Has COVID-19 changed interaction in brick-and-mortar stores? A study on self-checkouts

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ABSTRACT

The COVID-19 pandemic means a major disruption in brick-and-mortar stores. Customer-Facing InStore Technologies (CFIST) perception may be modified as new requirements and concerns arise when interacting in the physical space. Through surveys conducted before and after the COVID-19 lockdown, this study brings relevant findings about the impact of the pandemic in the retailer perception of a specific CFIST technology, Self-Checkout systems (SCO). We used a simplified adoption framework including a new construct, *Safety to Use*, to analyse the impact of health concerns in CFIST. Results show that both *Perceived Enjoyment* and *Safety to Use* are relevant predictors of the *Attitude towards SCOs*, and that *Retailer Perception* is strongly influenced by the *Attitude towards SCOs*. This study is one of the first to study the impact of COVID-19 in retail technology. Results can help to improve the deployment of this technology after the pandemic and may be extended to other CFIST technologies, setting new avenues of research for technology adoption scholars.

Keywords: Self-Checkout, COVID-19, Self-Service Technology, Brick-and-Mortar

INTRODUCTION

The retail sector has been suffering an important transformation in the last few years, mainly due to the disruption generated by e-commerce (Lal and Chavan 2019; Hagberg *et al.* 2016). Although retailers have embraced the omnichannel business, implementing e-commerce or click and collect services, there is still an important part of the business generated in the physical space (Clement, 2019; Sheth, 2021). Customers expect improved experiences in the brick-and-mortar stores, that help them to buy quicker and with a higher satisfaction and control (Spanke, 2020; Wilson, 2013). Customer Facing In-Store Technologies (CFIST) (Betzing *et al.*, 2018; Shankar *et al.*, 2020) play a major role in the evolution of the experience for two main reasons. First, customers are increasingly improving their technological skills in all aspects of their life and are used to interact with the environment digitally, expecting retailers to follow them (Baier and Rese, 2020). Parasuraman (2000) states that any kind of customer experience, satisfaction,

or loyalty, is mediated by the impact of technology. Second, CFIST bring benefits to retailers as they improve the information of the customer interactions, optimize supplies related processes, and integrate their online and offline channels through digitalization (Grewal *et al.*, 2020; Hänninen *et al.*, 2021).

Unfortunately COVID-19 has worsened the situation, generating a major disruption of the physical retail environment (Pantano *et al.*, 2020). Stores were fully closed in several countries. Once reopened, stores have faced important modifications of the customer experience. Health related measures, like social distancing, temperature screening, or single person entry, to name a few, impacted heavily in the shopping experience (Purcărea, 2020; Surendra and Lakshmi, 2020). As some of the consumers perceptions and beliefs will stay in the long term, once the pandemic is controlled (Roggeveen and Sethuraman, 2020a), it is relevant to review the impact of COVID-19 in the way that customers perceive and adopt CFIST technologies.

The objective of this work is to answer the following questions: Are there differences of perception about Self-Checkout (SCO) technology before and after the COVID-19 lockdown? Will health and safety become relevant to predict CFIST adoption? Our research will analyse SCO technology in grocery stores. Among the different retail subsectors, grocery is following a slower pace of e-commerce adoption than others (Bauerova, 2019; Dannenberg *et al.*, 2020; Statista, 2022), due to the perception of customers that some products as meat or vegetables need to be seen and chosen by themselves (Zorzini 2018; Kühn *et al.* 2020), making CFIST more relevant. Among the different technologies, scholars consider SCO a relevant solution in this environment (Lee and Yang, 2013; Rivera *et al.*, 2021).

This work delves into the customer's perception of SCO technology in grocery stores before and after the pandemic. Through a survey conducted in March 2020 and repeated in June 2020 (before and after the lockdown), we analyse the differences in attitude towards use and retailer patronage, including the criteria of health risk for the post-pandemic survey. To the best of our knowledge, this is the first work to include health risk as an attribute in technology adoption model, so our results bring unique findings for both SCO adoption and the impact of health risk in technology usage, opening several avenues of research for the post pandemic retail experience.

The rest of the document is structured as follows: In the next section we set the theoretical grounds of our research, analysing the existing literature of SCO and the situation that COVID-19 has created in retail. We then develop in the third section the conceptual model that we use for the empirical analysis in the fourth section. We discuss our results in the following section, and finish our paper with relevant conclusions, recommendations, and new avenues of research.

2. THEORETICAL BACKGROUND

2.1 OVERVIEW OF SELF-CHECKOUT TECHNOLOGIES

A Self-Checkout (SCO) may be defined as a system that "enables customers to place their merchandise on the counter and scan the items on their own, at the end of their shopping trip and after waiting in a checkout line" (Djelassi *et al.* 2018, p. 41). The first SCO was installed in 1992 in Price Chopper Supermarkets (Inman and Nikolova, 2017). SCOs are generally considered as a Self Service Technologies (SST), but such category is heterogeneous from adoption perspective due to its breadth, as it includes also mobile apps, ATMs or e-services (Kaushik and Rahman, 2015; Meuter *et al.*, 2000). For the purpose of our work, we follow the extant literature that includes SCOs as a CFIST technology (Balaji *et al.*, 2018; Grewal *et al.*, 2020; Kim *et al.*, 2017; Roggeveen and Sethuraman, 2020b; Roy *et al.*, 2017; Vojvodić, 2019; Willems *et al.*, 2017) as CFIST have their specificities from a customer adoption perspective (Lee 2015; James 2014; Djelassi *et al*, 2018; Inman and Nikolova 2017).

