A Research on User Adoption Behavior of IoT Technology in Logistics Service Industry Based on Cainiao Network

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PART 01

INTRODUCTION

- Research Background
- Literature Review
- Research Hypothesis

Research Background

With the rapid development of information technology, the combination of the Internet of things and modern logistics has produced a new situation.

The concept of IoT objects has expanded to include many digital devices (e.g., RFID, sensors, actuators, smartphones, smart things) that can be uniquely identified, read, sensed, addressed, and independently controlled through the Internet.

In recent years, the use of IoT technology in the logistics industry (L-IOT) is mainly in intelligent warehouse, unmanned distribution and logistics information system tracking.

Research Background

IoT + Logistics + User adoption = **New situation of intelligent logistics**

This study combines theoretical and empirical research to analyze the factors that influence users to adopt the L- IoT, then put forward suggestions on how to improve delivery efficiency and customer satisfaction for logistics enterprises.

This study will focus on the following three issues:

① What are the main technical factors and individual characteristic factors that influence the users' behavior intention (BI) of IoT in the logistics industry?

② What is the relationship between the influencing factors and users' BI of the IoT?

③ What is the mechanism of perceived usefulness (PU), perceived ease of use (PEOU), and users' BI in this paper's TAM structure?

Research Background

- The subject of this paper is China‘s well-known logistics platform Cainiao Network.

As a high-tech logistics company under Alibaba, Cainiao has been committed to building logistics IoT open platform to realize digital and intelligent upgrading of the entire logistics chain. However, the application of logistics ends users is not ideal, which limits the convenience of the IoT to be truly perceived by users.

- Cainiao and IoT

Focused on providing intelligent supply chain services, Cainiao, will spend 1.5 billion yuan to set up IOT technology company in 2020. Cainiao attaches great importance to the development of IOT, which will determine the competitive landscape of logistics in the future.

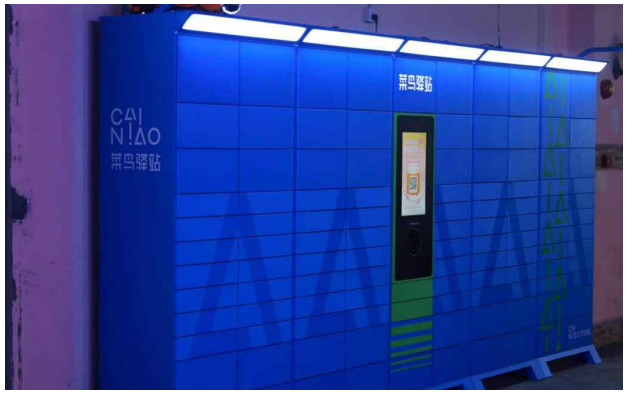
- The common IoT technologies for users focus on the last mile of unmanned delivery

Unmanned delivery technologies of the IoT, such as delivery robots, unmanned aerial vehicles and intelligent express cabinets, will become a mainstream technology for consumer-related delivery, representing the development degree of intelligence and automation in the logistics industry.

Research Background

(1) Intelligent express cabinet

A device based on IoT technology that can identify, temporarily store, monitor and manage items.
Cainiao's express cabinet is a device that can provide consumers and couriers with an simplified delivery process and package pick-up.



(2) Delivery robot

IoT intelligent mobile robot system with high performance and low cost, combined with a variety of IoT wireless networking and control technologies to achieve intelligent delivery robots with self-organization, autonomous operation and autonomous planning.

(3) Drone delivery

The application of 5G and IoT will make drone delivery more common, achieving faster and more accurate delivery of the "last mile" and greatly accelerating logistics delivery in remote mountainous areas.

