

# The Effect of Express Delivery Robot Autonomy on Customer Responsibility Attribution in a Service Failure Scenario

Zhen Fu<sup>1,\*</sup>

<sup>1</sup> School of Economics and Management, Tianjin University of Technology and Education, Tianjin, 300222, China

\* Corresponding author: Zhen Fu (Email: fz2024@126.com)

---

**Abstract:** In order to improve the efficiency of e-commerce logistics services and reduce labor costs, many cities have introduced express delivery robots to provide express delivery services. Robotic service failures occur from time to time due to the complexity of the service environment, immature technology, and other constraints. This study investigates the effect of service robot autonomy on customer responsibility attribution using a 2 (robot autonomy: high vs. low) x 2 (customer participation level: high vs. low) between-groups experimental approach to investigate the mediating role of controllability and the moderating role of customer participation using the scenario of service failure of a express delivery robot. The experimental results show that robot autonomy increases customers' attribution of responsibility to the robot in service failure scenarios, and controllability partially mediates this effect, but the moderating effect of customer participation is not demonstrated. The experimental results provide implications for the design and use of service robots.

**Keywords:** Service robot, Service failure, Responsibility attribution.

---

## 1. Introduction

Thanks to the development of technology and the support of relevant policies, service robots have achieved rapid popularization. However, with the popularity of service robots, service failures have occurred. For example, the Henn-Na Hotel in Japan, which is famous for its robot service, "fired" the robot Churi because it took the snoring sound of customers when they were sleeping as a call for help and disturbed the customers' rest and received complaints[1]. The robot was fired because it disturbed the rest of the customers by mistaking their snoring for help. The degree of sophistication of robotics technology and the complexity of specific service scenarios dictate that service failures are unavoidable.

From a management perspective, service failures can cause customer dissatisfaction[2] which in turn affects the reputation of the company[3]. Therefore, it is necessary to study the responsibility attribution of customers after robot service failure. By understanding the tendency of customers' attribution of responsibility after service failure and the factors affecting the attribution of responsibility can provide a reference for alleviating customers' negative emotions. In this paper, we use the literature method and experimental method to explore the effect of robot autonomy on customers' attribution of responsibility after robot service failure.

According to attribution theory, people naturally want to know why certain events occur in order to understand why they happen[4]. In traditional service situations, service failures caused by service providers elicit different attributions of responsibility from customers. However, when Leo et al. studied two types of services, pharmacy dispensing and restaurant cooking, as experimental scenarios, they found that customers reacted differently when the failed service was provided by a robot, triggering different attributions of responsibility[5].

There are fewer studies on attribution for robot service

failures, and the existing studies mainly focus on service scenarios such as hotels and restaurants, with less attention paid to the currently emerging express delivery robots. When express delivery services are provided by robots, how customers will be responsible for attribution remains to be explored. In addition, less attention has been paid to the autonomy of service robots. Many studies have focused on the impact of anthropomorphic qualities of service robots on service, but autonomy is also an important characteristic of service robots. Therefore, this study takes express delivery robots as the research object, and explores the influence of the autonomy characteristics of service robots on the attribution of customer responsibility after service failure and the way of influence based on attribution theory. The hypothesized model is proposed based on the literature review, and the experimental method is used to verify the model.

The experimental results show that the level of autonomy of the express delivery robot has a significant effect on customer responsibility attribution, which is partially mediated by controllability. This result provides a reference for robotics research and development companies and departments planning to introduce robotic services. It also enriches the research related to the attribution of responsibility after service failure of service robots.

## 2. Literature Review

### 2.1. Service robots

Service robots are defined as system-based, autonomous, adaptable interfaces for interacting, communicating, and providing services to an organization's customers[6]. It has already been popularized in several industries such as hotels, restaurants and retail.

Some studies have focused on the impact of service robot characteristics on customer satisfaction and behavioral tendencies after service failure. Autonomy and anthropomorphism are the most critical and unique

characteristics of service robots[7]. Epley defines anthropomorphism as human-like characteristics perceived in a non-human subject[8]. The International Organization for Standardization defines robot autonomy as the ability of a robot to perform its own actions with little (partially autonomous) or no (fully autonomous) human intervention and to adapt its behavior to a specific goal and execution context with the help of advanced machine learning algorithms[9], [10]. Among them, the anthropomorphic features of service robots have been widely noticed. Some experiments have shown that process failure brought about by humanoid robots reduces customer dissatisfaction relative to non-humanoid robots, but has no significant effect on the outcome failure group[11]. Meanwhile, several studies have found that anthropomorphism has a positive impact on technology perceptions, and that anthropomorphism can increase trust[12], [13], increased favorability[14] or higher fault tolerance[15]. However, some studies have also found negative effects of anthropomorphism, such as the "Uncanny Valley" theory, which suggests that highly anthropomorphic robots can be intimidating to consumers[16], [17]. The "Uncanny Valley" theory suggests that highly anthropomorphic robots can make consumers fearful. Some studies have also focused on the effect of robot autonomy on service failure, and Leung et al. explored the relationship between robot autonomy and consumers' identity motivation in six different scenarios: when consumption is driven by identity motivation, robotic services with a high degree of autonomy are unattractive[18]. Robot autonomy is a double-edged sword when it comes to customer acceptance of robotic services. While autonomy brings efficiency and flexibility, it also implies a lack of human supervision, and customers may be resistant to putting themselves entirely in the hands of a robot[19], [20]. The customer may be resistant to placing themselves completely in the hands of a robot.