The installation of SCOs has steadily increased in the last decade and keeps its pace (Grand View Research, 2022; James, 2014; Thomas-Francois and Somogyi, 2022). SCOs offer to retailers several benefits, as improved efficiency, decreased costs, or increase productivity (Kazancoglu and Kursunluoglu, 2018; Lee and Lyu, 2016). It has also a positive impact in customer experience and a growing percentage of customers prefer to use them (Kats, 2020;

O'Shea, 2019; Statista, 2019). From an experience perspective, SCOs are a key element in the overall customer experience that leads to satisfaction and loyalty to brands (Chiguware, 2022; Verhoef *et al.*, 2009) and gives more control to consumers (Demoulin and Djelassi, 2016). The usage of SCO speeds up checkout and reduce waiting time in queuing (Kokkinou and Cranage, 2013; Vannucci and Pantano, 2019), but it changes also the feeling of the time spent as it turns a passive activity (queuing) into an active activity (scanning and packing) (Marzocchi and Zammit, 2006). Only specific profiles of customers are reluctant to their use, as they expect human interaction instead of a machine interaction (Chen *et al.*, 2021; Jackson *et al.*, 2014). SCOs are an appropriate option to evaluate technology adoption, as they are broadly deployed and therefore a majority of people has used them. Furthermore, all SCOs have very similar characteristics, reducing perception bias (Lee *et al.* 2013).

2.2 ADOPTION OF SELF-CHECKOUT TECHNOLOGIES

Although there is extant literature about SST adoption (Kallweit *et al.*, 2014; Liang *et al.*, 2021a; Rinta-Kahila *et al.*, 2021) and CFIST adoption (Inman and Nikolova, 2017; Betzing *et al.,* 2018; Lorente-Martínez *et al.,* 2020), only few of the studies focus specifically on grocery SCO systems and the impact they have in customer's perception of the service, and this field is considered understudied by scholars (Fernandes and Pedroso, 2017; Inman and Nikolova, 2017), although it is raising interest in the last years. The literature available highlights four main findings that affect SCO adoption. First, the quality of the SCO implementation is key to customer satisfaction and customer loyalty (Demirci Orel and Kara 2014; Lee *et al.* 2009; Collier and Kimes 2013; Fernandes and Pedroso 2017). Second, personality and personal traits impact in the perception and adoption of SCOs (Lee and Leonas, 2021; Lee and Lyu, 2016; Liang *et al.*, 2021b). Third, past usage and experience is a better predictor of SCO use than actual intention (Demoulin and Djelassi, 2016; Lee, 2015; Simões *et al.*, 2022). Fourth, the perceived control, as a facilitating condition, boost the intention to use them (Fernandes and Pedroso, 2017; Le *et al.*, 2022). Other studies address the attitude towards co-producing a service as a predictor of positive attitude to use the service (Eastlick *et al.*, 2012; Thomas-Francois and Somogyi, 2022), the favourable ethical acceptance of SCOs (Fullerton *et al.* 2017), the social acceptance of its usage (Kinard *et al.* 2009) or the perceived enjoyment (Demoulin and Djelassi, 2016; Lee and Leonas, 2021) . Situational factors like order size, wait-time tolerance or the presence of other customers or employees have been also found as having a strong influence in SCOs decisions (Collier *et al.*, 2015; Yi and Kim, 2017). Only two studies addressed perceived risk related with SCOs adoption, but did not found any relationship (Jeon *et al.*, 2020; Kazancoglu and Kursunluoglu, 2018). Furthermore, the questions asked to assess risk were related with the malfunction of the system rather than health or safety dimensions.

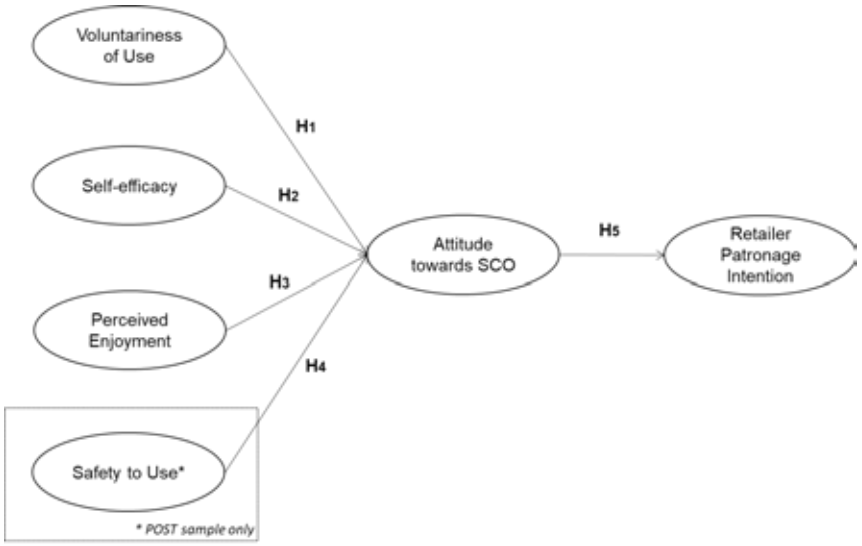
2.3 IMPACT OF COVID-19 IN CUSTOMER EXPERIENCE

The full impact of COVID-19 in the society is still to be estimated as the pandemic continues, but the reality is already devastating (Nicola *et al.*, 2020). Consumer's psychology has been dramatically impacted (Dvorak *et al.*, 2021; Kirk and Rifkin, 2020) and it is difficult to anticipate what perceptions will last in the long term. In disruptive events, the first behavioural changes are connected to safety (Donthu and Gustafsson, 2020; Roggeveen and Sethuraman, 2020a). Grocery stores implemented several measures to protect health that impacted in customer experience, like social distancing, sanitizer usage, temperature screening, announcements, time limits, or contactless payments (Martin-Neuninger and Ruby, 2020; Surendra and Lakshmi, 2020). Contactless interactions are becoming more relevant in the customer experience, not due to their convenience but to their safety; social distancing will accelerate online retailing but also non-human interactions in the physical space (Chang, 2021; Kirk and Rifkin, 2020). Brick-and-mortar grocery stores will still play a relevant role in the future (Babin *et al.*, 2021; Dannenberg *et al.*, 2020; Grashuis *et al.*, 2020) and therefore we can anticipate the relevance of self-service solutions like SCOs to avoid contact.