Literature Review

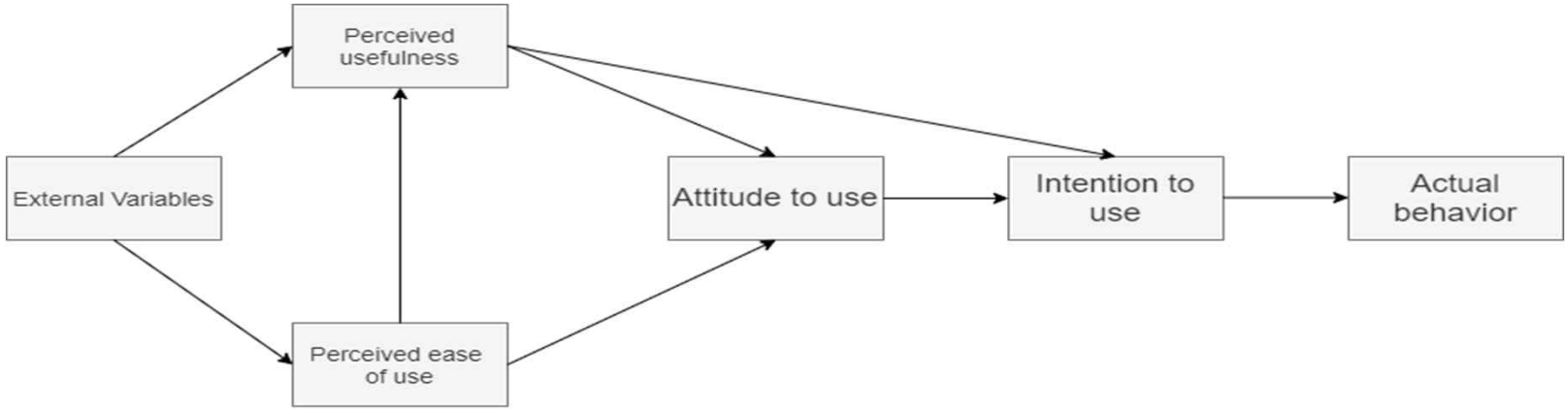


Fig. 1 TAM Structure (Davis ,1989)

- Davis (1989) proposed the Technology Acceptance Model (TAM). Through a series of causal relationships such as belief, attitude, intention, and behavior, analyze and verify the reasons that external variables affect individuals' use of the new information system.
- In the TAM model, it is argued that a person's behavior in using new information technology is mainly influenced by the user intention, which is simultaneously influenced by the perceived usefulness (PU) and perceived ease of use (PEOU) (Altaf, 2019).
- Davis (1989) did further research and found that PEOU affects PU. If users feel that the information system is very easy to use, then his/her efficiency will increase.

Literature Review

Regarding the external factor selection, this study considers technical factors and individual characteristics that have a range of effects on adoption outcomes.

1. In terms of technical factors, this study selected supporting facilities and security.

Supporting facilities means "the organization's support for the use of the system in terms of relevant technology and equipment".(Thompson et al., 2009). Convenient equipment support and comprehensive customer service increase PEOU and directly affect users' adoption in L-IoT (Bienstock, 2008). Cheung and Lee's (2010) study shows users believe that secure IoT applications are available and have higher usefulness.

2. In terms of individual characteristics, this study add individual innovation and perceived enjoyment.

Claudy (2015) found that innovative people are more willing to touch and learn how to use new technologies.

Self-determination theory proposes that internal and external motivations can combine to influence a person's specific behavior, and some studies point out that enjoyment motivation plays an important role in users' technology use scenarios (J. Lee et al., 2019).

