardt, 1989; Yin, 2014). Conducting a case study has become the primary method for industrial network research because it is deemed a suitable approach to studying business network interactions (La Rocca *et al.*, 2017).

The case is a source of the revelatory potential to observe the phenomenon in depth and extensively (Patton, 2002) as it provides unique and significant insights concerning the research objective and produces new theories. The case is particularly relevant because of the technological innovation that is somewhat unique in its specific field and the network of relationships developed with buyers and users, which comprise different actors in the network but are related and interdependent. Finally, the previous relationships lasting since more than 10 years and the proximity to the research group also granted easy access to evidence and key actors. The selected case belongs to the coffee-machine industry; this context provides interesting insights into the research on smart product development because of its network structure, where there is a differentiation between users and buyers and where the interests of different actors might be divergent. All these elements ensured the availability of information and the openness to gathering relevant data. The specific unit of analysis is the focal firm that (during the period under study) was figuring out how to manage its relationships with its customers (in terms of users and buyers) while developing new smart products. The observation and data collection period covered the beginning of 2020 until the end of 2022; however, the study's retrospective nature considers a period of almost 20 years when the focal firm attempted to develop and embed digital technologies in its coffee machines.

This study aims to shed light on the frictions emerging during the new smart product development process. The study's rationale is to analyse the frictions arising from potential divergent objectives between the focal firm and its customers when digital technologies are embedded in traditional products, such as in the case of professional coffee machines.

The study collected 12 in-depth semi-structured interviews (see Table 1) with key informants within the network (Kvale, 1997; Siggelkow, 2007). So far, almost 10 h of interviews have been gathered with six informants. These interviews were integrated with specific additional questions over time, and further key informants were identified as the research progressed. The structure of the interview protocol had three main parts. The first part was devoted to obtaining general information about the involved firms and the informants. The second part investigated how the focal firm involved customers in NPD and what the customers' role was supposed to be. The third part of the interview deepens the understanding of interactions and relationships between actors and the focal firm. Specifically, it focuses on the relationships between the focal firm and its buyers and users, including their perceptions and expectations about smart products and the effective use of technology. The interviews were recorded, transcribed, translated and edited to provide readable descriptions when possible. Some respondents were contacted informally to ask for clarification or further data. Additionally, one of the researchers had the opportunity to participate in several meetings between the focal firm and its suppliers. Another researcher's long relationship with the firm and its background allowed a thorough way of making sense of the data and information collected from primary and secondary sources. However, the names of all interviewees and companies involved are not revealed in this paper to ensure confidentiality.

Two authors conducted the interviews to ensure the comparison between the researchers and the completeness of information gathering, while the third author supported the reliability of the data analysis and the contributions. The interviews were conducted via conference calls instead of personal meetings because Italy struggled to cope with the COVID-19 pandemic. Each interview was transcribed, translated into English and analysed by each author. The results were discussed jointly to reduce subjectivity in interpreting the data and the study's implications (Eisenhardt and Graebner, 2007). In addition to the interviews, the researchers collected formal documents, magazines, market reports and corporate presentations as further secondary data to ensure triangulation with the data gathered from the key informants through interviews.

The data collection was developed using a snowball sampling process (Biernacki and Waldorf, 1981; Marcus *et al.*, 2017), where the informants were selected based on the information shared with the focal firm. All interviewees actively participated side by side with the focal firm in developing the smart product. All informants also engaged with the customers and users of the focal firm's smart products to define the products' technological requirements, fine-tune the software and gain a better understanding of the experiences of customers and users. The informants were interviewed more often when they had more information or collect information for the research between the interviews.

The data collection process did not foresee the direct interaction with customers as a specific imposition of the focal firm, which was linked to confidentiality reasons regarding the new product. In fact, because of the specificity of the case, where the firm had buyers and users among different business actors, it aimed to protect the innovation by not interacting with them to discuss the new product. However, the study's results are equally robust as it presents the perspective of the firm and the frictions it managed according to the commercialisation of the new smart product where it chose to

Table 1 Data collection

No.	Date	Position	Firm	Interview duration (min)	Data support
1	12 January 2021	Marketing manager	Focal firm	60	notes
2	26 January 2021	Operation manager	Focal firm	60	tape + notes
3	28 January 2021	Operation manager	Focal firm	45	tape + notes
4	5 February 2021	Electrical engineer	Focal firm	50	tape + notes
5	5 February 2021	Marketing manager	Focal firm	35	tape + notes
6	26 February 2021	Electrical engineer	Focal firm	30	tape + notes
7	1 March 2021	University professor	Univ2	45	tape + notes
8	1 April 2021	Sales	Supplier 1	40	tape + notes
9	28 May 2021	R&D engineer	Supplier 2	30	tape + notes
10	3 November 2021	Sales	Supplier 1	45	notes
11	5 November 2021	Marketing manager	Focal firm	30	notes
12	12 December 2022	Marketing manager	Focal firm	60	tape + notes

minimise the customers' involvement. The researchers recognise that the lack of the customer perspective represents a study's flaws and an opportunity to develop further the assumptions made in this paper.

3.1 Data analysis

The research adopted an abductive approach through the systematic combining methodology to analyse the data (Dubois and Gadde, 2002). The abductive approach fits the research goal of exploring and highlighting a rather new phenomenon in its real context (Corbin and Strauss, 2014). This methodology aims to match reality and literature through a non-linear, iterative process of analysis that consists of going back and forth between data and theory to produce new insights and gain a novel perspective. Thus, both researchers were involved in unfolding the research process. In analysing the case, the processual perspective and timing supported the understanding of how the events unfolded (Pettigrew, 1992; Langley, 1999) during the product development and how the different actors of the business network that participated in the process contributed to the focal firm in developing the new product.

