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Customer-Facing Social Robots in the Grocery Store: Experiences from a Field Trial

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Abstract: Customer-facing technology provided by retailers is becoming increasingly common in retail stores. In this study the focus is on customer-facing social robots (i.e. embodied robots that interact with humans) in a grocery store. Based on workshops, learning via making and a customer survey (n=39) during a field trial, this study explores potential roles for robots in a grocery store, how well the robots can perform the roles assigned to them, and customers' perception of the robots. Seven main roles that social robots could take on in a grocery store were identified: store guide, sales promoter, shopping assistant, entertainer, store chef, product supervisor, and experience evaluator. The two robots that were field trialled performed their tasks reasonably well. The results from the customer survey confirm previous research that customers perceive social robots primarily positively. This study, however, also indicates that a notable share of the customers may find social robots unpleasant in a store setting. Limitations and further research are also discussed.

1 INTRODUCTION

A key trend in the retail sector is the digitalization of the retail store. Not only are customers bringing their own technology, such as smartphones, to stores, but retailers are increasingly providing their customers with in-store technology. Consumer-facing technology plays an important part in contemporary in-store customer experiences (Berg et al., 2024; Fagerström et al., 2020). Technologies such as digital displays, self-checkout solutions and self-service kiosks are increasingly prevalent in many retail stores. Also, robotics and artificial intelligence (AI) are becoming steadily more common in a store context (Go et al., 2019). The presence of social robots (i.e. embodied robots that interact with humans) in stores and shopping malls is a further noticeable aspect of this phenomenon. Customers tend to feel positive about social robots, but the long-term benefits and impact of them are difficult to estimate, especially from a service and business perspective (Niemelä et al., 2019; Tigerstedt et al., 2023). Nevertheless, individuals may also perceive

robots negatively, potentially leading to job loss, dehumanization, privacy intrusions, and improper functions that lead to poorer in-store experiences (Fuste-Forne, 2022; Song & Kim, 2022). Therefore, it is important to identify key functions that are beneficial for the customer and to determine how robots can effectively contribute (Lu et al., 2020; Song & Kim, 2022).

In this study the focus is on customer-facing social robots in a grocery store. "The robot in the grocery store" -project took place in the spring of 2024 in Helsinki, Finland, with the aim to: (1) explore potential roles of customer-facing social robots in grocery stores, (2) conduct a field trial with two social robots in a grocery store in central Helsinki for one week (to find out how they interact with customers from feasibility perspective, i.e. whether they can be used successfully for the roles given to them), and (3) investigate store customers' perceptions and intentions when encountering social robots in a real-life grocery store setting.

The article is structured as follows. First, a literature review of previous studies with social

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robots in retail is presented, whereafter the methods are described. Then the results from the field trial are presented and discussed. Finally, further research ideas are proposed, followed by conclusions.

2 LITERATURE REVIEW

Niemelä et al. (2019) identified six quite different tasks or roles for a shopping mall social robot: information and guidance, entertainment and attraction, advertising and sales, shopping companion, shopping assistant, and robot for children. In their study, De Gauquier et al. (2018) detected the following themes or roles for retail robots: welcoming, informing, assisting, entertaining, and advertising. The study further suggests that more than a third of social robot tasks are in informing (e.g. presenting product info and guiding customers) followed by advertising. The entertaining role, such as making the visit pleasant and positive, is also quite common (Hägglund et al., 2023; Iwamoto et al., 2022). Using social robots to inform, guide, or advertise can also mean that they can be used to lead the customer to smarter, healthier, and ecologically sustainable decisions (Warringa, 2021). Overall, social robots can help with marketing of products (Iwamoto et al., 2020), and they have also been used in supermarkets to assist customers to shop for food (Iwamura et al., 2011; Thompson et al. 2018).

