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A System Dynamics Approach to E-Service Recovery and E-Trust

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Abstract

Researchers have highlighted the mediating role of trust in electronic circumstances. However, relatively few studies examine the links between e-trust and e-service recovery. This study explores e-service recovery in terms of e-trust. We utilize a system dynamics approach to building an e-recovery framework and subsequently conducting simulations to evaluate the recovery performance. The results of this study reveal that trust is indispensable to a successful recovery, which can boost long term firm profitability. Further sensitivity analysis is conducted regarding prior perceived quality, failure severity and customer participation. Results show that customers' perceived service quality have positive effects on their prior e-trust. Also, customers with low perceived quality will generate more profit for firms after service recovery. Interestingly, customers who have experienced high failure severity but ultimately have their problems solved will generate more profit for the firm. With respect to customer participation, the more customers contribute in recovery process, the higher post e-trust they will create. This study helps explain how e-trust plays a pivotal role in dynamic e-service recovery environments.

Keywords: System Dynamics, E-Service Failure, E-Service Recovery, E-Trust

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電子化服務品質補救與電子信任之系統動態模式

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摘要

雖然過去的文獻指出信任在電子商務中扮演的調節角色，但是並沒有太多的文獻討論電子信任與電子服務補救的關聯。因此，本研究就此關聯作進一步的探討，引用系統動力學方法建立電子服務補救的架構，並使用模擬評估電子服務補救的績效。研究發現電子信任對於成功的服務補救是不可或缺的，且可以大幅提升企業長期獲利。本研究續對事前認知服務品質、服務失敗嚴重性與顧客參與度作進一步的分析，結果顯示顧客事前認知服務品質對事前電子信任有正向的影響；並且事前認知服務品質低的顧客在電子服務補救後會對企業產生更多的獲利。另一方面，經歷高服務失敗嚴重性的顧客在問題被解決後也會對企業貢獻更多的獲利。而對於顧客參與度，研究顯示顧客參與更深入的服務補救過程，將會產生更高的事後電子信任。本研究結果可以幫助解釋電子信任在動態電子服務補救環境中的重要角色。

關鍵詞：系統動力學、電子服務失敗、電子服務補救、電子信任

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1. Introduction

In modern societies, the speed and convenience of Internet contribute greatly to the development and growth of e-commerce. A competitive e-commerce environment with low switching costs would result in a high customer churn rate on the Internet. A research report published by Skaanning (2005) indicated an average of 25% annual churn rate for Internet Service Providers. To increase the customer retention rate and consequently the revenue and profit, firms often provide online services (e-services) as a critical ingredient. Reichheld and Sasser (1990) claimed that increasing the customer retention rate by just 5% can boost profit by 25% to 85%.

Trust is a fundamental element in establishing and maintaining long-term relationships between firms and customers (Rousseau et al. 1998). The lack of online interpersonal interaction and the absence of physical contact in online exchanges have strengthened the significance of e-trust (Reichheld & Schefter 2000). Trust is the critical component driving customer satisfaction, loyalty, and purchase intention in online services (Ribbink et al. 2004; Gefen & Straub 2004; Kim, Zhao & Yang 2008; Kim, Jin & Swinney 2009; Chiu, Huang & Yen 2010). Hence, the importance of trust cannot be overemphasized and it is always crucial for firms to gain customer trust based on online service applications.

Firms inevitably experience service failure. For example, the B2B news (2010) announced that “Amazon Has Suffered a Temporary Web Service Failure” during the Christmas season, which caused troubles for consumers buying presents. A similar headline in reported by Wu (2011) that “Bank of America Website Down, Leaving Customers Unhappy.” In this case, a cracked website was too slow to load, which made customers unable to navigate and stopped their online banking. Such failures definitely decrease customer trust in service providers and increase their dissatisfaction. Kotler (1997) showed that the cost of acquiring and serving new customers is five times greater than the cost of retaining and satisfying current customers. Service recovery, however, is a subtle issue for firms. The “recovery paradox” literature indicates that customers who have experienced service failure but ultimately have their problems solved will become much more loyal than those who do not encounter failures. Liao and Wu (2009) revealed that trust is a key mediator in the process of service recovery. Trust can be influenced by an outstanding recovery performance and subsequently enhance customer loyalty. High service recovery can positively affect customer satisfaction,

purchase intention, and positive word of mouth (Miller, Craighead & Karwan 2000; Maxham 2001; Seawright et al. 2008; Sousa & Voss 2009). These again indicate the essential role of trust in service environments.

Although many studies examine traditional service recovery, relatively few discuss service recovery in e-commerce. The critical distinctions between traditional services and e-services include reduced human interaction and the mediating role of technology (Holloway & Beatty 2003). Consequently, the recovery difficulties and the factors influencing the recovery process online differ from those in offline circumstances. In addition, most researchers (e.g. Liao & Wu 2009) who have highlighted the significant mediating role of trustworthiness in the recovery process used quantitative methods to analyze the linear relationship between variables and service recovery.

This study proposes a system dynamics approach to discovering the causal relationships between trust and a number of variables in an e-service recovery process. Sterman (2000) showed that "system dynamics is a perspective and set of conceptual tools that enable us to understand the structure and dynamics of complex systems." Using the system dynamics approach, we can explicitly observe how things influence each other under complex systems over time, which allows firms to create more effective service recovery strategies. In this study, we attempt to explore the following research questions: (1) Will e-service recovery help enhance the trust of customers who experience service failure? (2) What are the major factors influencing e-service recovery in terms of e-trust? The remainder of this paper is organized as follows. Section 2 reviews related research, including service recovery and E-trust. Section 3 describes the research method and proposes an e-service recovery framework of e-trust. Section 4 presents the analytical results in details. Finally, Section 5 addresses the conclusion and Section 6 furnishes implications and suggestions for further research.

2. Related Works

2.1 E-Service Recovery

Service failures occur when service performance cannot meet customer expectations during the delivery process. Service failures decrease customer satisfaction, and reduce their trust and commitment to firms. Customers are prone to engage in negative word of mouth after unpleasant service experiences (Weun et al. 2004). Failure severity also has a negative effect on customer loyalty (Wang et al. 2010). Nevertheless, previous studies reveal that customers who air their complaints with service failures

offer firms a second chance to serve them and rectify their problems (also called service recovery). If customers are satisfied with the final recovery performance, they will be even happier than before. Hence, a successful recovery can earn frustrated customers back into loyal ones. High service recovery efforts can significantly increase customer post-failure levels of satisfaction and loyalty, boost their purchase intention, and strengthen their motivation to spread positive word of mouth (Miller et al. 2000; Maxham 2001; Seawright et al. 2008; Sousa & Voss 2009).

