REAL-CARGO INFORMATION TRACKING TECHNOLOGY (RCI), PERCEIVED VALUE AND INTENTION TO USE

[1] ANDREW PENG, [2] STEPHEN WANG

[1,2]National Taiwan Ocean University, Department of Shipping and Transportation Management, 2 Pei-Ning Road, Keelung 20224, Taiwan, ROC
E-mail: [1]zhihong529@gmail.com, [2]stephen@mail.ntou.edu.tw

Abstract - This study explores the adoption by Taiwanese companies in the manufacturing, logistics and distribution sectors of real-cargo information tracking technology (RCI) combined with the functions of RFID, GPS and other sensors The survey received 187 valid responses. The technology acceptance model (TAM) provides support to validate the effectiveness, efficiency and perceived value for companies to introduce RCI in the future. The four factors of legitimacy, responsiveness, visibility and ease of use are discussed. Three of these factors are recommended as incentives for companies in these sectors to acknowledge the value of RCI and as support for companies' intention to use it. Providingexceptional customer service and increasing operational quality using advanced concepts of IoT in the supply chain are shown to provide beneficial results.

Keywords - RCI, TAM, RFID, IoT, manufacturing, logistics and distribution industry supply chain.

I. INTRODUCTION

In the development of freight shipping over the past several years, transportation modes have changed greatly along with developments of society, technology and systems of value. Ranging from single third party logistics providers, sellers and buyersin manufacturing industries to the all partners in a supply chain, the concept of self –value that companies gain from enhancing service quality has prompted increases in this continuously changing environment[19], [16].

Along with technological developments, there has been great progress in the development of equipment for fresh and chilled cargo, which needs temperature-controlled and time-effective transportation techniques[9] so that when customers receive their cargo, it still maintains a high level of quality. Tracking and positioning technologies are developing to handle the information on storage, transporting and delivery processes using computers or mobile devices [37]. Further, reducing the use of paper, reducing uncertainty during transportation, and providing precise and immediate information can all increase operational efficiency and improve customer satisfaction[10].

Due to the gradual increase in efficiency-oriented and customer-oriented developments, many companies in supply chains have implemented information technologies to provide higher levels of customer satisfaction and also improve their efficiency of operation, raise their competitiveness in the global market and provide additional value through techniques such as WMS, VMI, CRM, ERP, BI, TMS, EDI, RFID, and others. Using managerial skill to handle information can create more value and to assist all sectors of the supply chain to process their tasks more smoothly [19], [40], [50].

To maintain progress of information technology in logistics and transportation, along with the Internet of Things (IoT) and the application of big data, enterprises can be involved in the supply chain from production to delivery. This will enable them to gain more specialized acknowledge and thereby increase their competitiveness[49], [16]. Real-cargo Information tracking technology (RCI), combined with IOT technique will help companies gain additional competitive advantage and give customers more value-added services in the future global logistics and supply chain networks[33].
In the current rapidly changing environment, companies should implement advanced technologiesin order to operate more efficiently and effectively withgaining more real-time information [4]. New tracking information technologies combined with the application of the newest network technologies in the segments of manufacturing, warehousing and transportation can increase competitiveness and provide more value-added services to customers. Detailed information allows companies to revise their strategies rapidly, [4] and also allows customers to understand the situation of their cargo in real time[3].

II. APPLICATION AND LITERATURE REVIEW

Following the development of information technologies over the past two decades, a transformation of system value has allowed enterprises to consider different phases more carefully and to include a wider variety of options. Companies generally invest great amounts of capital and effort in their supply chain technologies [20], [30] so that every sector of the supply chain can correctly implement procurement, fabrication, transportation and other tasks. To more closely linkall the stages and supply chain partners, and to expand enterprises'

operational scales [25], information sharing and communication between organizations should be more fluent and easy [26], [29].The technologies for thisare tools designed to solve these problems[51]. And information technology is widely utilized by companies to support their business activities by increasing operational efficiency [39]. Companies apply information technologies so that they can efficiently manage themselves and develop a long-range planning that enables them to dominate their market and supply chain [51]. Companies apply information technology create better performance and promote their competitiveness in achieving their end goals. The benefits derived from inventory management, more accurate information flow, and immediate response capability can increase competitiveness by more effectively utilizing information technology, leading to improved overall performance[51].