Customer-facing retail social robots have been researched in a field setting in different ways. Some studies have compared “customer-human employee” interaction with “customer-robot employee” interaction (e.g. De Gauquier et al., 2023; Roosen et al., 2022). De Gaugier et al. (2023) found that social robots can draw more customer attention than human employees, but the human employee creates more customer visits to the store. Roosen et al. (2022) found no difference in the perceived service quality when interacting with social robots or humans with customers who had positive attitudes towards social robots. Others have explored other aspects of customer experiences with social robots (e.g. Edirisinghe et al., 2023; Ferber & Vaziri, 2024; Golchinfar et al., 2022; Subero-Navarro et al., 2022), and some have investigated customer adoption of social robots (e.g. Niemelä et al., 2019; Meyer et al., 2020). Niemelä et al. (2019) concluded that a shopping mall social robot must be perceived as both entertaining and useful to be adopted by mall customers. Overall, they found that customers had positive attitudes towards social robots. Similarly, Ferber and Vaziri (2024) also found that customers of

a shopping mall perceived social robots positively, and especially the likability and perceived intelligence of a social robot received good ratings. Thompson et al. (2024) also found that participants in their study perceive social robots in a grocery store as easy to learn to use, helpful, and enjoyable. On the contrary, Söderlund (2022) suggested that social robots in a service context can also be perceived as creepy, similarly to Grazzini et al. (2023), who argued that social robots can generate discomfort among customers because of their machine-like appearance. Thus, we need to gain a better understanding of how social robots are perceived by customers in different contexts, such as a supermarket.

Overall, these studies, by using both quantitative and qualitative methods, have contributed to a better understanding of how to design and utilize social robots, and how they can potentially contribute in a retail setting. See also Table 1. for a summary of some recent field studies with customer-facing social robots in retail. Yet, to our best knowledge, few field studies with social robots have specifically focused on the grocery store or supermarket context.

3 METHODS

3.1 Study Design Development

To plan and design the field trial, we arranged two project workshops for the core project team consisting of a technical expert in social robots, a researcher in retail and digital commerce, a researcher in service design and social robots, and the store owner of the supermarket (where the trial took place). In these workshops the different roles of robots were discussed and evaluated. To illustrate some of the roles, two robots were used to create different real-life scenarios in a physical project room. These were evaluated within the group. Previous literature and similar robot studies were also discussed during the sessions for inspiration. Both sessions were documented by two participating researchers (e.g. as written notes and video footage of the proposed roles). The development process was also iterative, which meant that in addition to the organized workshops, more informal sessions were arranged by the team to iterate and develop the ideas into prototypes, i.e. learning via making (Oates, 2006). Three of the generated ideas developed into real roles for the robots, in the field trial. A description of the roles, together with some experiences from designing them, is presented in the results section.

Table 1: Some recent field studies with customer-facing social robots (SR) in retail.

Study	Main investigation	Data collection	Key results
De Gauquier et al. (2023)	Comparison between frontline human employee and a SR employee to investigate attention and conversion rates of customer store visits.	Observations at a chocolate store	The SR drew more attention, but the human employee created more store visits by customers.
De Gauquier et al. (2021)	Placement (inside or outside store) of an entertaining SR.	Observations at a chocolate store	When the goal is to create awareness towards the store then the SR should be placed outside. But to induce customers to enter the store the robot should be placed inside.
Edirisinghe et al. (2023)	Customer perception of SR advising to wear mask due to Covid-19 (if not wearing) when entering a store.	Observations and interviews at a clothing and sporting equipment store	The customers perceived SR to be friendly, polite, and fun. They would use such a SR in the future.
Ferber & Vaziri (2024)	Customer user experience and satisfaction with SR. Impact of Age.	Quantitative survey at a shopping mall	Consumers evaluated their SR-interaction experience positively. Especially likeability and perceived intelligence were rated well. Age had no impact.
Golchinfar et al. (2022)	Customer experiences of SR and its effect on customers' intention to use SR.	Quantitative survey and interviews at a shopping mall.	Hedonic quality contributes to predict customers' intention to use SR.
Heikkilä et al. (2019)	Characteristics of SR-guidance of shopping mall customers.	Interviews at a shopping mall.	Nine implications for guiding with SR, e.g. use gestures and short instructions for effectively guiding customers.
Meyer et al. (2020)	Customer adoption of SR in a retail setting	Interview and survey in a retail setting	Five drivers and barriers for customer SR adoption: Functional capabilities, Role Congruency, Discouragement, Social Presence and Physical Appearance.
Niemelä et al. (2019)	Customer adoption of a shopping mall SR	Quantitative survey and interviews at a shopping mall.	Customers perceived SR positively, but SR needs to be both entertaining and useful to be adopted.
Roosen et al. (2022)	Customer perception of service quality satisfaction between human-human and human-SR interaction	Quantitative survey at a shoe store	Customer perceived service quality of SR-interaction and human interaction did not differ for customers with relatively high positive attitudes towards SR
Subero-Navarro et al. (2022)	Customer intention to use SR in retail stores	Quantitative survey at a retail store	Pleasure is the main driver for intended use of SR.
Thompson et al. (2018)	Customer experience of SR	Quantitative survey and open-ended question at grocery store	Customers perceived SR easy to learn, helpful and enjoyable, and participants would use SR in the future.