Although researchers have instigated service recovery for a decade, a gap still remains for e-service recovery issue. It is not possible to compare online service recovery with offline circumstances because of the nature of service. The two major differences between online and offline services lie in reduced human interaction and the mediating role of technology (Holloway & Beatty 2003), which may lead to online failures. There are generally four types of online failures in e-services: (1) technology failures (e.g., web site is temporarily broken), (2) process failures (e.g. customers fail to receive the products ordered online), (3) poor design (e.g., it is difficult for customers to navigate web pages), and (4) customer-driven failure (e.g., customers fail to login due to a missing password) (Meuter et al. 2000, p. 56). Existing research on online service focuses on process failures, and tends to neglect the other three types of failures. To some degree, e-service recovery related to technology, poor design, and customer-driven failures have something in common: customer efforts are the key factor determining ultimate recovery performance when self-service technologies fail. Dong, Evans and Zou (2008) conducted an empirical study based on the scenario of Internet setup and online course registration. Their results demonstrate that customers who are involved in the service recovery process incorporating self-service technology appear to be more satisfied with the service recovery than those who are not. That is, the greater the customer effort, the higher the recovery performance will be. On the other hand, e-trust is a key factor in establishing and maintaining the relationship between customers and service providers. E-trust consists of e-service quality such as web site design (Tamimi & Sebastianelli 2007), which directly affect customer satisfaction and loyalty (Liao & Wu 2009). DeWitt, Nguyen and Marshall (2008) indicated that “trust has important mediating roles during the service recovery process” (p.269). A great deal of research has been conducted on e-service recovery. What seems to be lacking, however, is an analysis of e-trust in service recovery situations.

2.2 E-trust

Though the issue of trust has been universally studied for many years, the definition of e-trust (online trust) in an electronic commerce environment remains ambiguous. Bart et al. (2005) stated that "online trust includes consumer perception of how the site would deliver on expectation, how believable the site's information is, and the level of confidence in site" (p.134). Due to the distinction of service content, online trust differs from offline trust. In traditional circumstances, customers can based their trust on what they have seen, including the visible service delivery process and their interaction with front-line staff. In contrast, the reduced interpersonal interaction in online services increases the significance of technology's mediating role between customers and service providers. This also results in the diverse factors of online trust, most of which relevant to the technological factors such as web site characteristics, visual design, and perceived security. Thus, this study defines e-trust as user perception of how the online service would deliver on expectation.

E-trust is critical for creating loyalty when customers perceive a high level of risk (Anderson & Srinivasan 2003). Empirical research in e-services reveals that e-trust positively and directly affects customer satisfaction (Kim et al. 2008; Liao & Wu 2009; Kim et al. 2009). Trust is also critical to driving customer loyalty (Ribbink et al. 2004; Kim et al. 2009; Liao & Wu 2009), and to the relationships among perceived value, customer satisfaction, and commitment (Kim et al. 2008; Sanchez-Franco 2009). Trust is a key element in customer purchase intention (Gefen & Straub 2004; Chiu et al. 2010). Consequently, e-trust plays a pivotal role in e-service and directly affects the long-term relationship between customers and service providers.

Although many studies investigate e-trust, most of them focus on transaction trust (e.g., online shopping) or trust based on web site characteristics, but largely neglect system-based trust (Grabner-Krauter & Kalusha 2003). Most researchers studied different contexts of trust, and indicated that trust can decrease the level of perceived risk on the Internet (Chiu et al. 2010). Conversely, service failures can affect trust. Weun et al. (2004) explicitly pointed out that failure severity has a significant influence on trust. Their research reveals that customers who experience service failure are upset, diminish their trust on firms, and are prone to engage in negative word of mouth. Thus, service recovery becomes imperative and essential for firms wishing to enhance their trustworthiness. In summary, e-trust is indispensable to successful e-service recovery. Hence, this study focuses on trust in e-service recovery such as online searching service, translation service, auction service, etc.

3. Research Method

3.1 System Dynamics

System Dynamics, founded by Jay W. Forrester in mid-1950s, is an approach to dealing with "internal feedback loops" and "time delays" that affect the behaviors among complex systems over time (Sterman 2000). This approach can help researchers gain insight into the dynamic changes existing in every human activity and improve awareness of the complex phenomena in the real world. System dynamics can simulate considerable perspectives and provide long-term solutions because it effectively copes with the dynamic changes, feedback information, and time delays in complex environments.

System dynamics consists of causal relationships and utilizes feedback systems as the basis of causal feedback loops. Additionally, researchers can define the problems through the use of causal relationships. As a result, complex problems can be presented in a concise and systematic way to help managers to obtain a clearer view. This study addresses two different causal loops: the positive feedback loop and the negative feedback loop. The positive feedback loop, also called a reinforcing loop, generally contains an even number of negative relationships and leads to positive results (Fig. 1 (a)). In contrast, a negative feedback loop, also known as a balancing loop, usually includes an odd number of negative relationships and results in negative effects (Fig. 1 (b)). A system can consist of several positive and negative causal loops. Therefore, there may be different changes in patterns, including stability, growth, or decline. No matter how a system changes, it is possible to make an accurate judgment as long as key factors to problems can be grasped. Furthermore, the system dynamics approach features the existence of time delays, where the influence between two variables does not appear immediately, but will emerge after a period of time.

This study utilizes a system dynamics approach for several reasons. First, the e-service recovery process is very complicated. Michel, Bowen and Johnston (2009) addressed three key successes to recovery: (1) "Customer recovery," studied by marketing researchers, focuses on customer psychological recovery such as fairly treatment, quick apology, etc. (2) "Process recovery," discussed by operation researchers, focuses on delivery process such as how to utilize technology to appease customers after service failures. (3) "Employee recovery," emphasized in management literature, focuses on how to help employee to recover customers. However, most

studies examine the recovery issue by breaking it into subprocesses and adopt mathematical methods to reveal the linear relationships between variables, which may lack systematical thinking and fail to broaden perspectives. Since the system dynamics approach can overcome the limitation of linear thinking, it can help reveal the causal relationships among complex recovery process. A causal loop diagram makes it possible to conduct computer simulations and evaluate the performance of a recovery strategy. Thus, this study utilizes such a system dynamics approach to modeling an e-service recovery framework, and subsequently evaluating the recovery performance by employing "Vensim," a popular system dynamics software.