Intelligent logistics applications in different industry sectors, such as manufacturing, commercial trading and agriculture, have developed accordingly to specific features of these sectors. The management of information in the logistics industry, especially for the integration and audition of logistics resources, in order to strengthenand synchronize information processes can adoptthe empirical practices of intelligent techniques. Tracking the conditions of goods which are in the process of transportis well understood by manufacturers to be vital for managing the supply chain network more efficiently and to increase customer satisfaction [3]. The main technologies of cargo tracking include the extensive use of GPS and RFID [8], [21], combined with RCI to be implemented according to the individual needs of different industry sectors, as discussed below.

2.1 GPS

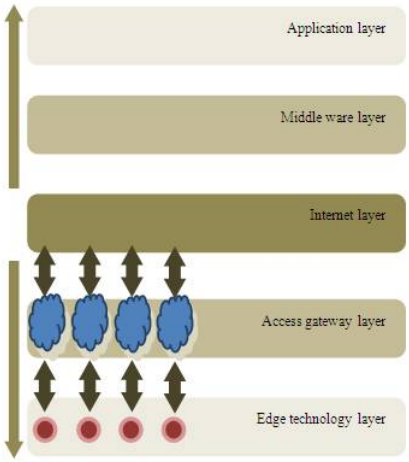
GPS(Global Positioning Systems), GIS(Geographic InformationSystems) and GSM(Global Systems for Mobile Communication) are well established in the field of positioning technologies.The application of tracking cargo utilizes GPS to acquire the precise location, time and speed of cargo and transportation means[49]. Utilizing GSM can provide communications with drivers and to transmit messages about the cargo's location and condition. Utilizing GIS to obtain geographical information and analyze data on the environment can provide a suggested route that is traceable. Thus delivery risk can be reduced and value added to freight transportation based on the use of logistics tracking during transportation [3].

2.2 RFID

Radio Frequency Identification (RFID) uses a micro-chip with an electric code number contained in a tag to obtain information on a product through non-contact or close-scan reader, and then by middleware filters and aggregates receiving data to conduct the application [5]. Usually, items or products that differ in form, fit and function are tagged with different coding designations [32]. With one small, multi-functional RFID chip, it iseasy to remotely accomplish a broad range of tasks.Three main benefits of RFID were outlined: to allow a faster response so that a manager could make an immediate decision; to reduce occurrence of human error; and to help streamline the operation process, thereby reducing costs [5]. In general applications of RFID in a logistics supply chain, warehouse or logistics operators can detect the designations, location, processing times, qualities and quantities of the items in all locations with a single reader [3]. By attaching an RFID or other intelligent sensitive chip to a product, the course of events pertaining to that item, including quality control, surveillance of in/out storage, planning, timing and recoding can be seen and addressed in stages from manufacturing to transport and finally to customer delivery[13], [49]. But the weak point of RFID is that the actual situation (e.g. outer effect or threat) of cargo in a container or loading space cannot be detected during transport[3], along with the lack of information on transiting from indoors to outdoors, from warehouses to containers [18].

2.3 Internet of Things

The Internet of Things (IoT) can be understood in three phases: 1. internet phase, 2. object phase,and 3. semantic phase. The intersection of these phases is the overall application of IoT[28]. The internet connects with physical object to interchange the information with their environment on the internet so that appropriate action can be taken [13]. The IoT intelligent environment utilizes information technology to effectively connect and interact with organic hardware and software [22]. There are five layers in the IoT structure [13] as Figure1 shows:



Edge-Technology Data Capture And Networks

Fig 1:Layered architecture for the Internet of Things

Source: Bandyopadhyay and Sen, 2011

Edge technology layer: this layer contains the sensing device, sensing chip, reader and other sensing

system and hardware components used to perform data collection, disposal, storage, control and drive.

Access gateway layer: this layer handles the path and publication of information, acquiring certification and the function of cross-platform communication.

Internet layer: this layer is for Internet connection.

Middle-ware layer: the middle-ware layer is the main bridge to connect with the edge technology layer, access gateway layer and application layer; it is responsible for filtering, clumping or assorting, translating, coding and accessing the data.

Application layer: this layer is responsible for transmitting all forms of information or commands to different needed users. Stimulated by the gradual maturity of RFID and other sensing technologies, there will be more advanced applications contained in the field of IoT.

2.4 Real-cargo information tracking technology (RCI)

Recently, "position" and "identification" technologies are applied to satisfy the needs of tracking and tracing to logistics or transportation supply chains[3]. Currently, the newest cargo tracking technology RCI combines with numerous sensing devices attached on the cargo during transit to evaluate the conditions of the cargo in the loading space such as temperature, humidity, vibration and whether the cargo has been damaged by any external factor [33]. By evaluating the information on damage factors,as shown in Figs.2, 3 and 4, the possibility of cargo breakage can be determined.

