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Point of Sale and Decision to Use e-Payment Channel

*Tatre Jantarakolica**
Faculty of Economics, Thammasat University, Thailand

Korbkul Jantarakolica
College of Innovation Management, Rajamangala University of Technology Rattanakosin, Thailand

Jutamas Wongkantarakorn
College of Innovation Management, Rajamangala University of Technology Rattanakosin, Thailand

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Abstract

The purpose of this research was to determine the impact of network externality of e-payment channel and factors at the point of sale on the decision to use the e-payment channel. The conceptual framework was applied from hierarchical elimination-by-aspect decision-making concept, two-sided market concept, network externality, diffusion of innovation theory, and factors at the point of sale. A stratified random sampling technique was applied to select 3,000 customers from mobile applications to answer the *self-report choice experimental questionnaire*. Data were organized as scenario-based panel data and analyzed by a multinomial logit model and nested logit model. Research findings revealed that the IIA assumption was violated; thus, the nested logit model should be applied in explaining the two hierarchical steps of payment channel decision. The major factor that determines the first step of e-payment decisions was the customer's perception of the network externality of e-payment. The decision to use a particular e-payment, either mobile banking, QR code payment, or e-wallet, was determined by factors at the point of sale, including availability, reward, transaction fee, perceived convenience, and security of that payment channel. Additionally, the effects of gender, age, and income of customers also significantly influenced the payment channel decision.

Keywords: Point of Sale, Payment Channel, Perceived Convenience and Security, Hierarchical Elimination by Aspect, Nested Logit Model.

JEL Classifications: C35, C38, G20, G21

*__Correspondence author__: Address: 2 Prachan Road, Phra Borom Maha Ratchawang, Phra Nakhon, Bangkok 10200. Email:tatre@econ.tu.ac.th

1. Introduction

In the age of disruptive technology, the world today has rapidly digitally transformed with the widespread use of electronic devices. Smartphones are one of the major developments which has changed everyday life of people. It becomes one of the necessities for most people. At the same time, there have also been many technological breakthroughs in the financial sector. This includes financial innovation via smartphone applications which significantly change people's habits. The advancement in the payment channel system has enabled people to pay bills through their smartphone applications.

The major breakthrough in the advancement of digital payment technology started from the advancement of Internet Technology 3G and smartphone in 2000. This led to the development of electronic payment channels through smartphones (Chucherd, 2018). According to World Bank (2011), only 2 percent of all consumable transactions in Thailand are non-cash payments. This showed that Thailand has high growth potential in this field. In Singapore, approximately 61 percent of all transactions are non-cash. With the enhancing policies[1] promoting e-Payment system of the Bank of Thailand, digital payment in Thailand has continuously and rapidly grown since the beginning of the policies in 2002. According to Bank of Thailand (2016, 2019), the number of electronic payment transactions has the highest growth rate of 97% in 2012-2016 and 83% in 2016-2019.

The advancement of credit card payment channels in 1970-1990 can be explained using the Two-sided Market and Network Externality by Rochet & Tirole (2003). The number of peers and the complementary are the two factors that affect the use of credit card payment. The volume of both customers and vendors must be large enough to satisfy the demands on both sides, and there must also be additional benefits to customers paying by a credit card over by cash.

Because of all the stated reasons above, the researchers were interested in whether the advancement of electronic payment in Thailand will be similar to that of the credit card payment. Can the Two-sided Market and Network Externality from Rochet & Tirole (2003) be applied in this case? The researchers have chosen many forms of electronic payments such as PromptPay (by QR Code), e-wallet (such as Rabbit Line Pay or TrueMoney Wallet, and mobile application wallet (such as GrabPay or Get Pay).

The purpose of this research is to study the effects of the network externality on electronic payments and the factors that affect electronic payment decisions. The researchers have narrowed down the forms of e-Payment to mobile banking, QR Code and e-wallets, including Rabbit Line Pay, TrueMoney Wallet, GrabPay and Get Pay.

2. Conceptual Framework

This research has applied the following frameworks: Decision Making based on Hierarchical Elimination by Aspect (HEBA), Two-sided Market, Diffusion of Innovation Theory, Innovation Adoption Process, and Factors at Point of Sale.

[1]In order to promote the safety and efficiency of the national payment systems, the Bank of Thailand has implemented four roadmaps for the e-Payment systems, which are the Payment Systems Roadmap 2004, the Payment Systems Roadmap 2010, the Payment Systems Roadmap 2012, and the Payment System Roadmap 2019-2021. These roadmaps provide framework for the development of Thailand's payment systems during 2002 – 2004, 2005 – 2010, 2012 – 2016, and 2019-21, respectively.

