科技部補助專題研究計畫報告

男性更能容忍女性機器人造成的服務失敗嗎？探討性別差異和行動者-夥伴效應

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本研究具有政策應用參考價值：■否 □是，建議提供機關
（勾選「是」者，請列舉建議可提供施政參考之業務主管機關）
本研究具影響公共利益之重大發現：□否 □是

中 華 民 國 111 年 05 月 12 日

中 文 摘 要 ： 本計畫探討了顧客性別在基於過程和基於結果的服務失敗中的作用。我們情境模擬的實驗中使用受試者內設計的結果發現：男性和女性顧客在服務失敗的結果上沒有顯著的性別差異。更具體地說，男性（或女性）顧客對機器人造成的服務故障的容忍度並不高。此外，顧客性別和服務補救策略之間沒有顯著的交互作用。結果發現：即使在服務機器人的背景下，傳統的服務恢復策略（例如立即的金錢補償和道歉）在不同的顧客性別中仍然有效。這個計畫有一些限制。首先，由於 COVID-19 的影響，由於招募參與者的困難，該計畫未能測試機器人性別和客戶性別的交互效果與行動者與夥伴相依效果。疫情期間，以替代方式進行場域試驗。但是，我們已經搜集一些數據來初步測試客戶的性別效應，但是服務機器人性別和顧客性別的交互效果是否存在仍不清楚。未來的研究可以使用更大的樣本進一步探索其交互作用與性別效果。其次，我們的研究背景是在餐廳環境中，其結果可能無法推斷到其他環境（例如圖書館服務或醫院服務）。我們鼓勵未來的研究人員調查其他場域和情境中的性別影響。

中 文 關 鍵 詞 ： 服務失敗，機器人服務，性別差異

英 文 摘 要 ： This project explores the role of customer gender in both process-based and outcome-based service failure. Our results using within-subject design in a scenario-based design show no significant gender difference between male and female customers on the outcome of service failure. To be more specific, male (or female) customers are not more tolerant of service failure caused by a robot. Moreover, there are no interaction effects of customer gender and service recovery strategy. The result suggests that traditional service recovery strategies (such as immediate monetary compensation and apology) are still effective across different customer genders, even in the context of service robots. There are some limitations to this project. First, due to the impact of COVID-19, this project needs to use alternative method to test the effect of both robot gender and customer gender due to the difficulties of recruiting participants. During the pandemic, field experiments cannot be implemented. However, we have recruited some initial data to test the gender effect of customers, whether an interaction effect of robot gender and customer gender remains unclear. Future studies can further explore the gender effect using a larger sample. Second, the context of our study was in a restaurant setting. The results may not be inferred to other contexts (such as library services or hospital services). We encourage future researchers to investigate the gender effect in other fields and contexts.

英 文 關 鍵 詞 ： Service Failure, Robot Service, Gender difference

Are males more tolerant of service failure caused by a robot? Investigating the gender differences and actor-partner effect

Abstract

This project explores the role of customer gender in both process-based and outcome-based service failure. Our results using within-subject design in a scenario-based design show no significant gender difference between male and female customers on the outcome of service failure. To be more specific, male (or female) customers are not more tolerant of service failure caused by a robot. Moreover, there are no interaction effects of customer gender and service recovery strategy. The result suggests that traditional service recovery strategies (such as immediate monetary compensation and apology) are still effective across different customer genders, even in the context of service robots. There are some limitations to this project. First, due to the impact of COVID-19, this project uses alternative methods to test the effect of both robot gender and customer gender due to the difficulties of recruiting participants. During the pandemic, field experiments cannot be implemented. However, we have recruited some initial data to test the gender effect of customers, whether an interaction effect of robot gender and customer gender remains unclear. Future studies can further explore the gender effect using a larger sample. Second, the context of our study was in a restaurant setting. The results may not be inferred to other contexts (such as library services or hospital services). We encourage future researchers to investigate the gender effect in other fields and contexts.

中文摘要

本計畫探討了顧客性別在基於過程和基於結果的服務失敗中的作用。我們情境模擬的實驗中使用受試者內設計的結果發現：男性和女性顧客在服務失敗的結果上沒有顯著的性別差異。更具體地說，男性（或女性）顧客對機器人造成的服務故障的容忍度並不高。此外，顧客性別和服務補救策略之間沒有顯著的交互作用。結果發現：即使在服務機器人的背景下，傳統的服務恢復策略（例如立即的金錢補償和道歉）在不同的顧客性別中仍然有效。這個計畫有一些限制。首先，由於 COVID-19 的影響，由於招募參與者的困難，該計畫未能測試機器人性別和客戶性別的交互效果與行動者與夥伴相依效果。疫情期間，以替代方式進行場域試驗。但是，我們已經搜集一些數據來初步測試客戶的性別效應，但是服務機器人性別和顧客性別的交互效果是否存在仍不清楚。未來的研究可以使用更大的樣本進一步探索其交互作用與性別效果。其次，我們的研究背景是在餐廳環境中，其結果可能無法推斷到其他環境（例如圖書館服務或醫院服務）。我們鼓勵未來的研究人員調查其他場域和情境中的性別影響。