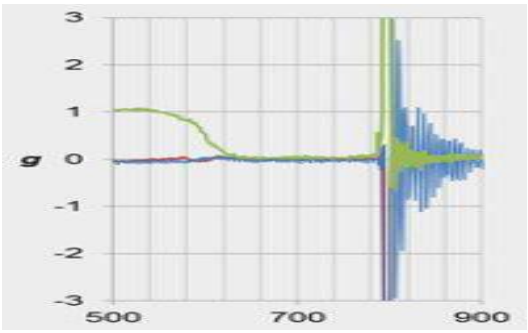


Fig 2 Cargo falling down (Red: front and back; Blue: left and right; Green: up and down)

Source: Peng, 2017

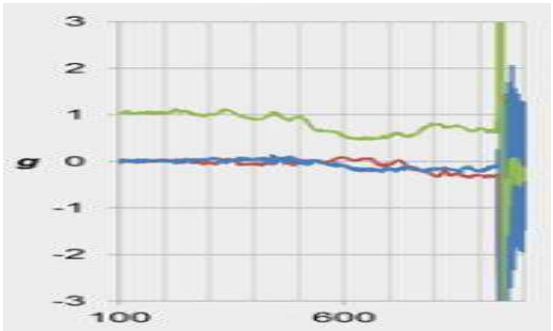


Fig-3 Cargo pulled down from a car(Red: front and back; Blue: left and right; Green: up and down)

Source: Peng, 2017

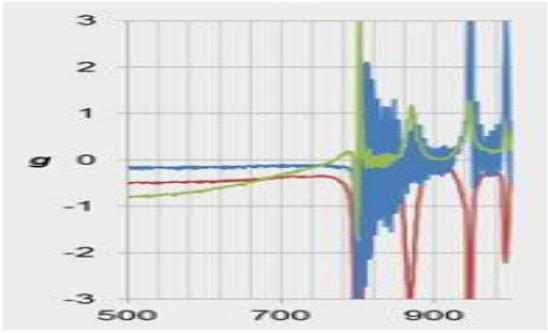


Fig-4 Cargo rollover(Red: front and back; Blue: left and right; Green: up and down)

Source: Peng, 2017

Examining these types of data helps a company to compensate for insufficient cargo preparation and make better plans (e.g. better packing) for delivery in succeeding shipments to ensure the stability and safety of the customer's goods[33]. The common benefits from real-time tracking technologies are [3]:

- identify and address weaknesses in a company's supply chain and the ability to manage suppliers performance
- reduce the total freight costs
- optimize inventory management
- increase the efficiency of a company's advance planning
- give more power in price negotiation
- reduce lead time
- reduce back orders

IBM researchersstated that in a customer-oriented environment,providing such value-added services is necessary for enterprises to succeed in a fiercely competitive market[12].

2.5 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) is widely recommended in many studies. TAM was first developed in 1986 by Davis, and in 1989 was adapted as a general model to predict and explain technology usage behavior. It identifies the factors that lead to degree of a user's acceptance or rejection of a certain technologyaccording to technological aspects and organization behavior concepts [18]. TAM has been explained as a concise model which is largely validated to depict the reasonable behavior of users [44]. TAM has been proven to be a robust model forevaluating the acceptance of new and developing technology by users with different characteristics in different organizations [1]. The theory of reasoned action (TRA) was the source of TAM, explaining the subject norms and attitudes of users' toward their behavior intentions [1]. A subjective norm was not initially adopted in TAM due to weak psychometric results[17], [44]. But since that time, researchers have added external variables to improve the feasibility of the original TAM into more valid extensions.

The adoption of future wearable technology such as smart watches can increase the affective quality, relative advantage, mobility, availability, subcultural appeal and cost, thereby further extending application of TAM [27]. The external factors of perceived risk and compatibility were added into TAM to investigate users' tendencies in accessing online banking services [44].In the current study, visibility, responsiveness, legitimacy and ease of use are discussed as external factors to articulate the constructs of TAM to explore the perceived value and intention of manufacturing industry, logistics and distribution companies when using RCI.

III. CONCEPTUAL FRAMEWORK AND RESEARCH HYPOTHSIS

RCI is a newly emerging cargo tracking technology. To explore the degree of acceptance an adopting intention by companies, the current study uses TAM to present hypotheses. As shown in Fig.5, this study defines visibility, legitimacy, responsiveness and ease of use as variables to impact the fit of association in TAM.

