

# 博士生論文發表佐證資料

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## A1.WEVJ 期刊收錄證明（抵學科考）

附件一：期刊等級證明

附件二：期刊接受證明

附件三：文獻來源和網路連結

### 附件一：期刊等級證明

The screenshot shows the Scopus Preview interface for the journal 'World Electric Vehicle Journal'. The page includes a search bar, navigation links, and a list of metrics. The journal details are as follows:

Metric	Value
CiteScore 2022	3.7
SJR 2022	0.477
SNIP 2022	0.819

World Electric Vehicle Journal  
開放取用 ⓘ  
Scopus 涵蓋年度: 從 2007 到 2013, 從 2015 到 2016, 從 2018 到 2023  
發表者: Multidisciplinary Digital Publishing Institute (MDPI)  
電子版國際標準期刊號: 2032-6653  
學科類別: Engineering: Automotive Engineering  
來源出版物種類 期刊

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## 附件二：期刊接受證明(102/07/17)

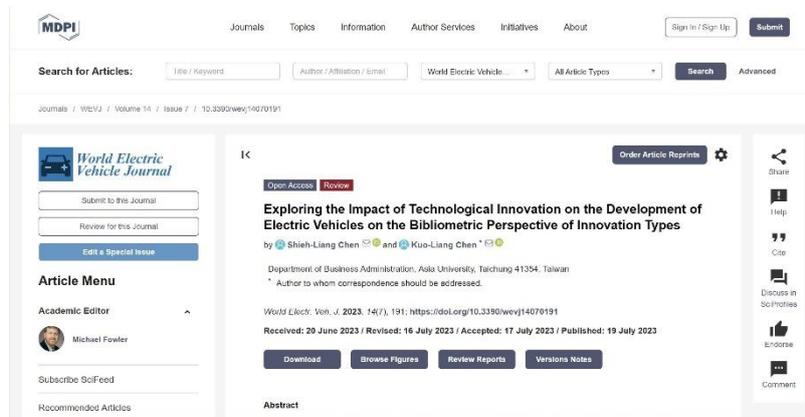


## 附件三：文獻來源和網路連結

Chen S-L, Chen K-L. Exploring the Impact of Technological Innovation on the Development of Electric Vehicles on the Bibliometric Perspective of Innovation Types. *World Electric Vehicle Journal*. 2023; 14(7):191. <https://doi.org/10.3390/wevj14070191>

Submission received: 20 June 2023 / Revised: 16 July 2023 / Accepted: 17 July 2023 / Published: 19 July 2023

Website: <https://www.mdpi.com/2032-6653/14/7/191>



## A1.期刊刊登全文

Review

# Exploring the Impact of Technological Innovation on the Development of Electric Vehicles - Based on the Bibliometric Perspective of Innovation Types

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**Abstract:** Innovation has always been the driving force behind social progress. Enterprises will adopt different types of technological innovations according to their goals, resources, and market strategies. The industry generally pays attention to the development and application of electric vehicle technology innovation, but a single method may not be able to fully explain the innovation of electric vehicle technology. Furthermore, the results of technological innovation must be presented in terms of market benefits, otherwise, insufficient cash flow will lead to innovation interruption. Therefore, this study uses the innovation matrix proposed by Rothaermel to classify the matrix formed by the market and technology. This study collects 43 periodicals and special publications published in 2010-2022, and 40 related electric vehicle literature that can be downloaded, summarizes the literature content according to the innovation matrix by means of literature bibliometric perspective and analysis, and obtains (1). Most of the innovative technologies of electric vehicles originated from the extension of previous technologies, and the proportion of radical technological innovation is relatively high; (2). Batteries and power supplements are the key items of electric vehicles, and they are also the main factors of market sales. Theoretically, this study can provide a basis for studying the combination of Rothaermel's "innovation matrix" and Ansoff's "expansion matrix". In practice, it is the first time to take the electric vehicle industry as an example, combining the two models, aiming at technology/production/market/performance for electric vehicle industry managers the technological innovation direction and the formulation of market strategy operations and advanced deployment.

**Keywords:** Innovation Type, Technological Innovation, Electric Vehicle, Rothaermel's matrix, Ansoff's matrix, Marketing Strategy

## 1. Introduction

With the development of science and technology, the automobile industry has undergone tremendous changes in innovation and technology application. New types of mobile manned vehicles such as electric vehicles have changed human driving habits and mobile demands [1]. The global automobile industry is facing the trend of electrification. Although traditional car manufacturers started slowly, they have gradually completed the development of pure electric vehicles and launched new brands or new series to cope with and defend the original market size [2]. New start-up manufacturers surpass traditional car manufacturers with brand, quality, and different types of technological innovations, and accelerate production expansion to seize market share. Global sales of electric vehicles are increasing rapidly. According to Trend Force [3] research in 2021, the total sales of new energy vehicles (including pure electric vehicles, plug-in hybrid electric vehicles, and fuel cell vehicles) will reach 6.473 million, with an annual growth rate of 122%. Japan's Fuji Keizai predicts that the market size of electric vehicles will surpass gasoline-electric hybrid vehicles in 2021 and become the mainstream of the new energy passenger vehicle market, and the global electric vehicle market is expected to increase nearly 11 times in 2035 [4].

Optimistic about the development of electric vehicles, scholars have successively published research based on innovative technologies related to electric vehicles, such as artificial intelligence on electric vehicle technology innovation [5]; electric vehicle technology and patents [6-8]; comparison between electric vehicle batteries and internal combustion engines [9]; Electric vehicle powertrain patent data [10], the previous literature mostly investigated the context of technological innovation, and there are fewer literatures for market and technology-based innovation types. We carefully evaluate that no matter how good the technological innovation is, if the innovative product cannot achieve good market performance, this kind of innovation is equivalent to invalid innovation. Ineffective innovation will also lead to the inability of the firms to survive and the

**Citation:** To be added by editorial staff during production.

Academic Editor: Firstname Lastname

Received: date

Revised: date

Accepted: date

Published: date



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interruption of innovation. Therefore, we combine based on market/product Ansoff's "Expansion Matrix" [11,12], and based on market/technology Rothaermel's "Innovation Matrix" [13,14], and a clear combination defines different innovation types corresponding to different markets to generate the best market strategy and achieve the best market performance. To the best of our knowledge, this is the first paper to combine two models recognized by academia and successful in the market are combined for innovation evaluation, which has sufficient novelty and use value.

This study attempts to analyze different types of technological innovation literature by bibliometric analysis; sorting 43 related electric vehicle literature published in journals and special publications in 2010-2022, which can be downloaded, and summarizes the content of the periodicals classified according to the "Innovation Matrix" [13] with the market and technology as the coordinate axis. Finally, it is explained according to the classification results to prove the impact of different types of technological innovation strategies in different markets on corporate performance. Finally, it proposes theoretical and management implications of the practice, explaining the technological innovation strategy of the electric vehicle market development in Taiwan. The remainder of the paper is organized as follows; Section 2 explains the important studies in the field of technological innovation and notes on innovation classification. Section 3 describes the methodology used and Section 4 shows the results, followed by a discussion. Section 5 the conclusions, implications, and scope for future research are outlined.

## **2. Theoretical Development**

### **2.1. Innovation**

Innovation can have different forms of process and different outcomes. Innovation can occur at the product, process, organizational, market, or input level and is a central action in all economic development and productivity [15]. In terms of innovation, it can refer to changes made to an existing product, idea, or field. In other words, innovation is thinking-oriented, using existing knowledge and materials to meet social needs, to improve or create new things, methods, elements, paths, and environments, and to obtain certain beneficial effects. Innovation is a topic of interest to both academia and industry. But the concept of innovation is complex and multifaceted [16], often overlapping, without clear and authoritative rulings [17]. In general, the simplest definition of innovation is doing something different [17]. The Oslo Manual [18] defines innovation as: "a new or improved product or process (or a combination thereof)". Scholars such as Baregheh, Rowley, and Sambrook [19] pointed out that, innovation is a multi-stage process in which enterprises transform ideas into new or improved products, services, or processes in order to be competitive in the market. Boer & During [20] also defined innovation as the creation of a new product-market-technology-organization combination. In these definitions, "new" is the main focus of innovation [21]. Based on the above definition of innovation, this study believes that Boer & During [20]'s description, which combines market and technology with products, is more in line with the focus of this study.

### **2.2. Technological innovation**

Technological innovation is mainly about the product or service, and the connections between its components, methods, processes, and technology [22]. Many authors [23-27] have combined technology and market perspectives in the development of innovation theory. Yam et al. [27] added that technological innovation resources are heavily invested in innovation activities, which are the most direct to performance improvement. According to Baden-Fuller and Haefliger [28], a radical improvement of a product or service will automatically bring about an increase in the profits of the innovative company. Huang et al. [29] explained that the competitive advantage comes from the R&D owned by the firm and the R&D capability executed. Its so-called R&D and execution capabilities are technical capabilities, and continuous innovation can maintain a competitive advantage. In other words, technological innovation is the core of a company's competitiveness. Hafeez, Zhang & Malak [30] also proved that companies develop technological innovations to obtain durable competitive advantages. Tirupati [31] pointed out that technology is regarded as a mechanism for transforming input into output. The higher the degree of innovation, the better the performance of output and market. Generally, product innovation has higher visibility than other technological innovations, so it is easier to identify. Comparing the sales of electric vehicle products, as scholars have put forward, people pay attention to new vehicles rather than innovative technologies. The phenomenon presented in the market also shows that the sales volume of new

brands is still higher than that of traditional brands, as shown in Table 1 [32]. In addition, the OECD also pointed out that all innovations must contain a certain degree of novelty, whether technical (product or process) or non-technical (marketing and organization) [33].

Table 1 Top 10 global sales of electric vehicles

Ranking	Group name	Sales (10,000 vehicles)	Compared with the same period last year (times)
1	Tesla	56.4	1.5
2	BYD (BYD)	32.4	3.5
3	SAIC Motor	31	1.3
4	Volkswagen	21.7	1.3
5	Hyundai + Kia	16.9	2
6	Nissan + Mitsubishi + Renault	13.3	1.5
7	Zhejiang Geely Holding Group	12.3	3.7
8	Stellantis group	11.6	1.4
9	Chery Automobile Group	11.1	3.3
10	Guangzhou Automobile Group	10	2.3

Source: [32], first half of 2022

### 2.3. Innovation Matrix

The type of innovation will have different classifications according to the needs of enterprises. The outcome of an innovation then depends on the type of innovation used [15]. Linton [34] calls for consideration of innovation inputs, outputs, and firm perspectives. In other words, what innovation pursues is enterprise performance. Therefore, some scholars have successively proposed related innovation matrices. For example, Kovacs et al. proposed a matrix of "Novelty/Impact" (radical, discontinuous, destructive, and breakthrough innovations) [35]. Lichtenthaler [36] proposed a matrix based on a "Service innovation/Business model". There is also a matrix focusing on the "Technology/Business model" (matrix content: incremental, Semi/Radical, and radical innovation) [37]. In addition, there is a "Technology (process) / Market" matrix (matrix content: incremental, disruptive, and breakthrough innovations) [38]. and Medhat et al. [39] on Rothaermel's "Technology/Market" matrix. Harvard scholars also proposed a matrix related to problem-solving [40]. Although the content of the matrix is closer to market technology, the main axis is to solve problems, not to create a performance. Therefore, this research adopts the innovation matrix proposed by Rothaermel [13] as the focus of this research. It mainly takes enterprise performance as the goal, market, and technology as the coordinate axis, and divides innovation types into 1. Incremental Innovation, 2. Disruptive Innovation, 3. Architecture Innovation, 4. Radical Innovation, as shown in Figure 1, the description is as follows;

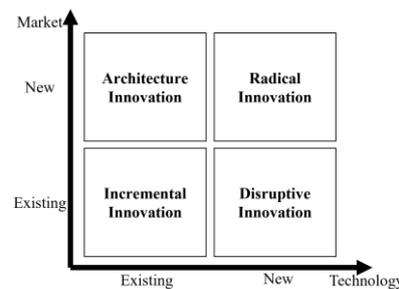


Figure 1 Innovation Matrix [13]

**Incremental Innovation:** Applies to existing technologies and existing markets. It is mainly based on existing technology and known content to further enhance or improve the technical level [41]. This type of innovation takes less time. However, continuous incremental innovation may also lead to radical changes [42], and then become Radical Innovation. For example, car computer upgrades, navigation, assisted driving, evolution to automatic driving... In addition to the car following, vehicle dynamic stability, fuel consumption, and driving comfort during car following are also considered [43]. All are changes brought about by the improvement and improvement of existing technologies. Its benefits are manifested in consumers' satisfaction with technical parameters and auxiliary functions.

**Disruptive Innovation:** Suitable for new technologies and existing markets. It is to create an

opportunity for new entrants to surpass the existing market leaders and tend to provide suitable technologies for non-mainstream markets to seize the market, and then technology upgrades to return to the mainstream market [44,45]. Danneels [46] pointed out that the core of disruptive innovation technology is that it changes the basis of market competition. For example, electric vehicles are causing a shift in consumer expectations despite their higher prices than conventional cars and hybrids [47]. However we argue that disruptive innovation is not just a supply versus demand issue [48], it is also related to consumer satisfaction and technological performance [49]. In other words, the disruptive innovation benefit of electric vehicles is that consumers are satisfied with the value of technical performance, not the disruption of price.

**Architecture Innovation:** Applicable to existing technologies and new markets. According to the market and strategy, combine ideas with existing technologies, transform concepts into products, develop, produce, and put them on the market. Make the enterprise's market strategy conform to the existing market changes [50-52]. The use of architectural innovation depends on the number of patents or the number of self-owned innovative technologies. For example, GU [53] for Tesla Motors;

Tesla has designed an architectural innovation of component function modularization. The connection between components remains unchanged, but changing the component function will also change the module function. This type of improvement means that the final product can be improved by replacing the entire module while keeping these modules linked, newer and better products will come out, and customers will benefit from not having to wait for the next model, year, and purchase a brand new vehicle.

**Radical Innovation:** For new technologies and markets. Involving the exploration of unknown technologies and leaps and bounds in technology upgrades, many new inventions, patents, or business models represent such innovations. This type of innovation requires a long period of R&D, experimentation, regulatory approval, and market acceptance. Its ultimate goal is to develop the blue ocean market and create new product value and new corporate profits [54]. For example, incremental and radical innovation represent the complexity of innovative technology (incremental = low complexity; radical = high complexity) [55]. However, converting an internal combustion engine into an electric motor is technically a radical innovation. This means that the vehicle's powertrain is completely different, requiring entirely new parts and maintenance. And the benefits reflected are environmental protection, carbon reduction, and no pollution.

The "Innovation Matrix" of Rothaermel [13] has similarities and differences with the "Expansion Matrix" of Ansoff [11]. The same parts are all strategic operations proposed in response to different markets; the different parts are that the "Expansion Matrix" only talks about original products and new products, while the "Innovation Matrix" is all new products corresponding to the market, but will propose different types of innovation strategies to develop different new products for different markets. By providing new products to consumers, companies establish a strategy to create new products and provide real new functions in order to be truly accepted by the market [13]. Although it is still unclear who the customer is before the innovation? No matter what type of innovation is used? But Sandberg [56] pointed out that for an innovation type to be successful, it must ultimately meet customer needs. And the willingness to take risks is an important success factor [57].

### 3. Research Methodology

In recent years, many scholars have paid more and more attention to interpreting disciplinary research in a structured and systematic comprehensive narrative way [58,59]. "Bibliometrics" mainly measures the influence of an article by the number of citations after the article is published. If the source of an article is cited many times, it means that its publication is useful to many people and has a high impact and high value [60]. This study attempts to use the "Bibliometrics" combined with the "Innovation Matrix" dimension to examine 43 electric vehicle-related and downloadable journals published in 2010-2022, sort out and summarize the contents of the journals, and systematically fill into the model framework of "Incremental Innovation", "Disruptive Innovation", "Architecture Innovation", and "Radical Innovation" of Innovation Matrix", the review agreement is shown in Table 2. In terms of data reliability, select 48 articles that have been published in periodicals and special publications, and use the word string "Electric Vehicle 2010-2022" as the range, search for 45 downloadable articles, analyze and compare, and fill in the "Innovation Matrix" respectively In the appropriate column; in terms of validity, in addition, to accurately

recording the operational factors in the process of data classification and sorting, it is ensured that subsequent researchers can follow the same research context to conduct research and obtain the same results. In addition, during the literature review, 5 periodicals whose content could not be classified were excluded to increase the validity of the content. In the end, a total of 43 journals were available for bibliometric analysis, and the selection rate was 87.75%, meeting the requirements of reliability and validity [61].

**Table 2. Review protocol**

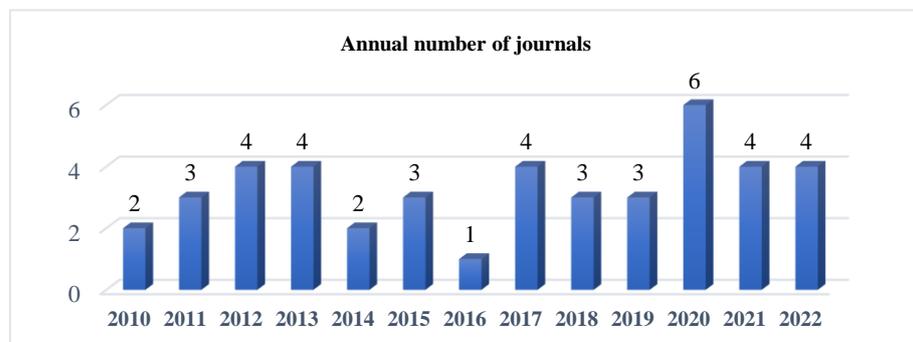
Document Type	Type Description
Articles with the title "Electric Vehicle"	(1) with the Key Word "Electric Vehicles 2010-2022" search string, which matches the words and sentences in the title, abstract, and keywords. (2) Articles must be from academic journals (peer-reviewed) and published and downloadable.
Special purpose	(1) White Papers of Research Units Related to Electric Vehicles.
Journal Field Analysis and Consolidation	(1) Select only the areas of business administration and policy. (2) Select only the Transportation and Environmental Science fields together. (3) Select only the fields of industry and technology development.
Timeline	2010 publications after the year.

#### 4. Analysis and Discussion

According to the content attributes of the selected 43 periodical documents, this research fills in the innovation matrix (multiple selections are allowed) and makes an electric vehicle innovation matrix document arrangement, as shown in Appendix 1; then according to Appendix 1, the year number of periodicals is sorted out, as shown in Table 3 and Figure 2; additionally, depending on the document type, organized into a table of the number of periodicals by category, as shown in Table 4; according to the content of the review, the number of years, and the number of countries in which the periodicals are published, it is organized into Table 5 and Figure 3.

**Table 3. Number of journal years**

Journal	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	Total
Renewable and Sustainable Energy Reviews				1		2	1							4
Journal of Cleaner Production										1	1			2
Journal of Nature Energy									1					1
IEEE Xplore	1	3	1	1	1				1			1		9
Elsevier :	1		1	1	1			1				2		7
Springer :			1	1		1								3
Intellect :			1											1
Inderscience :								1			1			2
ScienceDirect :											1			1
MDPI :											2	1	2	5
Science										1				1
McKinsey									1					1
ICCT										1				1
Unique articles for review								1			1		2	4
IET								1						1
Summary	2	3	4	4	2	3	1	4	3	3	6	4	4	43



**Figure 2. Annual Number of Journals**

Table 4. Number of journal categories

Journal classification	Quantity
<b>Content Direction</b>	
Business Management and Policy	17
Transportation and Environment	7
Industry and Technology	19
<b>Research Design</b>	
Qualitative	25
Quantitative	18
<b>Methodology Used</b>	
Case Study	7
Literature Review	14
Design Test	22
<b>According to Source</b>	
Observation Based	7
Survey Based	23
Theory Based	13

Table 5. Journal review contents and number of years

Censor Content	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
<b>Research Design</b>													
Qualitative	1	3	3			3	1	3	3	3	4		1
Quantitative	1		1	4	2			1			2	4	3
<b>Methodology Used</b>													
Case Study	1	2	1			1				1			1
Literature Review			1			2	1	3	1	2	4		
Design Test	1	1	2	4	2			1	2		2	4	3
<b>According to Source</b>													
Observation Based			1			1	1	1		1			2
Survey Based	1	3	3		2	2		1	3	2	5		1
Theory Based	1			4					2		1	4	1

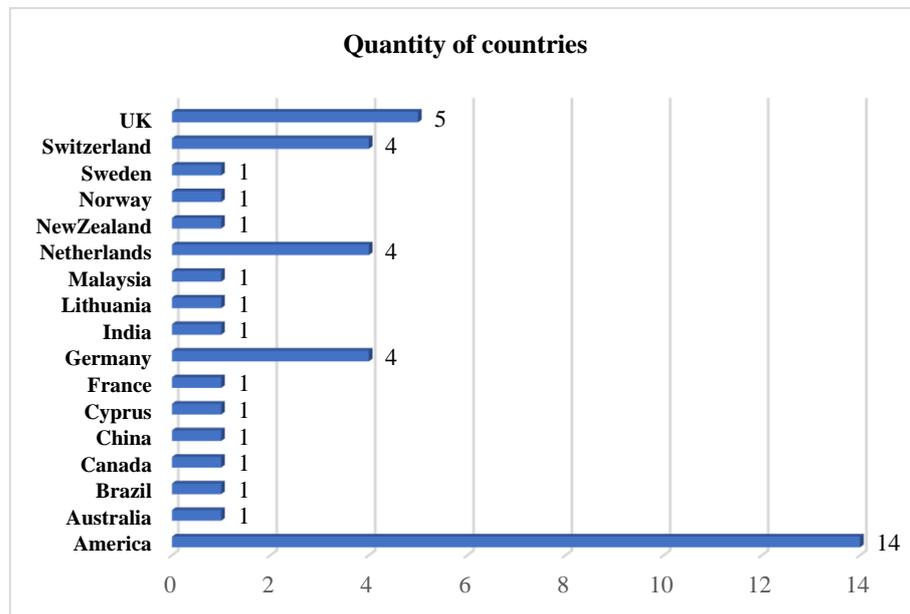


Figure 3. Number of journal publishing countries

#### 4.1. Findings

First, according to Appendix 1, there are 28 times in "Incremental", accounting for about 40%, 23 times in "Radical", accounting for about 32.85%, and 5 times in "Architecture", accounting for about 7.69%. , there are 14 times in "Disruptive", accounting for about 18.46%, as shown in Table 6; therefore, it can be concluded that most of the current innovative technologies of electric vehicles are derived from the extension of previous technologies. The conversion of electric vehicles from the original internal combustion engine system to the electric motor system involves a very large

technological change and conversion, which can be proved by the figures and proportions of radical innovation.