3. CONCEPTUAL MODEL

The main goal of our research is to see how CFIST technology adoption may be impacted by COVID-19 and how the emergent concern about safety can impact in customer's perception. Taking survey data from ongoing research prior to the pandemic, we simplified the research framework and conducted a second survey once the lockdown was finished, including health risk related questions. Such framework, that can be seen in Figure 1, was then analysed before and after the COVID-19 lockdown (March and June 2020). We have not based our simplified framework in a specific model but in specific constructs frequently present in the literature and relevant for our research question. According to Fernandes and Pedroso (2017), there is no evidence of a widely accepted model for SST adoption. Although TAM (Davis, 1989) is broadly used to explain technology adoption (Kallweit *et al.* 2014), it cannot explain completely SCO adoption (Curran and Meuter, 2005), as SCO technology aggregates self-service adoption characteristics (Kelly *et al.*, 2010). Another work suggests that perceived usefulness, a relevant component of TAM, is not relevant for SST technologies (Dabholkar and Bagozzi, 2002).

FIGURE 1:
PRE AND POST RESEARCH MODELS



3.1 VOLUNTARINESS OF USE

Customers must perceive the value gain of using SCOs (Hilton *et al.*, 2013). They will decide to use them if they obtain clear benefits beyond the interests of the retailer (Fernandes and Pedroso, 2017). The perception of SCOs and self-service in general is heavily influenced by customer personality (Jackson *et al.* 2014; Lee *et al.* 2010; Lee and Lyu 2016). As personality traits cannot be controlled by retailers, forcing customers to use SCOs may reduce patronage and increase technology anxiety (Lee, 2015). *Voluntariness of use* is a moderating variable of the UTAUT model (Venkatesh *et al.*, 2003), and may is defined as whether or not a customer may choose to use the technology (Rawstorne *et al.*, 2000). It becomes relevant in a post COVID-19 scenario, as the pandemic has modified the capacity of stores, increased waiting times, and forced contactless transactions, reducing customer choices at checkout (Surendra and Lakshmi, 2020). According to this, we state:

H1: *Voluntariness of Use* **has a positive impact in** *Attitude towards SCO***.**

3.2 SELF-EFFICACY

Self-efficacy is well grounded in technology adoption theories (Bandura, 1978) and is related to the confidence of having the skills to use the technology and appears positively related with satisfaction in the literature (Demoulin and Djelassi 2016; Wang *et al.* 2013). A similar description appears in the literature for perceived control (Fernandes

and Pedroso, 2017), showing also a positive relationship with attitude and repeated patronage (Wang 2012). Another related concept, technology anxiety, defined as the fear to use technology, appears as a strong reverse predictor of SCOs usage (Meuter *et al.*, 2003; Oyedele and Simpson, 2007). Self-efficacy and the lack of technology anxiety improve perceived control (James, 2014) that leads also to satisfaction (Marzocchi and Zammit, 2006), supporting the relationship among them. Self-efficacy becomes then a relevant comparison element between the PRE and POST COVID-19 scenarios. Therefore, we state that:

H2: *Self-efficacy* **has a positive impact in** *Attitude towards SCO.*

3.3 PERCEIVED ENJOYMENT

Perceived Enjoyment is the perception of a customer that the usage of a technology is enjoyable, and is related with the hedonistic reasons to use the technology (Wang, 2012). Several studies relate positively perceived enjoyment with SST adoption: It increases satisfaction and delight (Collier and Barnes, 2015; Fernandes and Pedroso, 2017; Marzocchi and Zammit, 2006), reduces anxiety (Wang, 2012), increases service quality perception (Demirci Orel and Kara, 2014), and is a better predictor of SST adoption than usefulness (Jones *et al.*, 2006), making it a valuable construct for the analysis of PRE and POST COVID-19 scenarios. Therefore, we propose the following:

H3: *Perceived Enjoyment* **has a positive impact in** *Attitude towards SCO***.**

3.4 SAFETY TO USE

We define *Safety to Use* as the perception of individuals that their health is safe when using the technology. Although there is no precedent of usage of this construct for technology adoption, the concept is well grounded by previous research. COVID-19 has forced several safety measures and new consumers perceptions (Surendra and Lakshmi, 2020; Zwanka and Buff, 2020), and customers will most likely put safety first in their new behaviours (Donthu and Gustafsson, 2020; Hahm *et al.*, 2019). Furthermore, previous studies did include perceived risk as relevant construct for technology adoption, defined as the perception of potential negative consequences when adopting a specific technology (Roy *et al.*, 2017). Although perceived risks related with SCO have been more of social and performance nature, (Dabholkar *et al.*, 2003; Kazancoglu and Kursunluoglu, 2018; Meuter *et al.*, 2005), and have being found as non-relevant for SCOs (Eastlick *et al.*, 2012), we expect customers to evaluate any future interaction in the physical space considering the potential risks for their health due to contagion. Therefore, we state that:

H4: *Safety to Use* **has a positive impact in** *Attitude towards SCO.*

3.5 ATTITUDE TOWARDS SCOS AND RETAILER PATRONAGE INTENTIONS

There is extant literature relating attitude with technology adoption. Attitude is a very common antecedent of intention in adoption models as TAM (Davis, 1989), and can be regarded as a full mediator of intention in CFIST technologies (Kim *et al.* 2017; Lee *et al.* 2006; Kim and Forsythe 2007). Literature shows a positive impact of SCOs adoption in retailer patronage intentions and vice versa. Inman and Nikolova (2017) suggested that the behavioural intention to use CFIST technologies are mediated by the perception of the retailer. According to Lee (2015), customers prefer to shop in retailers where the option to use SCO is available, and this creates an halo effect, creating a positive attitude towards SCOs. Patrons are more satisfied with the store when they use SCOs (Djelassi *et al.*, 2018). Customers perceive SCOs as an element of the overall experience and therefore they associate positive usage of SCOs with retailer patronage (Fernandes and Pedroso, 2017). According to this, we state the following:

H5: *Attitude towards SCO* **has a positive impact in** *Retailer Patronage Intention***.**

4. METHODOLOGY

4.1 INSTRUMENT

An ad hoc online survey was developed using the Qualtrics survey platform to empirically test the conceptual model, as there was no standardised instrument for the scope of the research. Online survey is the most frequent methodology used in technology adoption literature (Choudrie and Dwivedi, 2005). Some of the advantages of conducting it online are wider geographical reach, reduced costs and quicker response times (Lee and Yang 2013). The survey consisted of 17 items, including questions about age, gender, and previous experience. An explanation of the SCOs including a picture was presented prior to the questions. Scales were adapted from existing literature, modifying the wording to adapt it to the context. The list of items and their origin can be found in Table 1.