In the discussion of supply chain challenges, the concept of supply chain visibility (SCV) is broadly used by third party logistics service providers, transportation and other related companies in supply chains[48].According to professionals ofsupply chains in practice, real-time visibility across all tiers in the supply chain significantly increases speed to market and reduces the risks for management.In the current globalizedenvironment, the need for effective andresponsive results is typified by different and escalating customer requirements, unpredictable customer demand and situations, [34]. Customer satisfaction is reflected by the perception of responsiveness, as well as the accuracy and completeness of information quality [46]. Thus, service providersare willing to provide services that target clients' specific needs [2].Additionally, the IT usage decisionsmade by legitimacy that is extended from social norms urge the companies to adopt IT [6]. The forms of legal, economic and other social sanctionslead companies to have a conceptual perspective that can direct further attention to the issue of organizational legitimacy [23].Following the trend of increased mobile device applications, the current study focuses on the convenience and of applying this information system. Ease of use is an indication of the domination of customer's behaviors or belief to adopt the information system [45].Although some firms have reported positive results of adopting IT, implementation can be expensive and risky, and theramifications and outcomes of measurements are questionable [47]. Thus, before making a decision for utilization, critical customers will search for more detailed information [43] to determine whether or not to establish an RCI system. Currently, extensive research has validated the effectiveness of the TAM framework, and the results have enhanced the TAM conceptual framework to accommodate the customers'particular needs[44]. The increased perceived value of RCI further motivates customers' intention to utilize RCI.
Since IT has a positive impact on the use of supply chain partners and the performance of their operations, the exchange of information through the supply chain network gives enterprises a positive attitude towards IT [51]. For users, in the multi-reference to understand the benefits of tracking information technology, the following up value is limitless [41], [42]. The advantages and benefits of cargo-sensing ability provide robust pragmatic and theoretical reasons for managers (users) to use tracking technology [14], [15]. Different kinds of companies adopting tracking technology have different aspects or motivations, but the same reasons for utilizing the information technology effectively support companies in specific directions [51]. Also, the legitimacy of information technology adoption and the beneficial results of using information technology utilized are relatively positive [51]. Thus in order to enhance users' ability to recognize the performance of tracking information technology (e.g. RCI), this study proposes the following hypothesis:
H1: Legitimacy has a positive impact on perceived value

When a problem occurs, the usercan have rapid access to effectively solve the problem [31]. Also, when service staff quickly answer questions or complaints from users in response to problems with correct treatment, or when accidents and unexpected events occur, the service response can be fast, flexible and effective [31]. This will increase the degree of recognition. Thus not only will the supply side obtain higher performance ratings, but differences between actual service and customers' expectations will be reduced. The current study expects that the feedback of technological quality will demonstrate the value of response when the service side requests assistance, therebyencouraging companies to use tracking technology.This leads to the following assumption:
H2: Responsiveness has a positive impact on perceived value

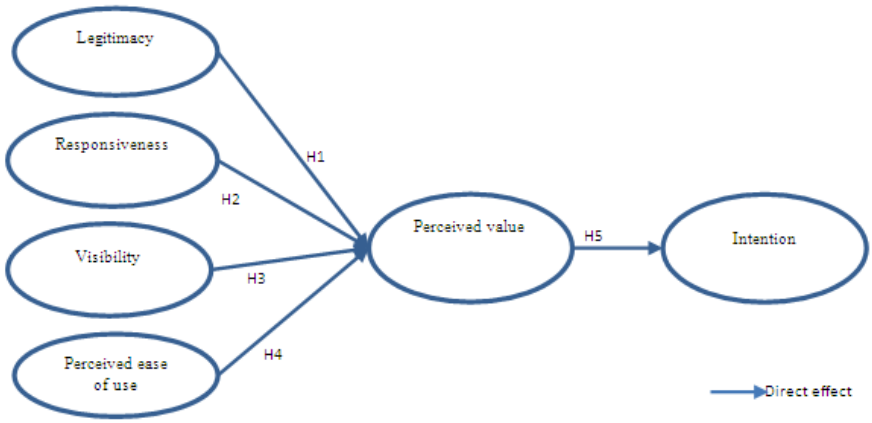


Fig- 5: Conceptual Model

Tracking technology in enterprises is a critical auxiliary function. The degree of transparency of tracking information supports goods in the transportation link, increasing the key success factors for obtaining good operating efficiency [20]. Real-time tracking technology provides optimal transparency in the product delivery process, which can enhance enterprises' control over the supply chain network [7]. The enterprises pay a significantly amount of attention to the visibility of tracking information that is generated during the process of delivering their products [19]. Thus, complete informative visibility can increase the value and extent of tracking technology. The visualization of information generated by the sharing of a tracking system in an established logistics supply chain network increases participant satisfaction in every sector[3]. Thus, there is the following hypothesis:

H3: Visibility has a positive impact on perceived value.