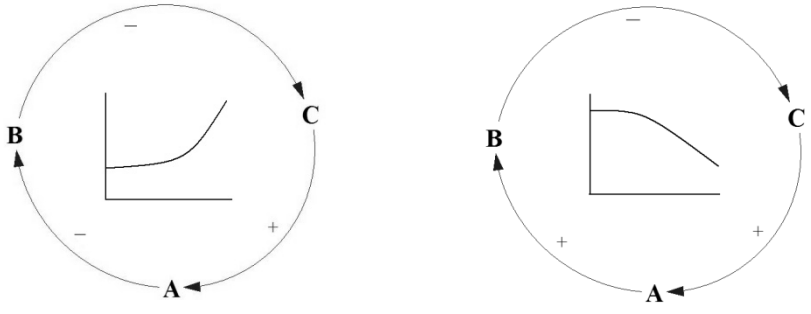

Figure 1：(a) Positive feedback loop (b) Negative feedback loop

3.2 Modelling Process

The first step in modeling a complex process in a system is to discover the casual relationships among variables. This study attempts to design the process of e-service recovery based on previous researches. Miller et al. (2000) divided the service recovery process into three phases, including pre-recovery, immediate recovery, and follow-up recovery phases. The failure severity, customer loyalty, perceived pre-service quality, and company guarantees all affect customer expectations of service recovery in the pre-recovery phase. The role of customer expectation is critical to the success of service recovery. If firms have a superior understanding of customer expectations, they can easily implement an effective recovery strategy to exceed customer expectations. Next, in the immediate recovery phase, there are four key elements to a successful recovery: the types of recovery activity (psychological and tangible efforts) and the delivery of service recovery (speed of recovery and front line empowerment). When failures occur, firms must quickly respond to customers, endeavor to appease them, and treat them fairly. Finally, follow-up recovery, which involves an apology or a tangible token, can

strengthen the effectiveness of recovery and subsequently lead to the success of maintaining long-term customer loyalty and satisfaction.

The recovery framework by Miller et al. (2000) is a unified framework for related situations owing to the survey conducted by a variety of companies in "either online or offline services." However, e-service recovery is still different from traditional service recovery, especially in terms of technology and the reduced human interaction (Holloway & Beatty 2003). Thus, this study considers some critical e-recovery factors from other empirical studies in e-services recovery (Dong et al. 2008). The proposed model is based on Miller's framework in terms of prior perceived service quality/prior e-trust (pre-recovery), service recovery effort (immediate recovery), and post e-satisfaction/e-loyalty (follow-up recovery). In addition, this study also attempts to place the significant role of e-trust on e-recovery process in consideration of the online trust framework built by Urban, Amyx and Lorenzon (2009). The results of their research show that customers will increase their trust based on the perceived internet quality (e.g., privacy security) and subsequently behave either in psychology (e.g., become loyal) or physiology (e.g., purchase or use services), which can result in firms' success and boost their profits. In the proposed model, e-trust also influences customer satisfaction and loyalty (Ribbink et al. 2004; Kim et al. 2009; Liao & Wu 2009). Service failure decreases e-trust accumulated by prior perceived service quality (Weun et al. 2004; Liao & Wu 2009; Miller et al. 2000). On the other hand, high service recovery effort affects satisfaction and loyalty (Miller et al. 2000; Maxham 2001; Seawright et al. 2008; Sousa & Voss 2009). These observations from existing literature demonstrate the significance of relationships among e-trust, service recovery effort, satisfaction and loyalty. That is, customers will accumulate their prior trust based on their perceived on-line quality before service failure. When failures occur and diminish customer trust, service providers must begin to deliver recovery and reestablish customer trust. As long as the recovery performance can satisfy customers, it can increase their trust and enable them be loyal users.

3.3 Causal Loop Diagram

This section explicitly describes the causal loop diagram of "e-service recovery in terms of e-trust." Figure 2 demonstrates the proposed causal loop diagram and Table 1 summarizes the definition of variables in causal-loop diagram. The following two subsections help to explain the relationships among variables in the diagram.