Research Hypothesis

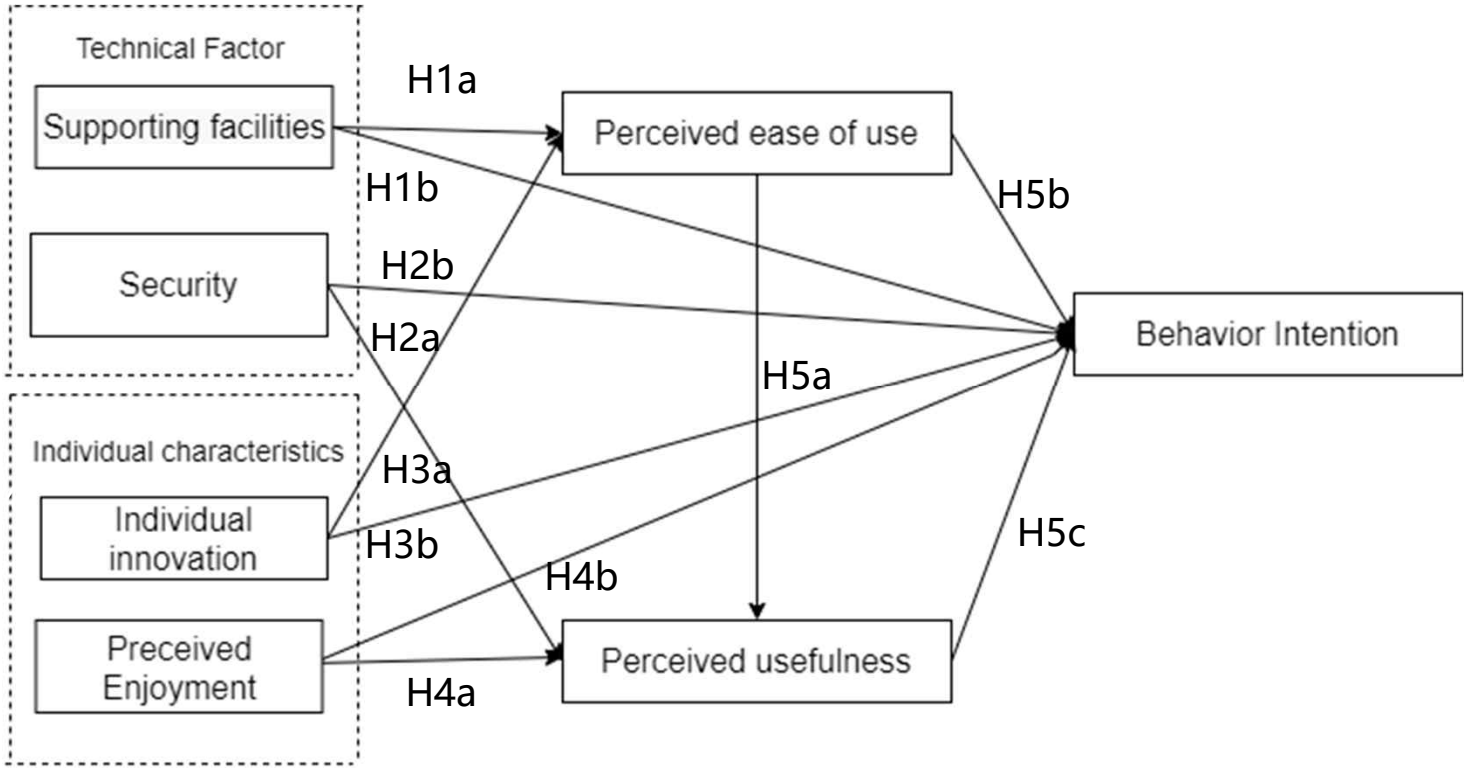


Fig.2 Research Model diagram

PART 02

METHODOLOGY

- Research design and data collection
- Data analysis methods
- Structural Equation Model

Research design and data collection

Sampling methods:

This study uses stratified sampling to investigate people related to the logistics field, which is a method of randomly selecting individuals of different strata from the total population in a specified proportion, to ensure that the structure of the sample is more similar to the total.

Sample selection:

The data was obtained using a questionnaire that allowed respondents to intuitively and quickly answer questions to determine their thoughts and behaviors.

The respondents were mainly employees in the Chinese Courier Station, delivery personnel, students studying the logistics, and general users to research multiple perspectives.

Data analysis methods

That questionnaire was distributed online, and the invitation to fill out the questionnaire was mainly sent through Questionnaire Star (http://www.sojump.com/) for the online filling to record the research respondents' opinions.

A total of 60 questionnaires were distributed during the pre-research process. After that, the questionnaires were revised according to communicating with the relevant people, then analyzed the reliability and validity and deleted some items, which formed the official research questionnaire.

Data analysis methods mainly include descriptive statistics, reliability and validity test, correlation test, path analysis, and mediation effect test. Finally, summarize the results and put forward suggestions.

Structural Equation Model

Structural Equation Model (SEM)

SEM incorporates both measurements of concepts and inter-concept relationships into the model, and the main purpose of SEM is to measure the hypothesized relationships between latent and explicit variables.

Structural equations have the following advantages:

(1) Structural equation modeling attaches great importance to the measurement of concepts.

(2) Structural equations allow for errors in the model for independent variables.

(3) Multiple dependent variables are allowed to exist in the model, there are also interactions between the dependent variables.

(4) Structural equation modeling conforms to the logic of scientific research.

Structural Equation Model

The basic steps of the structural equation used in this paper are:

(1) Model construction

(2) Model identification

(3) Parameter estimation

(4) Model evaluation

(5) Model correction

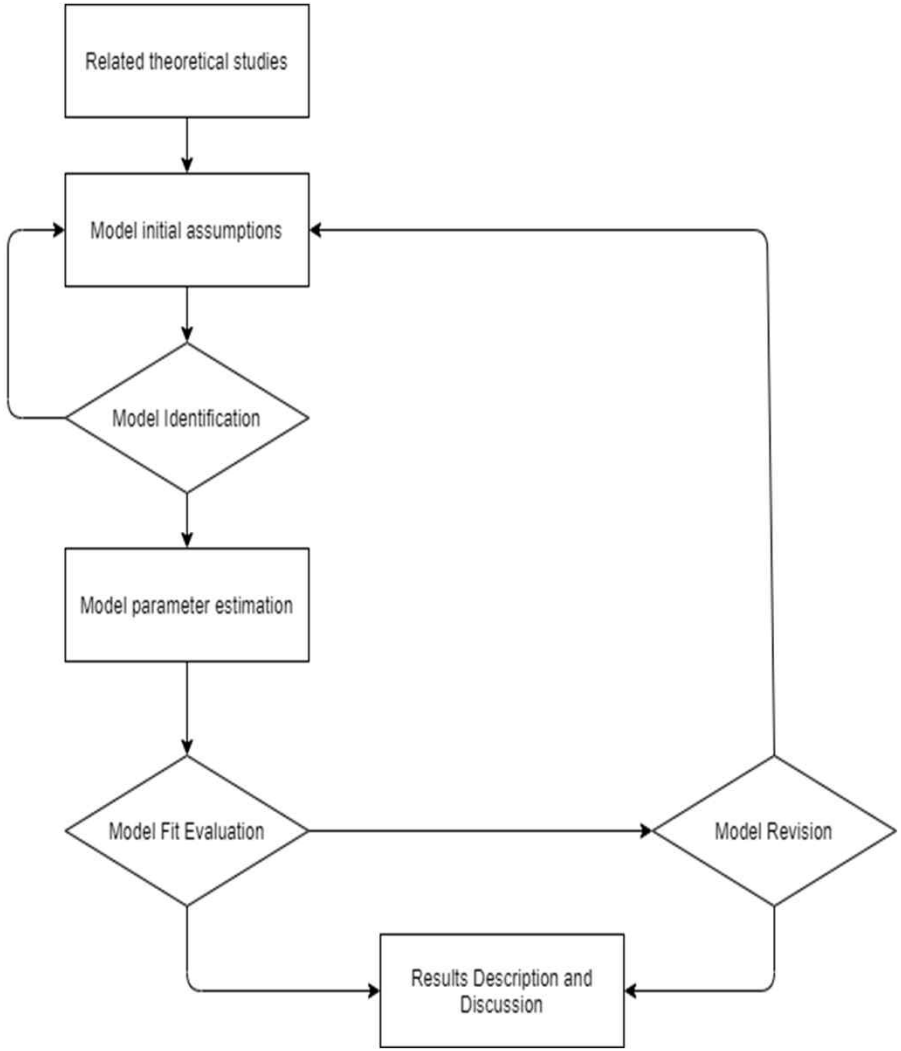


Fig 3 Basic structure of structural equation model

PART 03

RESEARCH RESULTS

- Descriptive Analysis
- Reliability and validity analysis
- Model hypothesis testing analysis

Descriptive Analysis

- The survey received a total of 317 questionnaires, including 54 invalid questionnaires and 263 valid questionnaires, with an effective rate of 83%.
- In terms of user experience, there are a few users who have not used them yet. It indicates that there is still a lot of room for the development of L-IoT services.
- In summary, the respondents satisfy the requirements of this study, and the data obtained from the survey has analysis and research value.

Table 1 Descriptive statistics

		Frequency	%
Gender	Male	144	45.4
	Female	173	54.6
Total		317	100
Age	0-15	3	0.9
	15-25	100	32.5
	25-35	75	23.7
	35-45	55	17.4
	45-55	63	19.9
	More than 55	21	6.6
Total		317	100
Education	Primary school	2	0.6
	Junior school	25	7.9
	High school	38	12.0
	Bachelor degree	148	46.7
	Postgraduate and above	63	19.9
	Else	41	12.9
Total		317	100
User Experience	Yes	267	84
	No	50	16
Total		317	100

Reliability and validity analysis

Table 2 Reliability Test

Dimension	Cronbach's Alpha	Number of terms
Supporting facilities	0.805	4
Security	0.887	4
Individual Innovation	0.869	4
Perceived enjoyment	0.858	3
Perceived ease of use	0.864	4
Perceived usefulness	0.866	3
Behavior Intention	0.875	4

- The α coefficients in this paper are all greater than 0.8, KMO value is 0.89 ,which means that the reliability of the questionnaire is acceptable.
- The correlation among supporting facilities, security, individual innovation, perceived enjoyment, perceived ease of use, perceived usefulness, and behavior intention is positive, the variables' correlation coefficients are between (0.139 ,0.611), and the results are significant.