3.2 Data Collection Through Customer Survey

During our uncontrolled field trial, we collected survey data from customers in the grocery store. Uncontrolled field trials, resembling case studies more than controlled experiments, are typical when introducing new types of technology (Oates, 2006). Two researchers conducted the survey by interviewing customers who visited the store using a predefined questionnaire consisting of an open-ended question and sixteen closed-ended questions (not all are analyzed for the purpose of this study). Customers

were informed about the study through signs in the store. Participation was voluntary with no compensation offered. In total, the two researchers interviewed 39 respondents, 11 men and 28 women; 17 in the age bracket 18-35 years, 9 in the bracket 36-55 years, and 13 were older than 55 years. Twelve respondents had interacted with social robots before, but only two in a grocery store.

In the survey, the respondents were asked an open-ended question: "Can you suggest what role a social robot could play in a grocery store?" In addition, in line with the Technology Acceptance Model (TAM) (Davis 1989), we asked them to

evaluate the perceived ease of interacting with the robots, the perceived usability of the robots, and their intention to interact with social robots in grocery stores in the future, if this was possible. Finally, we also listed some positive and negative words associated with social robots to the respondents: "Sympathetic", "Easy to approach", "Unpleasant" and "Machine-like" and asked them to evaluate their associations with the robots using a Likert scale from 1 to 5, with 1 meaning strongly disagree and 5 strongly agree. Due to the busy store environment, not all respondents had the time, or wanted to, answer all survey questions.

3.3 Data Analysis

The material generated from the workshops was analysed by all team members to summarize the generated ideas and create an overview of potential robot roles. A content-analysis of the open-ended survey question was conducted by one project-team member and verified separately by another team member. Frequency distribution was used to analyse the closed survey questions.

4 RESULTS

4.1 Identified Roles

Based on the material generated in the project team's workshops, learning via making and a content analysis of the open-ended question in the survey with customers, we identified the following potential

roles for a social robot in a grocery store: store guide, sales promoter, shopping assistant, entertainer, store chef, product supervisor, and experience evaluator. See Table 2 for a description of the seven roles.

Some of the respondents suggested several roles for the robots while some could not suggest any roles. In total, we received 39 proposals. Social robot as the store guide was mentioned 12 times. Typical answers were "Guides you in finding products" and "Good help if you go to a new store and it is difficult to find certain products". The role of a sales promoter was mentioned 13 times. Typical suggestions were "Introduce new products, hand out samples", "Show the best deals of the day" and "Surprise offers". The role as a shopping assistant was mentioned 9 times, with typical expressions such as "That [the robot] can even take your groceries to the car" and "That [the robot] can show product information, for example related to allergies". The role of entertainer generated 5 suggestions, such as "Light up your day when the robot wishes you a good day" and "This [robot] could cheer us customers up". The roles of store chef, product supervisor and experience evaluator were identified in the project team's workshops and were not mentioned by customers.

4.2 Description and Feasibility of the Three Developed Roles

For the field trial, three roles were developed with two social robots, Alf and Amy: 1. Guide to the week's offers, 2. Promoter of a secret offer and 3. Tasting waiter. See Figure 1 and a description below.

Table 2: Roles of customer-facing social robots in grocery stores.

