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How Does Digital Shadow Work Affect User Emotion and Behavior in Self-service Technologies Use?

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ABSTRACT

During the Covid-19 pandemic, social distance regulation calls for non-contact services, making self-service technologies gain much more attention. However, customers found they are pushed into more digital shadow work by employing Self-service technologies (SSTs). This research aims to examine how digital shadow work influences user emotions and behaviors during SSTs use. Based on the grounded theory method (GTM), this draft drives 128 codes and 7 categories to develop the theory of digital shadow work. Operations, consisting of pre-use, during use, and after use, along with the cognitions, including the perception of use-value and time efficiency, act as the trigger of digital shadow work. Achievement emotions, embodying happiness and satisfaction from technology use, result from the perception of high use-value and high time efficiency, while loss emotions, encompassing anger and disappointment from the user experience, generate from the perception of low use-value and low time efficiency, and finally, user responses from the digital shadow work - quitting, continuous and alternative behaviors are found as key factors. The interventing roles of a sense of control, system features, and compensation are also addressed. Examining users' psychological mechanisms academically contributes to developing the theory of digital shadow work whereas it advances the development of SSTs on a practical side.

Keywords: Self-service Technologies, Digital Shadow Work, Emotion, User Response, Grounded Theory

Ⅰ. Introduction

As "do more with less" campaigns launched in the business world, as well as the rapid development of information technologies (IT), self-service technologies (SSTs) are embraced by business organizations (Curran and Meuter, 2005; Hilton et al., 2013). SST is an efficient mechanism to co-create value with customers since many more tasks previously performed by employees are done by customers now through interacting with machines themselves (Hilton et al., 2013). In other words, the dif-

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fusion of SSTs allows customers to create more service outcomes on behalf of the business, by involving in creative activities, without direct interaction with service employees (Meuter et al., 2000). SSTs enable customers to obtain fast service by reducing waiting time and enabling companies to benefit from reduced costs (Yang and Klassen, 2008). Therefore, SSTs are extensively used both in public and private sectors in daily life. For example, usage of automatic teller machines (ATMs) in banks, self-checkout technologies in supermarkets, and self-check-out/self-check-in systems in hotels and airports. During the Covid-19 pandemics, SSTs rapidly spread due to the social distance regulations. Although the advancement in IT promises an easier life and work (Ryoo and Park, 2021), customers are being pushed into unpaid work. They are being expected to engage in various activities that are considered paid work in the previous (Pupo and Duffy, 2012). The effort poured into unpaid work activities is called *"Shadow Work"*.

According to Illich (1981), shadow work is defined as unpaid work that benefits someone else. Household work is a traditional case to explain shadow work. Washing machines, refrigerators, vacuum cleaners, and many other labor-saving appliances are used to reduce the time spent on housework. However, the time spent on shopping, maintenance, and management of these appliances is increased (Ryoo and Park, 2021). Recent diffusion of IT has changed the focus of shadow work from traditional situations to digital contexts. For example, customers book a trip ticket through websites and check-in in front of a machine, buy and sell stock themselves through applications, delete spam emails, and order food through their mobile phones. Interacting with high technology devices leads customers from doing traditional shadow work to "digital" shadow work. Although shadow work is gaining a significant uptick (Ryoo and Park, 2021) due to the explosive use of SSTs, there is still a dearth of research on shadow work, especially its influence on user emotions and behaviors are lacking.

Previous research on digital shadow work mostly focuses on the conceptualization and mechanism in the digital context. For example, Park and Lee (2019) used the grounded theory techniques to review the literature on shadow work and conceptualize this concept from theoretical insights. Park et al. (2020) identified shadow work mechanisms in digital technology environments. Lee (2021) further developed digital shadow work by identifying the classification, dynamics, and research direction of this new conception. Ryoo and Park (2021) developed an integrative model, encompassing system features and information overload features as antecedents, and fatigue and discontinuous intention as results of shadow work in the mobile shopping context. But their perceptions have a limitation on measurement development since they did not think of emotional factors or other cognitive factors in this model.

Information system researchers have gained significant outcomes toward understanding users' intentions, and behaviors of IT use (Davis, 1989; Venkatesh et al., 2003). However, their cognitive models and theories do not capture all of the antecedents of users' using intentions and behaviors since the usage of new IT is a complex process that highly relates to users' psychological conditions (Beaudry and Pinsonneault, 2010). Emotions also play a significant and central role in our behaviors because they influence our beliefs and attitudes, as well as guide our thinking, decision-making, and actions (Gratch and Marsella, 2004). Much research has been carried out using cognitive models, but little emphasis has been placed on emotions (Beaudry and Pinsonneault, 2010). Some researchers argue that cus-

tomers' cognitions and emotions are two different component sets that mutually act as essential antecedents to influence an individual's intention and behavior (De Guinea and Markus, 2009). The extensive application of SSTs makes users act as shadow workers spontaneously or passively. In other words, shadow work would affect users' mental states and emotional changes, affecting their intentions and behaviors. This study aims to propose an integrative mechanism, including cognition and emotion of digital shadow work in the context of SSTs usage by investigating customers' actual cognitive processes and feelings. We believe that understanding customers' emotions and their psychological states through digital shadow work in SSTs use can lead to higher customer satisfaction which can ultimately increase firm sales. Therefore, the research question is developed as follows: How does digital shadow work influence user emotion and post-usage behavior of SSTs?

This study contributes to developing an integrated mechanism of shadow work. Also, the study results are expected to provide critical practical implications for business organizations and technology providers.

Ⅱ. Theoretical Background

2.1. Self-service Technologies

Self-service technologies (SSTs) are defined as any use of technological interfaces, such as laptops, tablets, smartphones, and other types of terminal equipment, to provide service outcomes without involving employees directly (Meuter et al., 2000). In other words, customers produce services themselves by using technological interfaces. The use of SSTs can help businesses save money, increase productivity (Dabholkar, 1996), and provide convenience for customers. Additionally, SSTs lead to improving service delivery speed, accuracy, and customization (Berry, 1999), and build customer loyalty toward organizations (Kucukusta et al., 2014). Service providers all around the world are capitalizing on growing technological innovation by incorporating SSTs into their service delivery (Halstead and Richard, 2014). ATMs, self-service desks at airports, self-service gas stations, self-service kiosks, and self-check-in and checkouts in hotels, are common examples of services delivered via SSTs. With the rapid development of digital information, as well as mobile technologies, online shopping, online transaction, online education, and various internet services are everywhere in human daily life.