Manystudies on the extension of TAM confirm the effectiveness of the original TAM [44]. In the TAM framework, difficulties in using information technology would affect users' awareness of introduction or operation, thereby influencing the users' attitude. By manipulating the two dominant variables of perceived usefulness and perceived ease of use, systems developers can better predict perceptual preferences for information technology and user intentions to use new information technology, as well as further actual usage behavior [35]. However, this study replaces the variable o perceived usefulness with legitimacy, visibility and responsiveness, which provide important support for companies' usage of new technology to gain better operational effectiveness. Therefore, the following hypothesis is made:

H4: Perceived ease of use has a positive impact on perceived value.

According to the TAM structure, perceived value would affect the users' intention to use a technology [44]. When people have positive emotions toward a certain action, they would have intention to do it [38]. At that time, the aspect of cognitive perception positively affects the intention and behavior to use new technology. Therefore, there is the following **hypothesis:**

H5: Perceived value has a positive impact on Intention

IV. ANALYSIS

There were 187valid responses to 750 questionnaires which were sent out through e-mail and regular mail to different types of industries in Taiwan that needed transactions to buy/sell or deliver the products. These industries included manufacturing enterprises and logistics and distribution companies. The questionnaires were collected within one month and incomplete questionnaires were excluded. The types of companies completing questionnaires were as follows: electronics companies - 36(19.2%), optical product companies – 12(6.4%),machinery manufacturing companies – 30(16%),food manufacturing companies – 7(3.7%), plastic manufacturing companies - 9(4.8%),logistics and distribution service companies - 73(39%), and retailers – 9(4.8%). Non-manufacturing companies included customs brokers – 5(2.7%) and container freight stations – 6(3.2%). Overall, 115(61.5%) companies were familiar with IoT and 72(38.5%) were not. 119(63.6%) companies were familiar with RCI and 68(36.4%) were not. There were 113 companies (60.4%) that had an information department, and 74(39.6%) that did not. Exploratory factor analysis (EFA) is used to define latent variables by selecting the variables that can dominantly explain the original situation and depict interrelationships between many variables. Ordinarily, the KMO and Bartlett's Sphericity Test are used to test whether factor analysis is suitable. Kaiser (1974) proposed the criterion of fitness degree as shown in Table 1.

0~0.5	0.5~0.59	0.6~0.69	0.7~0.79	0.8~1.0
unacceptable	miserable	ordinary	moderate	good

Table-1: Criterion of fitness degree

We used Varimax to extract the factors which were >0.6 and conducted factor analysis to simplify the constructs. In this study, KMO is 0.898 with 0.000 P-value = 0.000 <0.05, which means this model is suitable for factor analysis. After deleting the factor loadings under 0.6 and then summarizing, the six major constructs were legitimacy, responsiveness,visibility,ease of use, perceived value and intention.The proposed model was estimated using SmartPLS 3. All the subsamples were run under the recommended 5000 times. We assessed the quality of measurement by investigating reliability and validity, including convergent validity and discriminant validity. As Table2 shows, we can view the goodness of Composite Reliability (CR) and Average Variance Extracted (AVE). AVE represents the percentage of latent variable for observed variable with estimating not only CR but also convergent validity and discriminant validity [12].

First, the Cronbach's alpha of all constructs exceeded the suggested 0.6 benchmark [11], [36]. Second, in the Confirmatory Factor Analysis (CFA) setting, determined by examining AVE values that were higher than 0.5 [11], [24] offered supporting evidence for convergent validity (the level of conjunction between measurements into a construct). Finally, discriminant validity was assessed by referring to Table3.