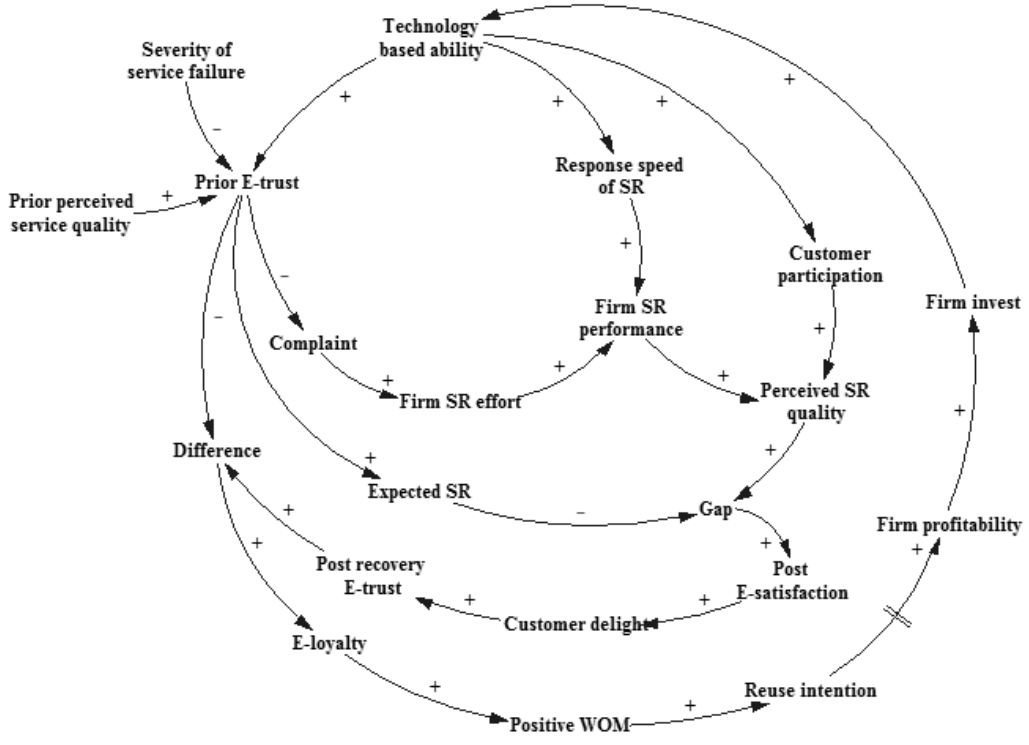

Figure 2：Causal loop diagram

Table 1：Definition of variables

Variable	Definition
Severity of service failure	The real or perceived breakdown of the service in terms of either outcomes or process. (Duffy, Miller & Bexley 2006; p. 115).
Prior perceived service quality	The delivery of service that customer experienced and perceived before the occurrence of service failure
Prior e-trust	The degree of confidence customers have for firms when e-service failures happen
Complaint	Customers who encounter service failures will tell others how they are dissatisfied with service failures.
Expected SR (service recovery)	Customers think service recovery will happen.
Firm SR effort	Firms attempt to rectify customers who experience service failure.

Firm SR performance	The degree of success of service recovery that firms perform
Response speed of SR	The time it takes for firms to deal with service failure and to give a reaction of service recovery to customers
Customer participation	The degree to which customer is involved in taking actions to respond to a service failure" (Dong et al. 2008; p. 126).
Perceived SR quality	Customers notice and understand firms' endeavor to service recovery.
Gap	A large difference between customer expectation and perception of a service recovery
Post e-satisfaction	The degree of recovery performance that meets the need and desires of customers
Difference	A gap between prior E-trust and post recovery E-trust.
Post recovery e-trust	The degree of confidence customers possess for firms after service recovery
Customer delight	An extension of customer satisfaction
E-loyalty	The customer's favorite attitude toward an electronic business, resulting in repeat purchasing behavior. (Anderson & Srinivasan 2003; p. 125)
Positive WOM	The positive information or experience of service recovery that customers share with others.
Reuse intention	Anticipated behavior of customers to reuse e-service
Firm profitability	The ability that firms can earn the revenues or profits in a given time period.
Firm invest	Firms spend money on self-service technologies with the goal of making a profit from it.
Technology based ability	Technology based ability as the level of self-service technologies that enable customers to produce a service.

3.3.1 Trust, Service Failure, and Service Recovery

When service failure occurs, it decreases the customer e-trust accumulated by prior perceived service quality (Weun et al. 2004; Liao & Wu 2009; Miller et al. 2000). Prior perceived service quality positively affects customer trust (Liao & Wu 2009; Miller et al. 2000). The more service quality customers perceive, the higher trust they will have for firms. However, service failure negatively influences customer trust (Weun et al. 2004). The higher the degree of service failure is, the lower trust customers will possess. The

more e-trust customers possess, the higher service recovery they will expect. Meanwhile, service failure will make customers voice complaints or spread negative word of mouth. Customers who encounter service failures will tell others how they are dissatisfied with service failures.

3.3.2 Customer Participation, Satisfaction, and Loyalty

Once a firm receives customer complaints, it should respond to the situation quickly using technology and devote serious efforts to service recovery. Simultaneously, customers encountering e-service failures may also participate in the recovery process. Customer participation is found to have positive effects on customer perceived value and satisfaction (Dong et al. 2008). Hence, the more efforts customers contribute, the higher recovery quality they will perceive (Dong et al. 2008). If the perceived recovery quality exceeds customer expectations, customer will be satisfied with the service recovery. The higher the state of satisfaction customers feel, the more delighted they will be. That is, satisfaction positively affects customer delight. As a result, customers will reestablish their trust in firms (Kim et al. 2008; Ribbink et al. 2004; Sanchez-Franco 2009).

Trust is found to have positive effects on customer loyalty (Liao & Wu 2009; Kim et al. 2008; Ribbink et al. 2004; Miller et al. 2000). If the post recovery e-trust surpasses the prior e-trust, firms can win customers' e-loyalty back and encourage them to engage in positive word of mouth. According to American Marketing Association (1997), "word-of-mouth communication (WOM) occurs when people share information about products or promotions with friends" (American Marketing Association 1997). In this case, the reuse rate will be higher for firms and service organizations can earn greater profit. In turn, a firm with greater revenue can invest more capital in self-service technology.

3.4 Stock and Flow Diagram

Next, a stock and flow structure is derived from the causal loop diagram. Stock, accumulated with time, represents the state of the system, while flow is the amount running through the stocks. System dynamics model often choose variables of interest as stocks to observe their transformation. This study identifies four stocks: prior e-trust, post e-trust, firm profitability, and technology based ability as shown in Fig. 3. First, e-trust is a key factor in driving customer satisfaction and loyalty among service recovery; thus, the quality of recovery performance can be judged by an evaluation of

customer e-trust. Next, a win-win service recovery is supposed to consider the interests of service receivers and providers. That is, a good recovery can satisfy customer needs and benefit service organizations. Finally, this study assumes that technology-based ability is superior to staff recovery ability when failures occur due to the unique characteristics of on-line services. Consequently, this study regards these four variables as stocks to evaluate e-recovery performance.