Previous research streams about SSTs focused on: (1) the development of the user profile, (2) the significant role of technology in service delivery, and (3) user readiness to adopt SSTs or satisfaction with SSTs use. Meuter et al. (2000) proposed that SSTs are changing the customer-company interactions in the business world. However, previous studies mainly started from a service delivery perspective. In 2008, from the customer's view, Cunningham et al. (2008) used multidimensional scales, including the customization/standardization dimension and separability/inseparability dimension, to classify 12 main types of SSTs. Another research stream focused on consumer readiness to adopt SSTs (Meuter et al., 2005), and satisfaction with different SSTs use (De Leon et al., 2020; Hossain et al., 2019). TAM theory which based on a user's perceived usefulness and ease of use, TAM2 theory which focused on social norms and a customer's perceived enjoyment, and Unified Theory of Acceptance and Use of Technology (UTAUT; Chopdar et al., 2018) which combines the most important eight theories in IS research, are many used in by researchers in this research stream.

The other research stream investigated customer experience on SSTs adaption (Hilton et al., 2013). Recently, some researchers suggest that consumers' self-concepts and affective effects are also should be considered (Antwi et al., 2021). Thus, studies on developing a comprehensive model which encompasses individual, systematic, and situational drivers of customers' intention and actual behavior to use SSTs are gaining an uptick in the academic world (Demoulin and Djelassi, 2016). Even though researchers have drawn attention to customers' factors in investigating adoption and post-adoption behaviors of SSTs, there is little research that separates the cognitions and emotions of customers' psychological mechanisms. To investigate shadow work due to SSTs use, this research proposes that it is necessary to examine both cognitive and affective factors.

2.2. Shadow Work

In 1981, Ivan Illich (1981) did a study on unpaid work in industrial society, defining unpaid work as *"Shadow Work"*. According to him, shadow work means *"an industrial society demands as a necessary complement to the production of goods and services, and this kind of unpaid servitude ravages subsistence."* Housework (such as shopping, household tasks, and children rearing) done by housewives, most of the homework done by students for passing the exams, and time spent by workers commuting from their home to the working places are typical examples of traditional shadow work. In 2015, Lambert (2015) developed the concept of shadow work as all the unpaid tasks we do on the behalf of business/organization and he claimed that the unpaid tasks we do in daily life are underestimated. For example, we pump our own gas, scan, and bag our own groceries, make our own stock trades, and assemble our furniture. Park and Lee (2019) conceptualized shadow work as "hidden efforts that digital technology users must make" from an academic perspective, by conducting grounded theory techniques to review literature in the digital environment. They suggested that studies based on realistic phenomena need to be conducted on how shadow work generates, and how to measure it. In addition, future research also should pay more attention to developing variables and instrumental items of shadow work (Park and Lee, 2019).

Following these research perspectives, Park et al. (2020) identified an individual's psychological mechanism of digital shadow work in conducting activities such as changing passwords, updating applications, and deleting spam emails. They found that the shadow work mechanism operates among three main concepts: the recognition of the necessity of shadow work, decision making on behavioral intention, and completion of digital shadow work. In addition, the 'adherence to managing digital information technologies', 'perceived effort requirements on digital shadow work', and 'perceived 'things that I must do' may influence the attitudes to conduct shadow work. Ryoo and Park (2021) argued that shadow work perceived by mobile shoppers might lead to a bigger problem, since mobile shoppers may become fatigued as a result of perceived shadow work and stop using mobile shopping applications. They drew an integrated model to reveal the antecedents - information overload and system feature overload, and consequences - fatigue and discontinuation of using a mobile app. Lee (2021) classified digital shadow work into four categories based on the voluntary participation dimension and work orientation dimension, and suggested future research on shadow work should consider digital shadow work dynamics, conducting survey methods in expanding user theories and investigating the social influence of digital shadow work.

Park (2019) claimed that user's activities such as changing and remembering passwords required by websites are examples of shadow work, and he developed a paradigm model based on grounded theory to explain how shadow work affects user behaviors when IT users are involved in these activities.

The significant proliferation of SSTs results in a growing amount of shadow work being passed on to consumers (Ryoo and Park, 2021). We use mobile scanners and self-check-out machines in the supermarket, order food or goods through mobile phones, buy a ticket online or through applications, and delete spam emails by ourselves. Shadow work due to SSTs use creates value for the business, as well as saves time, and increases autonomy for users as compensation, but it unveils users to a new type of middle-class serfdom (Ryoo and Park, 2021).

2.3. Emotions in IT Use

Emotions refer to the mental state brought by neuropsychological changes and help organize or adjust behaviors to meet the demands of the environment (Bagozzi et al., 1999). The relationship between emotions and technology use is intricate since emotions can alter technology use patterns and technology use may also change users' emotional states (Shank, 2014).

Some researchers proposed that emotions contribute to the acceptance and continuance of IT use directly, rather than through behavioral intentions (e.g., De Guinea and Markus, 2009), as users' emotions and adaptation behaviors will be changed when there is an interruption of an individual's routine, including the establishment of new routines and the re-establishment of old routines (Beaudry and Pinsonneault, 2010). Empirical evidence indicates that positive emotions (such as satisfaction, enjoyment, and affect) positively relate to intention/attitude to use and perceived ease of use, on the contrary, negative emotions (such as anger and anxiety) negatively relate to intention/attitude to use and perceived ease of use (Gelbrich, 2009; Gelbrich and Sattler, 2014; Venkatesh, 2000; Venkatesh et al., 2003). Moreover, the previous study has shown that negative emotions experienced while using a system can have a negative impact on important user behaviors such as purchasing decisions, technology use, and customer loyalty (Hibbeln et al., 2017). Stein et al. (2015) drew attention to the role of emotions in studying users' behavior patterns and concluded that emotions, including the single class of emotions and elicit mixed emotions, have a strong relationship with users' adoption strategies. In detail, ambivalent emotion can lead to active and positive user engagement. Although researchers have gained remarkable achievements in studying the role of emotions in IT use research, there is a recognized dearth of systematic theory development on the effects of emotions on technology use (Bagozzi, 2007; Stein et al., 2015).