**Table 6. Quantity table of innovation types**

I	D	A	R	Total
28	14	5	23	70
40%	20%	7.14%	32.86%	

Secondly, there are 10 articles in the literature that mention ☆ batteries, and 10 articles that mention ★ charging equipment, its proportion is 46.51%. A total of 20 articles are all about the development of batteries for electric vehicles and the installation of charging equipment, approximately accounting for half, As Shown in Table 7. Electric power is a key optimization item for electric vehicles, which determines the travel distance of electric vehicles. In addition, the storage capacity and life of batteries, as well as the equipment and places for supplementing power, become the main key factors for electric vehicles to be favored by market consumers.

**Table 7. Number of documents on batteries and charging equipment**

Journal				
	★Battery	★Charging Equipment	Other	Total
Quantity	10	10	23	43
percentage	23.255%	23.255%	53.49%	100%

Finally, the most important key of the bibliometric method is the number of citations. According to Appendix 1, we sorted out the top 10 citations of the literature. As shown in Table 8. Among them, there are 4 literature examining power equipment, and 4 kinds of literature focusing on batteries, there are a total of 8 literature discussing issues related to electric vehicle power supplements.

**Table 8 The top 10 literature citations**

References	Be Quoted	☆ Battery	★ Charging Equipment
[83]	1789		
[72]	1684	1	
[85]	1555		1
[69]	834	1	
[94]	489		
[68]	466	1	
[77]	345	1	
[97]	314		1
[70]	308		1
[93]	273		1

## 5. Conclusion and Suggestion

### 5.1. Theoretical Implications

The automotive industry is undergoing a deep technological transformation from internal combustion engine vehicles to new energy vehicles [62]. Innovative types of technological change may revolutionize the fundamentals of the automotive industry [63]. Especially power replaced by battery packs, electric motors, and chargers [64]. Based on the literature published in journals over the past 10 years, the results of this study prove that power optimization and supplementation approximately account for half, showing the importance of power supplementation for electric

vehicles. This is consistent with the academic patent literature. In addition, the recent innovation and development of energy storage technology systems in CATL (Contemporary Amperex Technology Co. Limited), as well as the technology development of Tesla and BYD in the battery part, can prove that the industry attaches great importance to the power of electric vehicles. Therefore, this study makes the following contributions; firstly, the review protocol framework improves the reliability and sustainability of literature sources. Secondly, the analysis of this study confirms the status of the industry and helps us understand the literature classification, trends, technologies, and research results. Third, for the first time, this study utilized two market-verified success matrices to fully explain the application from the production end to the market end for electronic vehicles. It is novel and valuable enough for theoretical research. Therefore, this study holds great importance and makes a valuable contribution. Moreover, the conclusion carries significant practical significance.

## 5.2. Management Implications

When discussing technological innovation, our minds often associate it with the development of new products. If we consider new technology as equivalent to new products, we can utilize the "Expansion Matrix" [11] (as depicted in Figure 4), which bears similarities to the "Innovation Type Matrix" [13]. This allows us to apply cross-functional strategies for market and product development. In other words, each innovation type corresponds to a specific market strategy. For instance, "Market Penetration Strategy" aligns with "Incremental Innovation," "Market Development Strategy" corresponds to "Disruptive Innovation," and "Product Development Strategy" complements "Architecture Innovation." By doing so, we ensure that the products being innovated and developed will deliver outstanding market performance.

Furthermore, radical innovation involves the creation of new products using novel technologies, which prove advantageous whether introduced in existing or new markets. By employing a combined approach of [11] and [13], managers gain the ability to anticipate the direction of technological innovation in advance. They can then devise appropriate market strategies, ultimately achieving optimal market performance. This holds exceptional practical significance and value for managers responsible for development and operations. In essence, the outcomes of this study empower managers to predict the results of technological innovation and market performance, allowing them to make strategic deployments to maximize profitability.

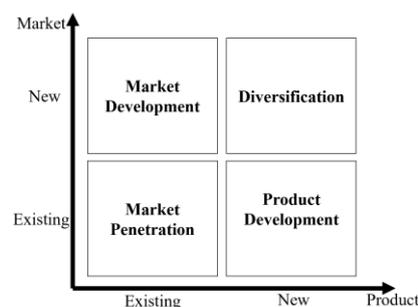


Figure 4. Ansoff Matrix

[11]Source: www.free-management-ebooks.com, Ansoff Matrix. Strategy Skills, 2013

## 5.3. Insights

Innovation is a central activity in the development and productivity of all economic activities, and its investment activities and outcomes depend directly on the type of innovation used and are related to products, technologies (processes), and markets [65]. The type of technological innovation of electric vehicles must first consider the characteristics of the targeted market and mainly meet market demand. The second is to apply for patent technology so that when the electric vehicle market is saturated in the future, two strategies of the "Product Development Strategy" corresponds to "Architecture Innovation" and "New Market Strategy" which corresponds to "Disruptive Innovation" make the market economic return of technological innovation more significant.

#### **5.4. Future Research Suggestion**

The development of electric vehicles is an inevitable trend, and there will be an increasing amount of literature on electric vehicles. In this study, through a bibliometric analysis, we have organized the literature on electric vehicles from 2010 to 2022. The results show that the current focus of technological innovation in electric vehicles lies in batteries and power equipment. Electric vehicle models with higher driving ranges are more favored in the market. With the promotion of technological innovations such as Industry 4.0 and Web 3.0, AI (Artificial Intelligence) is gradually gaining attention, and there have been recent studies on the application of ChatGPT in assisting circuit design. Therefore, it is a research direction to explore the potential widespread application of AI in electric vehicles in the future. Additionally, exploring business model innovation for electric vehicles is also a promising area for in-depth research in the future.

#### **Author's contribution:**

S-L Chen and K-L Chen conducted statistics and analysis based on the collected literature, and many of their conclusions are consistent with the actual industry, that is, the content and direction of the literature are consistent with the actual operation direction of the industry, and the analysis model can also be used as a reference later. signed the manuscript, and all authors have read and agreed to the published version of the manuscript.

#### **Funding:**

This study did not receive any external funding

#### **Conflicts of Interest:**

This study did not receive any specific funding from public, commercial, or not-for-profit sector funding agencies, nor was it considered for inclusion in any other journal.

## Appendix A

Appendix A-1 Literature review of innovation classification of electric vehicles

No	Author	I <sup>a</sup>	D <sup>b</sup>	A <sup>c</sup>	R <sup>d</sup>	Contents	Contributions	Be Quoted
1★	[66]	●			●	Combining a conventional internal combustion engine (ICE) with one or more electric motors powered by a battery pack that can be charged using an onboard generator and the regenerative braking technology to power the transmission.	It combines the advantages of traditional internal combustion engine vehicles and electric vehicles (EVs). The most significant advantages that HEVs possess over BEVs are superior mileage and flexibility in component size[9]. It is characterized by less complex configuration, lower hardware requirements, and lower cost.	466
2★	[67]	●				The continual development of electric vehicle power train, battery, and charger technologies has further improved the electric vehicle technologies for wider uptake.	Electric vehicles show better performance than internal combustion engine vehicles (ICEV) due to the use of more efficient drivetrains and electric motors [3].	834
3★	[68]	●				Focused on electric charging infrastructure development, total cost of ownership, and purchase-based incentive policies.	Technologies related to electric mobility have been changing exponentially; therefore, literature covering these changes has also increased significantly.	308
4★	[69]	●				The analysis focuses on key policies and the effects of incentives, charging infrastructure, and model availability on electric vehicle uptake.	1. Multi-faceted application of electric vehicles and a combination of promotional activities. 2. Introducing a significant cost advantage. 3. Support charging infrastructure to ensure consumer convenience.	37
5★	[70]	●				A comprehensive evaluation of various batteries and hydrogen fuel cells that have been successful in commercial applications.	The growing success of EVs can be attributed, from a technological perspective; to advances in electrochemical energy storage technology.	1684
6	[71]	●		●	●	It studies the optimal value of Connected Autonomous Electric Vehicles (CAEV) business models for their successful commercialization in the global market.	It combines a variety of techniques and high-tech elements to perceive its surroundings, including cameras, radars, ultrasonic sensors, and GPS. It also uses "Light Detection and Ranging" technology known as "LIDAR".	15
7	[72]				●	This paper will present a study of how latecomer firms approached the development of radical technologies by focusing on the actual experiences of China's EV industry in which modular product architecture or modular industry platforms may play a fundamental role in the implementation of industrial innovation.	The discontinuous innovation can be achieved by establishing an industry platform enabled by modular product architecture.	7
8★	[73]	●			●	On-Line Electric Vehicle (OLEV) draws its electric power from underground electric coils without using any mechanical contact.	Batteries are recharged whenever OLEV draws electric power from the underground coils and thus, do not require expensive separate charging stations. The infrastructure cost of installing and maintaining OLEV is less than those required for other versions of electric vehicles.	166
9	[74]	●	●			We explore the difference between technological growth and customer satisfaction by comparing the Electric Vehicle Business Model with the Hybrid Business Model on three parameters: channels, value propositions, and customer relationships.	Electric vehicles are rapidly gaining acceptance and adoption, further challenging classic diesel and gasoline, and even plug-in hybrid engine technologies.	24
10★	[75]	●				It is to understand the basic chemistry of the different batteries, and specific EV battery requirements of energy density, specific energy, power density, cost, durability, etc.	Electric vehicles (EVs) including hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and pure battery electric vehicles (BEVs) will dominate the clean vehicle market [1, 2].	345
11★	[76]			●	●	Innovative road dynamic wireless charging technology OLEV for electric vehicles. OLEV is an integrated invention and innovation system that combines automotive, electric, Electronics, power grids, road infrastructure, and information technology (IT). Road electrification will become a key R&D area related to the smart grid in the next few decades.	The wireless transmission of power to running vehicles can be a competitive design solution for future electrified roads and vehicles [4]. Therefore, wireless charging of electric vehicles, whether it is stationary charging or dynamic road charging, can be A technological innovation for the mass promotion of automobiles.	83

I<sup>a</sup>: denotes Incremental innovation;

D<sup>b</sup>: denotes Disruptive innovation;

A<sup>c</sup>: denotes Architecture innovation;

R<sup>d</sup>: denotes Radical innovation;

★: charging equipment,

☆: battery

Continued from the previous page

Appendix A-2

No	Author	I <sup>a</sup>	D <sup>b</sup>	A <sup>c</sup>	R <sup>d</sup>	Contents	Contributions	Be Quoted
12	[77]			●	●	1. The main goal is to explore different technologies. 2. Electric vehicle propulsion technology and product architecture.	The results show that innovations in product architecture can provide niche markets for electric vehicles.	43
13	[78]	●			●	Most innovations within the automotive domain are driven by embedded systems and software solutions.	The most noticeable effects are improved drivability and comfort; and enhanced passive and active safety.	99
14★	[79]	●			●	we analyzed whether the electric vehicle market share is linked with the availability of more electric vehicle models, charging infrastructure, fiscal and non-fiscal incentives, high-occupancy vehicle lane access, and other activities.	Because these next-generation electric vehicle models are expected to enter the market at lower prices and higher volume, this is an important time for governments to consider their support policies and investments in charging infrastructure.	33
15	[80]	●			●	In mobile systems, emissions from internal combustion engine vehicles (ICEVs) have a significant impact on climate change and the atmosphere. Technologies such as battery electric vehicles (BEV), hydrogen fuel cell vehicles (HFCV), and hybrid electric vehicles (HEV) offer a good alternative to setting up ICEV.	When an increased number and higher diversity of firms move into a new trajectory leading to more technological competition, the new technology is more likely to be continuously developed, improving its chances of commercial success.	110
16-	[81]					This paper reviewed the technologies in the WPT area applicable to EV wireless charging. By introducing WPT in EVs, the obstacles of charging time, range, and cost can be easily mitigated.	WPT technology is developing rapidly in recent years. At kilowatts power level, the transfer distance increases from several millimeters to several hundred millimeters with a grid to load efficiency above 90%. The advances make the WPT very attractive to electric vehicle (EV) charging applications in both stationary and dynamic charging scenarios.	1789
17	[82]	●				Using a policy-oriented technological innovation system, a comprehensive theoretical framework for development, use, and enterprise levels, to verify efficient incremental innovation in the automotive industry.	Technological change often depends on a combination of policy and firm-level efforts.	71
18★	[83]	●			●	The proposed framework covers two different domains: the grid technical operation and the electricity market environment.	Large-scale deployment will have a considerable impact on power system design and operation, but will also facilitate and favor the use of non-polluting energy.	1555
19	[84]	●	●		●	What is traditionally thought to be good at incremental innovation is actually a fundamental shift; that is, from the internal combustion engine through hybridization to "pure" electric propulsion and facilitates the restructuring of the industry.	Case companies are able to innovate not just incrementally, but beyond incrementally, as their position in the Electric vehicles race demonstrates.	10
20-	[85]	●				This study employs the vehicle policy analysis tool developed at Oak Ridge National Laboratory to systematically quantify the potential impact of "passenger vehicle enterprise average fuel consumption and alternative energy sources."	The BEVs with long electric ranges (such as 400 km) and the plug-in hybrid electric SUVs could be the most popular PEV types.	3
21	[86]		●	●		Proof that Tesla Motors is not following a disruptive innovation strategy. Its commercialization strategy is executed through architectural innovation and attacker advantage.	A performance trajectory describing Tesla's entry into the automotive market is constructed.	51
22★	[87]	●			●	This study integrates charging infrastructure usage in households, public places, and workplaces into a market dynamics analysis tool to systematically evaluate the impact of charging infrastructure on plug-in electric vehicle (PEV) ownership cost and market share impact.	The explosive growth of the PEV market requires a systematic and extensive charging infrastructure, including charging places such as homes, public places, workplaces, and highways for long-distance travel.	43

I<sup>a</sup>: denotes Incremental innovation;

D<sup>b</sup>: denotes Disruptive innovation;

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★: charging equipment,

☆: battery

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### Appendix A-3

No	Author	I <sup>a</sup>	D <sup>b</sup>	A <sup>c</sup>	R <sup>d</sup>	Contents	Contributions	Be Quoted
23	[88]		●			Norwegian purchase incentives are large enough to make electric vehicles a competitively priced alternative for vehicle buyers.	Increased selection of models, improved technology, reduced vehicle prices, and extensive marketing have spurred further sales.	211
24	[89]		●			Market trends and strong government policies suggest that national and regional PEV-related incentives can play an important role in kickstarting the PEV market.	The introduction of plug-in electric vehicles (PEV) for transportation represents one of the most promising pathways for reducing oil and GHG emissions, as well as for improving local air quality.	210
25	[90]	●			●	The empirical context of this study is the automotive industry, a classic example of the transition to electric vehicles (EV) or hybrid vehicles (HV) through internal combustion engine (ICE) refresh-dominated design.	Dominant design is embedded in product architecture, technology, and usage specifications through regulations and design rules, customer practices, or performance standards.	97
26★	[91]	●			●	Technical performance across different spatial and temporal scales, the importance of the key interplay between Charge infrastructure construction and consumer behavior.	The potential advantages of electric vehicles depend on breakthroughs in technology and engineering design.	273
27	[92]			●		Modeling of HEV, PHEV, and EV penetration should include improvements to interfaces with consumer surveys, modeling of automaker behavior, federal and state policies and their impact on the automotive market, competition between technologies, market volume, vehicle classification, and model parameter sensitivity analysis.	Hybrid, plug-in hybrid, and electric vehicles (HEV, PHEV, and EV) improve vehicle fuel economy, reduce petroleum consumption and increase efficiency, Life cycle economic benefits are provided for consumers, society, automakers, and policymakers.	489
28★	[93]	●				The differences in BEV technology in terms of drivetrains are assessed, with a focus on examining the possibilities regarding EV architectures, electric motors, optimization techniques, and their development as a future of green mobility.	The tailpipe of electric vehicles has zero emissions, so it can effectively curb the pollution caused by vehicle exhaust emissions.	192
29	[94]	●				The research focuses on innovative circular economy (CE) in the automotive ecosystem and sustainable tires; and also helps to clarify product characteristics and target group characteristics.	Integrating customer needs into product development in the automotive industry is key to success. Just as the CE ecosystem must be innovative and user-centric [13] to achieve sustainable development.	16
30★	[95]	●			●	Basic types of vehicles and their technical characteristics, fuel economy and CO2 emissions, EV charging mechanisms, and concepts of grid-to-vehicle and vehicle-to-grid architectures.	From the perspective of full cycle analysis, the electricity available to recharge the batteries must be generated from renewable or clean sources in order for such vehicles to have zero emissions.	314
31★	[96]		●		●	When comparing electric cars to gasoline cars, all the shortcomings of electric cars come from the battery. How far electrification can go depends largely on one factor... battery technology.	Solid-state electrolytes bring several advantages to lithium-ion batteries [8]. They are not flammable, eliminating the primary safety hazard of lithium-ion batteries—, and have high lithium-ion conductivity at room temperature, enabling the high power performance needed for fast charging.	149
32★	[97]	●			●	Plug-in hybrid electric vehicles (PHEVs) offer improvements in power electronics, energy storage, and support to deliver competitive driving range and fuel economy.	Given the current state of battery technology, the economics of hybrid electric vehicles (HEV) appear to be more favorable than pure electric vehicles (PEV).	100
33	[98]		●			Battery Electric Vehicles (BEVs) currently account for 66% of the global EV market. BEV sales are growing faster than plug-in hybrid electric vehicles (PHEVs). However, it will be affected by the preferences of specific markets, different government supervision policies, customer choice, and availability of specific models.	China has improved through higher EV sales, significant monetary and non-monetary incentives, a greater variety of vehicle models, and investment intensity in charging infrastructure.	64