## 2.2. Service failure

Service failure is defined as service performance that falls below customer expectations[21]. Although robot developers have invested considerable effort in avoiding robot mistakes, it has been shown that robots face a large number of service failures in complex real-world service environments[22].

Service failures can cause customer dissatisfaction with the service provider or even the entire service organization[2] and in turn negative word-of-mouth[3] and customer switching behavior[23] and customer switching behavior. Therefore, service failure is a problem that enterprises have to face when popularizing service robots. However, the current research on robot service failure has shown different results. On the one hand, some studies have shown that if a robot fails to serve successfully, people usually evaluate its ability negatively. For example, the results of Lee et al.'s experiments show that[24] that people rate services and robots lower when the robot makes mistakes. On the other hand, a study by Ragni et al. found that while people perceived flawed robots as less intelligent and less reliable than perfect robots, robots that made mistakes triggered positive customer emotions[25]. There is even research that suggests these mistakes may increase users' preferences for robots. For example, one study found[26] that participants perceived a robot with a blunder as more likable than a robot without a blunder, and participants expressed more positive emotions when the robot made a mistake.

## 2.3. Attribution of responsibility

Previous research has shown that customers' attributions for experienced service failures affect their attitudes and behavioral intentions toward the firm[27]. Previous research has shown that customers' attributions for experienced service failures affect their attitudes and behavioral intentions toward the firm. Based on self-serving bias, customers are more inclined to make external attributions of responsibility for service failures, i.e., they believe that service failures are caused by the service provider, the enterprise, etc., which affects the reputation of the enterprise and customers' repurchase intentions[28]. This will affect the company's reputation and customers' willingness to buy again[29]. However, when customers make internal attribution of responsibility, it can positively influence their perception and behavior towards the service provider and the service enterprise[18], [30], [31]. The following is an example of a study that explores the role of attribution in robot service failures. Therefore, exploring which factors affect customers' attribution points when robotic service fails can provide suggestions for avoiding the decline of corporate word-of-mouth and retaining customers.

There are more ways to reduce customer self-service bias when services are provided by machines than with traditional human services. One study found that anthropomorphic machines affect people's self-service bias and can alleviate customer dissatisfaction with service failures[32]. In the field of healthcare service robots, two experiments conducted by Meyer et al. demonstrated that the warmth and competence design of a robot affects customers' propensity to attribute responsibility: when service failure is provided by a robot with a warm design, it improves customers' internal attributions[30].

Attribution theory suggests that people naturally want to understand why certain events occur in order to understand why they occur[4]. Weiner classified the attribution process into three dimensions, namely causality, controllability and stability. Causality refers to the customer's perception of whether the problem is caused by something internal to the customer (i.e., the customer himself) or external to the customer (e.g., the service provider). Controllability refers to the customer's perception of the extent to which the service provider can control the failure, i.e., whether the service provider is able to control the occurrence of the service failure. Finally, stability refers to the customer's perception of the likelihood that the service failure will recur, i.e., whether the service failure is temporary or permanent[5]. A large body of research has centered on these three dimensions. Leo et al. show that customers perceive human and robotic service failures differently in terms of stability and controllability, which in turn affects the attribution of responsibility for the aftermath of a service failure[5]. Choi et al.'s study found that controllability attribution affects customers' perceptions and behavioral tendencies after service failure, eliciting a high degree of negative reactions from customers when they believe that the service provider has control over the occurrence of service failure[33], [34]. Some scholars have also focused on the effect of robot characteristics on responsibility attribution. The effect of anthropomorphism on responsibility attribution was described in a study as early as 2003[28]. The study found that anthropomorphic features can increase the attractiveness and favoritism of people[35], [36]. In a study of self-service technology, people attributed more responsibility to themselves after a service failure due to the

"liking effect", creating an internal attributional outcome that is contrary to the self-service bias. In a study of self-service technology, researchers found that the effect of anthropomorphism on attribution of responsibility was also moderated by technology self-efficacy and the construct of independence[32]. However, there has been less attention and exploration of robot autonomy. a study by Jakub Złotowski showed that robots with high autonomy gave people more threatening perceptions, triggering negative emotions[37]. In an experiment with three different scenarios, Caleb Furlough et al. found that if the robot in the scenario was described as non-autonomous, participants placed little blame on the robot, and conversely if the robot was described as autonomous, participants placed most of the blame on the robot[38], which is the same result as in previous studies[39].