Ⅲ. Research Design and Methodology

3.1. Grounded Theory Methodology

Grounded theory methodology (GTM) is a qualitative research method that enables researchers to create new theories or develop an existed theoretical topic through empirical observations or data analysis (Wiesche et al., 2017). Interviews, newspapers, letters, and anything related to the research topic can be used as data sources. GTM has been frequently used in social science research, especially it has widely used when there are limited prior studies on new phenomena or issues, for which a new theory needed

to be built (Gasson and Waters, 2013). In information system research, GTM is also frequently used in emerging research domains to study technological changes and socio-technical behavior (Wiesche et al., 2017). For example, Park and Lee (2019; 2021) used GTM techniques for reviewing the literature, developing the concept of "shadow work", and investigating user's behavior in digital environments. The core of the grounded theory is coding the collected data and there are three procedures of the coding process: open coding, which means to categorize and name the concepts; axial coding, which needs to analyze the core concepts; and selective coding, which means to define a new theory or modify an existing theory.

3.2. Research Design

Based on the GTM techniques, this research is conducted by two processes: the interview process and the data coding process. In the interview process, there will be four rounds of interviews totally: a round of preliminary interviews, two rounds of follow-up interviews, and a focus group interview. Before starting the main interview, preliminary interviews were conducted with five participants. Thus, we modified the interview questions and research design based on some findings from this process. The main interviews involved nine participants, including two local residents. At last, a focus group, consisting of five participants, is conducted to supplement the findings. The second process is data coding and this process was continued till the emotional mechanism of shadow work shows up.

3.2.1. Cases Description

In recent years, facing the challenges from the diffusion of e-business channels, the retail industry decides to apply the SSTs to increase revenue, reduce labor, and shrink the cost of business. Another technological innovation in the retail industry, which is named mobile self-checkout system, is increasingly embraced in recent years, as customers become more proficient and comfortable using mobile technology to search for product information by themselves. Walmart, U-Haul, IKEA, 7-11 and Macy's have already launched scan-and-go applications.

In the Netherlands, the biggest chain supermarkets, such as AH and Jumbo, are applying two types of self-checkout systems: fixed self-checkout system and mobile self-checkout system. With the fixed self-checkout system, the customer, at the self-checkout machine, uses a scanning device to identify the barcodes, and the payment process is carried out after scanning all the items (Andriulo et al., 2015). With the mobile self-checkout system, the customer picks an item along the aisle, scans it with a mobile identification device - a handheld scanner or their smartphone, and bags it directly. After selecting all the needed products, customers pay for their trip on their phone or at a regular checkout machine. Today more than 65% of retailers have installed the self-checkout system and some are moving to embrace mobile self-checkout (Andriulo et al., 2015), due to the quick diffusion and potential advantages of mobile technologies. The supermarkets reduce the management cost, increase efficiency, and cut the waiting line in front of cashiers and self-checkout desks. For customers, this system brings them time convenience by speeding up the purchase process and higher user control by using a mobile scanner (Andriulo et al., 2015). In addition, the mobile self-checkout system could track and give real-time feedback on spending for customers, which is seen as a good way to help manage customers' budgets (Van Ittersum et al., 2013).

This study interviewed nine customers of AH and Jumbo -- the two biggest supermarkets that adopt the mobile self-checkout system in the Netherlands. The mobile self-checkout method allows customers conveniently buy and improve the control of the whole shopping process (Johnson et al., 2020; 2021), however, activities such as finding an accessible scanner or downloading the application, scanning and bagging the items, searching for location information of products, and self-checkout increase much workload, which is shadow work, for customers.

3.2.2. Participants' Selection

A preliminary interview is conducted to develop a research question and revise the research design. In this stage, five participants (Participants 1, 2, 3, 4, and 5), including three users, who have used this mobile self-checkout system for at least one month, and two non-users, are invited to join this study. Three of them are in the master's process, one is a pre-master, and the other one is studying his bachelor's process courses in the Netherlands. These young international students (all of them are 25-30 years old), go to the supermarkets at least once or twice a week to buy ingredients for cooking themselves. We also invited these five participants to the main interview. Among them, the four participated in the main interview while one (Participant 4) quit joining the main interview.

In the main interviews stage, the other three mobile self-checkout system users (two females and one male) are involved in this study to share their experiences, feelings, and problems in using the mobile self-checkout system when shopping at a supermarket. In order to get more convincing evidence of local people's experiences and feelings, we invite two senior Dutch users to join us. Therefore, nine users participate in the main interviews in total. <Table 1> shows the basic information of our participants.

3.2.3. Interview Questions Set

Questions are divided into four parts. The first part is asking for basic information on the mobile

<Table 1> Basic Information of Participants

Participant	Gender	Age	Position	Frequency (monthly)	Use Period	Interviews Involved
1	Male	27	Master student	7 - 8	3 months	Pre, M, FGI
2	Male	26	Bachelor student	3 - 5	2 months	Pre, M, FGI
3	Female	27	Master student	2 - 3	2 months	Pre, M, FGI
*4	Male	27	Pre-master	0	None	Pre
5	Male	30	Master student	-	1.5 months	Pre, M, FGI
6	Male	26	Master student	1 - 2	1 month	M
7	Female	25	Bachelor student	1 - 2	One year	M, FGI
8	Female	24	Bachelor student	2 - 3	2 months	M
Dutch 1	Memal	45+	Employee	6 - 8	Couple of years	M
Dutch 2	Female	45+	Employee	6 - 8	Couple of years	M

Notes: 1. *: discarded in the main interview
2. Pre: preliminary interview; M: main interview; FGI: focus group interview