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### Appendix A-4

No	Author	I <sup>a</sup>	D <sup>b</sup>	A <sup>c</sup>	R <sup>d</sup>	Contents	Contributions	Be Quoted
34★	[99]	●	●		●	The aim is to provide an innovative way for electric vehicles to charge their batteries from another vehicle while driving, known as vehicle-to-vehicle charging (VVR).	Electric vehicles can receive power via wireless power transfer (WPT) to charge their batteries. Among the innovations are mainly (1) infrastructure changes, (2) device-level innovations, they(3) autonomous vehicles.	19
35☆	[100]		●			The best battery pack and electric vehicles component cost data available as of 2018 was collected.	The falling cost of batteries is the main reason for the falling cost of electric vehicles.	177
36	[101]		●			The results showed that the vehicles replaced by electric vehicles were relatively fuel-efficient: the average fuel economy of electric vehicles replacing gasoline vehicles was 4.2 mpg higher than the fleet average, and 12 percent of them replaced hybrid vehicles.	Even if tax credits boost EV sales, the emissions impact is likely to be small if EVs displace lower-emission class vehicles.	113
37☆	[102]		●		●	The electric vehicles market is becoming a mass market driven by economies of scale. Its cost and speed of market push are affected by the speed at which battery costs are falling.	The first is that the raw materials for making batteries are relatively scarce. Second, the main EV market is China, giving the company a strategic advantage in supplying key metals and mass-producing batteries.	10
38-	[103]	●			●	The example of the Tesla Roadster model shows that it is entirely possible for electric vehicles to equal or even surpass internal combustion engine vehicles in terms of speed, ride quality, and range.	The analysis of the main technical characteristics of EVs shows that they can travel more than 100 kilometers on a single charge, which can fully meet the needs of urban driving.	10
39-	[104]		●			In this study, electric vehicle (EV) technology is analyzed using an energy demand model, with the benefits and trade-offs of penetration of motorcycles and passenger vehicles in Thailand's road traffic.	Electric vehicle technology consumes less fossil fuels and produces fewer greenhouse gas emissions.	33
40- ★	[105]	●			●	Streamwise development of counter-rotating vortices induced by three different types of chevron Vortex Generators (VGs) placed upstream of Electric Vehicles (EV) dummy battery modules is experimentally visualized using a smoke-wire method.	The smoke-wire visualization setup consists of a thin, electrically heated Nickel-Chromium wire and a pressurized white oil container. A Continuous smoke layer is produced as the oil drips along the heated wire.	1
41	[106]		●		●	The magnets are removed from the stator to the rotor, and magnetized in a unique direction, resulting in a significant alleviation of stator tooth saturation level for the RPM-FS machines.	The predicted results indicate the proposed RPM-FS machine exhibits the largest power density, greatest torque capability, highest efficiency under rated operation, and improved flux-weakening ability.	27
42	[107]		●		●	Flux barrier design to increase torque capability of RPM-FS machines	RPM-FS motors have a higher electromotive force than conventional structures with only a slight increase in cogging torque. In addition, the insertion of a flux barrier can reduce flux leakage, improve magnetic saturation capability, and enhance the working harmonics of the air gap flux density. and gained efficiency.	3
43	[108]	●				Development and optimization of a special hybrid electric vehicle setup for a four-quadrant rotary converter.	Find the optimal mass distribution of the permanent magnets, optimizing the permanent magnet material, shape, and thickness to achieve maximum efficiency of the device. The results show that the overall theoretical efficiency of the external rotor unit increases from 90.2% to 94.4% after optimization.	5

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A<sup>c</sup>: denotes Architecture innovation;

R<sup>d</sup>: denotes Radical innovation;

★: charging equipment,

☆: battery

### References

- [1] Zeng, Zi-Rong. Facing the Opportunities and Challenges of Electric Vehicles: How Traditional Depots Can Turn Brilliantly, Taiwan Economic Research Monthly, 2021, 44(6), 27-34.
- [2] Wu, Bi-e. New Business Models in the Era of Electric Vehicles, United News Network/North American Intellectual Property News, 2021, Taken from internet 2021/7/16, <https://udn.com/news/story/6871/5605430>
- [3] Trend Force, The total sales of new energy vehicles in 2021 will reach 6.47 million. EE TIMES, 2022, Taken from internet

- 2022/3/7, <https://www.eetaiwan.com/20220307nt21-new-energy-automobile/> 2022-03-07
- [4] Shi, Hui-ci.; Wu, Yu-Ying. Implications of international electric vehicle industry policies for Taiwan, *Economic Prospects*, 2021, 198, 116-122.
  - [5] Lee, M. An analysis of the effects of artificial intelligence on electric vehicle technology innovation using patent data. *World Patent Information*, 2020, 63, 102002.
  - [6] Yang, L. F.; Xu, J. H.; Neuhäusler, P. Electric vehicle technology in China: An exploratory patent analysis. *World Patent Information*, 2013, 35(4), 305-312.
  - [7] Ma, S. C.; Xu, J. H.; Fan, Y. Characteristics and key trends of global electric vehicle technology development: A multi-method patent analysis. *Journal of Cleaner Production*, 2022, 338, 130502.
  - [8] Li, X.; Yuan, X. Tracing the technology transfer of battery electric vehicles in China: A patent citation organization network analysis. *Energy*, 2022, 239, 122265.
  - [9] Sinigaglia, T.; Martins, M. E. S.; Siluk, J. C. M. Technological forecasting for fuel cell electric vehicle: A comparison with electric vehicles and internal combustion engine vehicles. *World Patent Information*, 2022, 71, 102152.
  - [10] Phirouzabadi, A. M.; Savage, D.; Blackmore, K.; Juniper, J. The global patents dataset on the vehicle powertrains of ICEV, HEV, and BEV. *Data in Brief*, 2020, 32, 106042.
  - [11] Ansoff Matrix. *Strategy Skills*, 2013. [www.free-management-ebooks.com](http://www.free-management-ebooks.com).
  - [12] Loredana, E. M. The use of Ansoff matrix in the field of business. In *MATEC Web of Conferences*, 2016, 44, 01006.
  - [13] Rothaermel, F. T. *Strategic Management 2nd edition*, Georgia Institute of Technology, McGraw-Hill Education, New York, 2015.
  - [14] Ferro, A.; Martino, F.; Epis, S. *La mobilità del capitale umano dei e dai Balcani: quando l'innovazione riesce a frenare la fuga di cervelli*, 2022.
  - [15] Kogabayev, T.; Maziliauskas, A. The definition and classification of innovation. *Holistica – Journal of Business and Public Administration*, 2017, 8(1), 59-72.
  - [16] Siauliai, A. The Essence Of The Concept Of "Innovation" As An Economic Category And Economic Systems Management. *Electronic Scientific Journal*, 1979. [Http://Www.Uecs.Ru](http://Www.Uecs.Ru), Date: 31.10.2013.
  - [17] Stenberg, A. What does Innovation mean-a term without a clear definition? 2017.
  - [18] OECD. *Oslo manual 2018: guidelines for collecting, reporting, and using data on innovation. the measurement of scientific, technological, and innovation activities*. 2018. Available online: <https://www.oecd-ilibrary.org/content/publication/9789264304604-en>.
  - [19] Baregheh, A.; Rowley, J.; Sambrook, S. Towards the multi-disciplinary definition of innovation. *Management decisions*, 2009, 47(8), 1323-1339.
  - [20] Boer, H. WE. During, Innovation, what innovation? A comparison between product, process and organizational innovation, *International Journal of Technology Management*, 2001, 22(1-3), 83-107.
  - [21] Goswami, S.; Mathew, M. Definition of innovation revisited: An empirical study on Indian information technology industry, *International Journal of Innovation Management*, 2005, 9(03), 371-383.
  - [22] Kogabayev, T.; Maziliauskas, A. The definition and classification of innovation. *Journal of Business and Public Administration*. 2017, 8(1), 59-72.
  - [23] Kosenko, O. P.; Cherepanova, V. O.; Dolyna, I.; Matrosova, V.; Kolotiuk, O. Evaluation of innovative technology market potential on the basis of technology audit. 2019.
  - [24] Lee, M.; Yun, J. J.; Pyka, A.; Won, D.; Kodama, F.; Schiuma, G.; Zhao, X. How to respond to the fourth industrial revolution; or the second information technology revolution? Dynamic new combinations between technology, market, and society through open innovation. *Journal of Open Innovation: Technology, Market, and Complexity*, 2018, 4(3), 21.
  - [25] Park, H. S. Technology convergence, open innovation, and dynamic economy. *Journal of Open Innovation: Technology, Market, and Complexity*, 2017, 3(4), 24.
  - [26] Ritala, P., & Sainio, L. M. Coopetition for radical innovation: technology, market and business-model perspectives. *Technology Analysis & Strategic Management*, 2014, 26(2), 155-169.
  - [27] Yam, R. C.; Lo, W.; Tang, E. P.; Lau, A. K. Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries. *Research Policy*, 2011, 40(3), 391-402.
  - [28] Baden-Fuller, C.; Haefliger, S. Business models and technological innovation. *Long-range planning*, 2013, 46(6), 419-426.
  - [29] Huang, S. Y.; Chiu, A. A.; Lin, C. C.; Chen, T. L. The relationship between corporate innovation and performance. *Total Quality Management & Business Excellence*, 2018, 29(3-4), 441-452.
  - [30] Walsh, S.; Linton, J. D. The measurement of technical competencies, *The Journal of High Technical Management Research*, 2002, 13, 63-86.
  - [31] Tirupati, D. Role of technological innovations for competitiveness and entrepreneurship, *The Journal of Entrepreneurship*, 2008, 17(2), 103-115.
  - [32] Zhang, Chen-yu. Top 10 global electric vehicle sales in the first half of 2022, Japan-Global Vehicle Information Platform, 2022, Taken from internet 2022/8/1, <https://www.marklines.com/cn/country/japan>

- [33] OECD, Innovation and firm performance. in OECD Science, Technology and Industry Scoreboard 2009, OECD Publishing, Paris. DOI: [https://doi.org/10.1787/sti\\_scoreboard-2009-39-en](https://doi.org/10.1787/sti_scoreboard-2009-39-en)
- [34] Linton, J. D. De-babelizing the language of innovation, *Technovation*, 2009, 29(11), 729–737. <https://doi.org/10.1016/j.technovation.2009.04.006>
- [35] Kovacs, A.; Marullo, C.; Verhoeven, D.; Van Looy, B. Radical, Disruptive, Discontinuous and Breakthrough Innovation: more of the same? FEB Research Report, 2019, (Vol. MSI\_1904). <https://doi.org/10.5465/ambpp.2019.272>.
- [36] Lichtenthaler, U. Toward an innovation-based perspective on company performance, *Management Decision*, 2016, 54(1), 66–87. doi:10.1108/md-05-2015-0161
- [37] Davila, T.; Epstein, M.; Shelton, R. *Making Innovation Work: How to Manage It, Measure It, and Profit from It*, 3rd ed., 2006, Wharton Publishing.
- [38] Assink, M. Inhibitors of disruptive innovation capability: a conceptual model, *European Journal of Innovation Management*, 2006, 9, 215–233.
- [39] Medhat, R.; Othman, A. A. E.; Alamoudy, F. O. Risks of Innovation in the Architectural Design Process in Egypt: An Investigative Study. In *IOP Conference Series: Earth and Environmental Science*, August 2022, 1056(1), 012003, IOP Publishing.
- [40] Satell, G. *The 4 Types of Innovation and the Problems They Solve*, Harvard Business School Press. 2017, Taken from internet 2017/6/21, <https://hbr.org/2017/06/the-4-types-of-innovation-and-the-problems-they-solve>
- [41] Benner, M.J.; Tushman, M.L. Reflections on the 2013 Decade Award – “Exploitation, exploration, and process management: The productivity dilemma revisited”, ten years later *Academy of Management Review*, 2015, 40 (4), 497-514.
- [42] Souto, J. E.; Rodriguez, A. The problems of environmentally involved firms: innovation obstacles and essential issues in the achievement of environmental innovation, *Journal of Cleaner Production*, 2015, 101, 49-58.
- [43] Cheng, S.; Li, L.; Mei, M-m.; Nie, Y-l.; Zhao, L. Multiple-Objective Adaptive Cruise Control System Integrated With DYC, *IEEE Trans, Veh. Technol*, 2019, 68(5), 4550–9.
- [44] Chen, K-L; Chen, S-L. Explore the life-cycle strategies for LINE company from the perspectives of innovative use theory and communication regulations. *AIP Conference Proceedings*, 5 May 2023, 2685 (1), 040009.
- [45] Christensen, C.M.; Rayner, M.; McDonald, R. What is disruptive innovation? *Harvard Business Review*, 2015, 93 (12), 44-53.
- [46] Danneels, E. Disruptive technology reconsidered: a critique and research agenda, *Journal of Product Innovation Management*, 2004, 21(4), 246-258.
- [47] Weiss, M.; Zerfass, A.; Helmerts, E. Fully electric and plug-in hybrid cars - An analysis of learning rates, user costs, and costs for mitigating CO 2 and air pollutant emissions. *Journal of Cleaner Production* 2019, 212.
- [48] Gans, JS. Keep calm and manage disruption. *MIT Sloan Management Review*, 2016, 57(3), Cambridge: Massachusetts Institute of Technology, Cambridge, MA.
- [49] Muller, E. Delimiting disruption: Why Uber is disruptive, but Airbnb is not. *International Journal of Research in Marketing*, 2020, 37(1), 43-55. DOI: 10.1016/j.ijresmar.2019.10.004.
- [50] Raisch, S.; Birkinshaw, J.; Probst, G.; Tushman, M.L. Organizational ambidexterity: Balancing exploitation and exploration for sustained performance, *Organization Science*, 2009, 20, 685-695.
- [51] Mathews, S. Innovation portfolio architecture, *Research-Technology Management*, 2010, 53(6), 30-40.
- [52] Teece, D.J. The foundation of enterprise performance: Dynamic and ordinary capabilities in an (economic) theory of firms, *Academy of Management Perspectives*, 2014, 28 (4), 328-352.
- [53] Gu, Y. Architectural Design Innovation as a Contributive Factor for the Success of Battery Electric Vehicles in Automobile Industry. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 2019, 45(1), 101-108.
- [54] Kim, W.C.; Mauborgne, R. *Blue ocean strategy*, Harvard Business School Press, 2005, Cambridge, MA.
- [55] Hekkert, M.; Van den Hoed, R. Competing technologies and the struggle towards a new dominant design: the emergence of the hybrid vehicle at the expense of the fuel cell vehicle? *Greener Management International*, 2004, (47), 29-43.
- [56] Sandberg, B. *Managing and Marketing Radical Innovations*, Oxon: Routledge, 2008.
- [57] Brem, A. *The Boundaries of Innovation and Entrepreneurship*, Wiesbaden: Erlangen-Nürnberg, 2008.
- [58] Shukla, M.; Jharkharia, S. Agri-fresh produce supply chain management: a state-of-the-art literature review, *International Journal of Operations & Production Management*, 2013, 33, 114-158.
- [59] Rousseau, D.M.; Manning, J.; Denyer, D. 11 Evidence in management and organizational science: assembling the field’s full weight of scientific knowledge through syntheses, *The Academy of Management Annals*, 2008, 2(1), 475-515.
- [60] Cooper, I. D. Bibliometrics basics. *Journal of the Medical Library Association*, 2015 Oct, 103(4), 217–218.
- [61] Hee, O. C. Validity and Reliability of the Customer-Oriented Behaviour Scale in the Health Tourism Hospitals in Malaysia, *International Journal of Caring Sciences*, 2014, 7(3), 771-775.
- [62] Yuan, X.; Li, X. Mapping the technology diffusion of battery electric vehicle based on patent analysis: A perspective of global innovation systems. *Energy*, 2021, 222, 119897.
- [63] Christensen, TB. Modularised eco-innovation in the auto industry, *Journal of Cleaner Production*, 2011, 19(2-3), 212 -220.

- [64] Poullikkas, A. Sustainable options for electric vehicle technologies, *Renew Sustain Energy Rev*, 2015, 41, 1277-87.
- [65] Kogabayev, T.; Maziliauskas, A. The definition and classification of innovation. *Journal of Business and Public Administration* 2017, 8(1).DOI:10.1515/hjbpa-2017-0005
- [66] Sabri, M. F. M.; Danapalasingam, K. A.; Rahmat, M. F. A review on hybrid electric vehicles architecture and energy management strategies, *Renewable and Sustainable Energy Reviews*, 2016, 53, 1433-1442.
- [67] Yong, J. Y.; Ramachandaramurthy, V. K.; Tan, K. M.; Mithulananthan, N. A review on the state-of-the-art technologies of an electric vehicle, its impacts, and prospects, *Renewable and sustainable energy reviews*, 2015, 49, 365-385.
- [68] Kumar, R. R.; Alok, K. Adoption of electric vehicle: A literature review and prospects for sustainability, *Journal of Cleaner Production*, 2020, 253, 119911.
- [69] Wappelhorst, S.; Hall, D.; Nicholas, M.; Lutsey, N. Analyzing policies to grow the electric vehicle market in European cities, *International Council on Clean Transportation*, 2020.
- [70] Cano, Z. P.; Banham, D.; Ye, S.; Hintennach, A.; Lu, J.; Fowler, M.; Chen, Z. Batteries and fuel cells for emerging electric vehicle markets, *Nature Energy*, 2018, 3(4), 279-289.
- [71] Toglaw, S.; Aloqaily, M.; Alkheir, A. A. Connected, autonomous and electric vehicles: the optimum value for a successful business model, In 2018 fifth international conference on internet of things: systems, management and security IEEE, October 2018, 303-308.
- [72] Wang, H.; Xiao, J. Delivering discontinuous innovation through modularity: The case of Chinese electric vehicle industry, In 2011 Proceedings of PICMET'11: Technology Management in the Energy Smart World (PICMET), IEEE, July 2011, 1-7.
- [73] Suh, N. P.; Cho, D. H.; Rim, C. T. Design of on-line electric vehicle (OLEV), In *Global Product Development: Proceedings of the 20th CIRP Design Conference*, Ecole Centrale de Nantes, Nantes, France, 19th-21st April 2010, 3-8, Springer Berlin Heidelberg.
- [74] Benzidia, S.; Luca, R. M.; Boiko, S. Disruptive innovation, business models, and encroachment strategies: Buyer's perspective on electric and hybrid vehicle technology, *Technological Forecasting and Social Change*, 2021, 165, 120520.
- [75] Young, K.; Wang, C.; Wang, L. Y.; Strunz, K. Electric vehicle battery technologies, *Electric vehicle integration into modern power networks*, 2013, 15-56.
- [76] Suh, I. S.; Kim, J. Electric vehicle on-road dynamic charging system with wireless power transfer technology, In 2013 International Electric Machines & Drives Conference IEEE, May 2013, 234-240.
- [77] Yu, A. S. O.; Silva, L. L. C.; Chu, C. L.; Nascimento, P. T. S.; Camargo, A. S. Electric vehicles: Struggles in creating a market, In 2011 Proceedings of PICMET'11: Technology Management in the Energy Smart World (PICMET), IEEE, July 2011, 1-13.
- [78] Chakraborty, S.; Lukasiewicz, M.; Buckl, C.; Fahmy, S.; Chang, N.; Park, S.; Adlkofer, H. Embedded systems and software challenges in electric vehicles, In 2012 Design, Automation & Test in Europe Conference & Exhibition (DATE), IEEE, March 2012, 424-429.
- [79] Slowik, P.; Lutsey, N. Expanding the electric vehicle market in US cities, *ICCT*, 2017.
- [80] Wesseling, J. H.; Faber, J.; Hekkert, M. P. How competitive forces sustain electric vehicle development, *Technological Forecasting and Social Change*, 2014, 81, 154-164.
- [81] Li, S.; Mi, C. C. Wireless power transfer for electric vehicle applications, *IEEE Journal of emerging and selected topics in power electronics*, 2014, 3(1), 4-17.
- [82] Pohl, H.; Yarime, M. Integrating innovation system and management concepts: The development of electric and hybrid electric vehicles in Japan, *Technological Forecasting and Social Change*, 2012, 79(8), 1431-1446.
- [83] Lopes, J. A. P.; Soares, F. J.; Almeida, P. M. R. Integration of electric vehicles in the electric power system, *Proceedings of the IEEE*, 2010, 99(1), 168-183.
- [84] Pohl, H. Japanese automakers' approach to electric and hybrid electric vehicles: from incremental to radical innovation, *International Journal of Technology Management*, 2012, 57(4), 266-288.
- [85] Ou, S.; Yu, R.; Lin, Z.; He, X.; Bouchard, J.; Przesmitzki, S. Evaluating China's Passenger Vehicle Market under the Vehicle Policies of 2021–2023, *World Electric Vehicle Journal*, 2021, 12(2), 72.
- [86] Thomas, V. J.; Maine, E. Market entry strategies for electric vehicle start-ups in the automotive industry—Lessons from Tesla Motors, *Journal of Cleaner Production*, 2019, 235, 653-663.
- [87] Ou, S.; Lin, Z.; He, X.; Przesmitzki, S.; Bouchard, J. Modeling charging infrastructure impact on the electric vehicle market in China, *Transportation Research Part D: Transport and Environment*, 2020, 81, 102248.
- [88] Feigenbaum, E. Perspectives on Norway's supercharged electric vehicle policy, *Environmental Innovation and Societal Transitions*, 2017, 25, 14-34.
- [89] Zhou, Y.; Wang, M.; Hao, H.; Johnson, L.; Wang, H.; Hao, H. Plug-in electric vehicle market penetration and incentives: a global review, *Mitigation and Adaptation Strategies for Global Change*, 2015, 20, 777-795.
- [90] Midler, C.; Beaume, R. Project-based learning patterns for dominant design renewal: The case of Electric Vehicle, *International Journal of Project Management*, 2010, 28(2), 142-150.
- [91] Tran, M.; Banister, D.; Bishop, J. D.; McCulloch, M. D. Realizing the electric-vehicle revolution, *Nature climate*