1. Introduction

For the past years, we witnessed a growing interest of using robots to replace human frontline employee such as service in retail (Sabelli & Kanda, 2016; Kanda et al., 2010; Shiomi et al., 2009), hotel (Ivanov, 2019; Osawa, 2017; Pinillos, Marcos, Feliz, Zalama, & Gómez-García-Bermejo, 2016), restaurant (Mende et al. 2019), tourism (Yu & Ngan, 2019), transportation (van Doorn et al., 2017), and healthcare (Teixeira et al., 2017; Hudson, Orviska, & Hunady, 2017; Baisch et al., 2017; Hebesberger, Koertner, Gisinger, & Pripfl, 2017; WEI, 2017; (Pigini, Facal, Blasi, & Andrich, 2012). In other words, we enter the era where robots can be seen not only in science fiction movies but also in real life. We called these robots as service robots "a system-based autonomous and adaptable interfaces that interact, communicate and deliver service to an organization's customers" (Wirtz et al., 2018; Chen, Wu, Shuai, & Chen, 2017).

Unlike traditional industrial robots, service robots are designed to be capable of communicating and interacting with humans during service encounters. Although many technologies (e.g., Virtual Reality, Augmented Reality) continuously increase customer service experiences (e.g., Giebelhausen et al. 2014; Huang and Rust 2013; Meuter et al. 2005), the emergence of service robots is among the most dramatic evolutions in the service realm, and it is already underway. Since launched in 2014, Softbank has been succeeded to sold more than 10,000 humanoids "Pepper" worldwide (Tobe, 2016). Companies employed Pepper in different roles, such as salespeople (Nestle´, 2014), waiter (Curtis, 2016), or customer service (Heater, 2017). In such a turbulent and competitive business environment, firms are eager to adopt a service robot into the service process to increase customer satisfaction, operational efficiency, and revenue.

Despite this potential, the success of service robot integration faced many issues. Research in the area of service robots is relatively new, especially in the field of marketing and management. To date, stakeholders don't have any guiding principles for the development and design of service robots (Wirtz, 2019), and many robots are in the market can still be considered in the prototyping phase. The previous study on the failure of the Henn-na Hotel in employing various service robots highlighted that a lack of understanding of these issues could result in lower customer satisfaction. (Bhimasta and Kuo, 2019).

One critical issue of the service robot lies in service failure and service recovery(Albrecht et al., 2019; de Matos et al., 2007; Mattila et al., 2009). Although the service robot has increasingly become popular and prevalent in online and offline service encounters, the performance of the service robots in the current practice is not entirely satisfactory. A recent review paper indicates that robots operating

in unstructured environments are often challenged by frequent failures (Honig & Oron-Gilad, 2018). The authors conclude that communicating failures, perception and comprehension of failures, and solving failures are three unsatisfactory errors of service robots. Despite the popularity of the robot, the service failure of the robot not only affects the customer's evaluation of the service but also poses a threat to the brand experiences of the service.

In traditional service research, frontline employees are agentic and proactive in handling service failure by utilizing several effective service recovery strategies. There are ample studies and meta-analysis valuable for humans as a frontline employee (de Matos et al., 2007). However, when service robots become part of the service process, previous theories and knowledge are not useful due to the nature of the service robot. Unlike human as frontline employees, service robots are programmed to follow the service script to provide appropriate service to customers. Robot's communicative agency and recovery strategies are limited and less likely to accomplish the human actor's role (Araujo, 2018). Therefore, it is necessary to conduct new studies to understand service failure and recover of service robot.

Another essential issue of service robots is the gender of the robot (Nomura, 2017). Carpenter et al. (2009) indicate that even though people didn't have an overall preference for the gender of the robot, they attribute different tasks and roles to the robot. According to the theory of mindless and computers as social actors paradigm (Fogg, 2002; Nass et al., 1994), human reactions to computers or any industrial products may unconsciously affect our perception and behaviors. Also, several studies indicate the human apply gender stereotypes to a robot. Nass et al. (1997) found that humans used gender stereotypes also to machine even when minimizing the gender signals of the robot. The research found that customer's gender affects the acceptance of service robots and that their gender and personality stereotype leads to a different reaction to service robots (Tay et al., 2014). Those studies imply that when service firms and organizations attempt to utilize service robots as whole or part of the service process, the gender of customers and robots should be taken into serious consideration.

Previous studies have shown that customers' unsatisfactory response to service failure derives from different justice perceptions, including distributive, procedural, and interactive justice (Smith, Bolton, & Wagner, 1999). However, previous studies focus on how frontline employees make service recovery to increase service satisfaction and intention to use the service. Even though service failures in frontline employees' context have been widely explored, few studies examine the service failures in the robot-supported context. Although the technological advancement will eventually increase the

accuracy of the service responses and decrease the service failure of the robot, it is essential and necessary for service researchers to explore service failure in the service robot context.

The purpose of this two-year project is two-folded. First, this study investigates whether gender affects customers' reactions to service failure and recovery strategy caused by service robots. In particular, we are interested in the gender and actor-partner effect on the responses to different types of service failure. Although some studies have revealed the gender differences of human reaction to service robots, few studies consider types of service failure and actor-partner effect (male/female customer vs. male/female/neutral robot). A comprehensive evaluation is needed to uncover the underlying mechanism of gender effects. Second, we explore the effectiveness of different service recovery strategies on service failure of service robots by considering gender. In this study, we aim to evaluate two compensational strategies of service robot, i.e., apology and compensation, to ascertain whether there is an interaction effect among robot gender, user gender, service recovery strategy. To make our project clearer, this project investigate the following research questions:

1. Does gender affect customers' reactions to service failure? (robot and customer gender)
2. Do the types of service failure (process vs. outcome failure), robot gender and customer gender affect customers' reaction to service failure?
3. Do we need different service recovery strategies for customers with a different gender?