<Table 2> Interview Questions Set

Type	Questions Set
Basic Information	- Please describe the equipment installation of the supermarket the one you usually go to (self-checkout systems adoption; shopping environment; customer flow, etc.). - When do you start to use this system? Why do you decide to use it? How often do you use it?
Process	- Could you please introduce the process of using a mobile scanner? - Do you think you are capable to use this system? Why? - Do you have any problems or difficulties in the using process? What was the situation, and how did you solve that problem(s)? - Have you asked for help from an employee? What do you think about his/her response?
Experiences and Feelings	- Among cashiers (face-to-face service), fixed self-checkout system and mobile self-checkout system, which one do you prefer? Why? - What are your comments or feelings about these three methods, and do you have any priorities when you decide on using these three methods? - What do you think about the waiting line in the supermarket when you are shopping? - For convenience and time-saving, what is your opinion on these three methods? - What benefits or compensation do you get when you adopt mobile self-checkout system? - Do you think it is necessary to use the mobile self-checkout system? Why? - How do you think about the design of the mobile scanner?
Others	- What was your main feeling(s) when you first use this system? - Could you give a comprehensive comment on this system? - If let you rank and score the cashiers, fixed self-checkout technology, and mobile self-checkout system, what's your opinions? - Would you recommend this technology to your friends and/or acquaintance? - Do you have any suggestions for the supermarkets and/or technology providers?

checkout system adoption at the supermarket where the users usually go, and overall information on use. The second part relates to the process of conducting the mobile self-checkout system, which mainly aims to observe the problems and difficulties of use. The third part refers to users' experiences and feelings, while the fourth part is about their comments or suggestions toward the mobile self-checkout system. The interview questions set is shown in <Table 2>.

Ⅳ. Data Collection

4.1. Preliminary Interview

The preliminary interviews, with the involvement of five participants, aim to develop a meaningful and feasible research question. Participants 1, 2, and 3 have experienced the mobile self-checkout system in the supermarkets, while participants 4 and 5 have no experience in using a mobile self-checkout system. Preliminary interviews focus on why users decide to adopt or not adopt the handheld scanner, what are their attitudes toward this new technology, and to what degree they think they are capable to use this technology.

4.2. Main Interview

The research question and research design are developed after the preliminary interview, and then, we arranged the main interviews for two months,

with nine participants in total. Apart from participant 4, the other four participants from the preliminary interviews continued to join the main interviews. Considering that the participant selection in the preliminary interviews has imbalances in gender, age, and nationality, two female users and one male user, and the other two local senior Dutch people are invited to join the main interviews. The main interviews are held with an average of 30-minute in-depth conversations to investigate users' experiences, problems, and feelings about using a mobile handheld scanner in the shopping process.

4.3. Focus Group Interview

A focus group interview (FGI) is supplemented to assist the deeper and better understanding of a research topic by evaluating participants' reactions and/or perceptions of a shared experience.[1] Compared with one-to-one interviews, a focus group interview allows researchers to study users' perceptions in a more natural conversational context. Thereby, the focus group interview with five participants is supplemented in the final wave of data collection through a one-hour online meeting. After explaining the topic and purpose of the FGI, three male users (participants 1, 5, 6) and two female users (participants 3 and 7) are invited to sit together, sharing their experiences and feelings in turn. Most of them go to the supermarket once or twice a week, and some of them (participants 3, 5, 6) usually go to AH, while the others (participants 1 and 7) are regular customers of Jumbo. We asked about their different experiences and feeling in these two different supermarkets.

1) https://www.e-ir.info/2021/08/31/interviews-and-focus-groups/

4.4. Data Coding

The data coding and analysis process is conducted by using the Atlas ti, which is one of the most famous and useful software for analyzing qualitative data. Atlas ti is used to help researchers uncover and systematically analyze complex phenomena hidden in a variety of sources, such as texts, pictures, videos, as well as audio files, and this program can visualize the findings from the unstructured data. Researchers and practitioners from anthropology, arts, architecture, communication, criminology, economics, educational science, engineering, ethnological studies, management studies, and market research are embracing Atlas ti as the data coding software in qualitative research. In this research, data collected from multiple sources (such as word scripts, pictures, and videos) are coded and analyzed. 128 codes are found and named after open coding and then they are categorized into 18 groups in the axial coding process. Finally, the 7 important categories are determined in this research.

Ⅴ. Findings

5.1. Self-service Technology Adoption at AH and Jumbo

Albert Heijn (AH), founded in 1887, is the largest supermarket chain in the Netherlands with a market share of 34.8%.[2] Since 2015, the company has decided to test and adopt a new mobile technology that allows customers to scan items using an AH scanner or via a special mobile phone app, and at last pay for the bill themselves without the intervention of a shop

2) https://en.wikipedia.org/wiki/Albert_Heijn

worker. In 2019, AH deploy an "AH To Go" solution to facilitate a more convenient shopping trip. The customer scans their debit card at the entrance and cameras register the customer and the items that are picked, the total spending is deducted from their account after the customer leaves the store. Jumbo, originally established in 1979, is the second-largest supermarket chain in the Netherlands, with a market share of 21.8%.[3] In 2020, Jumbo adopted NCR technology to deploy the mobile scanning strategy to complement self-checkout solutions.

Findings Part 1: Shadow Work Deduction

Before starting the shopping trip, customers can apply for a self-scanner at the entrance for identifying the barcodes on the products when shopping, and they should return the mobile device to an assigned place before conducting payment in front of a fixed checkout machine. Therefore, the operation of using the mobile self-checkout system can be divided into three procedures: prepare for use (pre-use), during use, and after use.

Pre-use: Activities involved prepare for use refer to finding the terminal that manages the mobile self-service system and applying for a mobile scanner, or using their own mobile devices to download the application and then start their journeys at a supermarket. But at this stage, AH and Jumbo use different systems. In Jumbo, customers can walk directly to the computer terminal, click the red button on the screen, take out the mobile scanner assigned by the system, and start the system for shopping. But in AH, customers must carry an AH bonus card, and only after scanning the membership card can they successfully apply for a mobile scanner. This redundant step often confuses and dissatisfies customers.