TABLE 1:
INSTRUMENT

Variable	Item		Source (adapted)
Voluntariness of Use	VOL_1	I can decide to use the Self-Checkout or not in the places where I buy	Venkatesh *et al.* (2003)
Self-Efficacy	SEE_1	I believe that using Self-Checkout is a task I can perform well	Lee&Lyu (2016)
Perceived	PEE_1	Shopping using Self-Checkouts is more interesting	Demirci Orel&Kara (2014)
Enjoyment	PEE_2	I enjoy using Self-Checkouts	Fernandes&Pedroso (2017)
	PEE_3	It is fun to check out the items yourself	Fernandes&Pedroso (2017)
Safety to Use	SAF_1	Self-Checkouts are not risky as they reduce the physical contact	Kazancoglu *et al.* (2018)
	SAF_2	Self-Checkouts are not risky as they allow social distancing	Kazancoglu *et al.* (2018)
	SAF_3	Overall, using Self-Checkouts is not risky	Meuter *et al.* (2005)
Attitude	ATT_1	As a customer, Self-Checkout are Ineffective - Effective	Lee&Lyu (2016)
towards SCO	ATT_2	As a customer, Self-Checkout are Impractical - Practical	Lee&Lyu (2016)
	ATT_3	As a customer, Self-Checkout are Not helpful - Helpful	Lee&Lyu (2016)
Retailer	RPI_1	I prefer groceries that have Self-Checkouts	Lee (2015)
Patronage	RPI_2	I will shop again in stores with Self-Checkouts	Lee (2015)
Intention	RPI_3	I would recommend a store with Self-Checkouts to a friend	Lee (2015)

A five-point Likert scale, from “Totally agree” to “Totally disagree” was used, except for characterization questions (age, gender, and previous experience) and *Attitude towards SCO* (semantic differential, e.g., positive / negative). To make results more easily understandable, we reversed all scores such as low values represent disagreement and high values represent agreement with each statement. Items were presented in a random order to each respondent to avoid bias. A pilot study was conducted. The preliminary version of the PRE questionnaire was tested on 30 consumers that were requested to give extra feedback about the clarity, length or meaning of the items, that led to wording modifications. Due to the differences of *Safety to Use* (new variable in the POST questionnaire) with previous literature, an extra validation was done in two steps. First, 10 individuals were requested to suggest modifications to existing literature questions. Then, the questions were presented to other 10 individuals asking them to suggest the purpose of such questions, confirming that the items represented safety related topics.

Regarding common method bias, we took different measures, both procedural and statistical, to minimize risks. As mentioned above, we first conducted a two-step pilot study to make sure that items were clear in order to avoid ambiguous items and, therefore, participants’ reliance on systematic response tendencies such as a midpoint response style. Second, the questionnaire was anonymous to reduce social desirability. Third, items were randomly presented to participants. Fourth, we ascertained that Variance Inflation Factors (VIF) were lower than 3.3 as the occurrence of greater values is considered in PLS-SEM an indication of pathological collinearity and potential contamination of the model by common method bias (Kock, 2015). Regarding validity, we calculated for all the variables the Average Variance Extracted (AVE) values (Table 5). The AVE value for each variable represents the amount of variance that is captured by the construct in relation to the amount of variance due to measurement error (Fornell and Larcker, 1981). All AVE values are above the recommended threshold of 0.50, showing that the variance captured by the construct is larger than the variance due to measurement error, which is an indicator of good convergent validity. In order to assess the constructs’ discriminant validity we applied the Fornell and Larcker’s (1981) criterion, this is, $\sqrt{AVE}$ values for each variable in the model are greater than the correlations with the other study variables. These measures exhibit discriminant validity. Construct validity of the measures allows us to rule out substantial method effects. Last, reliability coefficients (Cronbach’s alphas and composite reliability) range between 0.69 and 0.93 (see Table 5), close to or over the recommended value (0.70).

4.2 SAMPLE AND PROCEDURE

Field work was conducted in two moments: March 2020, before COVID-19 lockdown in Spain (PRE sample), and May-June 2020, once the lockdown finished (POST sample). PRE field work did not include the *Safety to Use* variable, as at that moment there was no forecast of the reach of the pandemic; this variable (three items) was included for the POST field work. In both cases, the snowballing procedure was used, as it is considered effective in the literature specifically for self-service technologies (Considine and Cormican, 2017). Social networks were also used to distribute the survey.

The demographic composition of PRE and POST samples is presented in Table 2.

TABLE 2:
DEMOGRAPHIC COMPOSITION OF PRE AND POST SAMPLES.

PRE sample				POST sample			
	Variables		%		Variables		%
TOTAL	n_{PRE}	416		TOTAL	n_{POST}	286	
	Gender	Male	52.9		Gender	Male	49.0
		Female	47.1			Female	51.0
	Age	18 – 25	3.4		Age	18 – 25	1.4
		26 – 35	7.9			26 – 35	5.6
		36 – 45	18.8			36 – 45	22.4
		46 – 55	52.6			46 – 55	55.2
		56 – 65	11.8			56 – 65	11.5
		> 65	5.5			> 65	3.8
No SCO previous experience	n_{PRE0}	11	2.6	No SCO previous experience	n_{POST0}	16	5.6
	Gender	Male	81.8		Gender	Male	37.5
		Female	18.2			Female	62.5
	Age	18 – 25	0		Age	18 – 25	0
		26 – 35	0			26 – 35	0
		36 – 45	18.2			36 – 45	0.3
		46 – 55	27.3			46 – 55	43.8
		56 – 65	9.1			56 – 65	25.0
		> 65	45.5			> 65	31.2
SCO previous experience	n_1	405	97.4	SCO previous experience	n_2	270	94.4
	Gender	Male	52.1		Gender	Male	49.6
		Female	47.9			Female	50.4
	Age	18 - 25	3.5		Age	18 - 25	1.5
		26 - 35	8.1			26 - 35	5.9
		36 - 45	18.8			36 - 45	23.7
		46 - 45	53.3			46 - 55	55.9
		56 - 65	11.9			56 - 65	10.7
		> 65	4.4			> 65	2.2