Adopting the abductive approach allowed the researchers to identify the emerging themes during the customers' involvement in smart product development. The themes and dimensions were outlined through constant notes and interview transcript comparisons with the literature. Combining the insights from the interviews with the literature background framework allowed the development of new potential theoretical contributions to the IMP literature. First, the data gathered through the interviews and meetings with the informants were coded and reduced into themes. The literature on customer involvement and frictions in technological development, as presented in Subsection 2.3, was used. Through the comparison of the literature, particularly the potential sources of frictions in the case of high-technology products, transcripts and notes from the interviews were analysed to isolate the themes – and, therefore, the chunks of interviews depicted in Appendix 1 – that were consistent with the literature background of the study. The relevant chunks of text were then analysed to develop the common themes, which constituted the friction dimensions. Common themes were depicted through the constant comparisons between the most frequently recurring chunks of text and the literature; Appendix 1 also shows the number of occurrences for each theme/dimension (Miles and Huberman, 1994; Dubois and Gadde, 2002).

4. The coffee-machine context and the case profile

The coffee industry is one of Made in Italy's most important businesses. It is composed of an articulated system of firms operating at different levels of the supply chain: green coffee importers and trading companies, coffee roasters, coffee-machine producers, bars, coffee shops and other points of sales in the Ho.Re.Ca. segment (acronym of hotel, restaurant and catering. It refers to coffee shops, restaurants, pubs, fast-food chains, wine shops and so on). The Italian coffee industry involves more than 1,000 companies employing about 7,000 workers. Total revenues in 2018 exceeded €4bn, of which €1.35bn came from exports. Italy is the third-largest importer of green coffee (behind the USA and Germany) and ranks third worldwide (after Germany and Belgium) for export volumes of coffee in all its forms (IlSole24Ore, 2019; Beverfood, 2020). The global professional coffee-machine business was worth more than €1bn in 2018, with a 9.4% compounded average growth rate, accounting for more than 390,000 machines sold that year. With their share (more than €590m) of the total market (CoffeeBI, 2020), Europe and Russia have the highest demand for coffee machines. A basic professional coffee machine costs around €1,750.00, while a fully automatic machine – which can provide more than 250 cups of coffee per day – costs around €2,650.00 (CoffeeBI, 2019). However, the Italian business for coffee machines is worth only €60m, making it mandatory for Italian producers to export their machines. Producing a total turnover of more than €430m (Borsa Italiana, 2017), 34 coffee-machine producers represent the flagship of Made in Italy.

Regarding the case profile, since 1936, Alpha (the focal firm's pseudonym) has produced and commercialised professional coffee machines. The firm had a turnover of €70m and 150 employees in 2020. It is worth about 10% of the global coffee-machine business. It is also one of the most innovative coffee-machine firms worldwide. Alpha's commercialisation processes involve three types of actors: distributors, large buyers (coffee roasters, coffee shop chains and fast-food chains) and users (small coffee shops). These actors usually choose Alpha because of its machines' reliability and coffee quality in terms of taste and consistency

throughout the day. Alpha buyers are large coffee shops that sell more than thousands of coffee cups daily or luxury coffee shops looking for cutting-edge quality and taste. These relationships are managed through key account managers for large buyers, while relationships with the users are managed indirectly using distributors, sales agents and Web platforms. These ties allow the firm to have preferential access to customers' information, perceptions and expectations on how they would like to operate coffee machines. Alpha constantly interacts with the users of the coffee machines through its post-sales service. During technical support interaction, Alpha understands users' needs, identifies flaws and improvements and asks them to test new components and features. In addition to customer involvement, developing smart products also entailed the participation of technology suppliers and universities (see Figure 1). These two types of actors were considered key informants as they played a crucial role in supporting one side of the focal firm's technological development.

5. Case findings

The interviews with several informants made it possible to reconstruct the technological development of smart products in Alpha – the focal firm. That process was divided into three macro-phases, as illustrated below.

5.1 From early 2000s to 2019: seminal phase

The firm's attempts to integrate digital technologies into coffee machines dating back to the early 2000s when the focal firm began to study how to install a remote-control system in existing products. In 2013, the firm developed the first smartphone app for the remote control of coffee machines and data management. At that time, even though those technologies improved the coffee quality and performance of the coffee machines, the users (bartenders and coffee shop owners) were not ready to understand those potentials and therefore did not use them. Furthermore, back then, data management and real-time information were immature technologies (smartphones' diffusion, connection speed and computing power were lower then than now), and they found no support from users. Consequently, the firm decided to put the project on the shelf for future applications.