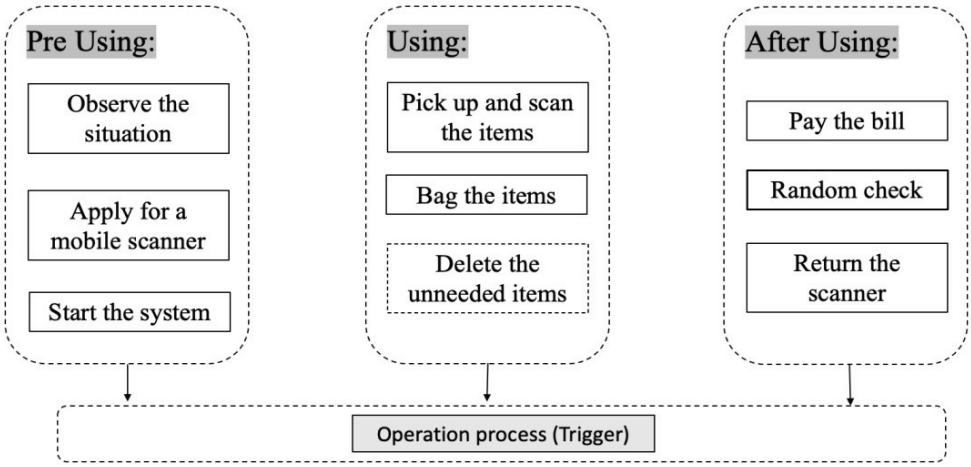
In AH, it is not convenient that only with a bonus card, can you use a mobile scanner. If I forget to bring the bonus card, I cannot use the mobile scanner. This happens from time to time, and I will not take the bonus card with me anytime, anywhere. (Focus Group Interview)

It happens several times that when I planned to use the mobile scanner, there always was a problem at the beginning. After I scanned my bonus card, the system showed complicated Dutch language, and I didn't know what to do. I don't know why, and it would be troublesome to call staff to help, so I gave up (using the mobile checkout system). (2nd Round Interview, Participant 5)

The system adoption strategy in AH supermarkets is that only with a bonus card, can users apply for a mobile scanner, which makes the pre-using process much more complicated than the system at Jumbo. In this process, both Jumbo and AH have no instructions to lead or teach users how to adopt this system contributes to a perception of the high cost of learning and the high cost of use for users, which further results in the low use rate of this mobile scanner.

During Use: During use refers to using a designated mobile handheld scanner or application on the smartphones to identify bar codes on the package of products, and then bag them directly when wandering around the supermarket. For the unneeded item, users delete it and then put it back on the shelf. In addition, there are "plus" buttons for adding more of the same items, and "minus" buttons for reducing or deleting an item on the screen of the handheld scanner.

3) https://en.wikipedia.org/wiki/Jumbo_(supermarket)



<Figure 1> Operation Process

It is easy to use and very convenient. If I want to get more hams, I just click the "plus" button here (in the scanner) and for the unneeded items, you can delete it. You can put the scanner on the hole of the cart or you can hold it when you are shopping. (1st Round Interview, Participant 1)

After Use: After scanning all the needed goods, customers go to the checkout area and find a fixed checkout machine, scan the QR code for handheld scanner payment or press a "pay for handheld scanner" button on the screen of the terminal to pay for the bills. But here two things should be noticed. Before paying, users should return the scanner to a designated place, and then all the purchase information can be transferred to the checkout machines and shown on the screens. The other unpleasant thing is random check, a rechecking activity conducted by employees to prevent illegal or immoral behaviors, which causes many unpleasant emotions during system use.

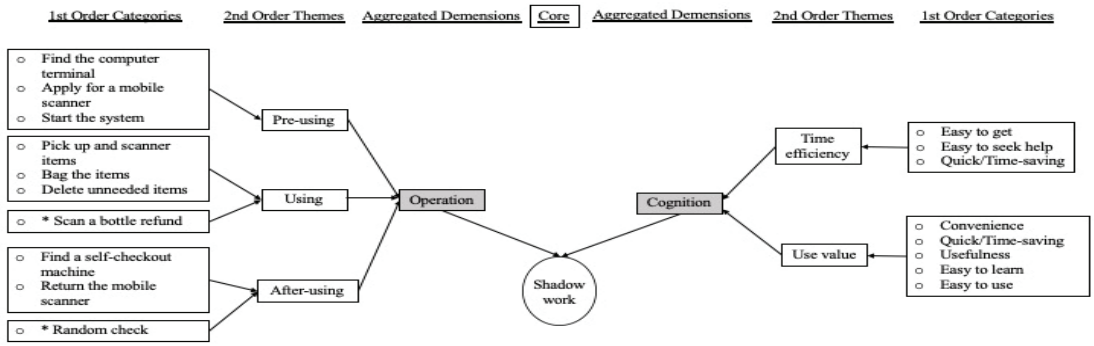
There was a time that I came to Jumbo and used a mobile scanner for shopping. I bought three pieces of goods and hoped to checkout out quickly because I had very important things to do that day. But unfortunately, I was selected to accept the random check, and the employees were very busy at that moment. It cost me a lot of time waiting there for random checkout. I thought if I did not use the scanner, I might have already checked out. Sometimes, it is time-consuming when there is a random check. (2nd Round Interview, Participant 2)

<Figure 1> shows the operation process of adopting the mobile self-checkout system. The process acts as the trigger of digital shadow work. The next part illustrates how the operation process interacts with user psychological thinking during mobile self-checkout system use.

Cognition

This category refers to the user's thinking process when interacting with the mobile self-checkout system. It is aggregated from the time efficiency and value of using this technology.

Time efficiency: Supermarkets adopt this mobile



<Figure 2> Shadow Work Deduction

self-checkout system to improve customers' shopping experiences by reducing waiting time for checkouts. Perceived ease of getting a mobile scanning device at the beginning of the shopping trip, ease of seeking help from the employees, and perceived shorter time for waiting to checkout are second-theme of perceived time efficiency.