Our project has several potential contributions. From a theoretical perspective, our project explores and examines service robot issues in service failure/recovery context by considering gender difference and actor-partner effect on the customer. Although few pioneering studies have investigated gender and robot issue, limited studies contextualize robot in specific service context to discuss the service failure issue. Our project contributes to extending the understanding of service failure/recovery literature by integrating the actor-partner effect into the analytical framework. Future service research can build on our analytical framework to investigate gender and service robot issues. For service firms, our study sheds light on capturing how to design a "gendered" service robot by evaluating male/female customers' reactions to a robot's service failure. Moreover, the new service development team will be informed of the prioritizing service failures and strategic compensation strategy for handling customers' dissatisfaction.

2. Literature Review and Hypotheses Development

To have a comprehensive picture of the service robot and service failure, we first review previous literature of service robots by identifying different types of service robots on the market. Second, we

investigate and explain why humans tend to view service robots as human beings rather than a machine by reviewing related theories of anthropomorphism in human-computer interaction and psychology literature. After we review different anthropomorphic cue of service robots, we review prior works of gender and service robots to build up a comprehensive understanding of how customer and service robot's gender may affect the service process. Lastly, we briefly review the literature on service failure and recovery by integrating prior wisdom of gender studies to develop hypotheses.

2.1 Service Robot

The emergence of service robot has been made possible because the rapid advancement of artificial Intelligence and increase in computational power, providing exciting opportunities for service robots the service delivery (Čaić et al. 2018; De Keyser et al. 2019; Wirtz et al. 2018, Huang and Rust, 2018). A recent study by IBM predicts that 85 % of all customer-firm-interactions will be conducted without human intervention by 2020 (IBM, 2017). Moreover, Expert predicts that the growth will continue, and service robots will claim at least twenty-five percent of the workforce in the service industry by 2030 (Bowen & Morosan, 2018). The revolution will start by replacing repetitive and boring jobs (Huang and Rust, 2018). It will likely impact a variety of service industries, such as education, healthcare, elderly care, hospitality, and retail (KPMG, 2016).

The rising of service robots reflects on how companies always try to evolve to stay competitive by engaging customers through technology. The ultimate aim of the adoption of service robots is expected to benefit both the benefits for firms and customers. Service robots are expected to bring optimization on firm operational performance (Osawa et al., 2017). Service robots will take care of the repetitive, physical, and tedious job that enables human employees to focus on more creative and empathetic tasks (Huang and Rust 2018). Therefore, either directly or indirectly (De Keyser et al., 2019), service robots can potentially bring improvement in customer experience (Wirtz et al. 2018). A recent study showed that whereas the current service robot might be limited in functionality, they can bring almost the same customer satisfaction compared to human frontline employees. More importantly, service robots could improve over time (Merkle, 2019).

Despite this potential, the success of service robot integration faced many issues. Research in the area of service robots is relatively new, especially in the field of marketing and management. To date, stakeholders don't have any guiding principles for the development and design of service robots (Wirtz, 2019), and many robots are in the market can still be considered in the prototyping phase. Moreover, although the service robot has increasingly become popular and prevalent in online and offline service encounters, the performance of the service robots in the current practice is not entirely satisfactory. A

recent review paper indicates that robots operating in unstructured environments are often challenged by frequent failures (Honig & Oron-Gilad, 2018). The authors conclude that communicating failures, perception and comprehension of failures, and solving failures are three unsatisfactory errors of service robots. Despite the popularity of the robot, the service failure of the robot not only affects the customer's evaluation of the service but also poses a threat to the brand experiences of the service.

Service robots are critically different from traditional self-service technologies in that they can more meaningfully engage consumers on a social level (van Doorn et al. 2017). This social interaction can be achieved by anthropomorphizing service robots, which refer the human effort to assign human capabilities, such as rational thought and feelings, to inanimate objects such as robots (Waytz et al., 2014). Anthropomorphism is the human tendency to assign human capabilities, such as rational thought and feelings, to inanimate objects such as robots (Waytz et al., 2014). According to theory, anthropomorphism is more comfortable if the service robot is equipped with human-like features, such as a human face, gesture, and emotion (Aggarwal and McGill, 2007; Epley et al., 2007). Consequently, many companies try to create service robots, such as Pepper, NAO, and, more recently Furhat that appear as much like humans as possible (see table 1). However, it is worth to note that consumers may find dealing with highly human-like robots uncomfortable, which are known as "uncanny valley" (Mori, MacDorman and Kageki 2012).