Table 3 Validity Test

Indicator	χ^2/df	RMSEA	SRMR	TLI	CFI	IFI
Criterion	< 3.00	< 0.08	< 0.08	>0.9	>0.9	>0.9
CFA	1.512	0.044	0.095	0.957	0.963	0.963

Table 4 Correlation Test

	Supporting Facilities	Security	Individual Innovation	Perceived Enjoyment	Perceived ease of use	Perceived usefulness	Behavior Intention	
Supporting Facilities	1							Supporting Facilities
Security	0.286**	1						Security
Individual Innovation	0.207**	0.212**	1					Individual Innovation
Perceived Enjoyment	0.139*	0.220**	0.357**	1				Perceived Enjoyment
Perceived ease of use	0.246**	0.440**	0.472**	0.365**	1			Perceived ease of use
Perceived usefulness	0.283**	0.429**	0.275**	0.343**	0.523**	1		Perceived usefulness
Behavior Intention	0.323**	0.451**	0.477**	0.393**	0.611**	0.508**	1	Behavior Intention

Model hypothesis testing analysis

Table 5 Path analysis

Path	Standardized Coefficients	Unstandardized Coefficients	S.E.	C.R.	P
PEOU <--- Supporting Facilities	0.142	0.154	0.069	2.218	**
PEOU <--- Individual Innovation	0.530	0.611	0.082	7.442	***
PU <--- Security	0.261	0.316	0.077	4.084	***
PU <--- Perceived Enjoyment	0.152	0.131	0.055	2.374	**
PU <--- PEOU	0.439	0.383	0.059	6.501	***
BI <--- Supporting Facilities	0.142	0.140	0.056	2.487	**
BI <--- Security	0.127	0.159	0.075	2.131	**
BI <--- Individual Innovation	0.180	0.187	0.075	2.483	**
BI <--- Perceived Enjoyment	0.133	0.119	0.054	2.218	**
BI <--- PEOU	0.336	0.303	0.070	4.328	***
BI <--- PU	0.181	0.188	0.073	2.585	***