5.2 From 2019 to 2020: Internet of Things technology phase

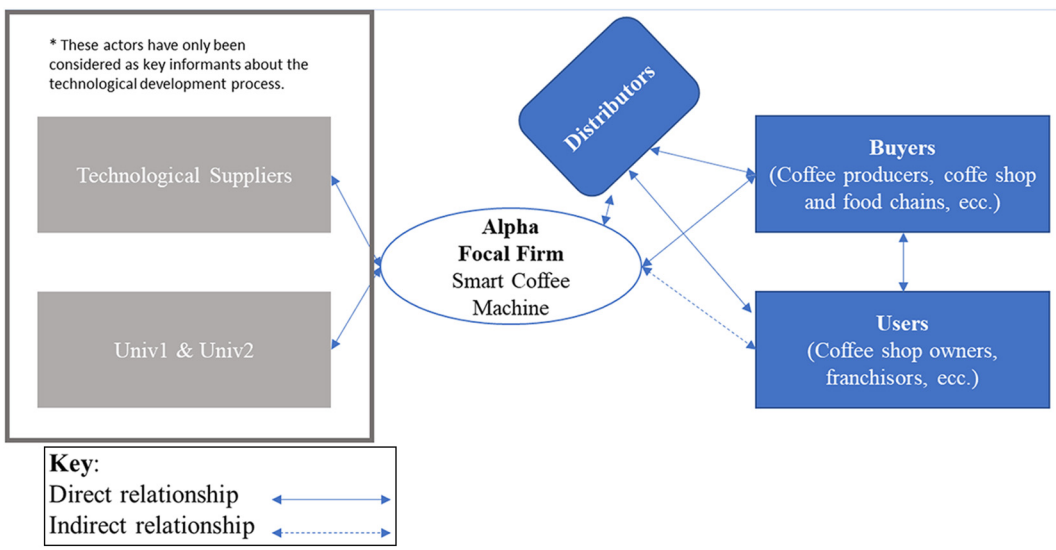
The firm has invested around €2.5m in developing digital technologies to embed in coffee machines. The firm began the development of a new technological infrastructure embedded in coffee machines to obtain data remotely, based on the Industry 4.0 and IoT paradigms. The technology's purpose was to develop a predictive maintenance system based on the existing data management technology; the coffee machine became capable of self-detecting failures and hazards to self-protecting and alerting users and the technical support department. This technology allowed Alpha to provide better services to users and to improve the effectiveness of the post-sales operations.

Buyers and users had not been involved directly in technological development until the product had been shown at a national fair. There, Alpha showed the first prototype of the smart coffee machine – a traditional machine with an embedded IoT system and a tablet to have real-time monitoring of working parameters, with the specific aim of collecting customers' feedback to understand the potential of innovation. Even though the fair generated positive impressions about the new machine, the enthusiasm needs to deal with the users' real willingness to adopt it.

5.3 From 2020 to present: testing and commercialisation phase

This phase entails commercialising smart coffee machines embedded with new sensors and algorithms. The algorithms oversee all the automation for data management, early failure detection, monitoring of the parameters of the coffee machine and delivery of indications to the users to obtain the best coffee possible. Before commercialisation, Alpha showed concerns about sharing the new machines with customers and was keen on maintaining its new machines "secret" as long as possible.

Figure 1 Overview of Alpha's smart product business network



As declared by the marketing manager, "Only some things are tested without revealing the overall product to the users".

As suggested by the informants, the firm asked customers to test the products in the real context to evaluate the robustness of the technology for remote control, the early failure detection system and coffee quality improvement. These field test were deployed with the support of a selected portfolio of Ho.Re.Ca. actors. The customers involved were selected worldwide to test the machines under very different conditions, while the data were collected using cloud technologies.

Therefore, as the operation manager stated, the development has mainly comprised customers involvement in reporting defects and performing field tests. However, this does not mean that Alpha has developed the technology without any customer knowledge because, despite its indirect relationships with buyers and users, the firm continuously gathers information from them in many ways through its academy, experience centre, e-learning platform, business relationships with agents and distributors and technical assistance and post-sales service. As stated by the marketing manager:

> Our process is not structured; we carry out checks and events with customers. There are exchange and collaboration, we have drawn from their experience, but it is not structured, and there is no precise method behind it.

The firm's long experience in producing and commercialising coffee machines worldwide for more than 90 years has allowed it to gather a large amount of knowledge about users. Moreover, Alpha does not have a direct relationship with all buyers and users but relies on agents and distributors. As mentioned by the marketing manager:

> We are still in close contact with customers. We know them and involve them. Even if there is no express request or direct contact, there is always interaction. There is always a basic involvement on our initiative or theirs; they are always involved.

It is worth noting that most of the requests for innovation are linked to large accounts managed directly by the focal firm. "We have developed a custom project with direct involvement; this happened mainly with 3–4 among food and coffee chains and coffee roasters", said the Marketing Manager. However, the Univ2 professor suggested that customers had not been sufficiently involved: "The B2B customer was little involved, [as for] the B2C [business-to-customer] – not at all".

As mentioned, the new digital technologies allow capturing relevant data, which might become further resources for Alpha and sources of further business opportunities. Unfortunately, buyers and users are not keen on sharing and letting Alpha collect and exploit those data through its smart coffee machines. Alpha's marketing manager argued:

> The machine allows you to know a lot of things. Above all, the food and beverage chains are jealous of the data. They do not want to share the data on coffees and time slots because, from these data, you could understand if the coffee shop is doing good business and works well. Business performance could be indirectly detected.

In other words, these companies (both users and buyers of the coffee machines) are afraid that all the information that the focal firm gathers from the machines' sensors might be used against them for any reason.

After one year of field tests (according to the marketing manager, approximately 170 machines and hundreds of customers were involved), the project manager admitted that Alpha had not yet defined how data gathered from the smart coffee machines would be exploited. There are mainly two causes of this situation. Firstly, the new smart coffee machine is more expensive than the previous one because of the new technology embedded. Secondly, technology enables the firm to navigate new ways of doing business because of the data, but the firm has no clear clues yet on how to make the most of those new ways enabled by digital technologies. According to the operation manager, "We are wondering how to sell services and data (which are very expensive to store), so we want to understand how to develop this business model". In other words, the focal firm has not yet formalised how to exploit the business potential enabled by the new smart coffee machines. Furthermore, as noted by the marketing manager, the commercialisation strategy is still under validation. Besides, the Univ2 professor seemed puzzled about this aspect, claiming, "It is not clear whether the service is paid or not; they do not know if the customer might be willing to pay for this new service or not".