Table 1. Notable example of advance service robot available in the market

Company	Softbank (formerly Aldebaran)	Softbank	Furhat Robotic
Product Name & Release Date	Pepper (2014)	NAO (V1 released on 2006, currently on V6 release in 2018)	Furhat
Product Image			

Distinctive Feature	Standing 120cm tall, Pepper has no trouble in perceiving his environment and entering into a conversation when he sees a person. The touch screen on his chest displays content to highlight messages and support speech Curvy design to ensure danger-free use and a high level of acceptance by users.	NAO has 25 degrees of freedom and a humanoid shape that enable him to move and adapt to the world around him. His inertial unit enables him to maintain his balance and to know whether he is standing up or lying down.	Able to display complex expressions without the mechanical limitations of other technologies. Comes with a selection of pre-built expressions and gestures which can be further customized to fit any character. The face be customized in several ways to create unique characters with their own personalities and quirks... just like a real human
Price Tag	US$ 30.000	US$ 9.000	US $17.000
Product Page	https://www.softbankrobotics.com/emea/en/pepper	https://www.softbankrobotics.com/emea/en/nao	https://www.furhatrobotics.com/

2.2 Anthropomorphism

Anthropomorphism refers to the effort to add an attribute of human characteristics to non-human objects (e.g., robot) to help rationalize their actions (Duffy, 2003). In the service robot context: 'for a robot to be understandable to humans as other humans are, it must have a naturalistic embodiment, interact with the environment in the same way as living creatures do and perceive the same things humans find to be salient and relevant' (Fong et al., 2003). The integration of human-like features, such as feelings or rational thoughts, is believed to influence users' perceptions of robots, through the cognitive process of anthropomorphism, to understand its otherwise unpredictable behavior (Aggarwal and McGill, 2007; Epley et al., 2007; Eyssel et al., 2011; Waytz et al., 2014;).

When imbued with human characteristics, anthropomorphized non-human objects become active participants in the consumption experience and are viewed and treated fundamentally different than those viewed merely as objects (Yang, Aggarwal, and McGill, 2020). Similarly, this explains why consumers prefer service robots with greater human-likeness as interaction partners (Kiesler et al., 2008). This understanding has influenced the development of service robots (e.g., Pepper, NAO, Furhat), which provides human-like features, such as faces or voices (Złotowski et al., 2015). According to Duffy (2003), a service robot requires a degree of human-like qualities, either in appearance, behavior, or both to interact with humans. However, to date, it is not clear on which human-like features should be implemented in the service robot to be able to increase critical factors, such as trust and co-creation, or to be able to cope with service failures.

Epley et al. (2007) proposed a theory to explain why people anthropomorphize non-human objects. The theory unveils three psychological factors to explain motivation (1) elicited agent knowledge, (2) social motivation, (3) effectance motivation. Empirical evidence from several experiments and fMRI studies have also verified the propositions of the SEEK model (Waytz, Morewedge, et al., 2010). The empirical support of people's tendency to anthropomorphize computers accordingly explains people's inner motivation not only to maintain the social nature of people but also to reduce the cognitive load of communication. The elicited agent knowledge mechanism stipulates that knowledge about humans is more readily available and richly detailed for humans than knowledge about non-human agents (Epley et al., 2007). Therefore, humans use it as a basis for their inductive reasoning when they observe human features in non-human agents. The more morphologically similar a robot is in its observable features, the more likely humans are to use themselves as a source of induction and engage in anthropomorphization (Krach et al., 2008). This mechanism recommends incorporating human-like characteristics, such as faces and bodies, in the design of robots to enhance their human-like appearance (Burgoon et al., 2000; DiSalvo et al., 2002).

The sociality motivation mechanism implies the need of humans for social interaction (Epley et al., 2007). If such social connections are not available (e.g., feel loneliness), people anthropomorphize robots to satisfy this need by focusing on the features that facilitate social functioning during an interaction, including non-verbal cues. The more physiognomically similar to a robot is in its social functioning, the more likely humans are to use themselves as sources of induction and anthropomorphize. This mechanism then suggests including human-like characteristics such as gaze, memory, and gestures in the design of service robots (Bruce et al., 2001; Mutlu et al., 2009; Richards and Bransky, 2014; Salem et al., 2013).

Effectance motivation entails a desire for understanding, predictability, and control over one's environment (Epley et al., 2010). When people face uncertainty, unpredictability, or randomness, they tend to anthropomorphize robots. The more predictable similar a robot is in its reasoning features, the more likely humans are to use themselves as a source of induction and engage in anthropomorphization (Epley et al., 2010). This mechanism then suggests features such as providing control, explanation in behavior in the design of service robots (Jörling, Böhm, and Paluch, 2019; Waytz et al., 2010).

2.3 Gender and service robot

When robots are created as service/domestic/social robots, the gender of the robot has received much attention. Different from industrial robots, which are created for automation and efficiency purposes, service robots are designed to fulfill the social roles of frontline employees, such as replacing tedious and repeated service tasks, increasing the efficiency of the service operation, or enhancing the service experience. In essence, the role of a service robot is easily seen as a human being because of sociality motivation of humans (Epley et al., 2007). Accordingly, most service robots follow the theory of anthropomorphism to manipulate several social cues to make customers feel that the service robot is a service frontline employee.