## 2.4. Customer participation

Customer participation has not yet been defined uniformly in academia. Some scholars define customer engagement in terms of individual behavior. For example, Ennew et al. used three dimensions of information sharing, responsible behavior, and interpersonal interaction to determine customer participation behavior[40]. Some scholars have also defined customer participation in terms of outcomes. Claycomb et al. define customer participation in terms of three dimensions: attendance, information provision, and co-manufacturing[41]. This paper adopts Bitner et al.'s definition of customer participation: customer participation is the extent to which customers are involved in the production and service delivery process[42].

The positive impact of customer participation on service satisfaction, perceived service quality, etc. is argued in many service scenarios[43]–[45]. In a survey of the tourism industry, it was found that tourist engagement had a strong positive effect on satisfaction and loyalty[46]. In the mobile app service failure scenario, it was found that there was a U-shaped relationship between the level of customer engagement and negative responses (including exit and neglect behaviors), while there was an inverted U-shaped relationship between the level of customer engagement and positive responses (including loyalty and voice behaviors)[47].

## 2.5. Review of the study

By combing the literature on robot service failure and attribution of responsibility, it is found that the factors affecting customer behavioral tendencies and attribution of responsibility during robot service proposed in past studies are mainly classified into four categories: (1) robot characteristics, such as the robot's autonomy, anthropomorphism, etc[15], [48]–[50]; (2) customer characteristics, such as the customer's technology self-efficacy, the customer's need for interpersonal interaction[32], [51] etc.; (3) human-robot interaction characteristics, such as customer participation level[40], [52] and the level of information provision[48]. (4) Other external characteristics, such as the use of the environment[48], the type of failure[34] and other external factors. Combined with the characteristics of express delivery robots and the service mode, this study will investigate the effects of robot autonomy and customer

participation on the attribution of customer responsibility after service failure.

Attribution theory is widely used in consumer psychology research. The attribution process of consumers' responsibility for services affects consumers' responses to sellers, such as their ratings, complaints, and repurchase behaviors, as well as their anger toward businesses and whether they demand compensation. Therefore, understanding the process of consumer attribution of responsibility for service can help companies adjust and optimize their service processes to avoid similar service failures in subsequent services and reduce consumer dissatisfaction at the root, as well as to maintain consumer loyalty and to develop measures for timely and effective restoration of remedies or compensation to reduce consumer dissatisfaction after service failures. However, the current research on the factors affecting the attribution of customer responsibility is still insufficient compared to the growing market for service robots.

Express delivery robots are a new type of service robot developed to improve the efficiency of express delivery, and several companies have launched express delivery robot services in increasing numbers, but current research on service robots mainly focuses on service scenarios such as hotels and restaurants, with less attention paid to express delivery service scenarios. Therefore, this paper chooses express delivery robots as the object of study and uses the attribution theory to explore the impact of their autonomy on the attribution of customer responsibility after service failure.

This study will use an experimental approach to validate the effect of robot autonomy on customer responsibility attribution after service failure, an effect that may be mediated by controllability. Meanwhile, the level of customer participation may moderate the effect of autonomy on controllability. The specific model is shown in Figure 1.

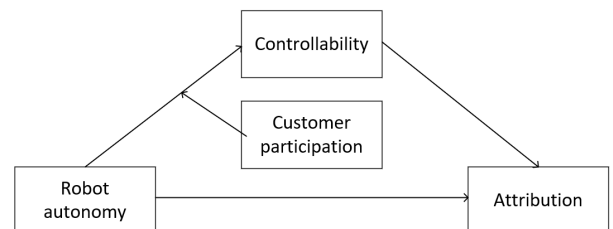


Figure 1. Research framework

## 3. Research method

An experimental questionnaire method was used to test the study. The experimental questionnaire was posted on the Credamo data collection platform, and subjects were paid RMB 1 yuan for completing the questionnaire. 122 questionnaires were recovered, and 102 valid questionnaires were returned after excluding questionnaires with incorrect answers to validation questions and short response times. Males accounted for 56% of the total and females for 44% of the total, and the age of the participants was concentrated in the 21-40, which accounted for 92% of the total number of participants. Specific demographic information is shown in table 1.

**Table 1.** Descriptive statistics for experiment

DESCRIPTIVE STATISTICS FOR EXPERIMENT		FREQUENCY	PERCENTAGE
GENDER	Male	57	56%
	Female	45	44%
AGE	Under the age of 20	2	2%
	21 to 30 years old	68	67%
	31 to 40 years old	26	26%
	41 to 50 years old	4	4%
	51 to 60 years old	2	2%
EDUCATIONAL BACKGROUND	Senior high school	4	4%
	Specialized training school	7	7%
	Undergraduate (adjective)	73	72%
	Bachelor's degree	15	15%
CAREERS	Court academician (in feudal China)	3	3%
	Student	28	28%
	Employees of state-owned enterprises	18	18%
	Government & Institution Employees	17	17%
	Employees of foreign-funded enterprises	10	10%
	Private sector employees	23	23%
	Others	6	6%
INCOME LEVELS	Less than 1000	12	12%
	1000—3000	16	16%
	3000—5000	15	15%
	5000—8000	34	33%
	More than 8000	25	25%