	Cronbach's Alpha	CR	AVE
Legitimacy	0.733	0.882	0.789
Responsiveness	0.888	0.804	0.654
Visibility	0.854	0.897	0.637
Ease of Use	0.841	0.926	0.862
Perceived Value	0.881	0.810	0.629
Intention	0.894	0.934	0.825

Table 2: Survey Instruments

Discriminant validity is used to examine the degree of discrimination of a feature by comparing one construct with other constructs. Fornell and Larcker (1981) advised that the square root of AVE for each construct should be more than the correlation coefficients which are connected with other constructs and itself. Kline (1998) thought that the correlation coefficients should be less than 0.85 in keeping with both standards presents the goodness of discriminant validity. Therefore, the square roots of AVE on the right side are larger than those on the left side, which indicates that every construct has good discriminant validity. Use path coefficient (β), P-value (<0.05) and T-value (>1.96) to test whether every latent variable has a significant existing relation.

	Ease of Use	Intention	Legitimacy	Perceived Value	Responsiveness	Visibility
Ease of Use	0.928					
Intention	0.224	0.908				
Legitimacy	0.377	0.440	0.888			
Perceived Value	0.338	0.569	0.576	0.793		
Responsiveness	0.321	0.382	0.401	0.644	0.809	
Visibility	0.286	0.489	0.371	0.668	0.659	0.798

Table-3: Discriminative validity instrument

EMPIRICAL RESULTS

According to the results, the path coefficient is significantly positive from legitimacy to perceived value is 0.324, from responsiveness to perceived value is 0.265, from visibility to perceived value is 0.365, from perceived value to intention is 0.569, all with P-value under 0.001(***) and T-value over 3.29. This only leaves the path coefficient from ease of use to perceived value of 0.026 with P-value 0.616. R square represents the ability for model explanation where the R square of perceived value is 0.610, and the R square of intention is 0.323. The two latent variables in the model are have the values of 61% and 32.3%, which indicates they have acceptable power for explaining the model.

The procedures were estimated by according to the recommended running times for bootstrapping (5000times) and the overall fit of model was acceptable to examine relationships among legitimacy, responsiveness, visibility, ease of use, perceived value and intention (Table4). The results revealed that the latent constructs of legitimacy, responsiveness and visibility all positively and significantly influenced perceived value, supporting H1, H2 and H3.Meanwhile, perceived the perceived value positively and significantly influenced intention, supporting H5. Only ease of use toward perceived value was non-significant, not supporting H4.

Path relation	Path coefficient(β)	T-value	P-value
H1: Legitimacy → Perceived Value	0.324***	5.779	0.000
H2: Responsiveness→Perceived Value	0.265***	3.784	0.000
H3: Visibility →Perceived Value	0.365***	5.625	0.000

H4: Ease of Use →Perceived Value	0.026	0.502	0.616
H5: Perceived Value → Intention	0.569***	11.459	0.000

Table 4: Results of the proposed model

Note: **for P<0.01, ***for P<0.001

CONCLUSIONS

Though RCI was designed to serve the delivery process, it has now been adopted both to help track real-time information for cargo and to give additional benefits to customers or companies (users). According to the model, in terms of legitimacy, companies that have a need for delivering cargo might consider if their partners or competitors could adopt the similar tracking technology for their operations. Thus, the companies could not only provide more effective and efficient operations in the supply chain network, but also would be more competitive in the global market by aligning themselves with global trends. In terms of responsiveness, both companies and customers in the current rapidly changing environment desire to acquire real-time information and responses. If there is any problem with RCI, its users would want to obtain an answer or solution from the RCI service provider. System stability and quick service response make companies feel the value effective service. In terms of visibility, immediate information sharing between supply chain partners is important, and fast linkage with every sector in a supply chain improves the efficiency of operation. Aside from the basic functions provided by RFID and GPS, the increased transparency of information on the detailed cargo situation provides more accurate and detailed information for companies to make instant decisions. Clear and precise information on their transported cargo is vital for companies when they check review it on an electronic device. However, in the respect of ease of use, there is no obvious impact on the perceived difficulty of using RCI. This is probably because current information technologies are designed with user-friendly interfaces and many systems and electronic devices are equipped with customized manipulation. Thus users may be less concerned with the challenges of a new technology, andease of use is not viewed by companies as matter of concern whether RCI is easy to use or not.

LIMITATIONS AND FUTURE RESEACH

First, in addition to the manufacturing sectors of electronics companies, machinery manufacturing companies, logistics and distribution companies, there are othercategories that require more responsive performance. Second, we were unable to identify the target individuals who were directly responsible for answering the questionnaires. There might be different situations for technology use and desired performance in different kinds of companies. Third, the samples were collected from companies in Taiwan, and there might be different perceptions or working procedures in other environments or cultures that would relate to the perceived value of RCI. Further study can consider the performance of RCI use with more specific industries or examine the degree of customer satisfactions in RCI user.

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