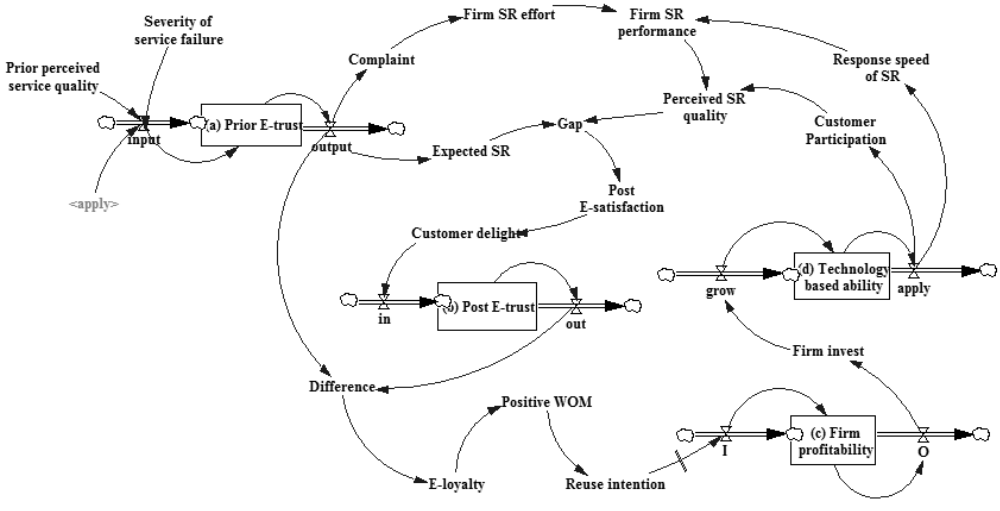

Figure 3：Stock and flow diagram

4. Simulation Analysis

4.1 Scenario Assumptions

After modeling the e-service recovery in terms of e-trust, we employ “Vensim” to evaluate the recovery performance. This study applies the 80/20 rule to establish the simulation scenario in Vensim. We assume that an excellent recovery can ultimately benefit service providers, regardless of the company’s ability. Thus, the proposed model initially assumes that the range of initial values is from 0 to 100, and uses a service organization owning medium profitability (Initial Value (IV): 50) and medium technology-based ability (IV: 50) to examine how a good recovery affect firm profitability. Meanwhile, customers are assumed to own high prior e-trust (IV: 80),

making it possible to observe its transformation with high failure severity (IV: 80) and service recovery. The positive influence on prior e-trust consists of 80% prior perceived service quality and 20% perceived application of technology-based ability. To sum up (Table 2), the stock of "prior E-trust" will be influenced by the auxiliary variable of "input", which is accumulated by three flows "prior perceived service quality, severity of service failure and application of technology based ability". Next, "post E-trust" will be affected by the flow of "customer delight" through the auxiliary variable of "in". Thirdly, reuse intention positively influences "firm profitability through the auxiliary variable of "I". Finally, technology based ability will be impacted by the flow of "firm invest" through the auxiliary variable of "apply".

Table 2：Initial value of four stock variables

Stock	Initial Value (IV)
(a) Prior E-trust = input-output	80
(b) Post E-trust = in-out	0
(c) Firm profitability = I-O	50
(d) Technology based ability= apply-grow	50

This study further assumes that 25% dissatisfied customers will air their complaints (Skaanning 2005), while 80% of them will expect service recovery. Once service organizations receive complaints, they endeavor to perform their recovery using 20% quick response and 80% recovery efforts. On the other hand, this study also assumes that 50% of customers encountering failures will be involved in recovery (Skaanning 2005), where perceived recovery quality consists of 60% firm recovery performance and 40% customer participation. Once customers perceive quality of recovery exceeding the expected recovery efforts, 80% of them will be satisfied and increase their trust in service providers. If the post e-trust is higher than prior e-trust, 80% customers will become loyal, spread positive word of mouth, and enhance their reuse intention. A time delay before firm profitability is enhanced due to the fact that customer intentions are inconsistent with their reactions. Finally, this study assumes that firms will invest 55% in self-service technologies (Google financial table 2010). This will speed up the response to customer after service failure and show customers how to participate in service recovery for the future.

4.2 Evaluation

The four diagrams in Fig. 6 illustrate the process of e-service recovery in terms of e-trust. The simulation time is 12 months to evaluate a long-term performance of e-services recovery, as firms typically measure their profitability annually. Figure 4(a) indicates that customer prior e-trust will decrease in the first month due to the occurrence of service failures. Simultaneously, firm profits fall to the lowest point. When firms perceive their declined business, they will endeavor to recover customers in the second month. Accordingly, customer post e-trust gradually rises and increases 6% in the sixth month (Fig. 4(b)). Though firms improve their profit slightly after recovery, they are still below the starting point (initial value= 50) from the first to the ninth month. This implies that there are time delays between customer reuse intention and firm profitability. When customers perceive the recovery performance and reestablish their e-trust on service providers, they may reuse the service after a period to test the inconsistence between their reaction and perception. Hence, there is a sharp increase on firm profitability in the tenth month (Fig. 4(c)). On the other hand, technology-based ability plays an important role in the recovery process (Fig. 4(d)). The higher technological ability a firm possesses, the more effective recovery it will perform on customer e-trust. In summary, service recovery seems to cost firms in the short run, and while recovery effects are difficult to detect, it can boost the firms' profits and revenue in the long run.