The PRE sample consisted of 416 participants (52.9% male, 47.1% female). Data were collected between March 5th and March 14th, 2020, before the enactment of the lockdown in Spain. As high as 97.4% (n_1 = 405 participants) had used SCOs before. Although we found some differences between users and non-users in their responses, the number of non-user's responses was too small to reach conclusions. Comparison between male and female participants only resulted in significant difference in one item "I will shop again in stores with Self-Checkouts" (RPI_2; male, n = 220: M = 3.12, SD = 1.16; female, n = 196: M = 2.85, SD = 1.11; t = 2.43). Regarding age groups, we found differences only in four items: "I believe that using Self-Checkout is a task on which I can perform well" (SEE_1; $F(5, 410) = 3.72$, p = .003), "Shopping using Self-Checkouts is more interesting" (PEE_1; $F(5, 410) = 3.39$, p = .005), "I enjoy using Self-Checkouts" (PEE_2; $F(5, 410) = 3.54$, p = .004), and "As a customer, Self-Checkout are Not helpful - Helpful" (ATT_3; $F(5, 410) = 2.34$, p = .041). In general, participants over 65, and in some cases aged 55-65, showed slightly lower scores than younger participants.

The POST sample consisted of 286 participants (51% female, 49% male). Data were collected between May 5th and June 22nd, 2020, once lockdown was lifted in Spain. 94.4% (n_2 = 270 participants) had used SCOs at least once, in line with the PRE sample. Comparison between genders only resulted in significant differences in two items: "I enjoy using Self-Checkouts" (PEE_2; male, n = 140: M = 3.16, SD = 1.23; female, n = 146: M = 3.48, SD = 1.26; t = -2.14), and "I will shop again in stores with Self-Checkouts" (RPI_2; male: M = 3.04, SD = 1.19; female: M = 2.74, SD = 1.18; t = 2.17). Finally, no differences were found regarding age groups.

In subsequent analyses, we focused on the data of those participants who had previous experience in SCOs (n_1 = 405 and n_2 = 270). The number of participants is similar to other SCOs studies (Demoulin and Djelassi, 2016; Fernandes and Pedroso, 2017).

4.3 DATA ANALYSIS

Descriptive statistics (mean values, standard deviations, mean comparisons) were calculated using SPSS software (Statical Package for Social Science). Data were further analysed using Partial Least Squares Structural Equation Modelling (PLS-SEM), which is useful in case complex mediation models are analysed with a large number of indicators and relationships (Hair *et al.*, 2017). SmartPLS v3.0 software was used (Ringle *et al.* 2015).

5. RESULTS

First, we compared data gathered in the PRE and POST samples at item level (Table 3), only using data from participants who had previously used SCOs (n_1 = 405 and n_2 = 270). Participants showed statistically higher agreement to the following statements in the PRE sample: "I can decide to use the Self-Checkout or not in the places where I buy" (VOL_1) and "As a customer, Self-Checkout are Ineffective - Effective" (ATT_1).

Next, the mean scores and correlations between the variables were analysed. Table 4 shows participants scored moderately high on *Attitude towards SCO*, both in the PRE sample (PRE: M = 3.78, SD = 1.13) and in the POST sample (POST: M = 3.68, SD = 1.14), and moderately on *Retailer Patronage Intention* (PRE: M = 3.33, SD = 1.05; POST: M = 3.25, SD = 1.09). All the correlations between the study variables were significant and positive.

TABLE 3:
ITEM COMPARISON BETWEEN PRE AND POST SAMPLES.

		PRE (T1)		POST (T2)			
		M	*SD*	*M*	*SD*	*t*	*p*
Voluntariness of Use	VOL_1	4.04	1.12	3.80	1.33	2.449	.015
Self-Efficacy	SEE_1	4.63	0.73	4.66	0.70	-0.570	.569
Perceived Enjoyment	PEE_1	3.12	1.23	2.98	1.19	1.523	.128
	PEE_2	3.36	1.34	3.36	1.23	0.000	1.00
	PEE_3	3.76	1.29	3.69	1.29	0.731	.465
Safety to Use	SAF_1	-	-	4.23	1.03		
	SAF_2	-	-	3.15	1.20		
	SAF_3	-	-	3.70	1.24		
Attitude towards SCO	ATT_1	4.11	1.13	3.92	1.23	2.087	.037
	ATT_2	3.86	1.24	3.79	1.19	0.745	.457
	ATT_3	3.38	1.41	3.35	1.41	0.246	.806
Retailer Patronage Intention	RPI_1	3.54	1.24	3.42	1.23	1.219	.223
	RPI_2	2.99	1.15	2.91	1.20	0.793	.428
	RPI_3	3.45	1.23	3.40	1.26	0.481	.631

Note. n_1 = 405 and n_2 = 270.

TABLE 4:

DESCRIPTIVE STATISTICS AND CORRELATIONS BETWEEN STUDY AND CONTROL VARIABLES BY TIME OF PARTICIPATION (PRE / POST).