Decision Making Based on Hierarchical Elimination by Aspect (HEBA)

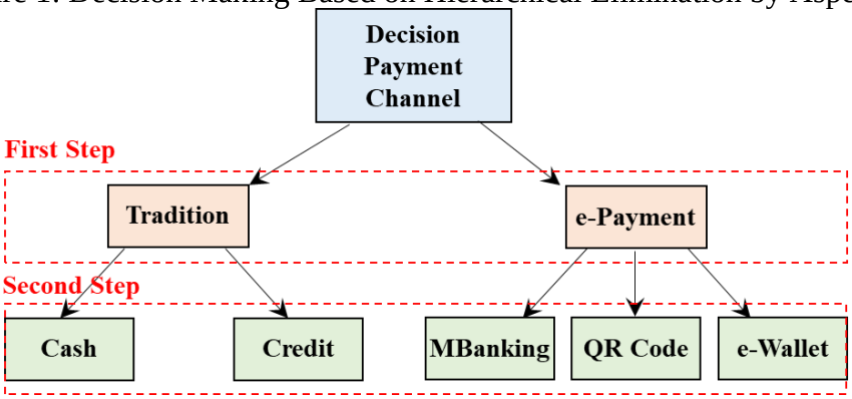
The Decision Making Based on Hierarchical Elimination by Aspect: HEBA framework is most appropriate to use when there are many choices. On the contrary, maximized utilities is appropriate to use when there are less choices. Because users had to evaluate all possible options, they may first organize the choices into different aspects and then evaluate each aspect in order. This method, which is more appropriate in this type of decision making, is called Hierarchical Elimination by Aspect (HEBA) (Tversky & Sattath, 1979).

The users may identify each aspect by the following steps:

The first step starts with choosing the category of choice; then, the undesired category can be eliminated. Figure 1 shows the Elimination by Aspect (EBA). In the case of payment category selection, the consumers can choose between the traditional method and e-Payment.

The second step is to choose the options within the selected aspect or category. In Figure 1, if the consumers opt for the traditional method in the first step, the e-Payment method would be cut off. In the second step, the consumers then choose between cash and credit. On the contrary, if the consumers opt for the e-Payment in the first step, the traditional method would be cut off. In the second step, the consumers then can choose among mobile banking, QR code, or e-wallet.

Figure 1: Decision Making Based on Hierarchical Elimination by Aspect



Source: Author's formulations.

(1) Factors that Affect the First Step

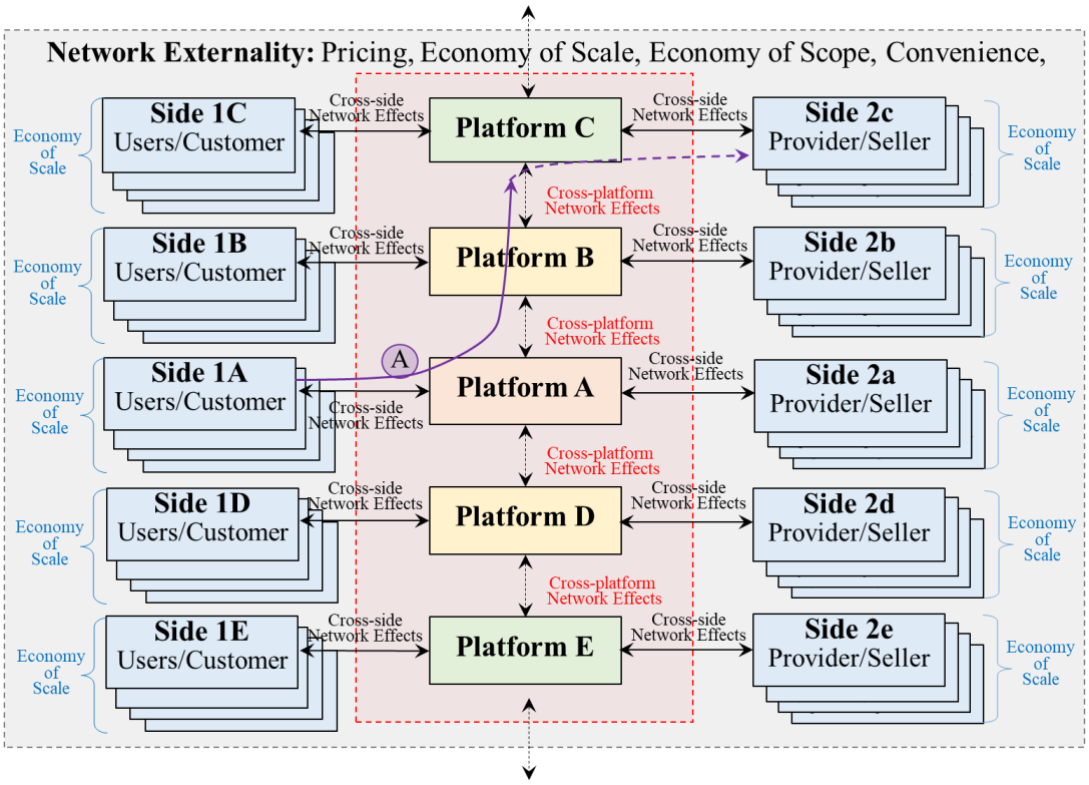
Factors affecting decision to choose between traditional and e-Payment platform include users' perception on network externality of the platform and characteristic of the user. Based on two-sided market concept, network externality of the platform helps facilitate the users to conveniently use that payment platform. Based on diffusion of innovation theory, a user with different characteristic has different level of innovation adoption. E-Payment platform, classified as financial innovation, would have different level of adoption based on different characteristics of the users.