Additionally, several interviewees stated that the use of the data gathered was not taken for granted, as many customers showed some form of reluctance because they would like to exploit their data but were unwilling to share them with third parties. Moreover, coffee machine users have always been analogically oriented instead of digitally oriented– because of the nature of their business, the high turnover and the low seniority of the front-line operators – and therefore, reluctant to adopt new technologies. Certain technologies have emerged to be highly discouraged, such as touchscreen buttons that easily become dirty and are less practical to use with gloves or wet hands.

As suggested by the focal firm's informants, the users of coffee machines are not yet ready for a technological shift as they are still more focused on the output (good coffee) and the machine efficiency (reliable over time, considering the need to provide more than thousands of coffee servings per day). These facts are also highlighted by suppliers who meet users during the testing and data collection. The operation manager said, "The bartender is conservative. For example, the touchscreen technology is not accepted; you always want to press the button". For these reasons, the marketing manager believed that users were not yet ready for this kind of innovation: "There was no interest from customers; very often, it was a 'dead letter'. They were not interested in this technology; they were not ready to use it". He was also convinced of the need to wait and see because not all users responded similarly:

> Over time, situations evolved; some customers started to show interest. These were large chains already using the previous technology. But we have to wait; the product was launched only few months ago.

Nonetheless, as evident from the most recent fair in late 2022, the embedding of digital technology in coffee machines is becoming common among coffee-machine producers. The informants claim that first sales have been made, and the demand is rising as they engage their long-time partners in using this new generation of coffee machines.

The analysis clearly reveals that the process deployed by Alpha has focused more on the technological development of

coffee machines than on customers' insights. In other words, the process started from the focal firm's technological ambition instead of beginning with a gap to fill in terms of customers' needs and desires. The marketing manager suggested:

> We are developing a technology that does not stem from customers' demands; it is very pushy. We have chosen to move forward because we believe that innovation is made this way. If you wait for customer demand, it is too late. You have to try to read it in perspective.

Alpha's marketing manager explained, "At first, we aimed to develop the new technology, then we analysed which product might be embedded to fit buyers' requirements". He added, "We did not begin from a need of the customers or users". On top of that, Alpha's operation manager said, "The project was a top-down decision from the management". He also pointed out that customer involvement was deliberately limited to avoid the risk of "losing traction" during the product development process by following all the potential users' requests. The marketing manager said:

> The risk is that each customer is a bearer of interests and that his objectives lead the company astray. For this, the company must have its own vision of the future.

He explained, "We did not start from an analysis of the market but from the sensitivity to the potential it can have as an appealing [prospect] in the market". He added, "The role of the customer was mostly passive. The input came from us; the idea came from us. We only interfaced to test some features".

6. Theoretical implications

Analysing the Alpha case allows for generating theoretical implications for customer involvement in developing new smart products and the friction arising from it, contributing to the IMP literature on technological development interactions. The theoretical implications are presented according to the two research questions of this study.

6.1 RQ1. How do smart products influence customer involvement during technological development?

The case describes a focal firm aiming to develop a smart product with the opportunity to offer new services. The study also provides new insights concerning the vast literature on innovation and customer involvement. The findings suggest that Alpha smart coffee machines' technological development has witnessed limited customer involvement (La Rocca *et al.*, 2016). The case unpacks how users and buyers were mainly involved in the machine trial and testing (Filieri, 2013; Forbord, 2015). Therefore, the interactions with users and buyers during the development process were enacted only to test specific features related to fine-tuning new technology. Buyers and users were mainly involved in reporting defects and testing the product. In contrast to Grubic and Peppard's (2016) suggestion, the case does not provide evidence of interactions among the focal firm, buyers and users at the earlier stages of the new product development process. Therefore, any discrepancies in the technological needs between customers and the focal firm could be ignored because of the limited early involvement of customers (Laage-Hellman *et al.*, 2014; La Rocca *et al.*, 2016). The potential influence of the smart product's technological development on customer involvement is then discussed.

Firstly, in line with Pardo *et al.* (2020), this study highlights the role of the focal product as an object with its specific usage and the users' expectations that are almost exclusively related to the core function of that product. As suggested by Björkdahl (2020), it is also worth noting that the core function of the coffee machine does not change as a consequence of embedding digital technology, and customers are keener on having good coffee instead of playing with data or the latest technological fancy. Hence, by observing the case of Alpha, this study argues that when a smart product does not change the core functions of the traditional product, customer involvement could be limited to testing and validating the developed solution. The study posits that customer involvement during smart product development is largely indirect as there is more emphasis on technology development, as the product *per se* does not change its main functions (Skarp and Gadde, 2008; Pardo *et al.*, 2020).