	PRE (n_1 = 405) M (SD)	POST (n_2 = 270) M (SD)	1	2	3	4	5	6	7
1. Voluntariness of Use	4.04 (1.12)	3.80 (1.33)	-	.20**	.16**	.20**	.15*	.20**	-.02
2. Self-Efficacy	4.63 (0.73)	4.66 (0.70)	.20***	-	.27***	.35***	.28***	.23***	-.07
3. Perceived Enjoyment	3.41 (1.14)	3.34 (1.05)	.24***	.32***	-	.71***	.75***	.76***	.06
4. Safety to Use	-	3.70 (0.91)	-	-	-	-	.69***	.76***	-.11
5. Attitude towards SCO	3.78 (1.13)	3.68 (1.14)	.31***	.32***	.80***	-	-	.78***	-.04
6. Retailer Patronage Intention	3.33 (1.05)	3.25 (1.09)	.29***	.27***	.73***	-	.76***	-	-.09
7. Gender (1=male, 2=female)	1.48 (0.50)	1.50 (0.51)	.07	-.07	.05	-	.02	-.08	-

Note. Means in bold denote significant differences between PRE and POST participants at $p < .05$. Zero-order correlations below the diagonal correspond to PRE participants; zero-order correlations above the diagonal correspond to POST participants. *$p < .05$. **$p < .01$. ***$p < .001$.

In evaluating and reporting the results to test our hypotheses, we accomplished a two-step analysis following the guidelines on partial least squares structural modelling (PLS-SEM) proposed by Hair *et al.* (2017). First, the measurement models were assessed (including validity and reliability). Second, we evaluated the structural model (this is, to what extent *Voluntariness of Use*, *Self-Efficacy*, and *Perceived Enjoyment* allowed predicting *Attitude towards SCO* to adopt technology and this, in turn, *Retailer Patronage Intention*). We used the bootstrapping procedure and selected 5,000 samples (no missing data; *Safety to Use* was only measured in the POST survey).

For both the PRE and the POST samples, the relationship between each indicator and its corresponding construct was significant ($p < .001$; except for *Voluntariness of Use* and *Self-Efficacy*, comprised by a single item respectively). All of the indicators' outer loadings were above the critical value of .70 (Table 5). Average Mean Extracted (AVE) values achieved the recommended threshold, .50 and composite reliability values were over .60 (Bagozzi and Yi, 1988). Overall, these results support internal consistency and convergent validity of the study variables.

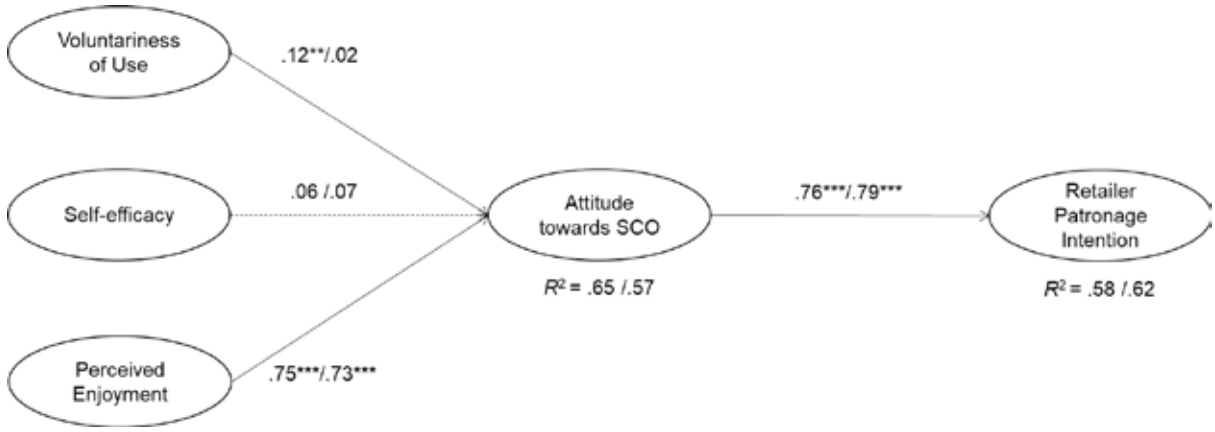
TABLE 5:
MEASUREMENT MODELS: RELIABILITY AND CONVERGENT VALIDITY FOR PRE AND POST SAMPLES.

		PRE ($n_1 = 405$)				POST ($n_2 = 270$)			
Latent variable	Item	λ	ρ_c	α	AVE	λ	ρ_c	α	AVE
Voluntariness of Use	VOL_1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Self-Efficacy	SEE_1	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Perceived Enjoyment			.91	.86	.78		.88	.80	.72
	PEE_1	.88				.85			
	PEE_2	.90				.84			
	PEE_3	.87				.85			
Attitude towards SCO			.92	.88	.80		.93	.88	.80
	ATT_1	.89				.90			
	ATT_2	.92				.90			
	ATT_3	.86				.89			
Retailer Patronage Intention			.91	.84	.76		.92	.86	.78
	RPI_1	.90				.89			
	RPI_2	.82				.84			
	RPI_3	.89				.92			
Safety to Use		-					.83	.69	.62
	SAF_1	-				.68			
	SAF_2	-				.83			
	SAF_3	-				.83			

Note. λ = outer loading. ρc = composite reliability. α = Cronbach's alpha. AVE = Average Mean Extracted.

Figure 2 depicts the relationships between the different variables considered for both the PRE and the POST samples. Before comparing both groups (PLS-SEM multigroup analysis), measurement invariance was tested. The MICOM (measurement invariance of composite models) procedure (Hair *et al.*, 2018) consists of three steps. First, configural invariance was successfully established as measurement models, structural model, and algorithm settings are identical for both groups. Second, compositional invariance assessment showed permutation *p*-values were larger than .05, so compositional invariance was established for all the variables. Third, measurement invariance was examined. No significant differences were found in the composite mean values and composite variances of variables across the two samples, except for *Voluntariness of Use.* Therefore, we conclude that the PRE and POST composite mean values and variances were equal regarding *Self-Efficacy, Perceived Enjoyment, Attitude towards SCO*, and *Retailer Patronage Intention*, but differed in the case of *Voluntariness of Use*. Consequently, full measurement invariance was not established.