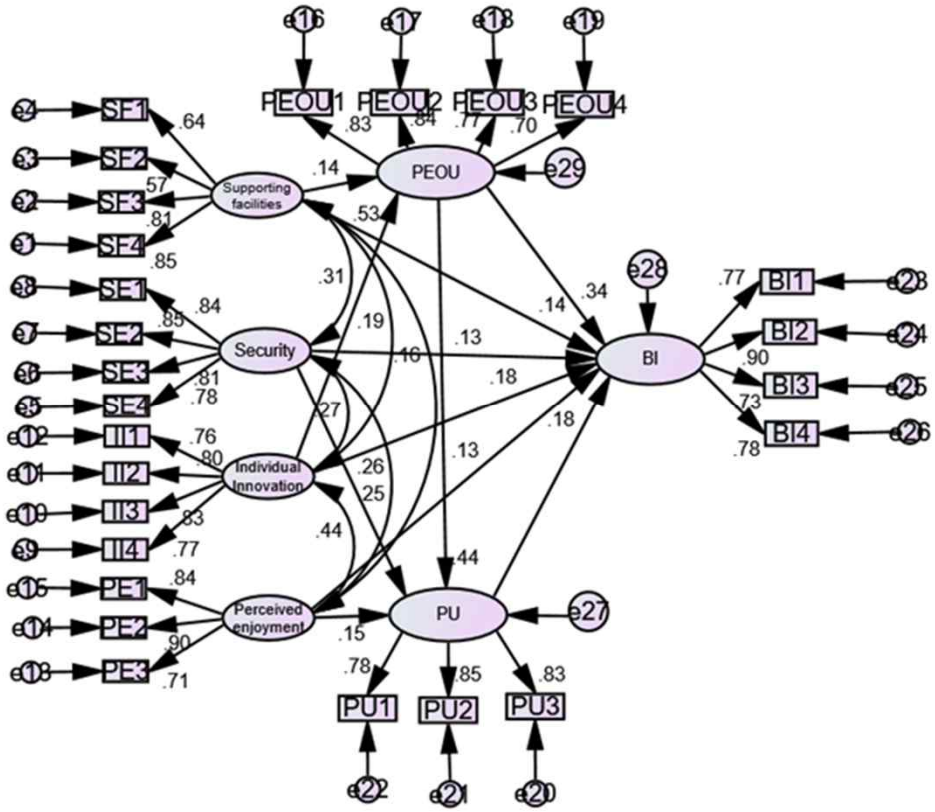


Fig. 4 Structural equation model

Model hypothesis testing analysis

- H1a: There is a significant positive effect of Supporting Facilities on PEOU ($\beta=0.142$, $p<0.05$)
- H1b: There is a significant positive effect of Supporting Facilities on BI ($\beta=0.142$, $p<0.05$).
- H2a: There is a significant positive effect of security on PU ($\beta=0.261$, $p<0.01$)
- H2b: Security has a positive and significant effect on BI ($\beta=0.127$, $p<0.05$).
- H3a: There is a significant positive effect of individual innovation on PEOU ($\beta=0.530$, $p<0.01$)
- H3b: Individual innovation has a positive and significant effect on BI ($\beta=0.180$, $p<0.05$).
- H4a: There is a significant positive effect of perceived enjoyment on PU ($\beta=0.152$, $p<0.05$).
- H4b: Perceived Enjoyment has a significant positive effect on BI ($\beta=0.133$, $p<0.05$).
- H5a: PEOU has a significant positive effect on PU ($\beta=0.439$, $p<0.01$).
- H5b: PEOU has a significant positive effect on the BI ($\beta=0.336$, $p<0.01$).
- H5c: PU has a significant positive effect on BI ($\beta=0.181$, $p<0.01$).

Mediation Test

Table 6 Mediation Test

Indirect path	Mediating variable	Indirect effect	S.E.	Lower limit	Upper limit	P-value	Results
Supporting Facilities →PU	PEOU	0.062	0.039	0.001	0.157	0.046	Supported
Individual Innovation→PU	PEOU	0.233	0.049	0.144	0.361	0.000	Supported
Security →BI	PU	0.028	0.036	0.006	0.152	0.032	Supported
Perceived Enjoyment→BI	PU	0.023	0.021	0.000	0.089	0.056	Not Supported
Individual Innovation→ BI	PEOU,PU	0.220	0.056	0.126	0.352	0.000	Supported
Supporting Facilities→ BI	PEOU,PU	0.059	0.037	0.001	0.147	0.047	Supported
PEOU→BI	PU	0.080	0.043	0.004	0.174	0.042	Supported

- **Method:** AMOS24.0 + Deviation Corrected Percentile Bootstrap
- **Set :** Bootstrap times to 5000 and the confidence interval to 95%.
- An indirect effect of support facilities on PU was noted, with an indirect effect size of 0.062, confidence interval of (0.001, 0.157), excluding 0, and the p-value less than 0.05.
- Among the seven indirect paths in the above figure, only perceived enjoyment did not pass the significance test of p-value equal 0.05 for BI, and the confidence interval contained 0.

PART 04

CONCLUSION & SUGGESTION

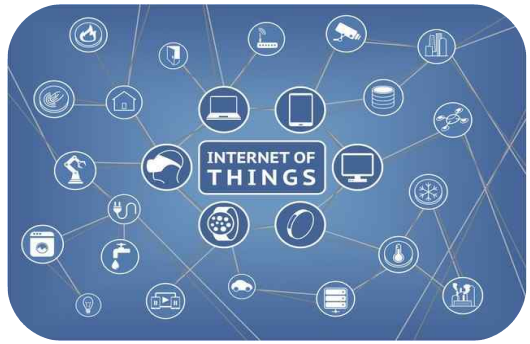
- Research Implications
- Research conclusion
- Research limitations and prospects

Research Implications

- **Attach importance to improving logistics IoT related supporting facilities.**

- **Improving the security of IoT products in the logistics industry.**

- **Designing easy-to-use IoT applications for the logistics industry.**



- **Focus on the cultivation of innovative people.**

Research conclusion

The hypotheses of this paper are verified by SEM. After data analysis, the conclusions are as follows:

① Summarizing the user-oriented L-IoT services.

② Find the relevant factors affecting user adoption of IoT in logistics industry. Among them, supporting facilities and individual innovation have positive effects on PEOU, while security and perceived enjoyment have positive effects on PU.

③ The basic theory of TAM framework is proven again, PU and PEOU are important features of designing L-IoT products.

Limitations:

- The respondents of the questionnaire are mostly young groups, especially students, which lack generalizability.
- The selection of factors influencing the study is not comprehensive and the impact of IoT on other participants along the logistics chain was also not studied.
- Future research needs to improve management and technical solutions, such as organizational solutions, market scenarios, social occasions to study the influencing factors of users using IoT products in different types of logistics industries.

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