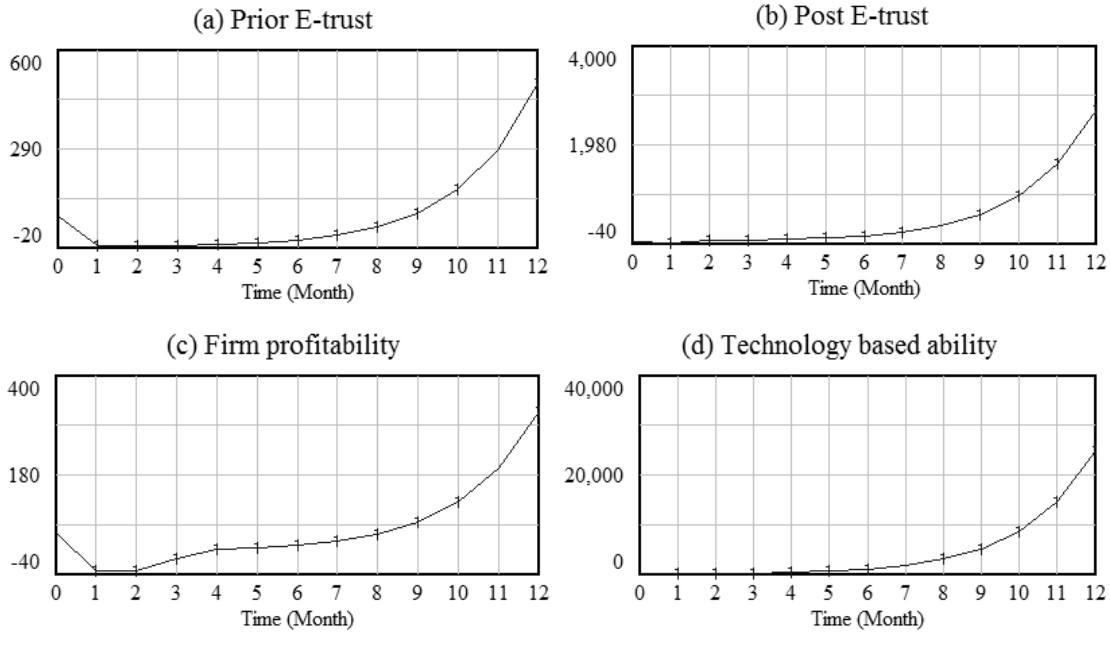

Figure 4：The results of simulation for four stock variables

4.3 Sensitivity Analysis

This section provides sensitivity analysis for different initial values of stock variables. This study assumes two different levels of prior perceived service quality (IV: 80 vs. 20) to examine how they affect customer e-trust and recovery performance. Also, since failure severity has a significant influence on customers, this study assumes two levels of failure severity (IV: 80 vs. 20) to examine. Finally, three different degrees of customer participation (20%, 50%, and 80%) were given to evaluate the role that customers play in the recovery process.

4.3.1 Prior perceived service quality

When the level of failure severity is the same (IV: 80), two groups of customers perceive two different levels of service quality before recovery. The first group has low perceived service quality (IV: 20), while the second group has high perceived service quality (IV: 80). Figure 5(a) indicates that the second group has greater prior e-trust than the first group when failures happen in the first month. That is, customer perceived service quality have positive effects on customer prior e-trust. However, the results of Fig. 5(b) reveal that the post e-trust in the first group grows faster than that in the second group during recovery. Additionally, firm profitability in the first group increases faster and becomes higher than the second group (Fig. 5(c)). Although two lines of profitability seem to converge in the long run, the gap between the two groups can lead to a range of 0.04 to 3.5 times difference in profitability every month. This implies that customers with high prior service experience can expect high service recovery. When firms do not reach or exceed their expectations, customers may not feel satisfied with service recovery. This results in a reduction of customer reuse intention and the slow growth of profits for firms. On the other hand, Fig. 5(d) shows that there is not much difference in technology-based ability under the two levels of prior perceived service quality. It reveals the same trend as we observe in Fig. 4(d) that the higher technological ability a firm possesses, the more effective recovery it will lead to. In summary, customers who initially have a low prior perceived service quality will generate more profit for firms than those with high perceived quality after recovery.

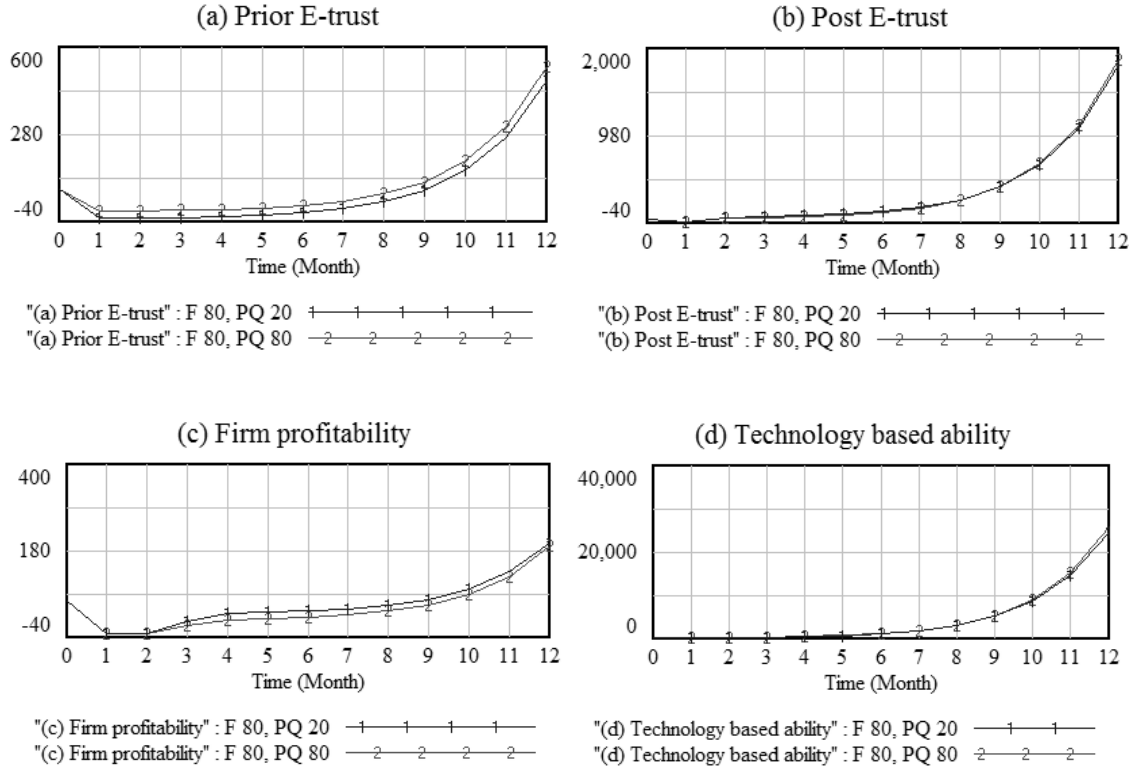

Figure 5：The results for different levels of prior perceived service quality

4.3.2 Failure severity

When the prior perceived service quality of customers is similar (IV: 50), the occurrence of failures with high (IV: 80) and low (IV: 20) severity will have different effects on e-recovery performance. Figure 6(a) indicates that failure severity negatively affects customer prior e-trust. Namely, customers who encounter a low degree of failure have greater e-trust than those encountering a high degree of failure. However, Fig. 6(b) indicates that customers with high failure severity will possess higher post e-trust than the others after service recovery. Fig. 6(c) shows that customers with high failure severity are 0.05 to 2.8 times more profitable every month than customers with a low degree of failure. Customers who initially encountered high degree of service failures but finally had their problems solved would generate greater profit for the firm than those with low failure severity. This implies that customers with high failure severity may strongly voice their complaints; the more they speak out, the more recovery efforts firms will make. Simultaneously, customers with high failure severity are more willing to engage in recovery. The more efforts customers contribute, the higher recovery performance. On the other hand, Fig. 6(d) shows that there is not much difference in

technology-based ability under the two levels of failure severity. In brief, customers who have experienced high failure severity and finally have their problems solved have higher reuse intention and thus generate more profit for the firm than those experiencing a low degree of failure.