- change, 2012, 2(5), 328-333.
- [92] Al-Alawi, B. M.; Bradley, T. H. Review of hybrid, plug-in hybrid, and electric vehicle market modeling studies, *Renewable and Sustainable Energy Reviews*, 2013, 21, 190-203.
- [93] Karki, A.; Phuyal, S.; Tuladhar, D.; Basnet, S.; Shrestha, B. P. Status of pure electric vehicle power train technology and future prospects, *Applied System Innovation*, 2020, 3(3), 35.
- [94] Wurster, S.; Heß, P.; Nauruschat, M.; Jütting, M. Sustainable circular mobility: user-integrated innovation and specifics of electric vehicle owners, *Sustainability*, 2020, 12(19), 7900.
- [95] Poullikkas, A. Sustainable options for electric vehicle technologies, *Renewable and Sustainable Energy Reviews*, 2015, 41, 1277-1287.
- [96] Crabtree, G. The coming electric vehicle transformation, *Science*, 2019, 366(6464), 422-424.
- [97] Ding, N.; Prasad, K.; Lie, T. T. The electric vehicle: a review, *International Journal of Electric and Hybrid Vehicles*, 2017, 9(1), 49-66.
- [98] Hertzke, P.; Müller, N.; Schenk, S.; Wu, T. The global electric-vehicle market is amped up and on the rise, *McKinsey Cent Futur*, 2018, Mobil, 1-8.
- [99] Nezamuddin, O. N.; Nicholas, C. L.; Dos Santos, E. C. The problem of electric vehicle charging: State-of-the-art and an innovative solution, *IEEE Transactions on Intelligent Transportation Systems*, 2021.
- [100] Lutsey, N.; Nicholas, M. Update on electric vehicle costs in the United States through 2030, *International Council on Clean Transportation*, 2019, 12.
- [101] Xing, J.; Leard, B.; Li, S. What does an electric vehicle replace? *Journal of Environmental Economics and Management*, 2021, 107, 102432.
- [102] Jetin, B. Who will control the electric vehicle market? *International Journal of Automotive Technology and Management*, 2020, 20(2), 156-177.
- [103] Tautkus, A.; Miceviciene, D. Prospects of Electric Vehicles Technologies: A Comprehensive Review, *Taikomieji tyrimai studijose ir praktikoje-Applied research in studies and practice*, 2022, 18(1), 95-99.
- [104] Saisirirat, P.; Chollacoop, N.; Tongroon, M.; Laonual, Y.; Pongthanasawan, J. Scenario analysis of electric vehicle technology penetration in Thailand: Comparisons of required electricity with the power development plan and projections of fossil fuel and greenhouse gas reduction, *Energy Procedia*, 2013, 34, 459-470.
- [105] Budiman, A. C.; Hasheminejad, S. M.; Sudirja, S.; Mitayani, A.; Winoto, S. H. Visualization of Induced Counter-Rotating Vortices for Electric Vehicles Battery Module Thermal Management, *Frontiers in Heat and Mass Transfer (FHMT)*, 2022, 19.
- [106] Su, P.; Hua, W.; Zhang, G.; Chen, Z.; Cheng, M. Analysis and evaluation of novel rotor permanent magnet flux-switching machine for EV and HEV application. *IET Electric Power Applications*, 2017, 11(9), 509-1674.
- [107] Nissayan, C.; Seangwong, P.; Chamchuen, S.; Fernando, N.; Siritaratiwat, A.; Khunkitti, P. Modeling and Optimal Configuration Design of Flux-Barrier for Torque Improvement of Rotor Flux Switching Permanent Magnet Machine. *Energies* 2022, 15, 8429. <https://doi.org/10.3390/en15228429>.
- [108] Havel, A.; Sobek, M.; Stepanec, L.; Strossa, J. Optimization of Permanent Magnet Parameters in Axial Flux Rotary Converter for HEV Drive. *Energies* 2022, 15, 724. <https://doi.org/10.3390/en15030724>.

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## A2. 期刊收錄證明(畢業資格條件)

附件一：期刊等級證明

附件二：期刊接受證明

附件三：文獻來源和網路連結

### 附件一：期刊等級證明

The screenshot shows the Scopus Preview interface for a source publication. The page title is "來源出版物詳情" (Source Publication Details). The journal information includes:

- Stats** (Open Access icon)
- Scopus 涵蓋年度: 2019, 從 2022 到 2023
- 發表者: Multidisciplinary Digital Publishing Institute (MDPI)
- 電子版國際標準期刊號: 2571-905X
- 學科類別: Mathematics: Statistics and Probability
- 來源出版物種類: 期刊

On the right side, the CiteScore 2022 is 0.3 and the SNIP is also displayed. At the bottom, there are buttons for "查閱所有文獻", "設定文獻通知", and "儲存到來源出版物清單".

## 附件二：期刊接受證明(102/12/28)



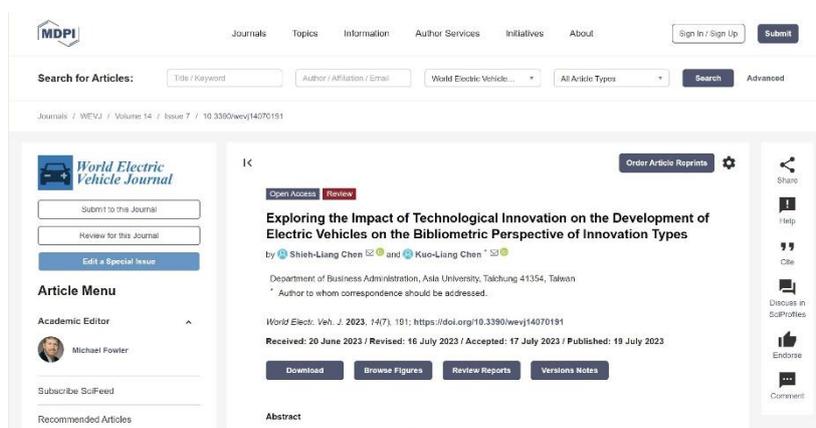
## 附件三：文獻來源和網路連結

Chen S-L, Chen K-L. The Mediating Impact of Innovation Types in the Relationship between Innovation Use Theory and Market Performance. *Stats*. 2024; 7(1):1-22.

<https://doi.org/10.3390/stats7010001>

Original submission received: 14 November 2023 / Resubmission received: 17 November 2023 / Revised: 27 December 2023 / Accepted: 28 December 2023 / Published: 30 December 2023

Website: <https://www.mdpi.com/2571-905X/7/1/1>



## 附件四：期刊刊登全文

Article

# The Mediating Impact of Innovation Types in the Relationship between Innovation Use Theory and Market Performance

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**Abstract:** The ultimate goal of innovation is to improve performance. But if people's needs and uses are ignored, innovation will be just a formality. In the past, research on innovation mostly focused on technology, processes, business models, services, and organizations. The measurement of innovation focuses on capabilities, processes, results, and methods, but always there has been a lack of pre-innovation measurements and tools. This study is the first to use the Innovation Use Theory proposed by Christensen et al., combined with innovation types, and uses the measurement focus on the early stage of innovation as a post-innovation performance prediction. This study collected 590 valid samples and used SPSS, and the four-step BK method to conduct regression analysis and mediation tests. The empirical results obtained: (1) Confirmed the model and scale of the Innovation Use Theory; (2) Innovation Use Theory three constructs have an impact on market performance; (3) Innovative types acting as mediators will improve market performance. This study establishes the Innovation Use Theory academic model to provide a clear scale tool for subsequent research. In practice, it can first measure the direction of innovation and performance prediction, providing managers with a reference when developing new products and applying market strategies.

**Keywords:** Innovative Use Theory · Innovative Use Scale · Innovation Type · Disruptive Innovation · Continuous Innovation · Market Performance

## 1. Introduction

The landscape of innovation remains an enduring focal point for corporate entities globally, mirroring the ever-evolving dynamics of the business environment. Navigating swift shifts in market trends and meeting the dynamic needs of customers present ongoing challenges that underscore the strategic imperative of prioritizing innovation in business operations. Simultaneously, corporate innovation is inherently driven by the overarching objective of enhancing performance [1,2]. The undeniable interconnection between innovation and performance reverberates across diverse business sectors [3]. In essence, innovation is a strategic endeavor meticulously designed to address consumer needs and usage patterns, yielding tangible performance outcomes for the company. However, a prevalent challenge faced by many companies lies in the propensity of innovation initiatives, particularly within research and development (R&D) departments, to invest substantial resources and time in the pursuit of an ostensibly flawless product. Unfortunately, such perfection-seeking endeavors may not align with the dynamic demands of the market [4], posing a critical predicament in corporate innovation.

In 2016, Christensen et al. introduced the Innovation Use Theory, heralding a paradigm shift in the approach to corporate innovation. Their proposal advocates for initiating innovation with a focus on multifaceted uses, recognizing the integral roles played by functional, social, and emotional factors in shaping successful innovations. According to Christensen, adopting a user-oriented methodology in product development, one that meticulously aligns with customer needs, is key to achieving success in the realm of innovation. This perspective marks a departure from the notion that innovation is a stroke of luck, emphasizing a strategic and purposeful approach to product development that considers diverse usage scenarios. The Innovation Use Theory posits that success in innovation results from thoughtful consideration of user experiences and needs, ushering in an era where innovation is an intentional and systematic endeavor rather than a gamble.

**Citation:** To be added by editorial staff during production.

Academic Editor: Firstname  
Lastname

Received: date  
Revised: date  
Accepted: date  
Published: date



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While it is intuitively evident that these innovations are likely to positively impact firm performance, existing evidence in the literature is predominantly anecdotal or derived from case studies, lacking comprehensive empirical support. Our study's primary purpose is to empirically investigate the impact of innovation on market performance from the perspective of the Innovative Use Theory. Additionally, building on Christensen et al.'s insights, our secondary objective is to explore the mediating role of two distinct types of innovation—highlighted by Augusto et al.'s findings [5]—in enhancing a company's economic performance and customer satisfaction. This study aims to delve into the crucial role of innovation types in satisfying three dimensions of consumer needs: functional, social, and emotional uses. Furthermore, our research seeks to examine the intricate interplay between innovation types and their connection to overall market performance. To structure these hypotheses, we propose a conceptual model (Figure 1) based on extant literature, elucidating the anticipated relationships among innovative use, innovation types, and market performance. This multifaceted exploration aims to deepen our understanding of how diverse categories of innovation contribute not only to consumer satisfaction but also to the broader landscape of corporate success in the marketplace.

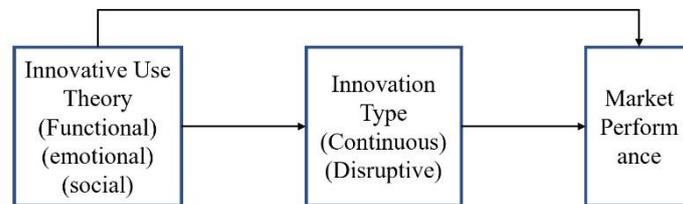


Figure 1 Concept model

According to the conceptual diagram, we will first establish the scale for the innovative use theory and transform it into effective measurement tools. Additionally, for the first time, we will combine the innovative use theory and innovation types to validate market performance. Based on this, we pose the following questions:

RQ 1: Do the three dimensions of the innovative use theory directly influence market performance? Is there a difference in the impact of these three dimensions?

RQ 2: Do the three dimensions of the innovative use theory affect innovation types? Which dimension has a more significant impact?

RQ 3: In terms of the impact on market performance, is the direct influence of the three dimensions of the innovative use theory or the mediated impact through innovation types more effective?

Our purpose is to understand the impact of the three aspects proposed by the innovative use theory on market performance through measurement. In addition, we also want to understand the differences in market performance through the mediating role of different innovation types. This study gathered 590 valid responses through surveys, utilized SPSS regression analysis to validate the reliability and validity of each scale, and subsequently applied the four-step BK method proposed by Baron and Kenny [6] to examine the mediating effect. Through empirical research, we have achieved several significant contributions. Firstly, we validated the model and scale of the innovative use theory, addressing the academic gap in the Innovative Use Theory scale. Secondly, we demonstrated that the three dimensions of the Innovative Use Theory have an impact on market performance, serving as a predictive tool for early-stage innovation. Lastly, we confirmed that incorporating the innovative use theory with different innovation types as intermediaries yields superior performance, facilitating adjustments in industry market strategies. To the best of our knowledge, this marks the first instance of combining a theory acknowledged by the academic community with a market-proven innovation model for measurement, introducing both novelty and practical value.

In the remaining sections of this paper, the arrangement is as follows: Section 2 elucidates the three dimensions of the innovative use theory and innovation types. Section 3 outlines the methodology employed, while Section 4 presents the results and subsequently conducts analysis and discussion. Section 5 provides conclusions, implications, and directions for future research.

## **2. Theoretical Development**

### **2.1 Innovative Use Theory**

When Christensen et al. [7] introduced disruptive innovation, it successfully established a new competitive model. However, this model does not provide specific guidance on the direction of corporate innovation or how to innovate to disrupt market leaders or pioneers. Managers must autonomously choose their innovation strategies based on market conditions and the resources available to their enterprises. Hence, Christensen et al. [8] subsequently proposed the innovative use theory, adopting a usage perspective to explore the reasons behind consumer purchases. According to this theory, companies should understand the specific "jobs" consumers hire their products for. In essence, consumers utilize various methods, tools, or products to accomplish a task, meeting their needs [8]. In simpler terms, consumers buy and use a particular product to fulfill their requirements and enhance their lives. The key insight here is that customers aren't seeking your product or service; rather, they are seeking a solution to their problem [8].

Delving deeper, Christensen et al. explored the innovative use theory across three key dimensions. Regarding the functional aspect, they probed into the new functionalities emerging from product innovation and development, seeking to understand the specific consumer needs these innovations aim to address. On the emotional side, the focus shifted to consumers' unique feelings when using the product and any emotional shifts they may experience. Regarding the social aspect, the examination extended to the impact of innovations on diverse ethnic groups, backgrounds, and social classes. This approach allows the innovative use theory to employ a uniform line of thinking and language, facilitating comprehension and enabling managers to contemplate and predict potential future innovation strategies effortlessly. Furthermore, at its core, the Innovative Use Theory encompasses three fundamental questions: (1) What change do you want to achieve? Including functional, emotional, and social aspects. (2) In what situation does the perplexing occur? Including who, when, where, and when and what was done. (3) What are the obstacles to progress? The moment of its innovation lies in finding the best method that can help consumers remove obstacles and achieve the job perfectly!

From a corporate perspective, the innovative use theory primarily focuses on the progress consumers desire. It uses this purpose as a guide for innovative development. The emphasis of innovation lies not in tools or methods but in observation, synthesis, and induction. The goal is to identify clues to innovative content, ensuring that the results of innovation align with the progress consumers aspire to achieve.

From the consumer's point of view, the change that consumers want in a specific situation is defined as progress [8]. The meaning is not the product, but the change after using the product, that is progress. That is to say, consumers hire or use products and services under specific circumstances because they need to complete a certain job to achieve the consumer's purpose, or what they want to progress.

Based on the above explanation, the core of the innovative use theory is to predict and provide solutions to solve needs and give consumers what they want; that is, companies predict the demand for innovation and provide solutions that meet consumers' needs and uses. Therefore, this study agrees with the definition of innovative use theory as innovatively developing products or services based on consumers' situations and desired changes to provide consumers with use and needs to satisfy their tasks and emotions [9].

#### **2.1.1 Functional use**

According to the Oxford English Dictionary [10], the function is defined as the purpose of something, which generally refers to purpose, goal, and intention. Miles [11] explains function as, the basic purpose of every product development expenditure. Functionality reflects consumers' perceptions of a product's ability to fulfill its purpose [12,13]. Therefore, product functionality refers to the specific functions, functions, or uses of this product. In addition, from the perspective of product design, product functions and the goals to be achieved by the product are related to technology, and are usually expressed in terms of technical operations [14].

Basic functionality is the main reason why users purchase products. For example, a light bulb has the basic function of providing a light source. However, users are not necessarily interested in

secondary functions, because they will only pay attention to basic functions, and users do not care about these secondary functions until they are needed. For example, a light bulb has three light sources that can be switched to bright white light, white light, and yellow light. Only when special needs arise, the user will press the switch to switch the color of the light. That is to say, only when product functions are guided by affordances can users use them appropriately, and can users and product functions be correctly connected.

According to the above literature description, we can define the functional aspect, as the specific technology and use of the basic functions of the product, which can meet the user's goals, objectives, and intentions in the process of realizing the needs. It is in line with the functional aspect questions asked by Christesen et al. on the What is new product development and innovation and What needs of consumers should be solved?

### **2.1.2 Emotional use**

The functions and attributes of a product can provide users with experiences that help them achieve their goals. If the goal is achieved and basic psychological needs are fulfilled, the inner emotions will cause a sense of happiness. Therefore, by providing experiences, products can provide pleasant interactions for users [15]. Therefore, Hassenzahl [16] stated that using a product with characteristics in a specific situation will lead to consequences, such as emotional ups and downs (satisfaction and pleasure, dissatisfaction, and anger), clear evaluations (judgments of good and bad, beautiful and ugly) or overt behavior (approach or avoidance). When a person is satisfied and happy with the outcome of an event, no need for any expectations will be funny [17]. However, as a result of the emotional side, satisfaction is related to success in using the product to achieve a specific goal, and fun is related to using the product in a specific situation and unimaginable situation.

Consumers' emotional responses to products vary depending on their mood. Researchers have found that emotions have a strong influence on consumer behavior [18]. Cheerful people are more likely to be attracted to products; when they are in a bad mood, their emotions will also affect their choice of products. Frijda [19] also proposed that all emotions involve a specific tendency to act in preparation for the impact caused by the emotion. In addition, there are also other different emotional reactions, such as surprise, sadness, jealousy, fascination, boredom, and surface reactions.

According to the above literature description, we can define the emotional side of products as the emotions, evaluations, and behaviors displayed in the process of achieving specific goals through perception and experience when using products with specific functions. The emotional aspect is related to the mood when using the product, which is in line with the emotional aspect of Christesen et al.'s question on the special feelings of consumers and product use, or questions about emotional changes.

### **2.1.3 Social use**

The concept of the social impact of products is interpreted as the impact of products on the quality of people's daily lives [20]. The focus is on the consequences of product use and the social issues associated with it. In addition, consumers will also like a certain product because of social recognition; in other words, the use of the product has a positive impact on society. The most obvious example that occurs in the surrounding area is that every year new mobile phones are released, which attracts many Apple fans, Samsung fans, and Huawei fans to replace their new mobile phones. The main reason is also social recognition.

Scholars [21,22] also noted that the relevance of specific social impacts often depends on the local environment, community, health, and economy. To predict social impacts, it is necessary to understand the society and stakeholders that may be affected [23], determine the areas of potential social impacts [24], which stakeholders should be concerned [22], and related measures for stakeholders [25]. Vanclay [26] added that the social impact of a product will affect the experience of individuals or communities. Employment, health and safety, network and communication, and cultural identity are used as the framework for the impact of products on society.

According to the above literature description, we can define the social aspect of products as the impact of product use and related information delivered on people's quality of life, social interaction, and work, the environment, and the safety, health, relationship networks, and ethnic groups, in the community positive impact. It is in line with Christesen et al.'s social aspect impact on different ethnic groups, backgrounds, and classes.

## 2.2 Continuous Innovation

Continuous innovation focuses on innovation processes and activities that occur continuously, regularly, routinely, in a structured manner, and over a longer period [27]. The main characteristics are persistence, sustainable economic growth, and sustainable development of enterprises [28]. The core elements of its conceptualization are continuous improvement and continuous innovation. Pasche & Magnusson [29] stated based on this that continuous and effective interaction can promote continuous improvement, learning, and innovation of enterprises and ensure their continued effectiveness. Lianto et al. [27] proposed that continuous innovation is defined as innovation processes and activities that are sustained, regular, repeated, and carried out over a long period, thus having a beneficial impact on the company. Watts [30] defines it as a moderate, incremental, and continuous upgrade or enhancement of existing products, services, or technologies. Some scholars also believe that continuous innovation requires enterprises to have the ability to implement continuous and incremental innovation while taking into account operational efficiency [31]. It involves a continuous interaction between operations, incremental improvements, learning, and radical innovation, aiming to effectively combine operational efficiency with strategic flexibility, resource development, and exploration [32].

Comprehensive literature shows that continuous innovation must combine efficiency, speed, flexibility, and continuity. Therefore, this study defines continuous innovation as the continuous improvement of ideas, technologies, and products based on resources and capabilities, maintaining their consistent continuity, and effectively combining innovation, development, efficiency, and flexibility, which can create performance and market competitiveness for enterprises. From the above literature, we propose the following hypothesis:

H1a: There will be a positive association between functional use and continuous innovation.

H1b: There will be a positive association between emotional use and continuous innovation..

H1c: There will be a positive association between social use and continuous innovation.

## 2.3 Disruptive Innovation

Disruptive innovation focuses on enterprises that have limited resources and difficulty in allocating them and must meet the needs of these external entities, such as customers in the consumer market and investors in the capital market [7,33]. Therefore, it must be disruptive. The approach is to obtain the low-end market or target market and continue to upgrade and innovate to meet the needs of high-end market customers; this means establishing advantages in the low-end market and also advancing to occupy the mainstream market [7]. Many scholars emphasize that the theory can be used to predict the operation of disruptive innovation and play an important role in management [34,35].