The involvement of the customers – both buyers (distributors and large companies) and users (bartenders or coffee shop owners) – in the final stages of technological development could also be aimed at minimising tensions (Håkansson and Waluszewski, 2003; Filieri, 2013; Forbord, 2015; Rubach *et al.*, 2017). The case suggests that friction might emerge when embedding IoT technologies, bringing new features that are neither requested nor welcomed by customers (Skarp and Gadde, 2008; Filieri, 2013; Forbord, 2015). Thus, customer involvement in the final stages allowed the firm to develop the smart product without the customers' distorted opinion of the product and its features (Forbord, 2015; Rubach *et al.*, 2017). Therefore, the study suggests that a smart product calls for "commercialisation-centric relationships" (Rubera *et al.*, 2016; Athaide *et al.*, 2019). The evidence suggests that the later involvement in the commercialisation and field tests for data gathering (Filieri, 2013; Forbord, 2015; La Rocca *et al.*, 2016) has become possible due to the customers' profound knowledge and use of the machine developed over more than 90 years of coffee-machine production.

6.2 RQ2. How do frictions emerge from customer involvement during smart products' technological development?

The theoretical implications stem from analysing the data collected according to the literature with the systematic combining approach. The framework illustrated in Section 2.3 allows for identifying the friction and its main dimensions. Appendix 1 shows different chunks of interviews for each dimension, as well as the key informant for each chunk and how many chunks have been identified for each dimension. The study has identified 57 chunks of interviews for the five dimensions. The theoretical implications are discussed in the following paragraphs. Abductively analysed according to the abovementioned theory and scrutinised through the theoretical lens of the IMP background, the case suggests that in a smart product's technological development, the actors show divergent interests and perspectives, particularly between the focal firm and buyers/users. Such divergence gives rise to friction – with the coffee machine as the focal resource – which emerges from the interface of digital technology (Baraldi, 2008). Because the product's core functions remain the same (e.g. making good coffee), the technology (in this case, the IoT

technology) becomes the interface where friction arises (Baraldi, 2008; Håkansson and Waluszewski, 2003). In particular, the friction unfolds through five dimensions presented and discussed below (see Figure 2). From the focal firm side, the identified dimensions of friction are its approach to innovation, the nature of the relationships with buyers and users and the need to look for new business models. From the user side, the dimensions are the reluctance to share data and the unwillingness or low readiness to adopt new technologies embedded in coffee machines.

6.2.1 Nature of relationships with buyers and users

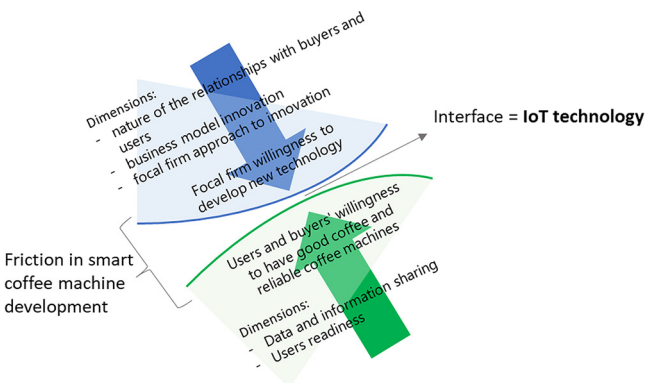
The study posits that managing the relationships with users mainly through post-sales and technical assistance services might create a distance between the firm and the users from the perspective of technological development. The evidence suggests that the focal firm has developed several initiatives, such as its academy, experience centre and e-learning platform (Gressetvold and Torvatn, 2006; La Rocca *et al.*, 2016), to avoid incurring the risks of missing details on how users and buyers perceive the new smart product (Codini, 2015). There is also the need to consider that Alpha has almost 90 years of knowledge in producing coffee machines and about coffee machines' users. This profound knowledge about customers allows the firm to rely on insightful information to manage smart product development without their formal involvement during the earlier stages (Rubera *et al.*, 2016; Athaide *et al.*, 2019).

The case suggests that the buyers that usually demand and interact in technological development are large firms (Coffee producers, food and coffee chains) with direct business relationships with the focal firm. Therefore, even if the focal firm continuously engages the participation of buyers and users to gather their knowledge and insights, most are not directly linked with the focal firm during the technological development (Sabatini *et al.*, 2020).

6.2.2 Data and information sharing

According to data and information sharing, the study uncovers two main issues related to the friction emerging from the technological interface. These are the reluctance to share sensitive business information on the users' side and the fear of innovation leakage on the focal firm's side. The focal firm aims to embed digital technologies, but the customers are reluctant

Figure 2 Friction's dimensions regarding customer involvement during smart product development



to use them. The key informants suggest that customers are unwilling to share their data (Oinonen *et al.*, 2018) for fear of losing control over information (Klein *et al.*, 2018) as these might be leaked from other firms or used against them. Thus, customers appear uninterested in the smart product's new digital features. On the focal firm's side, in line with Athaide *et al.* (2019), the study reveals that involving customers in the testing stage has been deemed a functional practice to prevent innovation leakage. The focal firm did not want to share the new product before commercialisation, and during field tests, the customers could not see the entire product but only some individual components (La Rocca *et al.*, 2016; Oinonen *et al.*, 2018). Therefore, on both sides, their fear of opportunism (Athaide *et al.*, 2019; Pardo *et al.*, 2020) has fuelled the emergence of friction and increased the divergence among the actors involved.

6.2.3 Business model innovation

The firm's efforts in technological development still have few effects on its business model (Bankvall *et al.*, 2017). The study contends that when adding new technologies and features, the business model should be updated and changed accordingly (Brax and Jonsson, 2009; Westergren, 2011; Hess *et al.*, 2016). However, the case provides novelty because, despite the firm's completion of the development of the new technology and the commercialisation of the smart product, it still lacks a clear clue on how to change the business model accordingly.