Among several social cues, gender is the most significant factor that robot designers would consider when designing a service robot because it is one of the most salient and omnipresent social categories in human societies that affects virtually every aspect of our every-day life (Harper & Schoeman, 2003). The gender factor is undeniable because service frontline employees provide the most service provision. According to role theory, all jobs are value-laden with specific expectations owing to social and cultural influence. When customers see service robots in front, they would unconsciously and consciously view non-human actors as social actors, such as clerks. This perspective is also confirmed in prior studies. Nass et al. (1997) found even only limited social cues are provided for a robot, people attribute robot to social actor and apply role stereotype to a robot. Carpenter et al. (2009) also indicate that although people do not have an overall preference of specific gender of a robot, they tend to attribute tasks and roles to service robots. Now that service robot has been "gendered" in the service contexts by the customer, there is a need to understand people's reactions to different gender of a robot.

Several prior studies found gender differences when people interact with a social/service robot (Kuchenbrandt et al., 2014; Nomura, 2017). Schermerhorn et al. (2008) found that males and females perceive differently to a social robot. He found that males attribute social robots more to human-like, whereas females attribute robots as machine-like. The difference in the perception also affects other-presence effect. In the arithmetic task, the social facilitation effect is found when male participants work with a social robot. This evidence shows that even when males and females interact with the same-sex robot, they perceive differently of the robot and trigger different social motivation to the task. This finding informs us of considering customers' gender when designing human-robot interaction.

Recently, several researchers focus on the gender stereotype issue of human-robot interaction. A review paper proposes a theoretical framework to understand how gender stereotype forms and how

the stereotype affects human's psychological and behavioral reactions to a robot (Nomura, 2017). He concludes that human factors (e.g., gender, education), robot factors (e.g., gender, embodiment), and situational factors (e.g., rules, tasks, cultures) affect both gender stereotypes and people's reaction whereas gender stereotypes also have a direct effect on reactions. For example, Tay et al. (2014) explore humans' stereotypes and robots. They found that people prefer android with matching gender-occupational role and personality-occupational role stereotypes. They also found that the acceptance of a service robot is not monotonically influenced by robot gender and personality. An interaction effect of stereotypes is found in the acceptance of social robots.

The above studies provide valuable insights into understanding the gender differences and gender stereotypes of human-robot interaction. Users' gender and the robot's gender both affect the perception and conceptions of the human. Moreover, human-robot interaction is also influenced by the situational factor and human stereotype, such as types of tasks. Accordingly, when we are contextualizing social robot into the service context, we need to consider the gender of both android and user, the role expectation of the robot, and task variety as a guiding principle.

2.4 Service failure and service recovery

Service failure refers to the dissatisfactory perceptions of customers during or after the service encounters in terms of service process failure and service outcome failures (Smith et al., 1999). Although maintaining the service quality is of great importance in service operation, there are always some unpredictable accidents leading to dissatisfactory responses from the customers. Therefore, there is a great deal of effort in preventing service failures and in managing service recoveries in online or offline service encounters to avoid the bad word of mouth and post switching negative word of mouth (Tripp & Grégoire, 2011; Wangenheim, 2005).

There are different classification of service failures, such as process failure and outcome failure, monetary and non-monetary failure, reversible, and irreversible failure (Roschk & Gelbrich, 2014). Among the different classification, process and outcome failure is the most widely recognized type of service failure because it has practical and managerial implications in frontline complaint management. Previous studies have also shown that customers' unsatisfactory response to service failure derives from different justice perceptions, including distributive, procedural, and interactive justice (Smith, Bolton, & Wagner, 1999). An interaction effect of the failure context and recovery attributes (compensation, response speed, apology, and initiation) is found to affect different types of justice. Accordingly, service organizations and frontline employees are informed to identify the exact type of service failure and choose an appropriate recovery strategy to handle customers' complaints.

Nevertheless, despite rich in service failure/recovery literature, previous studies mostly focus on frontline employees. One critical issue of the service robot lies in service failure and service recovery(Albrecht et al., 2019; de Matos et al., 2007; Mattila et al., 2009). In an existing service context, frontline employees are proactive, creative, and well-trained to handle the customers' complaints and service failure. When the frontline employees become non-human actors, consideration should be made to determine how to handle the service failure, especially when the service robot is anthropomorphically designed.

A recent review paper indicates that robots operating in unstructured environments are often challenged by frequent failures (Honig & Oron-Gilad, 2018). The authors conclude that "communicating failures," "perception and comprehension of failures," and "solving failures" are three unsatisfactory errors of service robots. According to a recent meta-analysis of service failure and recovery (Roschk & Gelbrich, 2014), the former two types of failures can be classified into "lack of attention (process failure)," whereas the latter can be classified into "failed service (outcome failure)." Based on the current understanding and experimental findings, "psychological compensation (apology)" is more useful to handle service failure of "lack of attention," whereas "new/reperformed service" has the most significant recovery effect in case of failed service. Also, research indicates that a combination of different strategies may be plausible solutions to handling service failure. However, previous findings are based on human-to-human interaction; it remains unclear whether such a recovery strategy is practical and useful when applied to treat service failure of service robots. Therefore, it is necessary to revisit the service failure and recovery strategy in the human-robot interaction to evaluate the appropriate guide to design service robots.