So far, disruptive innovation not only refers to technological disruption and innovation but also involves disruptive practices in other aspects such as products and business models [36,37,38]. Its research content is extensive and diverse, covering technology, business models, products, strategies, internal conditions external conditions, etc. But overall, its projects still follow the original connotation of disruptive technology [39]. Suseno [40] defines disruptive innovation as disruptive innovation usually using new technologies or business models to replace outdated business methods, create new business methods and new needs, and new competitors will also appear. Si & Chen [41] define it as an innovation process in which technologies, products, or services are inferior to existing enterprises in terms of attributes, but are cheap, simple, or convenient, and can attract and meet the needs of low-end consumers. Over time, through incremental improvements in technology or processes, the needs of mainstream consumers are gradually met, thereby gaining a certain market share in the mainstream market, and even replacing established products and companies in the mainstream market. Thomond & Lettice [42] also believe that disruptive innovation is a market strategy that successfully utilizes products, services, or business models, which significantly changes the needs of non-mainstream markets and subverts previous major players.

Comprehensive literature shows that the core of disruptive innovation is divided into two stages. The first stage is to develop niche markets with good quality and low prices; the second stage is technological upgrading to provide product needs for mainstream market customers and seize market share. Therefore, this study agrees with Chen & Chen's [9] definition of disruptive

innovation as changing the basis of products, services, and competition in the early stage, providing sufficiently attractive product functions and prices, developing niche markets; and then upgrading products and services to provide Mainstream customer demand, seize mainstream market share, while still maintaining the base market and advantages that led. From the above literature, we propose the following hypothesis:

H2a: There will be a positive association between functional use and disruptive innovation.

H2b: There will be a positive association between emotional use and disruptive innovation.

H2c: There will be a positive association between social use and disruptive innovation.

## **2.4 Market Performance**

Market performance is the final result of enterprise operations and policies [43], and is also the goal of enterprise establishment and operation. The level of market performance can be revealed through the size of the market share [44]. Saeko et al. [45] pointed out that business performance is the result of customers, markets, and market strategies, which are mainly related to sales, market share, and market development. According to research, good business performance is mainly sales value, sales growth, and market share that increase corporate profits [46]. Enterprise profitability is an important market performance result [47]. If the company's profits are too low, market performance is poor and it cannot make up for the shortcomings, the company will face the problem of business contraction or exit from the market.

Regarding market performance, Gunday et al. [48] believe that quality and consistency, total sales, market share, and customer satisfaction are used as measurement indicators of market performance. Cheng et al. [49] measure business performance in terms of return on investment (ROI), market share, profitability, and sales. Based on the market-side perspective, this study uses the assessment of market performance proposed by Gunday et al. [48] as a measure of market performance.

Based on the above literature, continuous innovation and disruptive innovation are two different types of innovation. They are directly related to product development and production and are also related to the market strategy adopted. Kogabayev & Maziliauskas [50] illustrate that the results (performance) of innovation depend on the type of innovation used. Based on this, we propose hypotheses about the impact of continuous innovation and disruptive innovation on market performance.

H3: There will be a positive association between continuous innovation and market performance.

H4: There will be a positive association between disruptive innovation and market performance.

In addition, scholars such as Gunday et al. [48] also explained that innovation is one of the basic ways to enter new markets, increase existing market share, and provide companies with competitive advantages. Since the innovative use theory can examine the direction of innovation types and help select which type of technological innovation to meet consumer needs and uses, it is "inevitable" to achieve performance goals. Therefore, we believe that the three constructs of the innovation use theory are also related to performance, so we propose the following hypothesis:

H5a: There will be a positive association between functional use and market performance.

H5b: There will be a positive association between emotional use and market performance.

H5c: There will be a positive association between social use and market performance.

## **3. Research Methodology**

Based on the above research hypotheses, the structure of this study is shown in Figure 2.

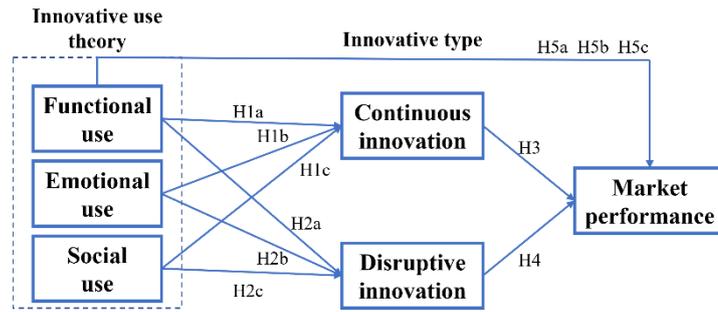


Figure 2 Research model

### 3.1 Variables and Analysis Methods

#### 3.1.1 Variables

##### 3.1.1.1. Independent Variables

Independent variables are variables that we can control and choose to change [51]. According to Figure 2, F, E, and S in this study are identified as independent variables. Changes in the conditions of independent variables will affect market changes. Therefore, proper management of independent variables can achieve ideal expected values.

##### 3.1.1.2. Dependent Variables and Mediating Variables

The dependent variable is a variable that we cannot directly control, and when we change the independent variable, the dependent variable also changes [51]. According to Figure 2, C, D, and M are identified as dependent variables. Furthermore, the two innovation types C and D also play the role of mediators. Therefore, choosing appropriate mediating variables will also affect the expected value.

##### 3.1.2. Analysis methods

We planned six analysis models based on the route in Figure 2, namely F-C-M, E-C-M, S-C-M, F-D-M, E-D-M, and S-D-M, and performed regression analysis on the routes within the model using SPSS-24. Secondly, regression analysis is performed on C-M and D-M. Finally, BK 4 steps are used to conduct mediation analysis and tabulate explanations.

### 3.2 Item Measurement

#### 3.2.1 Questionnaire items development

Yam et al. [52] illustrate that enterprises invest a large amount of technological innovation resources in innovation activities, which has the most direct effect on improving enterprise performance. However, if the innovative product cannot achieve good market performance, this innovation is equivalent to ineffective innovation. Ineffective innovation will also cause the company to be unable to survive and innovation will be interrupted [53]. Therefore, this study is based on the conceptual definition of six aspects for the first time, referring to the questionnaire design process [54,55], and adapting past research on technological innovation. and items from product design concept literature to develop the questions of this study, as shown in Appendix A. This study used an interval scale and measured it using a five-point Likert scale [56]. The strongly disagreeing is given for 1 point, disagreeing is given for 2 points, normal is given for 3 points, agreeing is given for 4 points, and strongly agreeing is given for 5 points. In addition, the basic information of the respondents is shown in Table 1.

#### 3.2.2 Expert validity assessment

After sorting the references, a total of 41 questions were generated. To ensure that the scale items have content validity, two scholars and two experts with practical experience in product development and production were invited to evaluate the content validity of the scale. First, it provides scholars and experts with conceptual definitions of each aspect. Secondly, four scholars and experts were invited to discuss whether each aspect item could fully reflect the conceptual connotation it measured. Based on the revised opinions given by the scholars and experts, the content and terminology of several items were revised. Finally, Signature confirmation.

**Table 1: Basic information of respondents**

A.Gender: 1. <input type="checkbox"/> Male, 2. <input type="checkbox"/> Female
B.Marriage: 1. <input type="checkbox"/> Single, 2. <input type="checkbox"/> Married, 3. <input type="checkbox"/> Single,
C.Age: 1. <input type="checkbox"/> Under 20 years old, 2. <input type="checkbox"/> 21-30 years old, 3. <input type="checkbox"/> 31-40 years old, 4. <input type="checkbox"/> 41-50 years old, 5. <input type="checkbox"/> 51-60 years old, 6. <input type="checkbox"/> 61 years old and above,
D.Educational: 1. <input type="checkbox"/> High school, 2. <input type="checkbox"/> University (Private), 3. <input type="checkbox"/> University (National), 4. <input type="checkbox"/> Master (Private), 5. <input type="checkbox"/> Master (National), 6. <input type="checkbox"/> Ph.D.(Private), 7. <input type="checkbox"/> Ph.D.(National),

### 3.2.3 Pre-test

The pretest of the scale is mainly to ensure that the questionnaire respondents have readability and understandability of the text of the items, and can clearly understand the meaning of each item. Therefore, this study first invited 13 actual users of the products illustrated in this study to conduct a preliminary test on each item from the perspective of consumer needs and usage.

**Table 2 Pre-test scores**

Question	Number	Judgment	Question	Number	Judgment
F1	4.538		C1	4.231	
F2	4.538		C2	4.308	
F3	4.462		C3	4.308	
F4	4.077		C4	4.308	
F5	4.538		C5	4.231	
F6	4.231		C6	4.077	
F7	4.385		C7	4.154	
E1	4.462		D1	4.077	
E2	4.231		D2	4.000	
E3	3.923	X	D3	4.308	
E4	4.385		D4	4.308	
E5	4.538		D5	4.231	
E6	4.000		D6	4.077	
E7	4.154		D7	3.923	X
S1	3.154	X	M1	4.000	
S2	2.923	X	M2	4.154	
S3	3.923	X	M3	4.538	
S4	3.846	X	M4	4.692	
S5	3.692	X	M5	4.385	
S6	4.308				
S7	4.308				
S8	4.385				

The pre-test interview process is as follows: First, the respondents are asked to read the noun definitions at the top of the questionnaire to confirm that they understand the meaning of the questions in this questionnaire. If the respondents do not understand the content and meaning of each item, each item will be explained individually. The conceptual category is reflected by the facet. Secondly, fill in the relevant information. Finally, the interviewees were asked to give trial answers and an overall evaluation of the questionnaire. Based on the suggestions of the respondents, this study made small corrections to the text content of some items without affecting the meaning of the questions to make them easier to understand. Please refer to Table 2 for the pre-test scores. According to the table, attention should be paid to E3, S1, S2, S3, S4, S5, D7 and other issues.

### 3.2.4 Data collection

This study focuses on those who use the LINE App. The questionnaire survey subjects are mainly employees of all ranks in the technology industry, covering multiple age groups and subjects with different educational backgrounds. 700 copies are sent in the form of an online

questionnaire (survey cake). Regarding the questionnaire, only 470 questionnaires were collected in the first week. After prompting, 190 questionnaires were collected successively, totaling 660 questionnaires, with a recovery rate of 94.28%. After excluding 70 invalid questionnaires, 590 questionnaires were analyzed, with an adoption rate of 89.39%.

### 3.3 Data Detection

The statistical software used in this study is the SPSS\_25 version. First, detect non-response bias [57]. We conducted a chi-square test on the four variables of gender, marriage, age, and education level of the subjects. According to the data in Table 3, there is no significant difference between the variables ( $p > .05$ ), so the null hypothesis is accepted, that is, there is no significant difference in the responses of the respondents between the early and late recycling periods.

Table 3 Non-response bias-Chi-square test

Item	Pearson Chi-square	Fd	P Value
Gender	0.644	1	0.422
Marriage	4.446	2	0.108
Age	9.622	5	0.087
Educational	4.433	6	0.618

Secondly, SPSS\_25 was used to conduct Exploratory Factor Analysis (EFA) with the Varimax rotation method, and items S1, S2, S5, D6, D7, and M3 with smaller factor loading coefficients were deleted. In addition, to ensure that the fit index GFI and the comparative fit index CFI can meet the requirements of  $>0.9$  or above, AMOS\_24 was used to conduct Confirmatory Factor Analysis (CFA). The results showed that  $GFI=0.915$ ,  $CFI=0.935$ ,  $AGFI=0.902$ ,  $RMSEA=0.037$ , the overall Cronbach's Alpha= $0.932$ , and the Cronbach's Alpha values of other aspects are all above 0.6, which are all acceptable standards [58,59].  $KMO=0.941$ , consistent with what Hu and Bentler [60] proposed. The Composition Reliability (CR) is all greater than 0.6, which is in line with what Fornell and Larcker [61] proposed.  $0.3 < AVE < 0.5$  is also consistent with the description of Shrestha [62], which is summarized in Table 4, indicating that this research model has a good fit, reliability, and validity.

Finally, linear regression analysis was performed on F-C-M, E-C-M, S-C-M, F-D-M, E-D-M, and S-D-M, and mediation validation was conducted using the 4-step BK method [6].

Table 4 Fit of the measurement model

Structure	Question	Standardized Estimate	Cronbach's $\alpha$	CR	AVE
Functional aspects	F1	0.658	0.824	0.825	0.403
	F2	0.652			
	F3	0.581			
	F4	0.597			
	F5	0.668			
	F6	0.647			
	F7	0.638			
Emotional aspects	E1	0.643	0.789	0.792	0.354
	E2	0.620			
	E3	0.570			
	E4	0.483			
	E5	0.546			
	E6	0.624			
	E7	0.660			
Social aspects	S3	0.631	0.765	0.768	0.399
	S4	0.565			
	S6	0.646			
	S7	0.668			
	S8	0.643			
Continuous	C1	0.688	0.837	0.838	0.425

innovation	C2		0.685	0.760	0.761	0.390
	C3		0.651			
	C4		0.631			
	C5		0.680			
	C6		0.587			
	C7		0.634			
Disruptive innovation	D1		0.580	0.634	0.641	0.314
	D2		0.619			
	D3		0.631			
	D4		0.588			
	D5		0.699			
Market performance	M1		0.640	0.634	0.641	0.314
	M2		0.623			
	M4		0.409			
	M5		0.541			
GFI=0.915、AGFI=0.902、CFI=0.935、RMSEA=0.037、chi-square=979.672、Chi-square/Fd =545、Cronbach's $\alpha$ =0.932、KMO=0.941						

## 4. Analysis and Discussion

### 4.1 Descriptive Statistical Analysis

#### 4.1.1 Basic information

The basic personal information of this questionnaire is shown in Table 5. Among the respondents, 251 were male, accounting for 42.54%, and 339 were female, accounting for 57.48%. Those who regularly use this product range from 21 to 50 years old, with a total of 551 people, accounting for 93.39%. This is in line with the normal age distribution of technology product users, and the information they gave back in the questionnaire is credible. In addition, as Cui et al. [63] remind us, consumer demographics (such as age, income, and education) have been widely used to describe different consumer groups. Secondly, general product development requirements should be as far as possible to be usable by men, women, old and young. According to research by Gilly et al. [64], consumer groups will face difficulties in adopting and enjoying new technologies. Consumers who may face barriers to adopting technology products include older adults and those from different income and educational backgrounds. Therefore, this study will conduct an in-depth analysis of gender, education level, and age, as shown in Table 6 and Table 7.

Table 5 Basic information of respondents (N=590)

Item	Content	Number	%	Item	Content	Number	%
Gender	Male	251	42.54	Education	High school	64	10.85
	Female	339	57.46		University (Private)	254	43.05
Age	Under 20 years old	9	1.53		University (National)	182	30.85
	21-30 years old	144	24.41		Master (Private)	38	6.44
	31-40 years old	250	42.37		Master (National)	48	8.14
	41-50 years old	157	26.61		Ph.D.(Private)	1	0.17
	51-60 years old	25	4.24		Ph.D.(National)	3	0.51
	61 years old and above	5	0.85				

#### 4.1.2 Cross-analysis by age and education level

As shown in Table 6, the chi-square test of age and education level  $p$ -value=79.697\*\*\*,  $df=30$ , so there is a significant relationship. The majority of respondents have a college degree, with a total of 436 people, accounting for 73.89%, followed by a master's degree, with a total of 86 people, accounting for 14.57%, and the third is a high school degree, with a total of 64 people, accounting for 10.84%. Comparing the age of normal users, there are 414 people aged 21 to 50 with a college

degree, accounting for 70.16%, 83 people with a master's degree, accounting for 14.06%, and a total of 497 people with a university and master's degree, accounting for 84.23%. A comprehensive review of the product usage set in this study in Table 7 shows that more than 70% of product users are mainly between the ages of 21 and 50 with a college degree. The main reason is that LINE App is a product with some technological components. Users with higher education can make full use of the functions provided by the LINE App in daily life and work.

Table 6 Cross comparison of age and education level

Ag/Ed	High school	University (Private)	University (National)	Master (Private)	Master (National)	Ph.D. (Private)	Ph.D. (National)	Total
Under 20 years old	1	3	5	0	0	0	0	9
	1.56%	1.18%	2.75%	0.00%	0.00%	0.00%	0.00%	1.53%
21-30 years old	10	60	52	6	16	0	0	144
	15.63%	23.62%	28.57%	15.79%	33.33%	0.00%	0.00%	24.41%
31-40 years old	15	108	89	14	21	1	2	250
	23.44%	42.52%	48.90%	36.84%	43.75%	100.00%	66.67%	42.37%
41-50 years old	25	76	29	17	9	0	1	157
	39.06%	29.92%	15.93%	44.74%	18.75%	0.00%	33.33%	26.61%
51-60 years old	9	7	6	1	2	0	0	25
	14.06%	2.76%	3.30%	2.63%	4.17%	0.00%	0.00%	4.24%
61 years old and above	4	0	1	0	0	0	0	5
	6.25%	0.00%	0.55%	0.00%	0.00%	0.00%	0.00%	0.85%
Subtotal	64	254	182	38	48	1	3	590
	10.85%	43.05%	30.85%	6.44%	8.14%	0.17%	0.50%	

#### 4.1.3 Cross-analysis by gender and education level

As shown in Table 7, the chi-square test of gender and education level  $p$ -value=9.639,  $df$ =6, significance=0.141, and the correlation is not significant. The ratio of male to female students who answered the questionnaire was approximately 4:6. Among them, the number of men and women with college degrees is 176 and 260, about 3:4.3. The number of people with a master's degree or above is 48:42, about 6:5.25. Generally speaking, men are more comfortable using technological products. Past research has shown that a higher proportion of women exhibit moderate to high levels of technophobia [65]. Recent research concludes that the past gender gap has now narrowed to the point where women are no longer more fearful than men when it comes to computer-related technology [66]. According to the results of this study, the proportion of girls using technology products is no less than that of boys. The main factor is that the educational level of men and women has generally improved, and there is no gender difference in the use of technology products for daily life.

Table 7 Cross-comparison of gender and education level

Ge/Ed	High school	University (Private)	University (National)	Master (Private)	Master (National)	Ph.D. (Private)	Ph.D. (National)	Total
Male	27	99	77	19	26	0	3	251
	42.19%	38.98%	42.31%	50.00%	54.17%	0.00%	100.00%	42.54%
Female	37	155	105	19	22	1	0	339
	57.81%	61.02%	57.69%	50.00%	45.83%	100.00%	0.00%	57.46%
小計	64	254	182	38	48	1	3	590

#### 4.2 Regression analysis

First, six analysis models were planned according to the path, namely F-C-M, E-C-M, S-C-M, F-D-M, E-D-M, and S-D-M. Regression analysis was performed on the routes within the model. The results are shown in Table 8.

Table 8 The impact of innovative uses and innovation categories on market performance

Construct	Path coefficient	t - value	Significance	Indirect impact	Total impact
Model 1	F-C-M				
F-M	0.369***	11.169	0.000	0.253***	0.501
F-C	0.620***	16.046	0.000		0.620
C-M	0.407***	14.690	0.000		0.407
Model 2	E-C-M				
E-M	0.379***	12.115	0.000	0.263***	0.504
E-C	0.646***	18.149	0.000		0.646
C-M	0.407***	14.690	0.000		0.407
Model 3	S-C-M				
S-M	0.288***	9.402	0.000	0.232***	0.148
S-C	0.570***	16.527	0.000		0.362
C-M	0.407***	14.690	0.000		0.407
Model 4	F-D-M				
F-M	0.369***	11.169	0.000	0.234***	0.603
F-D	0.608***	15.232	0.000		0.608
D-M	0.385***	13.921	0.000		0.385
Model 5	E-D-M				
E-M	0.379***	12.115	0.000	0.238***	0.617
E-D	0.619***	16.574	0.000		0.619
D-M	0.385***	13.921	0.000		0.385
Model 6	S-D-M				
S-M	0.288***	9.402	0.000	0.187***	0.475
S-D	0.486***	12.972	0.000		0.486
D-M	0.385***	13.921	0.000		0.385

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01

**Table 8 indicates the following results;**

1. Model 1 (F-C), function aspect has a positive and significant impact on continuous innovation, and its  $\beta$  value is 0.620 ( $p < 0.001$ ), reaching a significant level, so H1a is established.
2. Model 2 (E-C). Emotion aspect has a positive and significant impact on continuous innovation. Its  $\beta$  value is 0.646 ( $p < 0.001$ ), reaching a significant level. Therefore, H1b becomes
3. Model 3 (S-C), the social aspect has a positive and significant impact on continuous innovation, and its  $\beta$  value is 0.570 ( $p < 0.001$ ), reaching a significant level, so H1c becomes
4. Model 4 (F-D), the functional aspect has a positive and significant impact on disruptive innovation, and its  $\beta$  value is 0.608 ( $p < 0.001$ ), reaching a significant level, so H2a is established.
5. Model 5 (E-D), the emotional aspect has a positive and significant impact on disruptive innovation, and its  $\beta$  value is 0.619 ( $p < 0.001$ ), reaching a significant level, so H2b is established.
6. Model 6 (S-D), the social aspect has a positive and significant impact on disruptive innovation, and its  $\beta$  value is 0.486 ( $p < 0.001$ ), reaching a significant level, so H2c is established.
7. The  $\beta$  value of H3 (C-M) is 0.407 ( $p < 0.001$ ), and the  $\beta$  value of H4 (D-M) is 0.385 ( $p < 0.001$ ), both reaching the significant level, so both H3 and H4 are established.
8. The  $\beta$  value of H5a (F-M) is 0.369 ( $p < 0.001$ ), the  $\beta$  value of H5b (E-M) is 0.379 ( $p < 0.001$ ), and the  $\beta$  value of H5c (S-M) is 0.288 ( $p < 0.001$ ), all of which are significant level, the hypotheses H5a, H5b, and H5c are all established.