In the case of smart coffee machines, the present study suggests that digital technology provides add-on features that do not call for radical change in the existing product and can thus be avoided while using the product (Pardo *et al.*, 2020). At this point, friction emerges because if customers avoid using new features, are they willing to pay for them (Håkansson and Waluszewski, 2003)? The mismatch between the focal firm's expectations and the users' willingness challenges the firm regarding renovating its business model (Dwyer *et al.*, 1987; Brax and Jonsson, 2009; Kreutzer *et al.*, 2017; Hadjikhani and Lindh, 2020). Therefore, when developing a smart product, the development of a new business model should not be taken for granted (Brax and Jonsson, 2009; Westergren, 2011) but should be recognised as part of technological development.

6.2.4 Focal firm's innovation approach

The focal firm has developed a *technology push* process (Cooper, 1983) because of its belief that it is the best way to gain an advantage over competitors. Alpha also believes waiting for buyers' and users' requests for new technology might limit the firm's business potential. Hence, the focal firm began the development based on a top-down decision, not by involving buyers and users (La Rocca *et al.*, 2016). Moreover, they have aimed to fulfil their vision regarding technological development and avoid the risk of following several different user requests. This approach relates to the friction between the technology and the buyers' and users' needs (Håkansson and Waluszewski, 2003).

Furthermore, in line with Pardo *et al.* (2020), even though the focal firm put relevant efforts into developing the new technology, making good coffee is still the ultimate desire of customers when looking for a new machine. Another reason for the limited customer involvement is the firm's strong belief in its smart machine's business potential. Further reasons for the

firm's approach to innovation are its aim to avoid generating false expectations about the new product and – as suggested by Alpha's marketing manager – its customers' lack of awareness of what they want and what technology can do for them (Grubic and Peppard, 2016), as well as users' rejection of certain features (Forbord, 2015). Therefore, the study contends that in the case of smart products, a technology-push approach might be preferable to a collaborative one (Cooper, 1983; Lind and Melander, 2019) to avoid the negative effect of emerging friction.

6.2.5 User readiness

Technological development also causes disturbance in the case of smart products, creating friction between buyers and users (Chou and Zolkiewski, 2012; Munksgaard *et al.*, 2012). The uncertainty related to the novelty tends to frighten users who look for features that do not change (Dwyer *et al.*, 1987; Hadjikhani and Lindh, 2020). Users are still more interested in the machine's output (making "perfect" coffee) than in the technology. In fact, similar to Pardo *et al.* (2020), this study argues that customers are primarily interested in using the product and its main purpose rather than the embedded technology. The complexities related to smart product development (Tomiyama *et al.*, 2019) call the users to embrace changes they might not be ready for, giving rise to friction in the technological interface. Hence, in the case of a smart product, although it does not change its core functions, changes in the technological setting have always been a source of friction (Håkansson and Waluszewski, 2003).

6.3 Managerial implications

This study also has implications for managers. Considering the specificities of a smart product as one that does not change its core function, the new functionalities added by digital technologies (IoT in this study) change the extent of customer involvement and cause friction. In this case, the study suggests that managers opt for customers' later involvement that allows better technological development management, hence adopting the commercialisation-centric approach. Therefore, when embedding digital technology in an existing product, and the technology does not change the product's core functions (as observed in the case of coffee machines), buyers' and users' roles can be limited to field tests and trials. However, analysing the friction in the technology's interface and its five dimensions calls the managers' attention. The digital technology itself becomes the interface where friction arises. Managers should be aware of the double face of technology – opportunity and threat. Besides identifying the five dimensions of friction, this paper enhances managers' capabilities to recognise the central issues to manage for facilitating technological development. Furthermore, managers willing to develop smart products could use this study's contribution as a framework for working on the five dimensions of technological friction and the unfolding of the technological development process.

7. Conclusions

This paper aims to shed light on how the development of smart products influences customer involvement during technological development and how frictions emerge during the same process. The study considers the perspective of the coffee-machine producer and its network of actors, where business relationships are established. It offers a new perspective on friction, as discussed in the IMP literature, by scrutinising a case of smart product development. However, the research also suggests paying high attention to certain issues that risk hindering the development and commercialisation of smart products.

Answering the first research question, the study emphasises that because embedding digital technology in existing products does not change their nature, the process presents certain specificities. In terms of technological development in interaction, in line with Forbord (2015) and La Rocca *et al.* (2016), the study proposes that for smart product development, buyers' and users' later involvement might be a better solution for the commercialisation of the smart coffee machine. Hence, smart product development requires the focal firm to establish a commercialisation-centric approach (Rubera *et al.*, 2016; Athaide *et al.*, 2019), focusing on customer involvement in the last stages of technological development. The study suggests that this customer involvement approach is possible due to Alpha's previous knowledge about buyers and users, as it has been commercialising coffee machines for over 90 years. This profound knowledge about buyers and users allows the firm to possess insightful information for smart product development without the early involvement of the customers.

The second research question relates to the friction emerging during smart product development. The study argues that such friction arises from the different levels of willingness between the focal firm and its users and buyers. The focal resource is the coffee machine, and the interface where the friction arises is in digital technology; in this case, the focus is on IoT technology. Whereas the focal firm is willing to develop new smart products, the users and buyers are still attached to the quality of the coffee and the use of a reliable machine over time more than being keen on adopting the new technological features of the smart machine. The study highlights five dimensions of friction between the focal firm and the users arising from technological development. These have been identified as the nature of the relationships with buyers and users, data and information sharing, business model innovation, the focal firm's innovation approach and users' readiness. These five friction dimensions are not necessarily negative because they offer new insights into the areas where the focal firm needs to focus attention when developing smart products.