### 3.1. Experimental design

To verify the effect of robot autonomy on customer responsibility attribution and the moderating effect of customer participation, a 2 (robot autonomy: high vs. low) × 2 (customer participation: high vs. low) between-groups experiment was designed in which subjects were randomly assigned to one of the experimental groups, and the variables were manipulated through textual descriptions. The experiment was divided into four parts in which subjects were asked to imagine themselves using a express delivery robot to pick up a delivery. The first part began with a brief introduction to the use and functions of the express delivery robots to the participants, in which the high autonomy robots had an automatic adjustment function while the low autonomy robots required human intervention to complete the service. The second part introduced participants to the steps necessary to pick up a package using a express delivery robot, where subjects in the high customer participation group were required to complete four steps and provide more information, whereas subjects in the low participation group were only required to complete two steps and provide less information. The third part is a unified description of the service failure scenario, where participants were told that they did not succeed in picking up their package and a test question was set up for filtering participants who did not read the experimental description carefully. Finally, there were scale tests and demographic information questions.

### 3.2. Measurements

Autonomy, customer participation, and attribution of

responsibility were measured using previously developed scales, and the reliability of the scales was analyzed. Autonomy of the robot was measured using Rijdsdijk et al's Autonomy Scale[53], which contains 3 question items ( $\alpha = 0.813$ ). Customer participation was measured using HSIEH A's Customer Participation Scale[54], which contains 3 question items ( $\alpha = 0.762$ ). Customers' perceptions of the degree of failure of the robot-controlled service were measured using Hess Jr et al.'s controllability scale[27], [29], which contained 3 items each ( $\alpha = 0.728$ ). Responsibility Attribution Scale was used to measure customer attributions to robots, which contained 2 items, and the Spearman-Brown coefficient was used as an indicator of the reliability of the 2-item scale; the correlation coefficient between the two items was 0.617, which is significant at the 0.01 level of correlation. It indicates that the scales all have good reliability.

The fit of the model was tested using Amos 22.0. The results show that the measured model has CMIN/DF=0.080, IFI=0.935, TLI=0.901, CFI=0.932, and the model exhibits a good fit. According to the analysis of CFA results, the AVE values of all dimensions are greater than 0.5 and the CR values are greater than 0.7, indicating that all dimensions have good convergent validity and combinatorial reliability. The results of the test of discriminant validity showed that the correlation coefficients of the dimensions were less than the square root of the AVE values, indicating that the dimensions directly had good discriminant validity. The results of the CFA are presented in table2.

**Table 2.** CFA data

	CR	autonomy	cp	controllability	robot
autonomy	0.82	0.60			
customer participation(cp)	0.79	0.12	0.57		
controllability	0.76	0.13	0.01	0.52	
attribute to robot(robot)	0.79	0.30	-0.02	0.50	0.65
√AVE	\	0.78	0.75	0.72	0.81

## 4. Results

Before analyzing the results of the data, a manipulation test was conducted using the independent samples t-test. To test the success of the manipulation of variables in the experiment, after reading the scenario descriptions, participants were asked to rate how much they agreed with the scale statements on a 7-point Likert scale, with a score of 1 being "strongly disagree" and a score of 7 being "strongly agree". The results showed that there was a significant difference in the participants' perception of autonomy in the two levels of autonomy, with a significance test of 0.007, and based on the mean values, it can be seen that the subjects in the low autonomy subgroup rated the robot's autonomy as lower than in the high autonomy subgroup ( $M_{low}=11.50 < M_{high}=13.78$ ), suggesting that the autonomy manipulation was successful. There was a significant difference in the subjects' perceptions of customer participation across the two levels of customer participation, with a significance test of 0.006, and the participants in the high level of customer participation group rated the level of customer participation at a higher mean than that of the low level group ( $M_{low}=14.98 < M_{high}=17.04$ ), suggesting that the customer participation manipulation was successful.

**Main and Mediating Effects Tests:** To test the effect of robot autonomy on responsibility attribution and the mediating effect of controllability, linear regression analyses were performed using SPSS 26.0. The regression of robot autonomy on controllability was first tested, and the results showed that robot autonomy had a significant effect on controllability ( $p=0.016$ ). Then the effects of robot autonomy on responsibility attribution, autonomy and controllability on responsibility attribution were tested, and the results showed

that controllability had a significant effect on responsibility attribution ( $p<0.000$ ), and comparing the regression coefficients of robot autonomy in models 1 and 2, the regression coefficients in model 2 were smaller than the regression coefficients in model 1 ( $b_2=0.333 < b_1=0.501$ ), which indicated that the mediation of the controllability effect is significant and is a partial mediation effect.