Secondly, regarding the impact of innovative use theory on innovation types, it can be seen from Table 9 that F-C, E-C, and S-C are all greater than F-D, E-D, and SD. In addition, the C values of F-C-M, E-C-M, and S-C-M are also greater than those of F-D-M, E-D-M, and S-D-M. D value, it can be seen that the three constructs of the innovative use theory have a greater impact on continuous innovation than destructive innovation. in addition,  $E > F > S$ , that is, the impact of the emotional side will be greater than the functional side and the social side (Table 8 and Table 9). The path coefficients of this research architecture model are shown in Figure 3.

Table 9 The impact of innovation use theory on innovation type

	F-C-M			E-C-M		S-C-M		F-D-M		E-D-M		S-D-M			
	C	D	M	F	C	E	C	S	C	F	D	E	D	S	D
F	0.620	0.608	0.369	0.168***	0.325***				0.189***	0.297***					
E	0.646	0.619	0.379			0.180***	0.307***				0.206***	0.278***			
S	0.570	0.486	0.288					0.081**	0.362***					0.130***	0.325***
C			0.407												
D			0.385												

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01

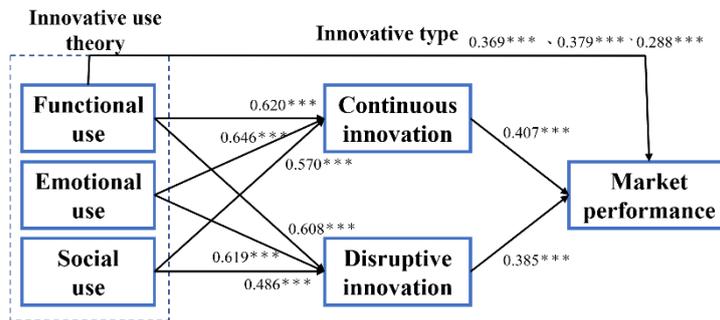


Figure 3 Path Diagrams

### 4.3 Mediation effect test (BK method)

According to the mediation operation (four steps of the BK method) proposed by Baron and Kenny [6], it is pointed out that if steps 1-4 (C, a, b, c') can be satisfied at the same time (C > a, b, c'), It is a partial mediation. If one item cannot be satisfied, it is partial mediation, as shown in Figure 4. Accordingly, the results obtained are shown in Table 10 and Table 11. The results show that C > c' has a mediating effect, and according to the data, it is a partial mediation.

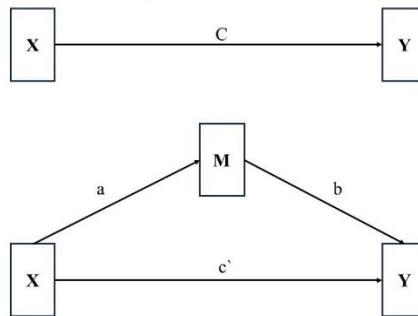


Figure 4 Four steps of the BK method [6]

Table 10 Mediation effect of continuous innovation

Continuous innovation	Regression				C > c'
	C	a	b	c'	Significance
F	0.369***	0.620	0.407	0.168***	0.000
E	0.379***	0.646	0.407	0.180***	0.000
S	0.288***	0.570	0.407	0.081**	0.017

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01

Table 11 Mediation effect of disruptive innovation

Disruptive innovation	Regression				C>c'
	C	a	b	c'	Significance
F	0.369***	0.608	0.385	0.189***	0.000
E	0.379***	0.619	0.385	0.206***	0.000
S	0.288***	0.486	0.385	0.130***	0.000

\*p < 0.1, \*\*p < 0.05, \*\*\*p < 0.01

#### 4.4 Research results

This study, through empirical findings, provides answers to three questions:

Ans 1: The three facets of the innovative use theory do indeed impact market performance (H5a, H5b, H5c) (Table 8). The emotional aspect has a more pronounced effect, with the b series consistently greater than the a and c series (Table 9).

Ans 2: The three facets of the innovative use theory do have an impact on innovation types, and continuous innovation has a greater influence on subsequent market performance (Table 9).

Ans 3: In this study, as an example, the effect of the innovation type as a mediator is more noticeable than directly using the three facets of the Innovative Use Theory on market performance (H3 & H4 > H5a, H5b & H5c). Among these, continuous innovation has a better impact on market performance (H3>H4). Thus, it can be inferred that evaluating the three facets of the innovative use theory in conjunction with innovation types is the correct approach (Figure 4).

Based on the research results, first of all, the three aspects of the Innovative Use Theory will indeed have an impact on market performance. Therefore, before launching new products, companies should carefully consider using the three aspects of the Innovative Use Theory to conduct pre-tests of innovative development to stabilize market performance. In addition, the types of innovation represented by Continuous Innovation and Disruptive Innovation will also have an impact on market performance, which is consistent with the results of innovation research. Finally, if the two types of innovation are used as Mediation and combined with the measurement of innovation use theory, there will be a better impact on market performance. Therefore, choosing the appropriate type of innovation becomes an important factor affecting market performance.

#### 5. Conclusions and Suggestions

The primary objective of this study is to base itself on the innovation use theory, integrate explanations from existing literature, define each variable, adapt questions from past relevant scholars for this study, and proceed with the collection and analysis of questionnaire data. Finally, through regression analysis using SPSS and mediation analysis using the BK method, the research inferences are validated, and empirical results are obtained. This study demonstrates that market performance is positively influenced by the independent variables within the theory of innovative use. Moreover, innovation types, acting as mediating variables, also positively affect market performance. According to the findings of this research, the impact of continuous innovation on market performance is more pronounced than that of disruptive innovation. Therefore, the mediating role of innovation types is crucial for a firm's competitiveness.

##### 5.1. Theoretical Implications

First of all, this study continues the spirit of the author of this theory and confirms the functional aspect, emotional aspect, and social aspect models of the Innovative Use Theory; based on this model, for the first time, a measurement scale is proposed before product innovation development, and demonstrate the feasibility of this model empirically. In this way, subsequent academic research on innovative use theory will have a reference scale for use.

Secondly, the three aspects of Innovative Use Theory will have a positive impact on market performance. Empirical analysis proves that this model framework does have an impact on market performance, and the emotional framework has a greater impact on market performance. For example, between the mobile phone duo Huawei and Apple, many Huawei and Apple fans are queuing up every time a new product is launched. Among them, the functions of the two mobile phones are each superior. The reason why Huawei fans and Apple fans rush to buy is not all because of the functions of the mobile phones, but because of the emotional support for their favorite mobile phones. Therefore, the emotions of future product development and production The surface evaluation will be greater than the functional surface of practical nature.

Finally, according to empirical data, innovation type, as the intermediary variable of the innovative use theory, has a greater impact on market performance than the innovative use theory aspect alone. In addition, choosing different innovation types will have different impacts on market performance. The impact of continuous innovation selected in this study is greater than that of destructive innovation.

## **5.2 Management Implications**

Although the essence of innovation type is to define the type of innovation, the industry can already regard innovation type as a part of the market strategy. Literature shows that the degree of innovation of Maintain continuous innovation will be similar to that of radical innovation. Scholars Chen & Chen [53] have also clearly pointed out that radical innovation is the development of new products using innovative technology, which has its benefits whether it is launched in new markets or original markets. Therefore, the practical implications of this study are as follows;

First, before product plan development, consumers` needs and use are evaluated using the three-facet model of the innovative use theory to develop products that consumers need. Avoid product developers who think they have developed a perfect product but are not favored by market consumers, which is a waste of resources and weakens the competitiveness of the company.

Secondly, empirical data shows that consistent and continuous innovation has a greater impact on market performance than destructive innovation. Therefore, it is a more prudent operation for managers to select appropriate innovation types for products developed according to market strategies. If various forms of innovation types are cross-used (dual or multiple), it will also make market operations more elastic and flexible, and have an absolute effect on the growth of market performance.

Finally, according to the data, we can also infer that among the types of innovation evaluated based on market and technology, disruptive innovation can achieve performance in the existing market by investing fewer resources to lower the technical threshold. Architectural innovation should be able to combine existing technologies in developing new markets and invest smaller resources to achieve greater market performance. Although radical innovation can achieve greater performance, it requires a relatively large investment of capital and technology, so it needs to be carefully evaluated. However, the selection of various innovation types can be carried out after careful evaluation based on the theory of innovative uses.

The results of this study can be used as a reference for managers on how to improve the accuracy of production and the application of market strategies through the use of appropriate innovation use theory scales and innovation types, thereby ensuring the sustainable operation of the enterprise.

## **5.3 Future Research and Suggestions**

### **5.3.1 Suggestions**

This study takes pre-product development as the main consideration, supplemented by the three aspects of innovative use theory, and combines innovation type as an intermediary to evaluate market performance. Based on this, the following suggestions are made; (1) The scale measurement unit should be composed of personnel from the production side and the sales side in a task grouping manner to avoid errors in data interpretation caused by departmentalism. (2) The measurement targets of the scale are mainly the original consumers of the company, and the future consumers are ancillary. The measurement after the target group is segmented will also be more

accurate for the subsequent development of innovative products. For example, the product in this study is tentatively designated as a digital product, so employees in the technology industry are the main test subjects. (3) It is necessary to fine-tune the text of the scale according to the attributes of product development (it would be better if the product characteristics could be listed) so that the respondents can understand the meaning of the questions and answer them correctly.

### 5.3.2 Future research directions

The main focus of this study is to avoid problems on the production side to facilitate market-side performance. Therefore, the three-facet scale of the innovative use theory is used to evaluate the needs of consumers in the real market and decide what kind of innovation to use for product development, which can not only avoid the wrong investment of resources but also ensure the acquisition of market performance. One of the important decisions is the mediating variable in this research framework, that is, the choice of innovation type. There are many types of innovation known at present. Which one is the most suitable innovation strategy? This needs to be evaluated through innovative use theory. Therefore, future research can have the following directions; (1) Use products with different characteristics to conduct scale testing. (2) Use multiple innovation types as intermediaries for verification. In addition, national conditions and cultures are different, and the views on product attributes are also different. Therefore, the scope of testing can also be increased as follows; (3) Consumers from different countries or living areas can be used as testing targets. Based on this, as a future research direction, the accuracy of this scale can be improved, and it can be used as a standard scale for pre-testing on the production side. It will also be closer to practical management applications and be more helpful to the market.

#### Author Contributions:

Kuo-Liang Chen: Writing—original draft, conceptualization, investigation, formal analysis, methodology, software, and visualization.

Shieh-Liang Chen: Writing-Review, Editing, Supervision, Formal Analysis, Methodology, and Validation.

All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Informed Consent Statement:** The respondents of the survey provided explicit consent to their participation in the study. No personal data was collected, the participation was voluntary, and the respondents had the option to withdraw at any time.

**Data Availability Statement:** Data are available on request.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Appendix A

Structure	Question Item	Reference
Functional Aspect	F1: The functions of this product are suitable for my use (such as messaging, stickers, or voice calls)	Adapted from
	F2: The functions of this product are easy to understand (such as messages, stickers, or voice calls)	
	F3: The functions of this product are easy to learn and use (such as messages, stickers, or voice calls)	[67]
	F4: This product has life-oriented functions (such as platform shopping, payment, or music entertainment)	[67,68,69]
	F5: This product has social link functions (such as groups, or communities)	
	F6: This product can effectively solve my problems (such as communication, social networking, or daily life applications)	
	F7: This product has value for me	
Emotional Aspect	E1: The messages, stickers, or voice calls of this product are my favorite functions and make me want to use them.	Adapted from
	E2: This product is easy to use and makes me feel good, so I am willing to use it	
	E3: This product can keep me connected and makes me feel at ease, so I continue to use it	[70]
	E4: Using this product's free calls saves me money, so I like to use it	
	E5: The functions of this product (such as text messages, stickers, or voice calls) are easy to use, so I am happy to use them	
	E6: Compared with other products of the same type, I have a better impression of this product's functions.	
	E7: I would recommend this product to my relatives and friends to learn about and use it.	

Social Aspect	S1: This product is safe for the body when used normally S2: Normal use of this product will not affect personal health S3: The correct use of this product can assist in work efficiency S4: The payment function of this product (such as LINE Pay) will increase the convenience of life S5: Normal use of this product will not affect the environment S6: The use of this product is recognized by the general public S7: This product is loved and used by the majority of users S8: Users of this product cover different jobs, ethnic groups, religions, classes, and nationalities	Adapted from [71] [67,68,69] [24]
Continuous Innovation	C1: This product will continue to develop and add new features that are different from existing products. C2: This product will continue to develop new features to improve ease of use for customers C3: This product will continue to develop new features to improve customer satisfaction C4: This product will continue to be developed and the quality of the service will be increased C5: This product will continue to be developed and the number of new services will be increased C6: The new features of this product are higher than those of competitors' products C7: This product will continue to launch new features based on market demand.	Adapted from [48] [72]
Disruptive Innovation	D1: This product can be integrated with existing functions (such as mobile phone and PC versions) D2: This product has sufficient maturity and reliability to meet the needs of consumers. D3: This product improves consumer satisfaction by simplifying technology (such as stickers replacing text) D4: This product will reduce the profits of certain services (such as free messages, free stickers, or free voice calls) to increase consumer usage D5: This product will gain new niche markets through innovative methods (such as free messages, stickers, or voice calls) D6: Compared with other products of the same type, this product is more cost-effective D7: This product develops the market with a new business model	Adapted from [35] [73] [74]
Market Performance	M1: The quality of this product has stable consistency M2: This product has good consumer satisfaction M3: This product has good market performance M4: This product has a good market share M5: This product has good market potential	Adapted from [72] [48]

## References

- [1] Wang, Z.; Qi, Z. Analysis of the influences of ICTs on enterprise innovation performance in China. *Managerial and Decision Economics*, 2021, 42(2), 474-478.
- [2] Lin, R.; Xie, Z.; Hao, Y.; Wang, J. Improving high-tech enterprise innovation in big data environment: a combinative view of internal and external governance. *International Journal of Information Management*, 2020, 50, 575-585.
- [3] Dekoulou, P.; Trivellas, P. Organizational structure, innovation performance and customer relationship value in the Greek advertising and media industry. *Journal of Business & Industrial Marketing*, 2017, 32 (3), 385-397.
- [4] Richtnér, A.; Brattström, A.; Frishammar, J.; Björk, J.; Magnusson, M. Creating better innovation measurement practices. *MIT Sloan Management Review*, 2017, 59(1), 45.
- [5] Augusto, M. G., Lisboa, J. V., & Yasin, M. M. (2014). The mediating role of innovation on strategic orientation and performance. *International Journal of Business Innovation and Research*, 8(3), 282-299.
- [6] Baron, R. M.; Kenny, D. A. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 1986, 51(6), 1173- 1182. <https://doi.org/10.1037/0022-3514.51.6.1173>
- [7] Christensen, C.M. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Boston MA: Harvard Business School Press, 1997.
- [8] Christensen, C.M.; Hall, T.; Dillon, K.; Duncan, D.S. *The Use Theory of Innovation: Mastering Consumer Choice, Innovation Don't Have to Hit Luck*. Boston MA: Harvard Business School Press, 2016, Translation by Hong Huifang, Commonwealth Magazine Press, 2017.
- [9] Chen, K. L.; Chen, S. L.. Explore the life-cycle strategies for LINE company from the perspectives of innovative use theory and communication regulations. In *AIP Conference Proceedings* (Vol. 2685, No. 1). AIP Publishing. 2023a, May, 5. <https://doi.org/10.1063/5.0111878>
- [10] Oxford English Dictionary. 2010. <http://www.oed.com/>.
- [11] Miles, L.D. *Techniques of value analysis and engineering*. McGraw Hill, New York, 1972.
- [12] Bloch, P. H. Product design and marketing: Reflections after fifteen years. *Journal of Product Innovation Management*, 2011,

28(3), 378-380.

- [13] Boztepe, S. User Value: Competing Theories and Models. *International Journal of Design*, 2007, 1(2), 55–63.
- [14] Aurisicchio, M.; Eng, N.L.; Nicolás, J.C.O.; Childs, P.R.N.; Bracewell, R.H. 18th International Conference on Engineering Design - Impacting Society Through, 2011, ICED11 15 – 18.
- [15] Pucillo, F.; Cascini, G. A framework for user experience, needs and affordances. *Design Studies*, 2004, 35(2), 160-179.
- [16] Hassenzahl, M. The interplay of beauty, goodness, and usability in interactive products. *Humane Computer Interaction*, 2004, 19(4), 319-349.
- [17] Hassenzahl, M. The thing and I: understanding the relationship between user and product. In *Funology*, 2003, 31-42. Springer, Dordrecht.
- [18] Faber, R. J.; Christenson, G. A. In the Mood to Buy: Differences in the Mood States Experienced by Compulsive Buyers and Other Consumers. *Psychology and Marketing*, 1996, 13, 803-819.
- [19] Frijda, N. H. *The emotions*. Cambridge: Cambridge University Press, 1986.
- [20] Burdge, J.R. *A community guide to social impact assessment*, 3rd ed. Wisconsin (WI): Social Ecology Press, 2004.
- [21] Epstein, M.J.; Yuthas K. *Measuring and improving social impacts: a guide for nonprofits, companies, and impact investors*. San Francisco (CA): Berrett-Koehler Publishers, 2014.
- [22] Fontes, J.; Gaasbeek, A.; Goedkoop, M.; Contreras, S.; Evitts, S. *Handbook for product social impact assessment version 30:roundtable for product social metrics*. PRe Sustainability, 2016.
- [23] Esteves, A. M.; Franks, D.; Vanclay, F. Social impact assessment: the state of the art. *Impact Assessment and Project Appraisal*, 2012, 30(1), 34–42.
- [24] Rainock, M.; Everett, D.; Pack, A.; Dahlin, E. C.; Mattson, C. A. The social impacts of products: a review. *Impact Assessment and Project Appraisal*, 2018, 36(3), 230-241.
- [25] Stevenson, P. D.; Mattson, C. A.; Dahlin, E. C. A method for creating product social impact models of engineered products. *Journal of Mechanical Design*, 2020, 142(4).
- [26] Vanclay, F. Conceptualizing social impacts. *Environmental Impact Assessment Review*, 2002, 22(3), 183-211.
- [27] Lianto, B.; Dachyar, M.; Soemardi, T. P. Continuous innovation: a literature review and future perspective. *International Journal on Advanced Science Engineering Information Technology*, 2018, 8(3), 771-779.
- [28] Chen, S. H. The influencing factors of sustainable enterprise innovation: an empirical study. *Sustainability*, 2016, 8(5), 425.
- [29] Pasche, M.; Magnusson, M. Continuous innovation and improvement of product platforms. *International Journal of Technology Management*, 2011, 56( 2/3/4), 256-271.
- [30] Watts, S. Continuous Innovation: A Brief Introduction. *BMG blogs: Go Big Dictionary*, 2020. Take from Internet 2020/07/08, <https://www.bmc.com/blogs/continuous-innovation/>
- [31] Boer, H. And (Jethro) Said-: Learning-the Link Between Strategy, Innovation, and Production: Full Text of the Inaugural Lecture. Aalborg University, Center for Industrial Production, 2001, May 4.
- [32] Soosay, C.A. An empirical study of individual competencies in distribution centers to enable continuous innovation. *Creativity and Innovation Management*, 2005, 14(3), 299-310.
- [33] Jeffrey, P.; Gerald, R. S. *The external control of organizations*. Harper & Row, New York, 1978.
- [34] Christensen, C.M. The ongoing process of building a theory of disruption. *Journal of Product Innovation Management*, 2006, 23(1), 39–55.
- [35] Wan, F.; Williamson, P. J.; Yin, E. Antecedents and implications of disruptive innovation: Evidence from China. *Technovation*, 2015, 39–40, P94-104.
- [36] Christensen, C.M.; Raynor, M.E. *The Innovator’s Solution: Creating and Sustaining Successful Growth*. Publisher, Boston MA: Harvard Business School Press, 2003. ISBN, 1578518520, 9781578518524.
- [37] Hang, C.C.; Garnsey, E.; Ruan, Y. Opportunities for disruption. *Technovation*, 2015, 39–40, 83–93.
- [38] Markides, C. Disruptive innovation: in need of better theory. *Journal of Product Innovation Management*, 2006, 23 (1), 19–25.
- [39] Alberti-Alhtaybat, L.V.; Al-Htaybat, K.; Hutaibat, K. Knowledge management and sharing business model for dealing with disruption: the case of Aramex. *Journal of Business Research*, 2019, 94, 400–407.
- [40] Suseno, Y. Disruptive innovation and the creation of social capital in Indonesia’s urban communities. *Asia Pacific Business Review*, 2018, 24(2), 174-195.
- [41] Si, S.; Chen, H. A literature review of disruptive innovation: What it is, how it works and where it goes. *Journal of Engineering and Technology Management*, 2020, 56, 101568.
- [42] Thomond, P.; Lettice, F. Disruptive innovation explored. In Cranfield University, Cranfield, England. Presented at: 9th IPSE International Conference on Concurrent Engineering: Research and Applications (CE2002), 2002, 17-28.
- [43] Bain, J.S. monopoly and competition. *Encyclopedia Britannica*, 2022, Take from internet, 2021/09/01, <https://www.britannica.com/topic/monopoly-economics/Perfect-competition>