Role categories	Description
Store guide	Product finder with interactive maps, motions, and voice for directions. Also "follow me" functionality to guide the customer to, for example, products in the store.
Sales promoter	Promotion of new products by conducting tastings. Recommend and promote products. Hand out coupons. Promote the store outside the store entrance.
Shopping assistant	Helping customers plan their meals, provide recipes, nutrition tips, sustainability-related information, etc. Cashier or help with check-out. Help customers carry their products within the store but also from the store.
Entertainer	Greet incoming and outgoing customers. Dancing, singing and telling stories to entertain customers.
Store chef	Provide customers with customized meals and drinks according to their preferences. For example, mixing a salad or a coffee for take-away.
Product supervisor	Monitor age-restricted products such as alcohol and assist with theft monitoring. For example, provide friendly reminders to young customers of age restrictions.
Experience evaluator	Collect responses from customers such as product feedback and store feedback.



1. Guide to the week's offers



2. Promoter of a secret offer



3. Tasting waiter

Figure 1: The three robot roles in the field trial. Photos by K. Kuvaaja & C. Tigerstedt. Used with permission.

Robot Alf, from Sanbot Innovation's fairy series, and robot Amy, originally from CSJBOT but now Suzhou Pangolin Robot Corporation, are both proprietary Android-based platforms from Asia. Alf is an interactive service robot, and Amy is specifically designed as a waiter robot. In this project, we used their primary features, but we also adapted them to the grocery store environment.

4.2.1 Guide to the Week's Offers

Alf was placed at the entrance of the store. The robot greeted customers by waving its arm, changing its facial expression, and verbally introducing itself, asking customers to interact with it to see the week's offers (such as a vegetarian choice). If customers interacted, different offers were shown on the screen for the customer to choose from. When an offer was chosen, the robot expressed a star-struck facial expression while presenting the price visually and verbally. The customer was also provided with the opportunity to see the location of the product in the store via Alf's screen map.

4.2.2 Promoter of a Secret Offer

Amy was waiting for customers at a designated point in the store. The location was chosen based on that the robot was easily accessible and visible to the customers, there was enough space to interact, and the distance to the secret offer (about ten meters) was appropriate. Customers were asked to interact with the robot to discover a secret offer. When the

customer activated the robot via the touchscreen interface, the robot verbally asked them to follow. The robot guided them to the secret product offer via a predetermined route. Once at its destination, the robot presented the offer both verbally and visually to the customer before going back to its designated point to wait for the next customer interaction.

4.2.3 Tasting Waiter

Amy's second role during the week was to act as a tasting waiter. Amy patrolled between four different points on a long, open stretch in the middle of the store with product samples on its tray, accompanied by the store's music and the offer displayed on the screen. The robot stopped when a customer got in its way, and if so, the robot verbally prompted the customer to taste a sample.

All three roles were mainly within the category of sales promotion, but also features of a store guide and an entertainer were included. Some technical problems and malfunctioning requiring some maintenance were encountered during the week, but overall, the roles were performed well. However, the roles can be further developed with additional features and some deployed functions can be further improved. Alf and Amy's basic design features also prevented us from developing certain elements of customer interaction, such as speech recognition.

Table 3: Perceptions of social robots and future intentions.

Variables	Strongly disagree	Disagree	In-between	Agree	Strongly agree
Ease of Use (n=30)	0%	3.3%	3.3%	13.3%	80.0%
Usefulness (n=29)	20.7%	0.0%	17.2%	17.2%	44.8%
Intention to use (n=33)	6.5%	1.1%	8.7%	12.0%	71.7%

Table 4: Positive and negative associations with social robots.

Variables	Strongly disagree	Disagree	In-between	Agree	Strongly agree
Sympathetic (n=17)	11.8%	0.0%	0.0%	0.0%	88.2%
Easy to approach (n=18)	0.0%	5.6%	0.0%	11.1%	83.4%
Unpleasant (n=17)	47.1%	11.8%	17.6%	5.9%	17.6%
Machine-like (n=18)	5.6%	0.0%	16.7%	38.9%	38.9%

4.3 Customer Perceptions of Social Robots and Future Intentions

Of the respondents, 93.3% felt that the robots were easy to use (see Table 3). Furthermore, 62% of the respondents perceived the robots as useful. The perceptions were, however, quite divided as 21% did not find them useful at all. Most of the respondents (72%) strongly agreed with the statement that they intend to interact with social robots in grocery stores in the future, whereas only 7.7% had no such intentions.

More than 80% of the respondents found the social robots sympathetic and easily approachable, whereas 12% did not find them sympathetic at all. More than half of the respondents did not consider the robots unpleasant as opposed to some 18%, who strongly did. Most respondents found the robots machine-like. See Table 4.