**Moderated mediation effects test.** The experimental data were analyzed using the PROCESS program in SPSS to test the effect of robot autonomy on customer responsibility attribution, the mediating effect of controllability, and the moderating effect of customer participation. Using Model 7, robot autonomy as the independent variable, customer attribution of responsibility to the robot as the dependent variable, customer participation level as the moderator variable, controllability as the mediator variable, and demographic information (including gender, age, education, occupation, and income level) as the covariates, a sampling of 5,000 was set up with a 95% confidence interval.

After controlling for demographic variables such as gender and age, the results again demonstrated that the direct effect of robot autonomy on customer responsibility attribution, and the indirect effect mediated by controllability were significant, whereas the product term of robot autonomy and customer participation was not significant in predicting controllability,  $p>0.05$ . The detailed data are shown in table 3. The moderating effect of the level of customer participation was not validated, possibly due to the fact that the textual description of the stimuli in the experiment was insufficient, resulting in customers being less influenced by the level of participation when making responsibility attributions.

**Table 3.** Effect test

REGRESSION EQUATION		FITNESS INDEX		SIGNIFICANCE OF REGRESSION COEFFICIENT		
OUTCOME VARIABLE	PREDICTOR VARIABLE	R <sup>2</sup>	F	β	95%CI	t
Controllability	Gender			-0.149	[-0.56,0.26]	-0.72
	Age			-0.001	[-0.36,0.36]	0.00
	Educational background			-0.156	[-0.45,0.14]	-1.06
	Careers	0.099	1.28	0.011	[-0.13,0.15]	0.15
	Income levels			-0.117	[-0.30,0.07]	-1.24
	Autonomy			0.912	[-1.01,2.83]	0.94
	CP			-0.013	[-0.09,0.06]	-0.33
	Autonomy×CP			-0.025	[-0.14,0.09]	-0.42
Attribute to robot	Gender			-0.271	[-0.64,0.10]	-1.44
	Age			-0.047	[-0.33,0.23]	-0.34
	Educational background			-0.072	[-0.34,0.19]	-0.54
	Careers	0.225	3.91***	-0.053	[-0.18,0.07]	-0.84
	Income levels			-0.036	[-0.21,0.13]	-0.43
	Autonomy			0.385*	[0.02,0.75]	2.08
	Controllability			0.341***	[0.15,0.53]	3.61

The findings showed that customers attributed more blame to the robot when the express delivery robot was more autonomous, an effect that was partially mediated by controllability, i.e., customers attributed more blame to the robot when they believed that the robot could have controlled this service.

## 5. Implications

### 5.1. Theoretical implications

First, this study chooses express delivery robots as the research object, which enriches the relevant scenarios of service robotics research. Previous research on service robots has mainly focused on service scenarios such as hotels and restaurants, while express delivery robots have received less attention as emerging service robots. Express delivery is an important part of the e-commerce logistics services, the use of express delivery robots can save manpower, improve distribution efficiency, many e-commerce, logistics companies embarked on the research and development of express delivery robots, there is a broad prospect for development.

Second, this study enriches the research related to robot autonomy by including robot autonomy as a dependent variable. Autonomy and anthropomorphism are two key features of service robots, and previous research has focused on the impact of anthropomorphism on robot service, while less attention has been paid to robot autonomy. This study enriches the research on the autonomy characteristics of service robots by finding experimentally that robot autonomy affects the attribution of customer responsibility after a service failure and that this effect is mediated by controllability.

Finally, this study expands the scenarios of attribution theory by using attribution theory to study customers' attributional behaviors in service robot service failure scenarios. This study uses attribution theory to explore customers' attribution of responsibility after the service failure of express delivery robots, which can help companies understand the way customers attribute when facing robot service failure, and help companies develop remedial measures after service failure to avoid the loss of customer satisfaction and loyalty.

### 5.2. Managerial implications

According to the results of the experimental analysis, the autonomy feature of the express delivery robot affects the attribution of customer responsibility after a service failure, and controllability partially mediates this effect. This finding can provide suggestions for the development of express delivery robots. When designing service robots, it is important to focus on the autonomous design of the robot. The common service robots on the market today have many designs in anthropomorphic features, but the design of robot autonomy is rarely reflected. Service robots have appeared in more and more service scenarios and undertake different types of service tasks. It is important to enhance the autonomy of service robots so that they have the ability to adjust to the service environment.

In addition, this study provides recommendations for the application of express delivery robots. Robot service failure is unavoidable due to technology and service environment. Therefore, while introducing express delivery robots to

reduce costs and improve service quality, it is also necessary to consider remedial measures after the occurrence of robot service failures to avoid reducing customer satisfaction and willingness to use due to service failures. For example, when a service failure occurs, develop appropriate compensation measures.