- [44] Zhang, C.; Hong, S-J. The China Business Model - Originality and Limits: Chapter 2 - Relation Culture, How it Affects the Business Model of Chinese Firms. Science Direct, Journals & Books, 2017, 19-40, ISBN 9780081007501, <https://doi.org/10.1016/B978-0-08-100750-1.00002-4>.
- [45] Saeko, A. N.; Chuntarung, P.; Thoumrungroje, P. The Impact of Integrated Marketing Strategy on Marketing Performance: An Empirical Evidence From Exporting Business in Thailand. *International Journal of Business Strategy*, 2012, 12(4), 56-73.
- [46] Ferdinand, A. Metode Penelitian Manajemen edisi kelima. Badan Penerbit Universitas Diponegoro, Semarang, 2014.
- [47] Smith, S. J. *International encyclopedia of housing and home*, 7<sup>th</sup>. Elsevier, 2012.
- [48] Gunday, G.; Ulusoy, G.; Kilic, K.; Alpkan, L. Effects of innovation types on firm Performance. *International Journal of Production Economics*, 2011, 133(2), 662–676.
- [49] Cheng, C. C. J.; Yang, C-L.; Sheu, C. The link between eco-innovation and business performance: a Taiwanese industry context. *Journal of Cleaner Production*, 2014, 64(1), 81–90.
- [50] Kogabayev, T.; Maziliauskas, A. The definition and classification of innovation. *Holistica– Journal of Business and Public Administration*, 2017,8(1), 59-72.
- [51] Leatham, K. R. Problems identifying independent and dependent variables. *School Science and Mathematics*, 112(6), 2012, 349-358.
- [52] Yam, R. C.; Lo, W.; Tang, E. P.; Lau, A. K. Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries. *Research Policy*, 2011, 40(3), 391-402.
- [53] Chen, S. L.; Chen, K. L. Exploring the Impact of Technological Innovation on the Development of Electric Vehicles on the Bibliometric Perspective of Innovation Types. *World Electric Vehicle Journal*, 2023b, 14(7), 191. <https://doi.org/10.3390/wevj14070191>
- [54] Patel, H. R.; Joseph, J. M. Questionnaire designing process: A review. *Journal of Clinical Trials*, 2016, 6(2), 2-7.
- [55] Krosnick, J. A. Questionnaire design. *The Palgrave handbook of survey research*, 2018, 439-455.
- [56] Likert, R. A Technique for the Measurement of Attitudes. *Archives of Psychology*, 1932, 140, 1-55.
- [57] Malhotra, M. K., Grover, V., 1998). An assessment of survey research in POM: From construct to theory. *Journal of Operations Management*, 16(4), 407–425.
- [58] Nunnally, J.C.; Bernstein, I.H. *The Assessment of Reliability*. *Psychometric Theory*, 1994, 3, 248-292.
- [59] Hair, J. F.; Black, W. C.; Babin, B. J.; Anderson, R. E.; Tatham, R. L. *Multivariate Data Analysis 7th ed.*, Upper Saddle River, New Jersey: Pearson Education Limited, 2009.
- [60] Hu, L.; Bentler, P.M. Fit indices in covariance structure modeling: Sensitivity to under parameterized model misspecification. *Psychological Methods*, 1998, 3(4), 424-453.
- [61] Fornell, C.; Larcker, D. F. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 1981, 18(1), 39–50. <https://doi.org/10.2307/3151312>
- [62] Shrestha, N. Factor analysis as a tool for survey analysis. *American Journal of Applied Mathematics and Statistics*, 2021, 9(1), 4-11. doi: 10.12691/ajams-9-1-2.
- [63] Cui, G.; Bao, W.; Chan, T. S. Consumers' adoption of new technology products: the role of coping strategies. *Journal of Consumer Marketing*, 2009, 26(2), 110-120.
- [64] Gilly, M.C.; Celsi, M.W.; Schau, H.J. It don't come easy: Overcoming obstacles to technology use within a constraint consumer group. *The Journal of Consumer Affairs*, Spring: 2012, 62-89.
- [65] Temple, L.; Lips, H.M. Gender differences and similarities in attitudes toward computers. *Computers in Human Behavior*, 1989, 5(4), 245-226.
- [66] Broos, M.A. Gender and information and communication (ICT) anxiety: male self-assurance and female hesitation. *CyberPsychology & Behaviour*, 2005, 8(1), 21-31.
- [67] OECD-EUROSTAT. *The measurement of scientific and technological activities. Proposed guidelines for collecting and interpreting technological data*, Oslo Manual, OECD, Paris, 1997.
- [68] Wang, S.; Barnes, S. Exploring the acceptance of mobile auctions in China. *Proceedings in Sixth International Conference on the Management of Mobile Business*, Toronto, Canada, 2007.
- [69] Wei, T. T.; Marthandan, G.; Chong, A.Y. L.; Ooi, K. B.; Arumugam, V. What drives Malaysian M-Commerce adoption? An empirical analysis. *Industrial Management & Data Systems*, 2009, 109(3), 370–388.
- [70] Tan, B.; Chou, P. C. The relationship between mobile service quality, perceived technology compatibility, and users' perceived playfulness in the context of mobile information and entertainment services. *International Journal of Human-Computer Interaction*, 2008, 24(7), 649–671.
- [71] Sweeney, J. C.; Soutar, G. Consumer Perceived Value: The Development of a Multiple Item Scale. *Journal of Retailing*, 2001, 77(2):203-220.
- [72] Ali, I.; Danaee, M.; Firdaus, A. Social networking sites usage & needs scale (SNSUN): a new instrument for measuring social networking sites usage patterns and needs. *Journal of Information and Telecommunication*, 2019, 4(26), 1-24. DOI:10.1080/24751839.2019.1675461
- [73] Kneipp, J. M.; Gomes, C. M.; Bichueti, R. S.; Frizzo, K.; Perlin, A. P. Sustainable innovation practices and their relationship with the performance of industrial companies. *Revista de Gestão*, 2019, doi:10.1108/rege-01-2018-0005

[74] Jianfeng, G.; Jiaofeng, P.; Jianxin, G.; Fu, G.; Kuusisto, J. Measurement framework for assessing disruptive innovations. *Technological Forecasting and Social Change*, 2019, 139, 250-265.

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## B1. 研討會接受函

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Dear Kuo-Liang Chen,

We are pleased to inform you that the following paper has been accepted for **ORAL** presentation at the 2021 IEEE International Conference on Social Sciences and Intelligent Management. The conference will be held online from August 29<sup>th</sup> to 31<sup>st</sup>, 2021.

Paper ID: 1157

Title: Market strategy of Clusters Economy in Taiwan Microenterprises

Author(s): Kuo-Liang Chen

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Yours Sincerely,

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## ACCEPTANCE LETTER

Paper No.:T210045

Paper Title: Explore the Life-cycle Strategies for LINE Messaging Company-From the Viewpoint of Innovative Use Theory and Communication Regulations

Authors: Kuo Liang Chen, Shi Liang Chen

Corresponding Author: Kuo Liang Chen

Affiliation: Kuo Liang Chen

I am pleased to inform you that the abstract you kindly submitted to the 3rd IEEE Eurasia Conference on IOT, Communication and Engineering 2021 (IEEE ECICE 2021) has now been accepted and you are invited to attend the conference to present your paper. Please submit your full paper before October 15, 2021.

For early registration, please register your paper by **September 30, 2021**. Your interest in IEEE ECICE 2021 is very much appreciated. I look forward to meeting you at the conference.



*Chi-Ting Ho*

Professor Chi-Ting Ho, Ph.D.  
Dean of Engineering,  
National Formosa University, Taiwan  
Program Chairman of IEEE ECICE 2021  
September 27, 2021

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## ACCEPTANCE LETTER

Paper No.:M220010

Paper Title: Explore the impact of education 4.0 on teaching innovation- Innovative Use Theory Perspective

Authors: Kuo-Liang Chen; Shieh-Liang Chen

Corresponding Author: Kuo-Liang Chen

Affiliation: Department of Business Management Asia University; Department of Business Management Asia University

I am pleased to inform and congratulate you that the abstract submitted to the 5th IEEE Eurasian Conference on Educational Innovation 2022 (IEEE ECEI 2022) has been accepted, and you are invited to attend the conference to present your paper.

For early registration, please register your paper and finish the payment by **December 31, 2021**.



*Chun-yen Chang*

Chair Prof. Chun-Yen Chang, PhD  
Director of Science Education Center,  
National Taiwan Normal University, Taiwan  
Conference Chairman of IEEE ECEI 2022  
December 15, 2021

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*The 5th IEEE Eurasian Conference on Educational Innovation 2022 (IEEE ECEI 2022)*



## B1. 研討會參加證明

附件一：IEEE-SSIM-1157-參加證明 Certificate-3N-20210830-朝陽科大



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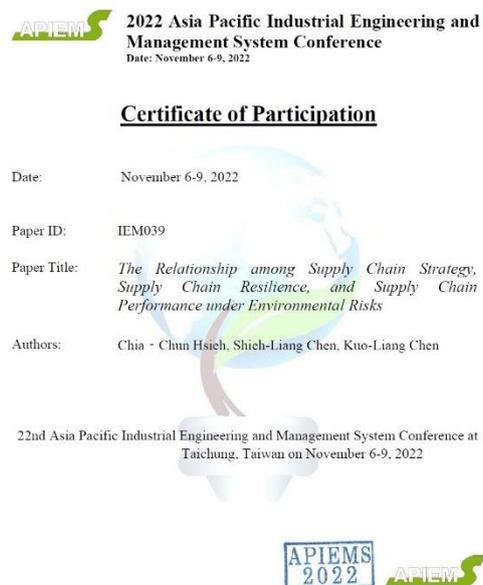




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## B2 研討會論文收錄證明

附件一：期刊等級證明

附件二：文獻來源和網路連結

### 附件一：期刊等級證明

The screenshot shows the Scopus Preview interface for the journal 'AIP Conference Proceedings'. The page title is '來源出版物詳情' (Source Publication Details). On the right, there are three metrics: CiteScore 2022 (0.7), SJR 2022 (0.164), and SNIP 2022 (0.247). The journal information includes: Scopus coverage from 1973 to 2023, ISSN 0094-243X, and subject category 'Physics and Astronomy: General Physics and Astronomy'. There are buttons for '查詢所有文獻', '設定文獻通知', and '儲存到來源出版物清單'.

### 附件二：文獻來源和網路連結

Chen, K. L., & Chen, S. L. (2023, May). Explore the life-cycle strategies for LINE company-from the perspectives of innovative use theory and communication regulations. In *AIP Conference Proceedings* (Vol. 2685, No. 1). AIP Publishing. <https://doi.org/10.1063/5.0111878>

Website: <https://pubs.aip.org/aip/acp/article-abstract/2685/1/040009/2888781/Explore-the-life-cycle-strategies-for-LINE-company?redirectedFrom=fulltext>

The screenshot shows the article page for 'Explore the life-cycle strategies for LINE company-from the perspectives of innovative use theory and communication regulations' by Kuo-Liang Chen and Shieh-Liang Chen. The page includes a search bar, navigation menu, and a 'View Metrics' button. The article is from Volume 2685, Issue 1, dated 5 May 2023. There is a 'Citing Articles Via' section with Google Scholar and CrossRef links. A 'Publish with us - Request a Quote!' button is also visible. The article abstract starts with: 'Due to the rapid development and popularization of Internet technology, mobile communications have appeared in the form of "disruptive innovation" in personal mobile phones and free instant messaging software, which has impacted traditional telecom companies and changed the way of communication between people, and has become an indispensable tool in modern life, so there is a need for in-depth understanding. At present, the academic circles are also generally concerned about...'.

RESEARCH ARTICLE | MAY 05 2023

# Explore the life-cycle strategies for LINE company-from the perspectives of innovative use theory and communication regulations

Kuo-Liang Chen ; Shieh-Liang Chen

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# Explore the Life-cycle Strategies for LINE Company-From the Perspectives of Innovative Use Theory and Communication Regulations

Kuo-Liang Chen<sup>a)</sup> and Shieh-Liang Chen<sup>b)</sup>

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**Abstract.** Due to the rapid development and popularization of Internet technology, mobile communications have appeared in the form of "disruptive innovation" in personal mobile phones and free instant messaging software, which has impacted traditional telecom companies and changed the way of communication between people, and has become an indispensable tool in modern life, so there is a need for in-depth understanding. At present, the academic circles are also generally concerned about the development of instant messaging software, but most of them are based on research on stickers, customer satisfaction and loyalty, technology acceptance models and marketing. This research attempts to use the innovative use theory of the functional, emotional and social dimensions proposed by Christensen (2017), and "disruptive innovation thinking, that using the first three stages of introduction period", growth period and mature period of enterprise life cycle to distinguish the LINE's events and discuss the "innovative use theory" three dimension , the impact on individuals and society of the LINE . In addition to providing academic implications for researchers, this research also provided many suggestions for practitioners

**Keywords:** innovative use theory, disruptive innovation, instant messaging, LINE

## INTRODUCTION

In the course of innovation, NOKIA's Slogan "Technology always comes from human nature" is the most impressive, while foreign NOKIA's English Slogan is "Connecting People", and some people say that the original sentence should be "Human Technology". All things that talk about innovation are inseparable from the key element of people's "needs and uses".

With the development of the Internet, innovation in traditional sales and the relationship between people connection has changed dramatically, traditional letters, telegrams, and faxes are upgraded to e-mail, blog, msn, and then developed to social networking sites such as FaceBook, Youtube, WhatsApp, Wechat, Instagram. From the perspective of marketing promotion. The companies of instant messaging partly uses free calls strategy of "disruptive innovation" and "continuous innovation" convenient functions, subverting the traditional way of calling and contacting through the national telecommunications company, and integrating into life at the same time. It has evolved into a full-featured mobile communication type, such as WhatsApp, which is commonly used in the Americas, Telegram, which is commonly used in Europe, Wechat, which is commonly used in mainland China, and LINE in Taiwan and Japan. This research only uses Line, an instant messaging software mainly used in Taiwan and Japan, as the main research subject.

The use of instant messaging software and other APPs has been integrated into our lives, and the content of the software and services are the same as those of the Ministry of Justice's "Communication Security and Supervision Act Article 3"[1]. The term for legal interpretation is "Communications" as referred to in this law. Such as: Wired and

wireless telecommunications, mail and letters, speech and conversation using telecommunication equipment to send, store, transmit or receive symbols, text, images, sounds or other information. At present, academic circles are also generally concerned about the development of instant messaging software, such as scholars Guo and Tian[2]; Dai and Wang[3] on the use of graphic sticker downloading; Chai, Cai and Xie[4], Chen, Zhang and He[5] used research on customer satisfaction and loyalty; Weng and Huang[6], Lu, Li, Chen, Zhang, and Xu,[7] ; Chang, Hsu, Kung, Chang, and Chao,[8] adopted the model of technology acceptance (digital life, health concepts, work performance); other researches such as teaching, communication, remote care, and marketing include Zeng and Wang[9], Huang, Ke, and Zheng[10], Xu and others[11]; Chen, Hsu, Yang, and Tsai[12], There is very little research on instant messaging and current communication regulations. Moreover, at this stage, the research and development of instant messaging software is mainly based on technological innovation companies, and the business areas covered are all evaluated based on the proportion of the global market, and the number of users is calculated in 100 million people. The current instant messaging software has surpassed the limitations of time and space. If it can break through the legal restrictions, its development speed and growth will exceed imagination. Therefore, it is necessary to study the legal restrictions, and it can also give software development units more active Technological innovation motivation, and then satisfy people's "needs and use".

This research use the "innovative use theory" proposed by Christensen, Hall, Dillon, and Duncan,[13], to disassemble the functional aspect, emotional aspect, and social aspect to sort out the technical application and service innovation of the instant messaging software LINE. In the process, whether it meets people's "needs and use", and the favored by consumers and owned advantages by self, are also the source of future competitiveness. Finally, conclusions and suggestions are put forward to provide suggestions for enterprises in their innovation and development.

## **THEORY DEVELOPMENT**

What the customer wants is not your product or service, but a solution to his problem. Since Christensen's innovative trilogy [14][15][16], The concept of innovation provides another way for companies to adjust their competitive advantages, and there are more and more researches and related applications of disruptive innovation. To put it more simply, disruptive innovation is a strategic choice. For example, scholars Paap and Katz [17] believe that whether it is disruptive innovation or continuous innovation, market demand and innovation itself have a dynamic relationship. This is reasons for the market to choose and accept.

### **Disruptive Innovation**

In a highly competitive environment, the competition and changes of globalization, new products, new services and new business models that can be developed are the focus of competition [14][18]. Destructive innovation was first roposed by Christensen in the "Innovation Dilemma", which includes two types of innovation, destructive and continuous. The main reason is that enterprises have limited resources and difficult allocation. They must meet the needs of these external entities, such as customers and investors [14][19]. Therefore, they must use disruptive innovations to obtain low-end markets or target markets in order to continuously upgrade and innovate. Satisfy customers who are willing to pay more and require better performance, and further ensure that they occupy the mainstream market [14].

This research defines disruptive innovation as: changing products and services, aiming at neglected market reverse integration, providing more fit functions, gaining a market foothold at a reasonable price, changing the basis of competition, and upgrading to provide mainstream customers The required functions, while still maintaining the advantages that allowed you to be successful in the first place.

### **Innovative Use Theory**

When Christensen proposed "disruptive innovation", it did successfully and effectively set another competitive model, but this model did not indicate where to look for new business opportunities? It can only be selected by the executor based on market conditions. Therefore, Christensen once again proposed the "innovative use theory" point of view, transforming thinking logic to reinterpret innovation, filling up the most critical gap in the theory of disruptive innovation, from the perspective of "use" to know the customer consumption of "reason" , the company Should understand what the consumer "hire" that product to do? In other words, consumers can use different methods or tools to achieve the "Task". The "Task" here refers to satisfying the consumer's "demand"[13]. In other words, consumers

use a certain product to make themselves better or to make their lives better. Christesen defines "progress" as the "progress" that someone wants to achieve in a specific situation [13]. Therefore, "innovative use theory" does not mean the product, but the change after using the product, that is "progress"; in other words, the customer "Hire" the product or service in order to complete a certain "Task". Therefore, the successful innovation is to find out the "purpose" of the product or service and help the customer to achieve the "Task" perfectly in the "Specific situation".

Christensen also re-architected innovation to take into account the "functional aspect": Why are new product development and innovation? What are the needs of consumers? "Emotional aspect": Consumers' special feelings about product use, or emotional changes! "Social aspect": The impact on different ethnic groups, backgrounds and classes. The three structure allows companies to simply think about the strategies that can be adopted in the future.

The opportunity for innovation is to find the best way to help consumers remove obstacles and achieve their tasks perfectly! This study defines "innovative use theory" as: empathizing with consumers' "situations", creating products or services for consumers' "use" needs to meet consumers' "tasks and emotions" needs.