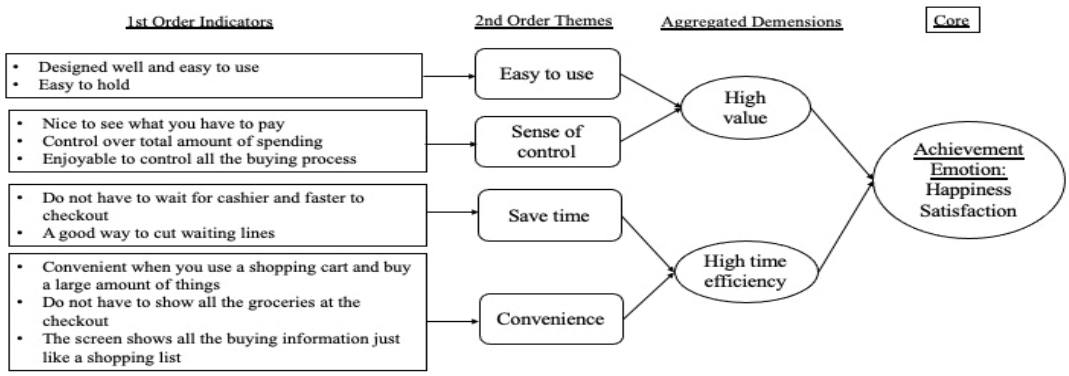
Use value: Apart from saving time, technology users are concerned about the value of the technology the most. Participants mentioned in the interviews that they cared much about saving time and the convenience of the mobile self-checkout system, in addition, they are also concerned about the use value. Use value is aggregated from convenience, usefulness, perceived ease of use, and perceived ease of learning. Many participants said mobile self-checkout technology is convenient, quickly/time-saving, useful, and valuable. However, with a random check, system breakdowns, or crowds during rush hour, users' positive thinking may turn to the other side. As Participant 2 said below:

In my opinion, the mobile scanner seems unnecessary and meaningless. I have gotten accustomed to using fixed self-checkout machines for paying. It is convenient for me and there is no necessary to learn and use another technology. It is not that valuable. I tried it last time, and it was … I mean it made me tired and felt busy to hold a scanner in my hand. I had my personal things to carry. (Participant 2, Pre-interview, 1st Round Interview)

Activities in the operation process are important triggers for digital shadow work, and cognition acts as a contextual condition. The deduction of digital shadow work is shown in <Figure 2>.

Findings Part 2: Emotion Outputs

Shadow work, along with the interventional effects of system features, directly influences user emotion. With good experiences interacting with technologies, emotions such as happiness, excitement, enjoyment, and satisfaction occur, while when there is a poor experience during technology use, anger, anxiety, worry, dissatisfaction, and annoyance show up. Emotional changes are complicated mental states involving or integrating with many affective factors. This research follows Beaudry and Pinsonneault's (2010) classification of 21 kinds of emotions. Achievement emotions, including happiness and satisfaction, are the main positive psychological changes, and loss emotions, embracing anger and anxiety,



<Figure 3> Emotion Output 1

are the main negative psychological changes when interacting with this new self-checkout technology. Achievement emotions arose from a perception of high value and a perception of high time efficiency while loss emotions result from a perception of low value and a perception of low time efficiency. We note that the two figures (<Figure 3> and <Figure 4>) we draw in this paper were based on the study of Möhlmann et al. (2021) addressing algorithmic management of work in online labor platforms.

Achievement Emotion

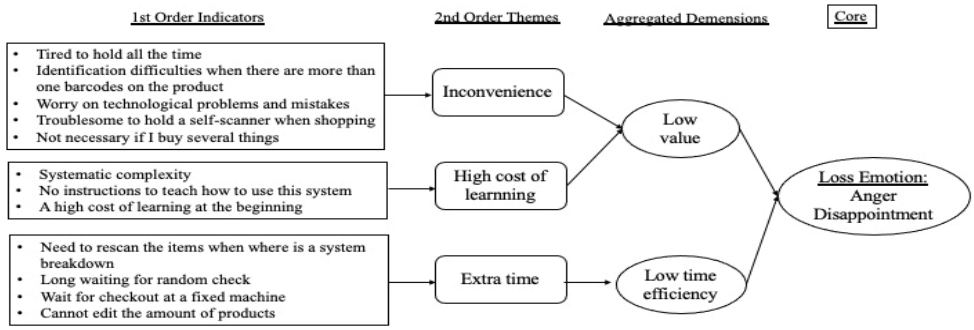
Achievement emotions are defined as feelings that are directly related to achievement activities or outcomes (Pekrun and Stephens, 2010). Generally, emotions in studying, working, and/or participating in sports are seen as achievements. In this situation, happiness and satisfaction generated from the mobile self-checkout system use are experienced in the use process. Happiness is an emotional state characterized by feelings of enjoyment, pleasure, and satisfaction. Cognitions, such as time-saving, convenient, useful, and valuable, attribute to generating happy feelings. The sense of control makes users feel playful when using mobile self-checkout technology. Happiness and satisfaction are both belong to achievement emotion, which aggregated from a perception of high value and a perception of high time efficiency when using this new system. <Figure 3> shows the core emotion output regarding achievement emotions.

It is very useful. Someday, I entered the supermarket with a handheld scanner, and a Dutch girl looked at me with an unbelievable face when I scanned and bagged items with the scanner. I felt proud of myself. Hhhhh… I have taught several friends how to use it and all of them love it. (Participant 1, 2nd Round Interview)

It is very interesting. When I successfully scanned the bar codes in the products, the scanner will make a voice. Especially, kids may be very interested in this technology, because it helps kids make their dreams come true – become shop assistants. (Participant 5, 1st Round Interview)

Loss Emotion

According to a previous study about user emotions on IT use, loss emotions are defined as emotions resulting from the perception of a lack of control over the negative outcomes of IT events (Beaudry and Pinsonneault, 2010). In this situation, anger and



<Figure 4> Emotion Output 2

disappointment are experienced when there is a failure during technology use, or user experience is under the estimated. The system breakdown makes users think that using a mobile self-checkout system may not always be a good and convenient thing. When there is a system breakdown, and the employees cannot give a quick response, the users may have negative emotions. They might regret using a mobile scanner when shopping. Disappointment is an emotion that is related to unhappiness from the failure of technology use, or a perception of the low value of this technology. <Figure 4> presents loss emotion as core emotion output by the user's cost assessment.