## 6. Research Limitations and Future Research

In conjunction with the literature compilation and findings, this study suffers from the following three shortcomings:

First, this study used an experimental questionnaire method to explore the attribution of customer responsibility after service failure of a express delivery robot, and the use of textual descriptions to implement the variable manipulation may have resulted in insufficient experimental stimuli. The source of data was mainly from questionnaires recovered from online platforms, which may have led to a lack of heterogeneity in the characteristics of the subject group. Future studies should incorporate fieldwork to expand the experimental sample size.

Second, this study did not consider customer characteristics in designing the model. In this study, only robot features and human-robot interaction features were considered in the design of the model, and no customer features were included. Customers' personal characteristics also influence the way they attribute when faced with service failures, e.g., previous studies have demonstrated that customers' self-efficacy for technology, and their need for interpersonal interactions affect their preference and attributional approach to robots[32], [51].

Finally, this study uses a single experimental scenario to validate the route by which the autonomy of a express delivery robot affects the attribution of customer responsibility after a service failure, but it remains to be explored whether this finding applies equally to other service scenarios. Subsequent experiments should be designed to be repeated with different experimental scenarios to verify the applicability of the conclusions.

## Acknowledgment

This work was supported by a scientific research project (2021SK009) of Tianjin Municipal Education Commission.

## References

- [1] R. A. Bhimasta and P.-Y. Kuo, "What causes the adoption failure of service robots?: a case of Henn-na hotel in japan," in *Adjunct Proceedings of the 2019 ACM International Joint Conference on Pervasive and Ubiquitous Computing and Proceedings of the 2019 ACM International Symposium on Wearable Computers*, London United Kingdom: ACM, Sep. 2019, pp. 1107–1112.
- [2] A. Parasuraman, V. A. Zeithaml, and L. L. Berry, "A Conceptual Model of Service Quality and Its Implications for Future Research," *Journal of Marketing*, vol. 49, no. 4, pp. 41–50, Sep. 1985.
- [3] M. L. Richins, "Negative Word-of-Mouth by Dissatisfied Consumers: A Pilot Study".
- [4] B. Weiner, "Attributional Thoughts about Consumer Behavior," *J. Cons. Res.*, vol. 27, no. 3, pp. 382–387, Dec. 2000.