To make clear our study clear, we classify the service failure of service robots into process and outcome failure. The service process failure refers to incapability of understanding and comprehension of customers' demand while the outcome failure is the solving failures, i.e., providing the wrong service of customers' requirements. In addition to the failure type, we choose three strategies that widely used in the service context, i.e., apology, immediate monetary compensation, and service re-provision. Roschk and Gelbrich (2014) indicate that compared to delayed monetary compensation, immediate monetary compensation is a more effective recovery strategy. Therefore, we choose immediate monetary compensation rather than delayed monetary compensation.

2.4.1 Gender and service failure

As described earlier, the male and female customer has a different preference toward a service robot. Schermerhorn et al. (2008) found that male customers view robots more as a human-like actor

while female customers regard robot more like a machine. These differences also lead to different social interactions and other-presence effect. When customers view the service robot more as human-like service frontline employees, it is more likely for customers to trigger more gender stereotypes and role expectations of the robot. That is, when the service robot is viewed as a real frontline employee, the service provision would be treated more critically and thus, the role of the service robot would also be critically evaluated. Accordingly, compared to male customers (seen robot more as human-like), female customers are expected to be more tolerant of the service failure of service chatbot. That is, the dissatisfaction and future intention to use the service is higher for a female customer.

H_1: Compared to male customers, females are more tolerant of the service failure of service chatbot.

McColl-Kennedy et al. (2003) are the very first to discuss the gender issues of service failure and recovery in service research. They indicate that male and female customers have different preferences in the service process. Male customers focus more on the outcome of the service, while females customers prefer participating in the service recovery process. According to the research finding, male customers seem to pay more attention to the outcome of the service. They do not expect much interaction during the service encounter with a service robot.

On the other hand, the female customer focuses more on the interactive process of service encounters. They may show their interest in exploring the service robot to see how the service robot can consider their voice and opinions. Based on this difference, we expected that female customer would be more tolerant of the outcome-based service encounter while the male customer is more tolerant of process-based service encounters. Thus, we have:

$H_{2(a)}$: Compared to male customers, females are more tolerant of the outcome-based service failure of service chatbot.

$H_{2(b)}$: Compared to female customers, males are more tolerant of the process-based service failure of service chatbot.

2.4.2 Gender and service recovery

According to gender differences, male and female customers put different emphasis on service failure and recovery. As noted earlier, male customers are more outcome-based while female customers are process-based. Therefore, compensation strategies are expected to have gender differences. Now that female customers may be more democratic and participative in the process of service recovery, psychological compensation (i.e., apology) is more likely to be an effective strategy

for female customers. Following similar logic, male customers are out outcome-orientated. More specifically, male customers may care more about whether they can receive fair treatment at the end of the service. Therefore, when service failure happens, male customers would identify and consider whether they can obtain appropriate compensation in the service recovery process. Based on these arguments, we have:

$H_{4(a)}$: When the service robot makes service failure, immediate monetary compensation is a better strategy for male customers.

$H_{4(b)}$: When the service robot makes service failure, apology (admitting mistakes) is a better strategy for female customers.

3. Research Methodology and Design

In this project, we aim to explore the gender and service failure/recovery issue using both the scenario-based survey and field experiment. We first introduce the scenario-based study and explain how this method works in prototyping and marketing research and then explain how we conduct our research design to confirm our hypotheses.

3.1 Scenario-based Survey

Scenarios are stories about people and their activities (Carroll, 1999). Scenarios describe what and how people interact with the system through a sequence of actions taken to achieve their goals. It involves how a user senses the information presented via interfaces, what the user makes sense of it, and what it leads the user to take actions that change his/her status quo. Carrol (2000) specified several elements to compose a scenario. They are setting, actors (agents), goals, actions, and events. A setting is a context in which an actor interacts with the system involving particular objects and composed of episodes as states. An actor typically has his/her goals or objectives, which are changes that the actor wishes to achieve in the circumstances of the setting. Scenarios have plots, which include sequences of actions that actors do, events that happen to them, and changes in the conditions of the environment. The narrative is written to evoke an image of people doing things, pursuing goals, using technology in support of these goals.

There are many design methods for interaction design to generate prototype products and usability tests. For example, design thinking (Brown, 2009) has been widely used for product and service design process, by IDEO, Stanford d-school, and many institutes and companies. The divergent-convergent process taking empathy, define, ideate, prototype, and iterative test stages facilitate the creation of

innovative products or services with participants across disciplines. Many other design methods and tools like design thinking, such as Double Diamond Model by Design Council, UK, emphasizes the outside-in and inside-out process to discover users' needs and develop and test new products or services through a composition of methods and tools to facilitate communications and collaboration of participants.

Take a scenario of service cute robot example as an example. An actor, Wang, is a male college student with a major in computer science. The setting is at the Hotel receptionist's desk. The plot is he need to check-in with a service robot. He found that the robot is cute with a bulging forehead, large eye and rounded cheeks. The robot asked consent from Wang to be able to collect his personal data including personal information, conversation and emotion during the encounter with the robot. This action is optional.

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In the design process, user feedback may be obtained in informal settings; for example, a participatory test of prototyping products or services. The evaluation could be analytic through claims analysis and other design review activities (e.g., usability inspections or cognitive walkthrough; Nielsen, 1995; Nielsen & Mack, 1994; Polson et al., 1992). All of these activities yield formative evaluation feedback that guides changes and expansion of the design vision. Each analyzed feature with its consequences is called a claim (Rosson & Carroll, 2002). Scenario-based design is guided by usability evaluation throughout development. Each narrative serves as a test case of analytic assessment; each claim hypothesizes usability outcomes for one or more test cases. Scenarios and their associated applications are combined to create usability specifications. A usability specification is a representative task context that has been analyzed into critical subtasks, with each subtask assigned targeting usability outcomes. Figure 5 illustrates the scenario-based design framework.