I experienced the system breakdown once, and at that time I worried that my scanning work was in vain and I have to rescan the items. I had no ideas on what should I do at that time: do I need to try again with another machine, or just wait for employees to come to help? I also thought that if I use a cashier or fixed self-checkout system, I might already go out. Maybe that would save more time. (Participant 1, 2nd Round Interview)

I think the random check is not good…I feel not happy with that because random check wastes my time. I have to wait for employees to rescan my items and sometimes it takes a long time to wait. Sometimes I felt anxiety. (Participant 1, 2nd Round Interview)

Findings Part 3: Users' Response and Behavior

User emotion directly influences user behavior. After undergoing different emotions in the mental process, users would continue, alternate, or quit using this mobile self-checkout technology.

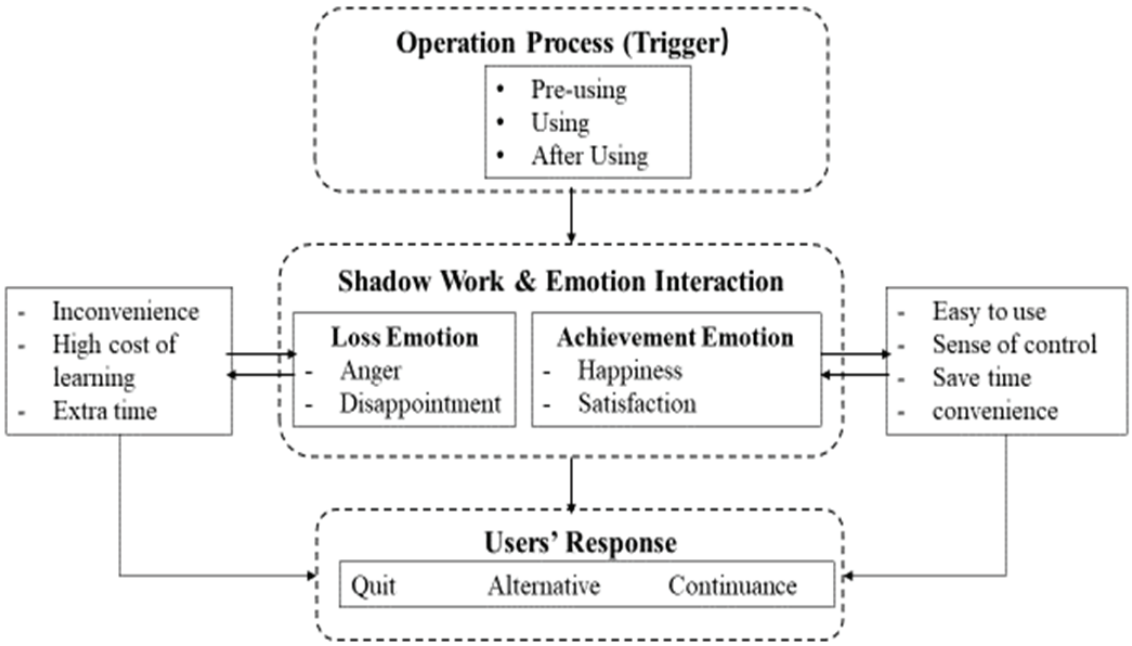
Continuance: Users who have experienced positive emotions in using a mobile scanner prone to have a continuous usage intention.

Alternative: Users who haven't found the value of mobile self-checkout technology would consider it as an alternative when shopping in the future.

I would like to use a mobile scanner when I carry with a shopping cart because I can put it into the hole of the shopping cart. (Participant 2, 1st Round Interview; Participant 5, 1st Round Interview)

Quitting: Stop using this technology and turn back to other alternatives, either using a cashier service or using a fixed checkout machine.

The relationships between shadow work, emotion, and behavior are shown through the visualization of



<Figure 5> Integration of Shadow Work, Emotion, and Behavior

these important categories, as shown in <Figure 5>.

System feature

System feature refers to special functions of this technology, and this category is gathered from a sense of control and shopping budget monitoring.

Control: Compared with checkout in front of a cashier, adopting a mobile self-checkout technology significantly enhance the sense of control in the shopping process. Customers can select, scan and bag items flexibly, at their speed.

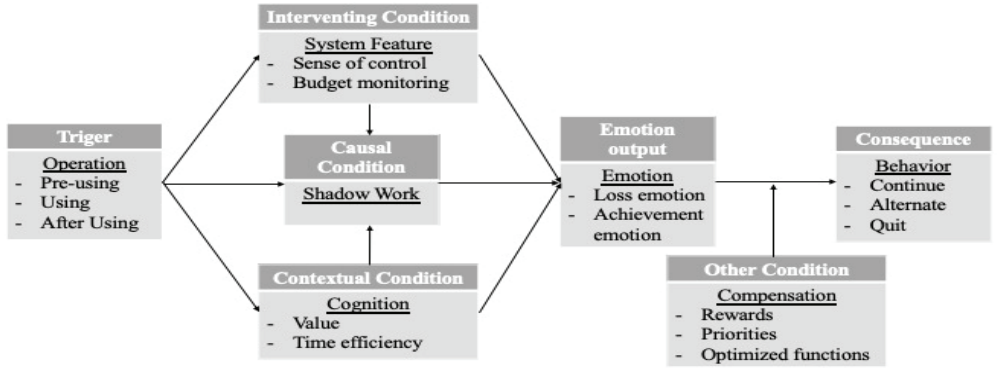
Budget Monitoring: Information such as price, discount, and total spending is recorded and shown through the screen of a mobile handheld scanner. It is a good way to monitor and manage customers' budgets.

You can check the price, confirm your orders and check your total spending through the buying process. It helps a lot to the budgets, especially for people or students who have no plan for using money. (Participant 5, 1st Round Interview)

Compensation

Some users, with negative cognitions and emotions towards this new technology, are expected to get some compensation from businesses, because they already realized that this technology benefits businesses a lot, while they as ordinary customers get few benefits. Therefore, there are no drivers to adopt new technologies for users without expected benefits. Rewards, priorities, and optimized functions aggregate the compensation category.

Rewards: Rewards are defined as something given



<Figure 6> Theoretical Framework of Shadow Work

in exchange for good behaviors or performances. Users poured working labor when using SSTs and undertook work that belonged to employees. Thus, they expect to get some monetary compensation from businesses. In addition, if they think the perceived convenience, time-saving, and usefulness of adopting mobile self-checkout technology are more important than the labor input, they tend to accept and continue to use this technology. Therefore, businesses can provide some non-monetary compensations.