- [5] X. Leo and Y. E. Huh, "Who gets the blame for service failures? Attribution of responsibility toward robot versus human service providers and service firms," *Computers in Human Behavior*, vol. 113, p. 106520, Dec. 2020.
- [6] J. Wirtz et al., "Brave new world: service robots in the frontline," *J. Serv. Manage.*, vol. 29, no. 5, pp. 907–931, Nov. 2018.
- [7] D. Marinova, K. de Ruyter, M.-H. Huang, M. L. Meuter, and G. Challagalla, "Getting Smart: Learning From Technology-Empowered Frontline Interactions," *J. Serv. Res-us.*, vol. 20, no. 1, pp. 29–42, Feb. 2017.
- [8] N. Epley, "A Mind like Mine: The Exceptionally Ordinary Underpinnings of Anthropomorphism," *Journal of the Association for Consumer Research*, vol. 3, no. 4, pp. 591–598, Oct. 2018.
- [9] J. M. Beer, A. D. Fisk, and W. A. Rogers, "Toward a Framework for Levels of Robot Autonomy in Human-Robot Interaction," *Journal of Human-Robot Interaction*, vol. 3, no. 2, p. 74, Jun. 2014.
- [10] "ISO 8373:2021(en), Robotics — Vocabulary." [Online]. Available: <https://www.iso.org/obp/ui/en/#iso:std:iso:8373:ed-3:v1:en>
- [11] S. Choi, A. S. Mattila, and L. E. Bolton, "To Err Is Human(-oid): How Do Consumers React to Robot Service Failure and Recovery?," *J. Serv. Res-us.*, vol. 24, no. 3, pp. 354–371, Aug. 2021.
- [12] P. A. Hancock, D. R. Billings, K. E. Schaefer, J. Y. C. Chen, E. J. De Visser, and R. Parasuraman, "A Meta-Analysis of Factors Affecting Trust in Human-Robot Interaction," *Human Factors: The Journal of the Human Factors and Ergonomics Society*, vol. 53, no. 5, pp. 517–527, Oct. 2011.
- [13] A. Waytz, J. Heafner, and N. Epley, "The mind in the machine: Anthropomorphism increases trust in an autonomous vehicle," *J. Exp. Soc. Psychol.*, vol. 52, pp. 113–117, May 2014.
- [14] E. Broadbent et al., "Robots with Display Screens: A Robot with a More Humanlike Face Display Is Perceived To Have More Mind and a Better Personality," *PLoS ONE*, vol. 8, no. 8, p. e72589, Aug. 2013.
- [15] A. Fan, L. (Laurie) Wu, and A. S. Mattila, "Does anthropomorphism influence customers' switching intentions in the self-service technology failure context?," *J. Serv. Mark.*, vol. 30, no. 7, pp. 713–723, Oct. 2016.
- [16] S. Y. Kim, B. H. Schmitt, and N. M. Thalmann, "Eliza in the uncanny valley: anthropomorphizing consumer robots increases their perceived warmth but decreases liking," *Market. Lett.*, vol. 30, no. 1, pp. 1–12, Mar. 2019.
- [17] M. Mori, K. MacDorman, and N. Kageki, "The Uncanny Valley [From the Field]," *IEEE Robot. Autom. Mag.*, vol. 19, no. 2, pp. 98–100, Jun. 2012.
- [18] E. Leung, G. Paolacci, and S. Puntoni, "Man Versus Machine: Resisting Automation in Identity-Based Consumer Behavior," *J. Marketing Res.*, vol. 55, no. 6, pp. 818–831, Dec. 2018.
- [19] L. Xiao and V. Kumar, "Robotics for Customer Service: A Useful Complement or an Ultimate Substitute?," *J. Serv. Res-us.*, vol. 24, no. 1, pp. 9–29, Feb. 2021.
- [20] G.-Z. Yang et al., "Medical robotics—Regulatory, ethical, and legal considerations for increasing levels of autonomy," *Science Robotics*, vol. 2, no. 4, p. eaam8638, Mar. 2017.
- [21] K. D. Hoffman and J. E. G. Bateson, *Essentials of Services Marketing*. South-Western College Pub, 2001.
- [22] S. Honig and T. Oron-Gilad, "Understanding and Resolving Failures in Human-Robot Interaction: Literature Review and Model Development," *Front. Psychol.*, vol. 9, p. 861, Jun. 2018.
- [23] M. A. McCollough, L. L. Berry, and M. S. Yadav, "An Empirical Investigation of Customer Satisfaction after Service Failure and Recovery," *J. Serv. Res-us.*, vol. 3, no. 2, pp. 121–137, Nov. 2000.
- [24] Y. Lee, S. Lee, and D.-Y. Kim, "Exploring hotel guests' perceptions of using robot assistants," *Tourism Management Perspectives*, vol. 37, p. 100781, Jan. 2021.
- [25] M. Ragni, A. Rudenko, B. Kuhnert, and K. O. Arras, "Errare humanum est: Erroneous robots in human-robot interaction," in *2016 25th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, New York, NY, USA: IEEE, Aug. 2016, pp. 501–506.
- [26] N. Mirnig, G. Stollnberger, M. Miksch, S. Stadler, M. Giuliani, and M. Tscheligi, "To Err Is Robot: How Humans Assess and Act toward an Erroneous Social Robot," *Frontiers in Robotics and AI*, vol. 4, p. 21, May 2017.
- [27] R. L. Hess Jr., S. Ganesan, and N. M. Klein, "Service Failure and Recovery: The Impact of Relationship Factors on Customer Satisfaction," *Journal of the Academy of Marketing Science*, vol. 31, no. 2, pp. 127–145, Apr. 2003.
- [28] Y. Moon, "Don't Blame the Computer: When Self-Disclosure Moderates the Self-Serving Bias," *Journal of Consumer Psychology*, vol. 13, no. 1–2, pp. 125–137, Jan. 2003.
- [29] D. Nikbin, I. Ismail, M. Marimuthu, and I. Younis Abu-Jarad, "The impact of firm reputation on customers' responses to service failure: the role of failure attributions," *Business Strategy Series*, vol. 12, no. 1, pp. 19–29, Jan. 2011.
- [30] N. Meyer, M. Schwede, M. Hammerschmidt, and W. H. Weiger, "Users taking the blame? How service failure, recovery, and robot design affect user attributions and retention," *Electron. Mark.*, vol. 32, no. 4, pp. 2491–2505, Dec. 2022.
- [31] G. Yalcin, S. Lim, S. Puntoni, and S. M. J. Van Osselaer, "Thumbs Up or Down: Consumer Reactions to Decisions by Algorithms Versus Humans," *J. Marketing Res.*, vol. 59, no. 4, pp. 696–717, Aug. 2022.
- [32] A. Fan, L. (Laurie) Wu, L. Miao, and A. S. Mattila, "When does technology anthropomorphism help alleviate customer dissatisfaction after a service failure? – The moderating role of consumer technology self-efficacy and interdependent self-construal," *Journal of Hospitality Marketing & Management*, vol. 29, no. 3, pp. 269–290, Apr. 2020.
- [33] S. Choi and A. S. Mattila, "Perceived controllability and service expectations: Influences on customer reactions following service failure," *J. Bus. Res.*, vol. 61, no. 1, pp. 24–30, Jan. 2008.
- [34] A. Walton and M. Hume, "Examining Public Hospital Service Failure: The Influence of Service Failure Type, Service Expectations, and Attribution on Consumer Response," *Journal of Nonprofit & Public Sector Marketing*, vol. 24, no. 3, pp. 202–221, Jul. 2012.
- [35] P. Aggarwal and A. L. McGill, "Is That Car Smiling at Me? Schema Congruity as a Basis for Evaluating Anthropomorphized Products," *J. Cons. Res.*, vol. 34, no. 4, pp. 468–479, Dec. 2007.
- [36] T. Verhagen, J. Van Nes, F. Feldberg, and W. Van Dolen, "Virtual Customer Service Agents: Using Social Presence and Personalization to Shape Online Service Encounters," *Journal of Computer-Mediated Communication*, vol. 19, no. 3, pp. 529–545, Apr. 2014.
- [37] J. Zlotowski, K. Yogeewaran, and C. Bartneck, "Can we control it? Autonomous robots threaten human identity, uniqueness, safety, and resources," *Int. J. Hum. Comput. Stud.*, vol. 100, pp. 48–54, Apr. 2017.