This paper does not provide a processual and dynamic view of the phenomenon but unfolds the different dimensions of friction when developing smart products. Thus, the emerging friction is crystallised over time. It is also possible to believe that, in the future, users might change their approach to smart coffee machines – as digital technology continues to permeate people's lives – making them more relevant than ever. Finally, the study contends that technological integration into a standard product might change how customers are involved in technological development. Therefore, the focal firm might limit customer involvement to late testing activities avoiding friction during the technological development of smart products in which the technology is embedded and does not affect their core functions.

However, this study has limitations as it risks providing insights that are limited in scope and specific to the context. Although qualitative studies are increasingly adopted to shed light on new and ongoing phenomena, they are still context-specific and limited in scope as they observe a single focal actor. Unfortunately, due to the decision of the focal firm, the study lacked the opportunity to consider the customers' perspectives, which might have added further information to shed light on such a complex phenomenon.

This paper calls for further studies to uncover how this phenomenon unfolds in other cases; in particular, it could be interesting to explore if any differences emerge, considering standard smart products or smart products made according to the buyers' specific requirements. Therefore, further research that considers buyer and user perspectives is recommended. Potentially, multiple and comparative case studies are also welcomed to appreciate the differences and analogies among various settings and to provide new insights into the literature. From a broad perspective, the embedding of new technologies is still increasing. This paper's authors believe that the issue of how firms manage to create new products and services with the involvement of their customers remains a major concern for academics and practitioners.

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Appendix

Table A1

Label	No. of chunks	Chunks from interviews
Nature of the relationships with buyers and users	11	[OpMan] "The end user customer was involved for some field tests in the field" [EleEng] "We started the field tests which will last 6 months for the study of the data and 6 months for the optimisation. The field tests will be carried out with selected customers, the main selection criteria are proximity and comfort, they are all local" [MarkMan] "to carry out the field tests we need structures equipped to be able to understand the instrument and who know how to interface with experimental projects. There are no guarantees of the functionality of the machines and you must be aware and prepared to do these activities" [SalSup1] "In the part of the field tests there was a collaboration of end customers and other collaborators located in different locations with different usage habits. This project should have taken place earlier, but despite being done ex-post it has maintained its significance" [EleEng] "There was a study on the defects and on the reports that came from the customer" [EngSup2] "We gave pumps sensorized to the company so they were tested around the world and in a few months, so as to have data on performances in the field. So we can know how long our pumps last in real conditions and provide answers to other customers as well" [MarkMan] we are still in close contact with customers, we know them and involve them. Even if there is no express request or direct contacts, there is always interaction. There is always a basic involvement, either on our initiative or theirs, they are always involved [MarkMan] "the 'superautomatic' world is where the market is reactive in these things here, even for the bi-directional communication of data. The technician or manager changes the setting of all machines. On traditional machines which have a separate coffee machine, there are less automatisms and therefore bi-directional communication is still not particularly useful" [MarkMan] We have developed custom project where there was a very direct involvement, this happened mainly with 3–4 among food and coffee chains and coffee torrefactors [MarkMan] "they provide the specifications. Either they just made a request for information like shopping list, I need the machine to communicate with this protocol. In some other cases there was a confrontation at the level of technical offices, they started with technical offices which then developed ad hoc things" [MarkMan] "in the case of retail chains, they still use the cash register system, without the need for a coffee machine to register any data. Those who have to run the café are satisfied with the cash register"
Data and information sharing	10	[MarkMan] "The machine allows you to know a lot of things. Above all, the food and beverage chains are jealous of the data, they do not want to share the data relating to coffees and time slots, because from these data you could understand if the coffee shop is good and if it works well. Business performance could be indirectly detected" [MarkMan] "Only some things are tested without revealing the overall picture" [MarkMan] "The large customers (chains) have not been involved because there is a talk of industrial secrecy in the development phase" [MarkMan] "The smart product is our idea that takes a long time to develop and anticipating this could have a boomerang effect. Both in terms of expectations and secrecy" [SalSup1] "The predictive maintenance project had the objective of introducing technology in a non-invasive way, without modifying the current electronics and mechanics. An external observation system was created using a sensor platform for data acquisition with an algorithm whose goal is to anticipate the breakdown of components" [MarkMan] "When Apple made the iPad, there was a risk that the market would not does it acknowledge? There is always risk behind every business decision. There is no certainty that technology will be accepted by the market, this exists only in the abstract of the theoretical world. The technology itself has no value, it must be aimed at something, there are some performances that help the customer" [MarkMan] "the use of this information has both a management nature, such as sales volumes or the intensity of machine use and time comparisons, linked to aspects of fault and abnormal signaling, and therefore able to recognise alarm signals. Monitoring of the constancy of the quality of coffee provided by the machine"

(*continued*)