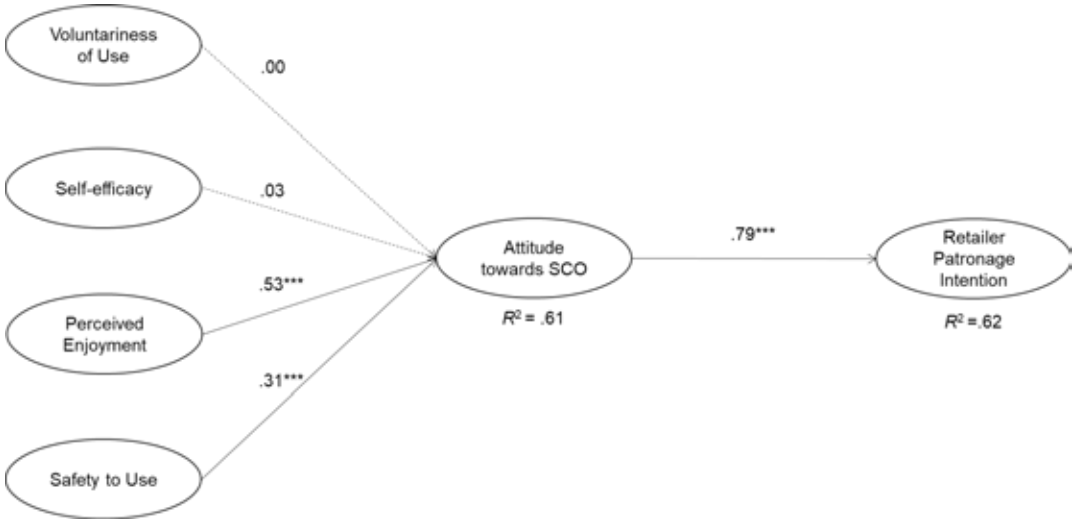
FIGURE 2:
PRE (LEFT VALUES) AND POST (RIGHT VALUES) STRUCTURAL MODELS.



Note. Dotted lines: Non-significant paths. ***p* < .01. ****p* < .001.

Finally, we retested the model including *Safety to Use* (only considering the POST sample, Figure 3). Internal consistency and convergent validity of the constructs were adequate (specifically for *Safety to Use*: λ_{SAF_1} = .68, λ_{SAF_2} = .83, λ_{SAF_3} = .83; composite reliability = .83; Cronbach's alfa = .69; Average Mean Extracted = .62). The addition of this new variable slightly improved the variance explained of *Attitude towards SCO* to 61.2%, and no changes were found in the explained variance of *Retailer Patronage Intention* (61.9%). Although the most relevant variable continued to be *Perceived Enjoyment*, it reduced its strength (β decreased from .73 to .53). *Safety to Use* appeared as the second relevant variable, while *Voluntariness of Use* and *Self-Efficacy* remained non-significant.

FIGURE 3:
POST STRUCTURAL MODEL INCLUDING SAFETY TO USE.



Note. Dotted lines: Non-significant paths. ***p < .001.

6. DISCUSSION

The field research of the present work consists of two samples taken with a difference of three months. Such period is too short to register significant differences in technology adoption unless a disruptive event happens, such as COVID-19. Indeed, in the interval between surveys, the pandemic reached its peak and participants endured a lockdown of fifty days in their homes. Our research shows similar results for PRE and POST samples, except for the construct *Voluntariness of Use*, which was slightly significant in the PRE model but not in the POST model after lockdown. As shown in Table 3, both samples show a statistical difference in the answer to the question "I can decide to use the Self-Checkout or not in the places where I buy", probably related with the change to local grocery stores during the pandemic, as consumers strongly reduced their movements and malls were partially closed. In such convenience stores there is a smaller penetration of SCOs and therefore customers responded based on the lack of systems where they were buying. The lack of relevance of *Voluntariness of Use* may be explained by the instrument used to test the model. In previous studies voluntariness was measured by on site surveys and therefore the respondent had just used the SCO (Demirci Orel and Kara, 2014; Demoulin and Djelassi, 2016; Fernandes and Pedroso, 2017). In our case, as respondents answered the online survey based on their previous experiences, results allow to intuit that they mixed different experiences, with and without voluntariness, to answer the questionnaire.

Results show a significant, strong, and positive link between *Perceived Enjoyment* and *Attitude towards SCO* in both samples, showing the importance of *Perceived Enjoyment* as antecedent of *Attitude towards SCO*. This finding is consistent with previous works that relate enjoyment with SCOs adoption in different ways. Demoulin and Djelassi (2016) found that enjoyment is not only an antecedent of perceived ease of use in an extended TAM3 model, but also a direct predictor of technology usage. Enjoyment is the strongest effect on service quality, and service quality on intentions, in Dabholkar's work (1996). Emotive reaction plays a major role in consumer reaction, and this role is enhanced by the introduction of risk perception in the adoption. Besides the support that this finding has in existing literature, our results go one step beyond as they show that, contrary to our hypothesis, *Self-Efficacy* is irrelevant in our model, allowing us to state the predominance of enjoyment over control, supporting the notion mentioned above of emotion over cognition as driver of consumer behaviour. SCOs users participate in the creation of the service (Pantano *et al.* 2018; Eastlick *et al.* 2012), reduce their queuing time (Collier *et al.*, 2015) and improve their social reputation (Kinard *et al.*, 2009), increasing their level of satisfaction and creating a feeling of entertainment. Although this feeling cannot be reached if there is a lack of service quality or complex processes (Lee *et al.*, 2009), our simplified model shows a prevalence that has important managerial and theoretical implications.

As the main objectives of our study, *Safety to Use* was introduced in the POST survey and resulted in a relevant variable in the model with also a positive and strong link to *Attitude towards SCO* (POST: β = .31, $p < .001$). This result shows the influence of the pandemic in the results and is from our perspective the biggest contribution of this study to technology adoption theory. The analysis of the POST model with and without *Safety to Use* shows the impact on *Perceived Enjoyment*, that stays as the most relevant antecedent of *Attitude towards SCO* but reduces its influence (from β = .73, $p < .001$ to β = .53, $p < .001$), showing that the need to shop safely is a requirement to have a positive perception of the SCO technology.