5 DISCUSSION AND CONCLUSIONS

The first aim of this study was to identify possible roles for social robots in grocery stores. Based on the findings and in line with prior research, we argue that a range of different roles can be given to and met by customer-facing social robots in a grocery store. In this study, seven main roles were identified: Store guide, Sales promoter, Shopping assistant, Product supervisor, Entertainer, Store chef and Experience evaluator. Similar roles were identified by, for example, Niemelä et al. (2019) for social robots in a shopping mall. Here, however, the focus was specifically on the grocery store context, and thus the identified roles (Table 2) contribute to the literature on how social robots can be used in a supermarket to support customer service and experience.

Furthermore, the identified roles constitute a reasonable starting point for grocery retailers who are contemplating using social robots and evaluating different options.

The second aim of this study was to place two social robots in a grocery store for one week to establish, from a feasibility standpoint, how social robots interact in specific roles with customers in a grocery store. They were given three tasks: to promote a secret offer; to guide to offers of the week, and act as a Tasting waiter. While they were all primarily sales promoters, their roles also included features of a Store Guide and an Entertainer. These three roles provide concrete examples of how social robots can be deployed in a grocery store setting. Amy and Alf performed the tasks well, although we did experience some technical difficulties and malfunctioning during the week. Also, the basic design features of Amy and Alf delimited the implementation to certain features. It would therefore be advisable to deploy social robots that can take on several of the roles described (see Table 2). The initial investment costs and maintenance costs for retailers to use robots in stores can also be reduced if the robot can flexibly and efficiently perform multiple roles or tasks, rather than just one or a few specific ones (which is quite common with social robots today).

The third aim of the study was to shed light on how customers perceive social robots in a grocery store, and whether customers intend to interact with or use them in the future. Most respondents were quite positive about interacting with the robots, and given the opportunity, they would interact with social robots in a grocery store in the future. Amy and Alf were also considered easy to interact with and mainly useful. However, the perceptions of usability were quite divided, further highlighting the need to assign suitable roles for social robots, and identify and improve the design and features that add value to customers. Most of the respondents found the robots

to be sympathetic and easy to approach, in line with previous research (e.g. Edirisinghe et al., 2023; Niemelä et al., 2019; Tigerstedt et al., 2023; Thompson et al., 2018). However, a rather considerable share (18%) found them unpleasant, which is something retailers must take very seriously. Creating unpleasant experiences or discomfort for some customers can be a risky solution for a retailer, even if most customers perceive them positively, and even if the robots could replace human employees for certain roles in the store. Also, a majority agreed that robots are machine-like, which can impact the customer experience negatively. Grazzini et al. (2023) suggest that social robots should be developed to become more human-like by adding features that convey "warmth" to their appearance. Similar findings were suggested by Söderlund (2022), that human-like attributes affect perceived service quality of social robots positively.

5.1 Limitations and Future Research

This study was an exploratory study to better understand the potential roles of customer-facing social robots and customer perceptions of them in a supermarket. The study is limited to one field trial in one grocery store, and an obvious further limitation is the small customer sample. In addition, the novelty of social robots in grocery stores can naturally affect customers' perception of them and their future intended use. Additionally, those who choose to voluntarily try out the robots and participate in an interview about robots may be the more tech-savvy customers, which can result in an overly positive image of robots (Niemelä et al., 2019). Thus, further research could implement similar field trials with a larger sample of respondents, including also other types of robot roles. Future research could also use stricter experimental designs, such as controlled before-and-after studies, to identify more specific effects of social robots in grocery stores.

5.2 Final Conclusions

Quite little research has been conducted to understand how social robots can be used in a supermarket context. This study identified seven main roles that social robots could take on in a grocery store when facing customers. In addition, we field-trialled two robots and three roles to provide concrete examples of how social robots can be used in grocery stores, and were able to demonstrate that our robots interacted with customers in the intended manner and performed their tasks reasonably well. Finally, the

results confirmed previous research that customers perceive social robots primarily positively. This study, however, indicates that a considerable share (in this study 18%) of the customers may find social robots unpleasant. To establish how large this group in fact is, and how to tackle their negative perceptions, is very important for grocery retailers to understand.

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