Table A1

Label	No. of chunks	Chunks from interviews
		[MarkMan] "By cross-referencing certain parameters, we are able to understand whether there is any consistency in the quality of the coffee being delivered by the machine, which allows us to assess anomalies at the staff or equipment level"
		[MarkMan] "continue to do things as they have been done. The case of the torrefactor is where the torrefactor must ask its customer to read the data of his activity. This is not that everyone is allowed to share this information, there is a strong aspect of privacy"
		[MarkMan] "a large part of this information is for technical aspects and to have a warning for the technician to optimise assistance and use"
Business model innovation	5	[OpMan] "We are wondering how to sell services and data (which are very expensive to store), so we want to understand how to develop this business model"
		[OpMan] "We are convinced that we can sell services - such as predictive maintenance - aimed at lengthening the machine life cycle"
		[MarkMan] "the business model we will apply has not yet been defined"
		[ProfUni2] "it is not clear whether the service is paid or not, they do not know if the customer might be willing to pay for this new service or not"
		[MarkMan] "we have developed the whole platform we sell with a subscription system. Started only a few months ago. There are no significant case numbers. In prospect we think that the availability and sensitivity for this service will increase"
Focal Firm innovation approach	25	[OpMan] "The project was driven by the development of technology. . . . It is a world where there are conflicts of this type. We as a company have pushed a lot because we believe in it a lot"
		[OpMan] "The technological development part started in 2018, even if some primordial works had already been done before"
		[EleEng] "we at the technical level decide how and where to direct the forces for a new machine or a new component. The specifications are defined by the technical department"
		[EleEng] "in the case of predictive maintenance, through a market research we assessed that AI and 4.0 were of interest for our context. Furthermore, we saw that we did not have well-defined statistics regarding product failures but we knew how much it cost us to manage the entire support process. From there we have defined the components with the highest defects. So, we implemented sensors and algorithms to develop the power of predictive maintenance. The machines are not yet ready to be marketed, but ready to be set up and start the field tests"
		[EleEng] "On the one hand, the project was born to follow the fashion of big-data, on the other hand to meet the needs of customers and improve the quality of service. The customer wants the machine that works for him and calls assistance as little as possible"
		[EleEng] "For the company's DNA, we focus a lot on technological innovation, first we metabolise within the company then we propose to customers"
		[MarkMan] "Knowing the market made it possible to understand which technologies could be applied"
		[MarkMan] "the project was a top decision, from the management"
		[MarkMan] "the risk is that each customer is a bearer of interests and that his objectives lead the company astray. For this, the company must have its own vision of the future"
		[MarkMan] "at first, we aimed to develop the new technology, then we analysed which product might be embedded to fit buyers' requirements"
		[EleEng] "The customer wants the machine that works for him and calls assistance as little as possible"
		[EleEng] "Most of the needs are with a minimum common denominator: maybe *large chain customer* has different needs from the roaster or a bar that focuses more on product quality. But the quality of the coffee and the machine is a common point"
		[MarkMan] "We did not start from a market need. Indeed, we were forerunners. We wanted to explore a potential need before we were actually asked and/or other competitors went to work on it first. Knowing the market made it possible to understand which technologies could be applied"
		[MarkMan] "we did not start from an analysis of the market but from the sensitivity on the potential that it can have as an appealing in the market"
		[ProfUni2] "with customers they only spoke to us them and for me a little. Never done focus groups which in my opinion is essential. Here they should improve"
		[ProfUni2] "The b2b customer was little involved, the b2c nothing"

(*continued*)

Table A1

Label	No. of chunks	Chunks from interviews
		[SalSup1] "As far as I know the customers were involved in the end, first we worried much more to understand how and why to collect data from these machines and how, then we thought about whom to use these machines"
		[EngSup2] "I don't know if the company had a clear vision of customers, I think so"
		[MarkMan] "the role of the customer was mostly passive, the input came from us, the idea came from us, we only interfaced to test some functionalities"
		[MarkMan] "the development of catalog products requires customer involvement different from those on order"
		[EleEng] "the design of a new product starts from a market research that is done by those who travel on a commercial or technical level and try to understand how customers' needs change"
		[MarkMan] "our process is not structured, we make checks and events with customers, there is exchange and collaboration, we drew on their experience, but it is not structured and there is no precise method behind it"
		[MarkMan] we are developing a technology that does not stems from customers demand, it is very push. We have chosen to move forward because we believe innovation is made this way. If you wait for customer demand, it's too late. You have to try to read in perspective
		[MarkMan] "otherwise, you have to do the pull logic, which is a follower's and not an innovator's logic. It is clear that everything is born out of a deep knowledge of the market, it's not as if you woke up in the morning and go. But being innovator means that"
		[MarkMan] "field test to collect data to understand how problems occur. We have done 170 machines, so a hundred customers. Of various types, it's a thing we're doing on our own initiative, so we're interested in having a complete panorama. We're driving this and we're not following a market queries. We expect data to be processed by the algorithm. We do not expect market feedback but only technical feedback"
Users Readiness	6	[OpMan] "The bartender is conservative, for example, the touchscreen technology is not accepted, you always want to press the button"
		[MarkMan] "few customers are using this technology. The market is not ready yet. We are already prepared"
		[MarkMan] There was no interest from customers, very often it was a "dead letter". They were not interested in this technology, they were not ready to use this technology
		[MarkMan] "the market is poorly receiving. Because those who needed it have taken the step. Because in reality it is focused on point-of-sales management or the sales network, there are many devices that must converge and not just one"
		[MarkMan] Over time situations evolve, some customers started to show some interest. These are large chaines which were already using the previous technology. But we have to wait, the product have been launched only few months ago
		[MarkMan] "in 2017 we changed the device, now it's a less expensive gateway that has lowered the barriers and only uses wifi. Then now we have redone another platform launched a few months ago that we are proposing and still there is not much interest. Lukewarm market"

Notes: Informants' Keys: OpMan = Alpha's Operation Manager; MarkMan = Alpha's Marketing Manager; EleEng = Alpha's Electrical Engineer; SalSup1 = Supplier 1 sales account; ProfUni2 = University "2" ProfessorEng; Sup2 = Supplier 2 Engineer

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