## Communication Regulations

According to the 2013 National Communications Commission of the Executive Yuan-Telecommunications Law[20], the Measures for the Administration of the Establishment and Use of Mobile Communication Network Business Base Stations 2020[21]; The Ministry of Justice of the Executive Yuan 2018-Communications Security and Supervision Law [1]; Communications and Communication Law 2021 The year version[22] stated that the content and scope of operations and restrictions on telecommunications are roughly as follows: "Telecom: refers to the use of wired, wireless, optical, electromagnetic systems or other technological products to send, transmit or receive symbols, signals, text, images, and sounds Or other types of information "; "telecom service: refers to the communication service provided by the use of telecommunication equipment."; "the operation of the telecommunications business is divided into the first type of telecommunications business and the second type of telecommunications business. The first type of telecommunications business refers to the establishment of telecommunications Machine line equipment, a business that provides telecommunications services. The telecommunications equipment in the preceding paragraph refers to the network transmission equipment connecting the sender and the receiver, the switching equipment integrated with the network transmission equipment, and the accessory equipment of the two. The second type of telecommunications business refers to telecommunications businesses other than the first type of telecommunications business. ]"; 「 Communications referred to in the Communication Law are as follows: 1. Wired and wireless telecommunications that use telecommunications equipment to send, store, transmit or receive symbols, text, images, sounds or other information. 2. Mail and correspondence. 3. Remarks and conversations. ]'; 「The first category of telecommunications enterprises shall be licensed and issued by the Ministry of Communications before they can operate. 」

The above-mentioned laws and regulations are mostly repetitive explanations of the business content, but they will distinguish the functions of the competent authority and the scope of control due to the different functions of the competent authority, but the establishment conditions are restrict, forming an oligopoly; in addition, the establishment process includes basic telecommunication transmission equipment, which is expensive It also creates barriers to entry. In this way, before the initial cost of the telecommunications business is recovered, the funds and willingness to reinvest in innovation and research and development will inevitably decrease, and the innovation process will also be blocked, which will not be conducive to the evolution of instant messaging. At present, due to changes in technology, technological progress, and consumer habits in the telecommunications industry, the revenue, profit, and the amount of dividends in the telecommunications industry, unlike the past [23], traditional telecommunications companies have been unable to obtain sufficient profits from communications and switched to business operations. Fixed-line, mobile phone binding basic fees, additional charges for audio and video... etc. Therefore, the continuous innovation of people-to-people connection is mostly undertaken by technological innovation companies such as instant messaging.

## RESEARCH METHOD

This research attempts to use the destructive innovative thinking and innovative use theory proposed by Christensen [13][14]to examine the convenient functions provided by the instant messaging software line launched by Taiwan Connection Co., Ltd. (hereinafter referred to as LINE), and analysis it. Understanding, sorting, and summarizing within the framework of functional, emotional, and social aspects. Produce during execution to influence and the future business direction and competitiveness upgrade of the company. In addition, considering the restriction

of "no need to manipulate behavioral events" and "focus on current events" in this study, it is appropriate to adopt the "case study method"[24].

In terms of data sources, in addition to reviewing the current state of academic research on "innovative use theory", the company's official website, press releases, website information, periodicals and professional newspapers and magazines are used [25][26][27][28][29][30][31][32][33] other secondary information. Using the first three stages of the "enterprise life cycle", the "introduction period", the "growth period", the "mature period", and using the Christesen's "innovative use theory"[13] three-structure frameworks "functional aspects", The "emotional aspect" and the "social aspect". By comparing the conceptual framework established by LINE on the functional, emotional and social sides, it is presented in a systematic way in a "narrative", "time series", and then Carry out type comparison to increase internal validity.

Furthermore, in order to increase the validity of the structure, in the data collection stage, multiple sources of evidence are adopted (for example, for the Line company, the data of all parties are collected, and the multiple sources of information are aggregated and classified to establish a series of evidence chains). Cite relevant data in a timely manner and establish a database, compare data from multiple parties, and eliminate the inconsistent parts of the data in the time series to improve the validity of the content. In terms of reliability, the steps of the research will be recorded in detail, and the data collection of the case study will be established, and the operating factors in the data collection process will be recorded to ensure that subsequent researchers can follow the same research context to conduct research and obtain the same results.

## ANALYSIS AND DISCUSSION

In September 2000, LINE, formerly known as HANGAME Japan Co., Ltd., was formally established in Japan. In August 2003, it was merged into South Korea's NAVER and changed its name to NHN Japan Co., Ltd.; in June 2011, LINE instant messaging software was launched in Japan. This research will be explained in chronological order after the official launch of LINE instant messaging software in Japan in 2011. The sequence is "Entry Period", as shown in Table 1; "Growth Period", as shown in Table 2; and "Mature Period", as shown in Table 3.

**TABLE 1.** Entry Period-"Innovative Use Theory" Analysis (2011-2013)

Structure	Date	Event
Time Sequence	Jun 2011	* The instant messaging software Line is officially launched and uses the "Read Receipt" function
	Oct 2011	* Free call function between users
	Feb 2012	* Officially used in Taiwan, with celebrities as spokespersons
	Aug 2012	* Added homepage and timeline function of SNS function
	Apr 2013	* NHN Japan changed its name to LINE Co., Ltd., and LINE business was incorporated into a subsidiary of Naver Corporation
	May 2013	* Taiwan LINE company was officially established
	Oct 2013	* Launched LINE Web Store service in Taiwan
	Other	* Co-published mobile games, including LINE stickers
Functional Level		* "Read Receipt" can confirm the existence of the other party * The free phone function increases the contact frequency * Instant messaging and media messaging services * Online store to buy stickers or games and game tokens and communication solutions * Launched a series of mobile games of LINE Rangers and LINE Disney Tsum Tsum
Emotional Level		* It is easy to know the current situation and strengthen the connection between people * Free phone function to increase contact frequency * Share mind with friends through Line * Celebrity endorsements increase recognition * Increase the use of entertainment services sticking to the student population * Increase life service functions to attract people to use
Social Level		* According to the disaster situation, can quickly contact to know the status of the other party and carry out rescue * The connection between people is closer * The rapid update of mobile communication technology, the rise of smart phones, functions to replace computers, and the trend of everyone owning a mobile phone is coming * The rapid expansion of Line is the result of verifying the ease of use and usefulness of technological innovation * Mobile consumption is gradually launched * Nov 25, 2013 The number of users exceeded 300 million

Source: Collated from secondary data

**TABLE 2. Growth Period- "Innovative Use Theory" Analysis (2014-2017)**

Structure	Date	Event
Time Sequence	Dec 2014 Jan 2015 Mar 2015 Aug 2015 Dec 2017 Other	<ul style="list-style-type: none"> <li>* "Line Pay" is officially launched in Line</li> <li>* Established an independent business Department "Line Friends" to enhance the brand value of characters</li> <li>* Taiwan established a "Link-Plus Internet Company" to specialize in Line Pay to conduct third-party payment services</li> <li>* Formally launched Line Out call service</li> <li>* Invest in a card ticket company to develop electronic payment business and become the largest shareholder</li> <li>* Increase life-oriented functional services, such as Line Today, Line Travel, Line Shopping, Line Taxi</li> </ul>
Functional Level		<ul style="list-style-type: none"> <li>* Operating living expenses and third-party payment services</li> <li>* Integrate a variety of bank cards to provide a variety of payment methods</li> <li>* Use Line Out to make local calls and mobile phones</li> <li>* Including multiple life services such as news, travel, shopping, car-hailing, etc.</li> </ul>
Emotional Level		<ul style="list-style-type: none"> <li>* Use Line as the platform to increase life-oriented services and enhance the convenience of life</li> <li>* Line Pay payment will be notified of real-time transaction information through Line message</li> <li>* Payment is convenient and experience the convenience and advantages brought by technological financial payment services</li> <li>* Lower spent, even free, high consumer acceptance</li> <li>* Become a daily necessities</li> </ul>
Social Level		<ul style="list-style-type: none"> <li>* Gradually change the lifestyle to form the necessity and convenience of life, in line with the usefulness and ease of use proposed by the technology acceptance model</li> <li>* Promote Taiwanese people to experience more contactless, cashless electronic payment services</li> <li>* Integrate different types of contact devices, more usable and more popular</li> <li>* Enhance brand value, turn creativity into reality, and quickly meet various needs of users</li> <li>* Aug 13, 2014 The number of users exceeded 500 million</li> </ul>

Source: Collated from secondary data

**TABLE 3. Mature Period-"Innovative Use Theory" Analysis (2018-20xx)**

Structure	Date	Event
Time Sequence	Sep 2018 Feb 2020 Jun 2020 Jul 2020 Apr 2021 Aug 2021	<ul style="list-style-type: none"> <li>* In cooperation with the All-in-One Card, launch the "Line Pay All-In-One Card Account" with third-party payment functions</li> <li>* The full line of Kaohsiung passenger Transport officially opened the boarding code service</li> <li>* LINE community online service</li> <li>* LINE Homepage and Wallet Revamped Online Services</li> <li>* Established Line Financial, held shares in Line Bank and obtained online banking license, and officially opened</li> <li>* LINE "Chat Room Emoji" service starts</li> <li>* The new group function "LINE form a group" is officially launched</li> </ul>
Functional Level		<ul style="list-style-type: none"> <li>* Integrate electronic payment and third-party payment functions into one card and verify them separately</li> <li>* Enable mobile payment and QR Code ride payment services</li> <li>* Provide online banking financial services</li> <li>* Select and recommend viewing based on topics that users may be interested in</li> <li>* Started group purchase and integrated LINE Pay and LINE Bank to make receive and payment more convenient</li> </ul>
Emotional Level		<ul style="list-style-type: none"> <li>* Convenient payment function</li> <li>* The pleasure can take a car without having to bring money</li> <li>* Highly related use functions are integrated together for easy use</li> <li>* The service scope is integrated into life and easy to use</li> <li>* Convenient services can be used without going out</li> </ul>
Social Level		<ul style="list-style-type: none"> <li>* Intervene in public transportation services to provide convenience for payment</li> <li>* Change the mode of living consumption payment</li> <li>* Digital wallet in life and personalized content tailored for users</li> <li>* According to the environmental changes caused by Covid-19, the movement of people is restricted</li> <li>* Integrate online financial transactions and change consumption habits</li> <li>* Oct 24, 2019 The number of users in Taiwan is 21 million; the number of daily messages exceeds 1 billion</li> </ul>

Source: Collated from secondary data

## Theory Structure Analysis of Innovative Uses

**Entry Period (2011-2013):** During this period, the name and management rights were changed several times. After the market was launched, it was mainly to expand the popularity and practicality of LINE. In addition to having the same free voice function as Skype in the US and Mixi in Japan, it also emphasizes the message "reading receipt" in order to grasp the static information of the recipient. Increase the number of video games and mobile games and interesting digitize sticker graph in order to quickly expand the number of registrations and users.

**Growth Period (2014-2017):** Use LINE instant messaging software as a platform to expand into digitize life, consumption, leisure, travel, audio-visual, entertainment, and third-party payment services, allowing consumers connections through LINE to meet digitize life and interpersonal Demand.

**Maturity Period (2018-20xx):** In response to the improvement of 5G technology, combined with smart phone functions, expand the service scope of the LINE platform, participate in public transportation payment and online banking business through digitize, diversification, other change the consumption mode of life.

## CONCLUSION AND SUGGESTION

The "innovative use theory" is mainly to help companies understand what factors motivate customers to use a certain product or service in their lives. Therefore, the value of "innovative use theory" is not to explain past successes, but to predict new innovative examples. This research is based on the "introduction period", "growth period", "mature period" of the enterprise life cycle, and the "functional aspect", "emotional aspect", and "social aspect" proposed by Christesen. It is known through comparison and analysis that LINE The company has 21 million registered users in Taiwan, and its powerful disruptive innovation. The free voice function has surpassed all current telecom companies in Taiwan. According to Gartner's survey, Singapore, Australia and New Zealand, the amount of instant messaging commonly used locally is also greater than that of this phenomenon has been arise in Western Europe, Canada, the United States, Japan, South Korea, In the markets of traditional telecommunications providers [23]. Therefore, as the company grows, LINE's communication technology has updated its transmission speed from 2G to 5G, and has gradually developed from the inside to the outside, from messaging, voice, games, stickers, third-party payments, public transportation payments to legally operating online banking, On the "functional side", in addition to satisfying the "usefulness" and "easy-to-use" of the technological acceptance model; on the "emotional side", what it brings to users is convenience and life-oriented, and it makes users love it, and the degree of adhesion is very high. ; On the "social level", it helps to solve the payment method of public transportation, improves the convenience of use, and then changes the consumption pattern of life. It can be expected that if LINE encounters a "recession period" in the future, the acquisition of telecom companies and diversified operations will be the best strategic choice.

### Academic Implications

This study uses the "functional aspect", "emotional aspect", and "social aspect" proposed by Christesen as the framework to organize and summarize the secondary data according to the order of the life cycle of the enterprise, which has a positive contribution to the construction of the "innovative use theory", so For academic research, it has its importance and contribution.

### Management Implications

The phenomenon found in this research based on actual data comparison and the development of LINE company can provide several directions for instant messaging companies to think about.

The first is the "disruptive innovation of the integration of the virtual and the reality": The product extension of the digital totem is the specialty of Japanese companies. The existing LINE Friends are responsible for the commercialization of all LINE stickers, and they also have the title of "Asian Money-sucking Group". The physical stores is relatively scant for hundreds of millions of registered users. Increasing regional physical stores close to the crowd is a direction that can be considered.

The other is "think about merging and acquiring telecom companies to stay invincible": At present, telecom companies are in an oligopolistic market, and there are responsibilities and obligations assigned by the government

that must be implemented. Now instant messaging has impacted traditional telecom companies. Will it remain the same in the future? Or is it a law to restrict the scope of instant messaging business? It is not yet known, so it is better to plan ahead.

## Suggestions

According to the structural analysis of "functional aspect", "emotional aspect", and "social aspect" of the innovative use theory, it is suggested that enterprises can refer to the strategy application: as shown in Table 4, the explanation is as listed!

**TABLE 4.** Strategies of enterprise life-cycle

	<b>Disruptive Innovation</b>	<b>Continuous Innovation</b>
<b>Mature period</b>	Sustaining Strategy	Expansion Strategy
<b>Recession Period</b>	Acquisition Strategy	Diversification Strategy

### *Sustaining Strategy*

At present, companies of the same type have fierce competition in the market, such as messenger, WhatsApp, and Viber. LINE can maintain the same free voice communication as its competitors, and from time to time give away digital stickers and consumer points that are superior to other companies in order to maintain its market advantage.

### *Expansion Strategy*

Take advantage of scientific and technological innovation to expand participation in the digital construction and service of public utilities, and widen the market gap with other companies of the same type.

### *Acquisition Strategy*

Because the free voice function impacts traditional telecom companies, it is currently unknown whether other factors will cause government enforcement restrictions in the future. Therefore, acquiring telecom companies to avoid future legal restrictions or developing alliances with telecom companies are all options that can be considered.

### *Diversification Strategy*

The business department operates independently, and in a diversified manner, risks can be diversified; when the business department's operating conditions are poor, it can be cut and dealt with without affecting the business body.

## Future Research Directions Limitations

Due to the LINE has not yet been listed on the stock market, the financial performance cannot be correctly evaluated. Future research suggestions can consider several more companies for comparison, and obtain financial reports in the stock market as a basis for development performance. In addition, attention must be paid to changes in laws and regulations to allow the research results to have a wider scope of application, so that such research will be more convincing and more valuable.

## REFERENCES

1. Executive Yuan Ministry of Justice, "Article 3 of the Communication Guarantee and Supervision Law", National Law Database, 2018, <https://law.moj.gov.tw/LawClass/LawAll.aspx?pcode=K0060044>.
2. Guo Yingfeng and Tian Zihong, "The Influence of LINE Corporate Sticker Types on Advertising Effects", Journal of Information Management of the Republic of China, 2017, Vol. 24, No. 4, pp. 455-484.
3. Tai Chiying and Wang Lanting, "Research on Image Action and Emotion Communication of LINE Original Stickers", China Printing Technology Annual Report, 2019, P156-175.

4. Chai Kangwei, Tsai Chengyueh, Hsieh Chiachan, "A study on service innovation, customer satisfaction and loyalty for mobile communication software— The case of LINE", *Management Information Computing*, 2018, Volume 7, Issue 2, Pages 146-155.
5. Chen Yi, Zhang Teng, He Fang, "Research on College Students' Purchase Intention and Loyalty of Social Apps-Taking Line as an Example", *Journal of Graphic Communication Art*, 2013, P106-110.
6. Weng Chenyu & Huang Huiping, "Exploring the use of LINE TV with an extended and integrated technology acceptance model and digital lifestyle", *Information Society Research*, 2017, Issue 33, P17- 63.
7. Lu Yunlin, Li Chengxun, Chen Jingyi, Zhang Jiaming, Xu Zheming, "Discussing college students' health management APP use behavior with health concept and technology acceptance mode", *China Medical Journal*, 2016, Issue 44, P38-54.
8. Chang Shuhua, Hsu Chehan, Chien-Chi Kung, Chang Hsingyun, Chao Chienlei, "Combining technology to accept models and tasks Properly Exploring the Impact of Nursing Staff's Use of Social Media on Work Performance with Science and Technology", *Journal of Medical Management*, 2019, Volume 20, Issue 4, P267-287
9. Zeng Ronghua & Wang Shengzhong, "Come to a Destruction Class-Examining the Teaching Examples of Card Learning Aids with Innovative Use Theory", *Journal of Teacher Training and Teacher Professional Development*, 2018, Volume 11, Issue 3, P137- 148.
10. Huang Meili, Ke Shuting, Cheng Ronglu "A Case Study of Parent-Teacher's Communication by Line APP", *Management Information Calculation*, 2017, No. 6 Volume Special Issue 1, pp72-81.
11. Xu Jingyi, Qiu Liling, Xu Qiuyi, Wu Yanwen, Lin Henghsu, Chen Chiachi, Chen Mingshu, "The feasibility and benefit evaluation of the new newsletter community software for post-discharge outpatient telecare for cardiovascular patients: a pilot study of a single medical center", *Journal of Medical Management*, 2017, Volume 18, Issue 4, P292-314.
12. Chen Yunhua, Hsu Yueting, Yang Xinyi, Tsai Fuden, "The Impact of the Banking Industry's Use of Communication Software Marketing on Consumers' Decisions-Taking LINE as an Example", *Journal of Graphic Communication Art*, 2019, P79-86.
13. Christensen, C. M., Hall, T., Dillon, K., Duncan, D. S., "Innovative use theory – Cmpeting Against Luck", translated by Hong Huifang, *Commonwealth Magazine*, 2017, Taipei.
14. Paap, J. & Katz R., "Anticipating Disruptive Innovation", *Research Technology Management*, 2004, Vol. 47 (5), pp.13-22.
15. Christensen, C.M., "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail", Boston MA: Harvard Business School Press,1997; Shang Zhou, 2007.
16. Christensen, C.M. & Raynor, M.E., "The Innovator's Solution: Creating and Sustaining Successful Growth", Boston MA: Harvard Business School Press,2003; Translated by Li Fangling,2017, Li Tianshu, Commonwealth Magazine Press.
17. Christensen C.M., Anthony D.S. & Roth A.E.," Seeing what's next? using the theories of innovation to predict industry change", Boston MA: Harvard Business School Press,2004; Translation by Li Fangling ,2017, ommonWealth Magazine Press.
18. Hamel, G.," Leading the Revolution", Harvard Business School Press, 2000, Boston, Massachusetts.
19. Jeffrey, P., & Gerald, R. S.," The external control of organizations", Harper & Row,1978, New York.
20. National Communications Commission of the Academy, "Telecommunications Law", National Regulations Database, 2013, <https://law.moj.gov.tw/LawClass/LawAll.aspx?pcode=K0060001>
21. National Communications Commission, "Administrative Measures for the Setup and Use of Base Stations for Mobile Communication Network Business", 2020, <https://law.moj.gov.tw/LawClass/LawAll.aspx?pcode=K0060089>
22. National Communications Commission "Communication and Communication Regulations Compilation 2021 Edition", National Regulations Database, 2021, [https://www.ncc.gov.tw/chinese/news\\_detail.aspx?site\\_content\\_sn=3885&cate=0&keyword=&is\\_history=0&pages=0&sn\\_f=45904](https://www.ncc.gov.tw/chinese/news_detail.aspx?site_content_sn=3885&cate=0&keyword=&is_history=0&pages=0&sn_f=45904)
23. This Weekly, "The telecommunications industry wants to return to glory and there are these roadblocks", 2020, <https://ctee.com.tw/news/stocks/345470.html>
24. Yin, K. R.," Case Study Research: Design and Methods",1994, London: Sage.
25. Taiwan Connection Co., Ltd., 2021, <https://www.twincn.com/item.aspx?no=24556886>
26. Line Blog, "The first public use of LINE's big data!", 2019, <https://official-blog-tw.line.me/archives/81291901.html>

27. Daily Toutiao, 2016, <https://kknews.cc/zh-tw/tech/npaj3g.html>
28. Key Commentary Network, 2014, <https://www.inside.com.tw/article/3743-the-story-of-line-founder-lee-hae-jin>
29. Cheng Tingfang, Vision Magazine, 2014, <https://www.gvm.com.tw/article/19019>
30. Yang Chenxin, "Analysis of the Latest Layout of Instant Messaging App", Future Business, 2020, <https://fc.bnext.com.tw/articles/view/127>
31. Gao Xiaochi, newtalk, 2020, <https://newtalk.tw/news/view/2020-02-17/367982>
32. Chen Guanrong, "2020 LINE App Taiwan users love to use new features ranking list released", technews, 2020, <https://technews.tw/2020/12/31/2020-line-app-function-rankings/>
33. Qiu Liyan, "LINE's new service focuses on seamless experience. Can it really become Taiwan's "super app"?", Foresight Magazine, 2020, <https://www.gvm.com.tw/article/7367>