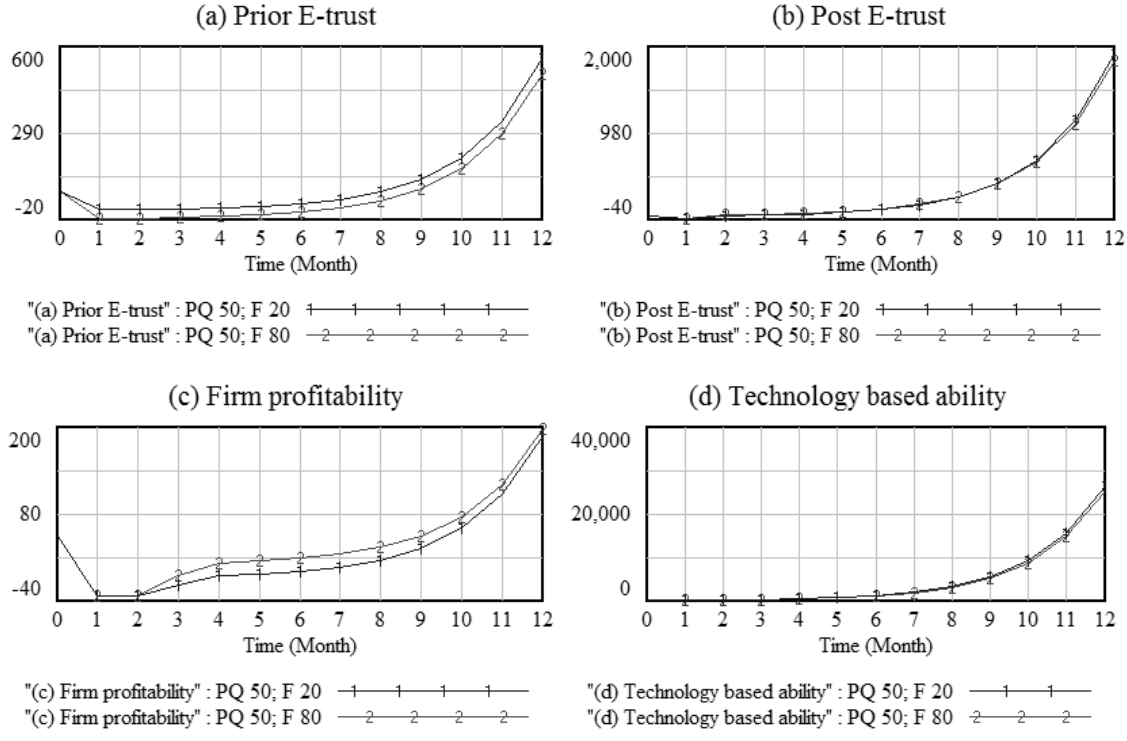

Figure 6：The results for different levels of severity of failure

4.3.3 Customer participation

Since customers play a key role in the e-recovery process, the degree of their participation will affect recovery performance. This study consider three groups of customers who encounter the same failure severity (IV: 80) and possess identical prior perceived service quality (IV: 80), but contribute 20%, 50%, and 80% efforts to self recovery. As Figure 7(a) shows, the curves of prior e-trust in three groups appear similar before firms rectify their problems. However, Fig. 7(b) reveals that the more customers engage in recovery process, the higher their e-trust will be. There is not much difference in the three curves before the seventh month, but the gaps widen in the eighth month. The change of post e-trust in these three groups significantly affects firm profitability. Fig. 7(c) shows that the amount of firms' profits suddenly falls to the lowest point due to the occurrence of failures in the beginning. Next, a time delay obviously exists in the

first and the second month, followed by a slight increase in firm profitability from the third to the seventh months. The gap appearing between the three curves becomes larger over time. This suggests that reduced interpersonal interaction and mediating technology result in high recovery difficulties in electronic commerce. When failures occur, customers rarely seek aid from the first-line staff members of e-service companies. Customer also causes some e-failures, such as missing passwords. If customers perceive the risks of failures, they may be unwilling to participate in self recovery in fear of jeopardizing their safety and property. An example of this is theft identity to be used in illegal actions. While customer participation can help speed up the recovery process and shorten the recovery time, it can also result in high recovery performance. On the other hand, customers who engage in the self-recovery process may have a better understanding of the e-service or have more interaction with service providers via website or email. Fig. 7(d) shows little difference between the three groups in terms of technological ability. That is, the ratio that firms invest in technology is the same regardless of how profitable they are. This implies that firms may have grasped the appropriate ratio of investment that has the greatest effectiveness in self-service recovery technologies. In summary, customers with high participation are critical to successful recovery, and can also generate more profit for firms.