- [38] C. Furlough, T. Stokes, and D. J. Gillan, "Attributing Blame to Robots: I. The Influence of Robot Autonomy," *Human Factors: The Journal of the Human Factors and Ergonomics Society*, vol. 63, no. 4, pp. 592–602, Jun. 2021.
- [39] T. Kim and P. Hinds, "Who Should I Blame? Effects of Autonomy and Transparency on Attributions in Human-Robot Interaction," in *ROMAN 2006 - The 15th IEEE International Symposium on Robot and Human Interactive Communication*, Univ. of Hertfordshire, Hatfield, UK: IEEE, Sep. 2006, pp. 80–85.
- [40] C. T. Ennew and M. R. Binks, "Impact of Participative Service Relationships on Quality, Satisfaction and Retention," *J. Bus. Res.*, vol. 46, no. 2, pp. 121–132, Oct. 1999.
- [41] C. Claycomb, C. Lengnick-Hall, and L. Inks, "The Customer As A Productive Resource: A Pilot Study and Strategic Implications," *Journal of Business Strategies*, vol. 18, no. 1, pp. 47–70, Jan. 1970.
- [42] M. Jo Bitner, W. T. Faranda, A. R. Hubbert, and V. A. Zeithaml, "Customer contributions and roles in service delivery," *Int. J. Serv. Ind. Manag.*, vol. 8, no. 3, pp. 193–205, Aug. 1997.
- [43] D. S. P. Cermak, K. M. File, and R. A. Prince, "Customer Participation In Service Specification And Delivery," *Journal of Applied Business Research (JABR)*, vol. 10, no. 2, p. 90, Sep. 2011.
- [44] Peng YJ and Jing FJ, "A study of customer involvement in services and its impact on customer satisfaction," *Economic Management*, no. 10, pp. 60–66, 2008.
- [45] Wang HJ and Wang T, "A Study of the Relationship between Customer Involvement, Perceived Control and Customer Satisfaction," *Management Sciences*, no. 3, pp. 48–54, 2007.
- [46] S. M. Rasoolimanesh, S. Md Noor, F. Schuberth, and M. Jaafar, "Investigating the effects of tourist engagement on satisfaction and loyalty," *Serv. Ind. J.*, vol. 39, no. 7–8, pp. 559–574, Jun. 2019.
- [47] Y. Park and T. Gong, "Curvilinear relationship between customer engagement and responses to service failures," *Serv. Ind. J.*, pp. 1–27, Jan. 2023.
- [48] D. Belanche, L. V. Casalo, C. Flavián, and J. Schepers, "Service robot implementation: a theoretical framework and research agenda," *Serv. Ind. J.*, vol. 40, no. 3–4, pp. 203–225, Mar. 2020.
- [49] M. Jörling, R. Böhm, and S. Paluch, "Mechanisms and Consequences of Anthropomorphizing Autonomous Products: The Role of Schema Congruity and Prior Experience," *Schmalenbach Business Review*, vol. 72, no. 4, pp. 485–510, Oct. 2020.
- [50] R. M. Stock and M. Merkle, "A service Robot Acceptance Model: User acceptance of humanoid robots during service encounters," in *2017 IEEE International Conference on Pervasive Computing and Communications Workshops (PerCom Workshops)*, Kona, HI: IEEE, Mar. 2017, pp. 339–344.
- [51] Y. Hu, H. (Kelly) Min, and N. Su, "How Sincere is an Apology? Recovery Satisfaction in A Robot Service Failure Context," *Journal of Hospitality & Tourism Research*, vol. 45, no. 6, pp. 1022–1043, Aug. 2021.
- [52] C.-Y. Chen, "How customer participation influences service failure attribution: The moderating effect of self-efficacy," *Journal of Service Theory and Practice*, vol. 28, no. 3, pp. 298–314, May 2018.
- [53] S. A. Rijdsdijk and E. J. Hultink, "'Honey, Have You Seen Our Hamster?' Consumer Evaluations of Autonomous Domestic Products," *J. Prod. Innovat. Manag.*, vol. 20, no. 3, pp. 204–216, May 2003.
- [54] A. Hsieh, C. Yen, and K. Chin, "Participative customers as partial employees and service provider workload," *Int. J. Serv. Ind. Manag.*, vol. 15, no. 2, pp. 187–199, Apr. 2004.