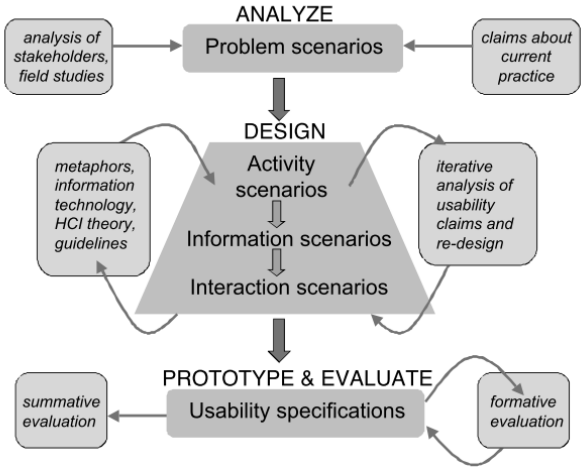

Figure 1. Scenario-based design framework (Rosson, & Carroll, 2002)

3.2 Research Design

To confirmed our hypotheses, both within- and between- subjects fixed effect factorial designs were adopted to evaluate the interaction effect of service failure (process, outcome), customer gender (male, female) and robot gender (male, female), strategy (compensation, apology). To contextualize our research hypotheses into more authentic service encounters, we design two scenarios (restaurant ordering and library discussion room reservation) to verify our assumptions. We decide on the two service encounters based on the following reasons: First, the two services are task-oriented service; therefore, there is no need for customized or personalized service to increase the confounding effect of the experiment. Second, if the service process is not too complicated, customers can experience the service failure more directly and straightforwardly. Therefore, the responses are expected to be more reliable and valid. Third, recently more and more restaurants and public libraries are experimenting with service robots in real service encounters. Customers are believed to have limited difficulties in interacting with the service robot in these services. Lastly, with the support of the university and the author's convenience, we can empirically test these two services in the National Tsing-Hua library and a family-owned beef noodle restaurant.

3.2.1 Material development

In the service failure condition, we manipulate the process and outcome errors of service encounters. We use voice control as our interaction type. For service process failure, the customer will be instructed to order his/her dishes on the robot. Still, the service robot is intentionally designed to display an error message *"Sorry, I don't quite understand what you order, please try again,"* and the

robot will ask the customer order again. For the outcome failure, after the customer's request, the service robot will tell the customer, *"Oops! The dishes you ordered have been sold out. Please order again."*

We manipulate the robot gender by two social cues, robot name, and voice. We name the male service robot as Brian whole the female robot as Lisa. We recruit professional actors and actresses to record the voice for this study. We will develop a scandalized script to ensure both male and female service robots demonstrate the same information. In the script, we also include the content for service recovery, in terms of apology and immediate monetary compensation. The robot will read the script for the apology and admitting that "He/She is still learning.". For the compensation scenario, when customers complain about the flawed service, the robot would give an instant coupon for the customer. Also, to evaluate whether the manipulation is successful, participants will be asked two questions to identify the robot gender.

3.2.2 Pilot Study

To ensure the quality of research instruments and the design of a service robot, we conduct one pilot study before the scenario-based experiment. The goal of the pilot study is to ensure (1) that the manipulation is successfully received, (2) the reliability and validity of the measures. The within-subject design will be employed in the pilot study. We expect to collect 21 university student samples and 21 adult samples (from our part-time MBA program) (42 participants in total). Each participant will experience both restaurant ordering and library discussion room booking (we will randomly arrange the sequences of the experiment). In each trial (restaurant vs. library), participants will be randomly assigned to one of the four conditions.

The pilot study is expected to take 30 minutes. We will distribute a recruitment ad at the Facebook page of ISS and dorms of National Tsing Hua University. Interested participants will be invited to room with a computer and a projector. The instructor will explain the overall of the experiment and ask the participants to sign-up the informed consent. Then, the participant will randomly be assigned into two conditions (library condition and restaurant). In each condition, the projector will show the instruction of each experiment and ask the participants to conduct a designated task. The participants will then be asked to self-report their dissatisfaction, continuous intention to use the service, demographic data, and control variables. After the experiment, each participant will be given 100 NTD as a monetary reward. After the pilot study, we will evaluate the process and outcome of the pre-test and modify the experimental procedure in the scenario-based experiment.

Results

A series of t-tests and ANOVA tests were conducted to examine the proposed hypotheses. To test whether females are more tolerant of the service failure of service robots, we conducted six t-tests to evaluate the model. We chose (1) satisfaction, (2) loyalty, and (3) intention to use robot service in the future. As shown in Table 1, no significant differences were found between male and female customers on either process-based or outcome-based service failure. Therefore, H1, H2(a), H2(b) were rejected.