Priorities: Priority means the quality or state to be prior. The mobile self-checkout system shares the same checkout machines, which makes users think lower of its necessities. Therefore, users expect that businesses should consider setting specific checkout machines or special aisles for mobile scanner users.

Optimized functions: It is regarded as an underdeveloped and immature technology, and it only has a single function. Users expect to add a payment system to this mobile scanner technology. Scanning, bagging, and payment are supposed to be conducted in a scanner.

The system features act as interventing factors in the process of digital shadow work deduction, while compensation acts as other mediating factors between the relationship of emotion and behavior. Therefore, a theoretical framework integrating the seven main categories is shown in <Figure 6>.

In the self-checkout system-based marts, the shadow work of customers is triggered by operations. Both system features like budget monitoring as an intervening condition and cognition as a contextual condition may affect shadow work which leads to their emotions such as loss and/or achievement emotion. The consequences of emotion output are customer's response behaviors such as continuance, alternative, or quitting. In the relationship between emotion and consequences, compensation such as rewards and priority could act as other conditions.

Ⅵ. Discussion and Conclusion

6.1. Discussion of Findings

Our findings show that the deduction of digital shadow work not only relates to the operational activities but also relates to users' cognitions during SSTs use. Users' achievement emotions (happiness and satisfaction) and loss emotions (anger and disappointment) generated from the perception of digi-

tal shadow work highly relate to users' responses (quitting, alternative, and continuance) toward this technology. Although emotional changes directly relate to digital shadow work, there is no convincing evidence to prove that behavioral changes are also determined by digital shadow work.

The findings from the deduction process of digital shadow work indicate that during SSTs use, users' perceived time efficiency and value of use highly relate to their decisions on doing or not doing digital shadow work. Despite users agreeing that the adoption of SSTs is faster than the former methods, they would continue to employ the old methods that they have become accustomed to, rather than embracing the new technology. The value of adopting new technology, encompassing the convenience, usefulness, ease of use, and ease of learning, is the dominant factor in decision making. Therefore, users' responses – quitting, alternative, and continuance – are only related to the cognitions (time efficiency and value of use) and emotions generated from digital shadow work. However, based on the findings, we cannot conclude that users' responses are directly impacted by digital shadow work. Furthermore, benefits, such as extra bonus, priorities to checkout, and multifunctions of the self-scanner contribute to the continuous intention of use. In addition, we found that there is a significant difference between local users and foreign users, no matter how old are they. That is mainly because foreigners have language problems when using the new technology, resulting in a higher perception of difficulties and inconvenience of use.

6.2. Implications for Research and Practice

Self-service technologies are embraced in our daily life nowadays because of the Covid-19 pandemic, as well as the diffusion of digital technologies development. Self-service technologies bring much convenience on the one hand, on the other hand, customers are doing more and more shadow work instead of business which results in generating not only achievement emotions but also loss emotions during human-system interaction. However, there is less research on users' emotional responses because of digital shadow work. Therefore, this research has contributions both theoretically and practically.

From the academic side, this research developed the concept of digital shadow work and expanded existing SST research. Firstly, this study tried to drill down the components of digital shadow work and connect them, exploring the emotions and responses surrounded by shadow work. On top of that, an integrated model, which specifies the relationships between digital shadow work and achievement/loss emotions was proposed as an initial step to deeply touch the user's psychological states in the SSTs context.

Secondly, this study mainly focused on customers' emotions through shadow work and found that the working mechanism of shadow work is more complicated owing to various emotions in self-checkout activities at supermarkets. Emotions and shadow work could appear concurrently or might affect each other in the two directions. Therefore, this paper contributes to future research, considering emotional factors in measuring digital shadow work.

Thirdly, we discussed the emotional and behavioral effects through the perspective of shadow work in the context of SSTs use. The result of this study contributed to the understanding of how customers' psychological states and overall processes work in the SSTs context. In addition, this study in detail dealt with both emotional outputs and cognitive factors which appear in SSTs usage, and enlarged the

existing SST research by taking emotional factors into consideration.

Finally, the elaborated link between shadow work and SSTs was also explored in this study. We suggest much attention to shadow work in future SST research and call for discussion on the measures to eliminate the negative effects of shadow work in applying SSTs.

This research also provides some practical suggestions for businesses. For supermarkets, this paper suggests that they should simplify applying, returning, and paying process, which could make users more convenient to get and return the scanning devices. Also, they should lower the frequency of the random check, which is the most dissatisfying part of the mobile self-checkout system. Furthermore, the supermarkets should consider opening 'green passage' to mobile scanner users. The mobile self-checkout system and fixed self-checkout system are sharing the same machines to conduct payment. Even though with a self-scanner, the user should go to the fixed self-checkout machines to wait for payment. Considering this problem, we suggest that the technology providers should diversify the functions of the self-scanner, for instance, develop the payment function inside the self-scanner. They should consider making self-scanner more convenient, by fixing them with the shopping baskets or shopping carts.

From the system design and human-computer interaction (HCI) perspective, this system needs to be designated with high ease of use or visible benefits, so that even seniors and foreigners who are not accustomed to using this are also satisfied. On top of that, companies may consider issuing some coupons to customers who utilized the system during this visit, which will be available when their next visit. Such strategies may increase customers' revisit and reduce the customers' perceived shadow work, lowering their psychological resistance and barriers to the first use of the system. This can also reduce the uncomfortable minds of customers who feel the shadow work is a transfer of the firm's paid work to them. It may alleviate the level of shadow work that customers might perceive as transfer of work.

6.3. Study Limitations and Future Research Directions

This research is done in the context of mobile self-checkout technology use, which is hard to represent all the situations of self-service technologies. This study does not talk about other emotions, such as challenge emotions and deterrence emotions. Also, this study has a limitation on the number of participants, which may make it hard to generalize the results. Considering these limitations, we suggest conducting a multi-case analysis in the future to get more convincing results and high validity of the study findings. Furthermore, quantitative research based on questionnaire surveys or a mixed method combining qualitative and quantitative research is needed. Finally, future research can develop the measurements of digital shadow work combining emotional factors.

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