Finally, both the PRE and POST samples show the importance of *Attitude towards SCO* as predictor of *Retailer Patronage Intention* (PRE: β = .76, $p < .001$; POST: β = .79, $p < .001$). This finding is consistent with previous works. Lee (2015) analysed the perception of the quality of an SST service and concluded that patronage intentions had similar antecedents that actual usage intentions, showing that a positive retailer perception impacts in the perception of the technology and vice versa. More importantly, Djelassi *et al.* (2018) found that the satisfaction with SCOs was a strong mediator on store satisfaction and therefore in *Retailer Patronage Intention*. Our study is different in that the survey has not been administered on site, nor related with a specific brand, increasing the value of the generic relationship between the *Attitude towards SCO* and a positive *Retailer Patronage Intention*.

7. CONCLUSIONS

The objective of our study was to analyse the impact of COVID-19 on the attitude of customers towards the adoption of CFIST technologies, specifically SCO systems. Although some studies have addressed the usage of in.store technologies after the pandemic (Camplone and Villani, 2021; Díaz-Martín *et al.*, 2021; Shankar *et al.*, 2020), health risk perception has not been studied as a adoption model attribute and therefore our findings entail an additional contribution to post COVID-19 research.

The similarities of results between the two samples, PRE and POST, indicates the stability and appropriateness of the proposed model. Furthermore, the simplicity of our model has allowed us to highlight important conclusions about enjoyment, safety, attitude, and retailer patronage intention related with SCO usage. The answer to our research question ("Are there differences of perception about technology before and after the COVID-19 lockdown?") is positive: *Safety to Use* becomes relevant while reducing the importance of *Voluntariness of Use* and *Perceived Enjoyment*.

Our paper has important technology and managerial implications, as the robustness of the findings allow to define action plans based on the constituents of our model. The SCO systems and their physical set up in the stores must consider the emotional appeal. SCOs must be built in a way that makes them enjoyable, with a pleasant user interface and simple flows carefully designed, probably including interactions with customers smartphones, delivering appropriate information of what is happening and transmitting empathy to customers when something goes wrong. New interfaces should be tested. For example, consumers could see through augmented reality the goods included in their basket and the SCO could detect them and accelerate the checkout. SCO could also implement a gesture based system that could reduce the physical contact and make the interaction more natural.

Our main contribution is the relevant and unique finding of this study about the impact that criteria related with health protection are having and will have on technology adoption. The coming of the pandemic, far from ruining our running study as initially planned, has offered us the option to compare data and obtain compelling findings. *Safety to Use* shows a very relevant impact in *Attitude towards SCO*, which means that customer have included in their mindset the perception of the value of a technology to protect their health. Manufacturers and retailers must go beyond implementing safety measures; such measures must be communicated to customers that have to perceive security. Otherwise, even if there is an objective protection, customers will not feel safe, and their perception will restrain them to adopt the technology. This finding concurs with Maslow's hierarchy of needs: following physiological needs, the need for safety is the most important to be in place before other considerations. In the case of SCOs, several options can be implemented: Contactless technology, self-cleaning surfaces, distance between machines, and frequent cleaning of all surfaces, to name a few. But such options require to be complemented by communication and visible proofs of what is claimed. Waiting time reduction has been a positive element of the usage of SCOs in

the past (Djelassi *et al.*, 2018; Liang *et al.*, 2021a) (Collier *et al.*, 2015; Djelassi *et al.*, 2018; Marzocchi and Zammit, 2006), but has become also relevant for safety, as waiting mean queues and queues mean crowds. Retailers wanting to increase SCOs usage should link the efficiency with the security in order to have customers tend to SCOs.

The strong relevance of *Attitude towards SCO* in *Retailer Patronage Intention* has also important implications for the management in the evolution of SCOs. Beyond the benefits of efficiency and cost reduction that SCOs bring in the short and long term, retailers must value the impact in the perception of the overall experience. The optimisation of any SCO deployment will bring several benefits, creating a virtuous circle of efficiency, service quality and customer experience. SCO can be a competitive advantage from all points of view. Retailers must install SCO whenever the volume of the business justifies the investment, carefully planning the layout, communication, and choice of technology.

Our study also adds up to the existing CFIST literature. We expect this category to settle with one name or the other, as different researchers are using different names (Betzing *et al.* 2018; Grewal *et al.* 2020; Roy *et al.* 2017; Lorente-Martínez *et al.* 2020). CFIST technologies are a cornerstone of brick-and-mortar stores survival, and we expect a paramount role of them in the business and technology research.

Even though this study presents relevant findings and contributes to the body of knowledge, it is not free of limitations. First, the model used had few constructs, looking to reduce the size of the survey and therefore increase the number of valid responses. A more complete model would probably extract further conclusions. Second, *Safety to Use* construct was not included in the PRE sample, as at this time there was no expectation of the coming crisis and therefore no expected relevance of such construct. Third, PRE and POST samples have not been undertaken from the same respondents, due to the anonymous nature of the survey. With the same respondents for both moments the data would have an additional value. Fourth, there is a potential technology bias in the online survey, that is probably the reason of such a big percentage of previous usage of SCOs in the sample. The fact of responding through digital means reduce the diversity of respondents. An onsite survey to random population of a grocery store would reduce this bias, although it would likely introduce others (geographical, day of the week, or time of the day). Fifth, the study should be repeated in a longer term, as the two measurements had only a difference of three months. Although the perception changed in this period, it is needed to see if consumers have kept the feeling over time.

For scholars, this study opens several avenues of research. We foresee three major lines of work. First, further theoretical models that include *Safety to Use* as construct can be applied to SCOs adoption, in order to see the comparative importance of this new construct. Second, the model can be taken to other CFIST technologies, whether they are SST technologies or other kind of customer facing technologies. Third, more detailed research on *Safety to Use* as a construct may lead to split it into different elements to delve into customers health-related concerns when interacting with technology in retailers.

We hope that this study helps to understand the shift in perception that the pandemic has generated in consumers and contributes to look for solutions that help retailers to stay in the game despite the crisis that we will endure in the next years.

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