Table 1: Results of independent samples t-test

	Independent Samples Test		
	t	df	*p*
Satisfaction $_{process}$	.173	162	.863
Loyalty $_{process}$	1.434	162	.154
Intention $_{process}$	.383	78	.702
Satisfaction $_{outcome}$	-.876	162	.382
Loyalty $_{outcome}$	.311	162	.756
Intention $_{outcome}$	.225	78	.823

Table 1: Group descriptive sataistics

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Satisfaction $_{process}$	Male	65	3.4667	1.18849	.14741
	Female	99	3.4310	1.35547	.13623
Loyalty $_{process}$	Male	65	3.5231	1.20181	.14907
	Female	99	3.2121	1.45176	.14591
Intention $_{process}$	Male	32	2.2813	1.17656	.20799
	Female	48	2.1875	.99623	.14379
Satisfaction $_{outcome}$	Male	65	4.2821	1.83734	.22789
	Female	99	4.5286	1.71297	.17216
Loyalty $_{outcome}$	Male	65	4.1487	1.64995	.20465
	Female	99	4.0640	1.74228	.17511
Intention $_{outcome}$	Male	32	3.0625	1.43544	.25375
	Female	48	2.9931	1.29463	.18686

Hypotheses 4 aims to understand the role of compensation in service failure and service recovery. Before evaluating the interaction effects, simple effects were tested using six ANCOVAs by including gender as a covariate. The results found that three service recovery strategies (none, apology, and apologies with immediate monetary compensation) do not affect service outcomes in process-based service failure. However, significant main effects of service recovery strategies were found in outcome-based service failures including satisfaction ($F(2) = 90.772$, $p < .00$), loyalty ($F(2) = 63.39$, $p < .00$), and intention to use robot service ($F(2) = 90.772$, $p < .00$). To evaluate the effect of the service recovery strategy, three one-way ANOVA with post hoc tests were conducted, suggesting that apologies with immediate monetary compensation (AIMC) are significantly higher than an apology, and none response in satisfaction and loyalty. For future intention to use the service robot, apology or AIMC is significantly higher than none, but no significant differences were found between apology and AIMC.

Six two-way ANOVA tests were conducted to evaluate the interaction effect of customer gender and compensation strategies. The six tests show no significant interaction effect between gender and compensation strategies. However, the simple main effect of service recovery strategies was found. This finding suggests no gender difference between different service recovery strategies and that AIMC is the most effective service recovery strategy in either male or female customers. Therefore, H4(a) and H4(b) were rejected.

Conclusion

This project explores the role of customer gender in both process-based and outcome-based service failure. Our results using within-subject design in a scenario-based design show no significant gender difference between male and female customers on the outcome of service failure. To be more specific, male (or female) customers are not more tolerant of service failure caused by a robot. Moreover, there are no interaction effects of customer gender and service recovery strategy. The result suggests that traditional service recovery strategies (such as immediate monetary compensation and apology) are still effective across different customer genders, even in the context of service robots. There are some limitations to this

project. First, due to the impact of COVID-19, this project fails to test the effect of both robot gender and customer gender due to the difficulties of recruiting participants. During the pandemic, field experiments cannot be implemented. However, we have recruited some initial data to test the gender effect of customers, whether an interaction effect of robot gender and customer gender remains unclear. Future studies can further explore the gender effect using a larger sample. Second, the context of our study was in a restaurant setting. The results may not be inferred to other contexts (such as library services or hospital services). We encourage future researchers to investigate the gender effect in other fields and contexts.

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109年度專題研究計畫成果彙整表

計畫主持人：王俊程			**計畫編號：**109-2629-H-007-003-		
計畫名稱：男性更能容忍女性機器人造成的服務失敗嗎？探討性別差異和行動者-夥伴效應					
成果項目			量化	單位	質化 （說明：各成果項目請附佐證資料或細項說明，如期刊名稱、年份、卷期、起訖頁數、證號...等）
國內	學術性論文	期刊論文	0	篇	
		研討會論文	0		
		專書	0	本	
		專書論文	0	章	
		技術報告	0	篇	
		其他	0	篇	
國外	學術性論文	期刊論文	0	篇	
		研討會論文	0		
		專書	0	本	
		專書論文	0	章	
		技術報告	0	篇	
		其他	0	篇	
參與計畫人力	本國籍	大專生	0	人次	
		碩士生	1		碩士論文題目：The Impact of Robot Cuteness and Service Recovery Strategy on Customer Behavioral Intentions: The Mediating Role of Emotions。 由於人工智慧在旅遊和飯店行業的應用越來越廣泛，服務機器人如何從產 生的服務失誤中恢復是值得實證研究的。本研究旨在探討可愛對服務失誤的影響。我們預計可愛將透過降低負面情緒來提高顧客的忠誠度。我們還預計，由於服務恢復策略的不同，可愛效果會對顧客的忠誠度產生不利的影響。本研究使用 3 x 2 受試者間設計表明，服務機器人的可愛使顧客對服務失誤的反應具有 積極影響，以及兩種中介效果（積極情緒和負面情緒）和可愛效果的邊界（服務恢復策略）。這些發現，增加了對人工智慧輔助服務的理解，讓我們更深入了解可愛的設計在旅遊和餐飲業中的應用。
		博士生	0		
		博士級研究人員	0		

		專任人員	0		
	非本國籍	大專生	0		
		碩士生	0		
		博士生	0		
		博士級研究人員	0		
		專任人員	0		
其他成果 （無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。）					