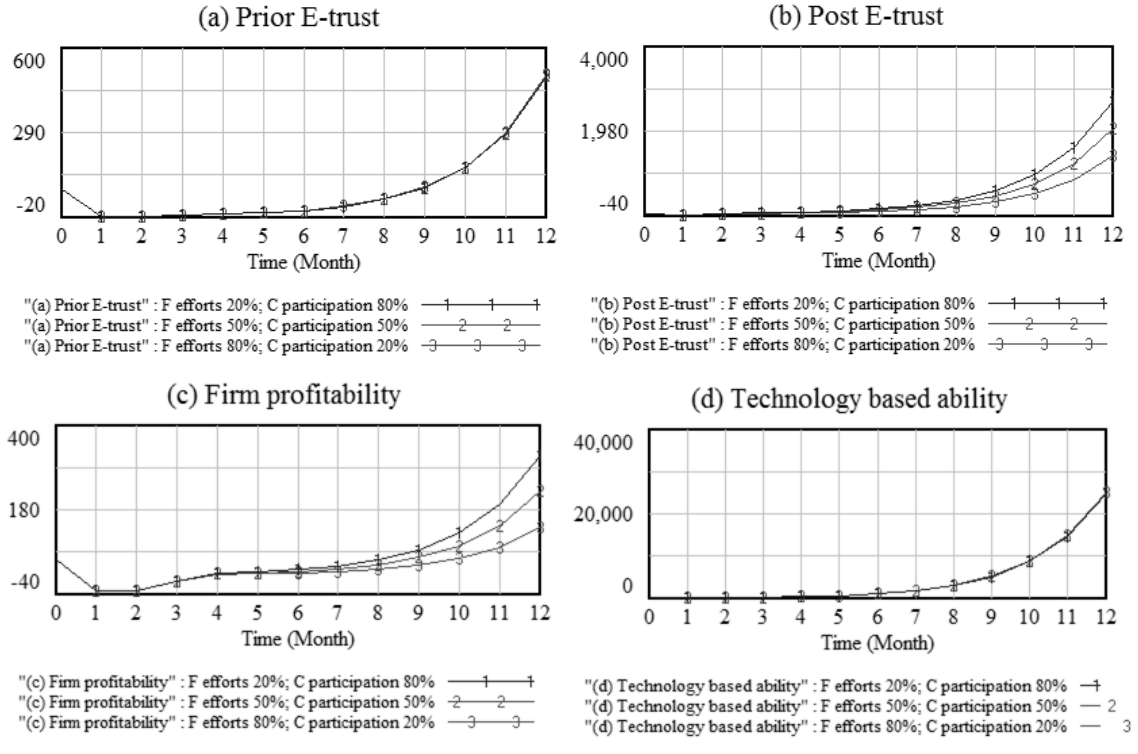

Figure 7：The results for different degrees of customer participation

4.4 Validity of System Dynamics

The validity of system dynamics has built on foundation of usefulness and confidence (Sterman 2000). Firstly, we use "structure verification test" to examine how close our model to the real world. In this investigation, our major structure is referred by existing literature and researches. We also discovered some positive and clear numbers to help our setting reference. That is, the proposed model was constructed accordingly based on structure verification test. Secondly, we use "parameter verification test" to examine the parameters of our model. Owing to limited time and resources, we try to discover real numbers from public data. This study also examines the extreme parameters for the model. The results showed less difference among extreme parameters. Thirdly, this study applies "behavior reproduction test" to examine the process of simulation. Because people may have different responses on the same effects or at the same time, we build several months to observe customer long-term behavior. Particularly, stimulation of a long period can decrease the influences of unusual behaviors effectively. According to the analysis, the results confirm the validity of our simulation experiments.

5. Conclusions

E-service in the fiercely competitive e-commerce has become more and more important over the years and thus drawn a lot of research attention. To maintain long-term relationships with customers and their reuse intention rate, service providers must satisfy the needs of customers, especially when service failures occur. If firms cannot deal with failures effectively, customers may easily become upset and quickly change their service providers. One the other hand, e-trust also plays a critical role in driving customer relationships in the e-recovery process. Thus, service managers must thoroughly consider the recovery process when designing an efficient and successful strategy.

This study employs a system dynamics approach to modeling an e-service recovery framework incorporated with e-trust and providing firms with insights into the causal relationships among trust issues in the complex recovery process. We do observe that e-service recovery will enhance the trust of customers when facing service failure. However, this relationship will be contingent upon such factors as firm's technological ability, customers' prior perceived service quality, severity of failures, and customer participation.

The analytic results show that a firm's technology-based ability will contribute to effective recovery and thus gain customer e-trust. Customers' prior perceived service quality positively affects prior recovery e-trust when failures occur. However, customers who posses low perceived service quality will generate more profit for firms than those with a high perceived service quality. The severity of failures negatively influences customer prior recovery e-trust. Customers who encounter high failure severity yet ultimately resolve their problems will generate more profit for firms than those with a low degree of service failure. Finally, customer participation is also critical to the success of e-recovery. The more customers contribute to the recovery process, the higher post e-trust will be.

To conclude, this research combines perspectives of marketing, operation, and management to examine long-term effect of e-service recovery on trust issue. Previous researches merely focused on a specific field and limited variables for examination. This study uses systems dynamics to provide a macro-view of a holistic framework in a complex environment. The results were derived from a simulation of long-term effect which different from a short-term effect of existing researches. Moreover, the combined variables from various fields also help companies identify critical factors in the integrated framework by simulation. The critical value of this is study is that system dynamics furnishes a macro perspective which complements the micro perspective of survey or experiment researches.

6. Implication and Limitation

This study utilizes a system dynamics approach to discover the causal relationships between trust and influential variables in an e-service recovery process. For academic implication, since there are multiple variables influencing the complex process of service recovery, most researchers examine the issue of service recovery by breaking it into sub processes and adopt mathematical methods to real the linear relationships between variables, which may lack systematical thinking and fail to broaden perspectives. System dynamics provides a macro-view to observe the performance of service recovery in a long-term period. Existing researches of service recovery majorly cover three fields: marketing, operations, and management. This study combines three perspectives to examine the interaction and relationship of service recovery by using system dynamics.

For practical implication, the proposed recovery model can help managers think in

a broaden perspectives and realize how things influence each other among complex recovery process. Managers can set appropriate numbers according to the situations and subsequently examine the long-term recovery performance of e-service by using simulation. Traditionally, certain firms used to conduct surveys; however, the way of developing and collecting questionnaires is time consuming and costing. Using the system dynamics approach can not only help companies think systematically and overcome the limitation of linear thinking but also assist examine long-term e-service recovery performance easily and effectively. Particularly, companies can allocate resources efficiently and effectively to maximize the performance of service recovery. For example, firms can build feedback mechanism to inform customers their endeavor to service recovery. They can also develop customized service recovery strategy to satisfy the variety of customers after realizing the failure severity implication to them. They can even develop explicit online instructions to show customers how to participate in self-recovery, or provide an integrated complaint system for those who are unwilling to participate in recovery.

There are few limitations to this study, which should be considered when interpreting the findings. First, there is a variety of factors in the service recovery process. To simplify, this study defines the research boundary and focuses e-service recovery on system-based trust and technology-based failures. Second, this study sets equations for computer simulation by referring to previous studies, and subsequently evaluates the recovery performance for service companies in the real world. Hence, the simulation results cannot be applied to all cases of e-service recovery, and are not appropriate for all kinds of e-service firms. Due to different external environment that enterprises confront, the proposed e-recovery model should be modified according to different situations. The proposed model is suitable for companies which mainly use self-service technology to deliver e-services to customers, such as on-line booking, on-line banking, Software as a Service (SaaS) and so on. Finally, even though the simulation results are beneficial for a company to practice its strategies in many ways, future research work may use empirical verification such as field studies, interviews, and case studies to collect accurate data and to verify the simulation results.

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