Two-sided Market Concept

After the development of the credit card payment method, Rochet & Tirole (2003) have formed market platform strategies to explain the cause of its growth, which can also be found in the credit card payment platform such as Visa, Master, and American Express. The growth of the platform can be explained in the form of a Two-sided Market between consumers and merchants.

Rochet & Tirole (2003), Rysman (2009), Holzer & Ondrus (2009), Weyl (2010), and Lin & Lu (2011) explained that platform developers can choose to charge consumers, merchants, or both depending on the type of service in a two-sided market. In Figure 2, each platform can charge its service fee from consumers, merchants, or both. The option and the amount depend on the sensitivity to price and the marginal cost of each side (Rochet & Tirole, 2003, 2006; Weyl, 2009). For example, in a market where the consumer has a high sensitivity to price, the price of that product tends to be low in a two-sided market. The lower price would attract more customers and increase demand. On the other side, more merchants will join the market due to the increase in demand, therefore lowering the sensitivity to price. Because of this, some platform providers would choose to lower the price to be below the cost on one side to increase the demand on the other side.

Figure 2: Two-sided Market and Network Externality of Platform Cycle



Source: Author's formulations.

For example, Visa and Master, the credit card platform providers, would choose to waive the service fee for the credit card customers to increase the number of users. Instead, they would charge the merchants for accepting payment with their cards. This shows that the credit card platform providers choose to take a loss on one side of the market (customers) to gain profit from the other side (merchants). Table 1 shows the example of a two-sided market such as PC Operating System, Online Recruitment, or E-market Places.

Table 1: Example of Two-sided Market

Networked Market	Loss-Leader Side	Profit-Making Side	Platform Providers
Payment Systems	Users	Merchants	Visa, Master, AliPay, LinePay
PC Operating System	Application Developers	Consumers	Windows, Macintosh
Online Recruitment	Job Seekers	Employers	JobsDB, JobTopGun
Web Search Engine	Searchers	Advertisers	Google, Yahoo
Video Games	Developers	Players	PlayStation, Xbox
Ticketmaster	Event Organizers	Users	ThaiTicketMajor
E-market Places	Buyers	Sellers	Lazada, Shopee

Source: Author adjusted from Holzer & Ondrus (2009), Rochet & Tirole (2003, 2006) and Weyl (2009).

Under the two-sided market concept, platform providers can develop their market competitiveness by enhancing their market power through network externality of the platform (Bardey, Cremer, & Lozachmeur, 2014).

Network Externality

In the platform market competition, the providers may try to dominate the market in order to become a monopoly. The success of a platform application depends on multiple factors. One of the factors is Network Externality.

Figure 2 shows the effects of network externality. This occurs when the two-sided market pricing is used to increase the platform users to apply the economies of scale. The cross-side network effects occur when the platform application links the two sides together. When a platform application has a high volume of users on both sides, the platform can create market size effects.

In addition to the market size effects, most platform providers usually create network externality from creating cross-platform network effects by linking their applications to other platforms. For example, Wongnai, Thailand's leading super-lifestyle platform, linked its application with Google Maps. This platform link can cause the economies of scope, which can cause compatibility effects.

When a platform application successfully creates a competitive advantage from the network externality, it can create market power. As a result, the platform competitors would lose and close down until only few applications remained. The market then would become an oligopoly or monopoly.

For example, the smartphone operating system market only has 2 main competitors: iOS from Apple, which is a closed technology, and Android from Google, which is an open source technology. In the past, large firms were unable to successfully launch their system. The failures of Symbian from Nokia Ericsson, RIM from Blackberry, and Microsoft phone have led to the finding that a centralized portal has a competitive advantage over a decentralized portal. The developing tools in the platform application must be linked to the platform. The platform must at least have partial integration or full integration. The platform with no integration or device integration cannot compete with the market. Whether the platform has closed technology or open technology, it has no effect on the ability to compete in the market. Whether the platform has one device or multiple devices, it also has no effect.

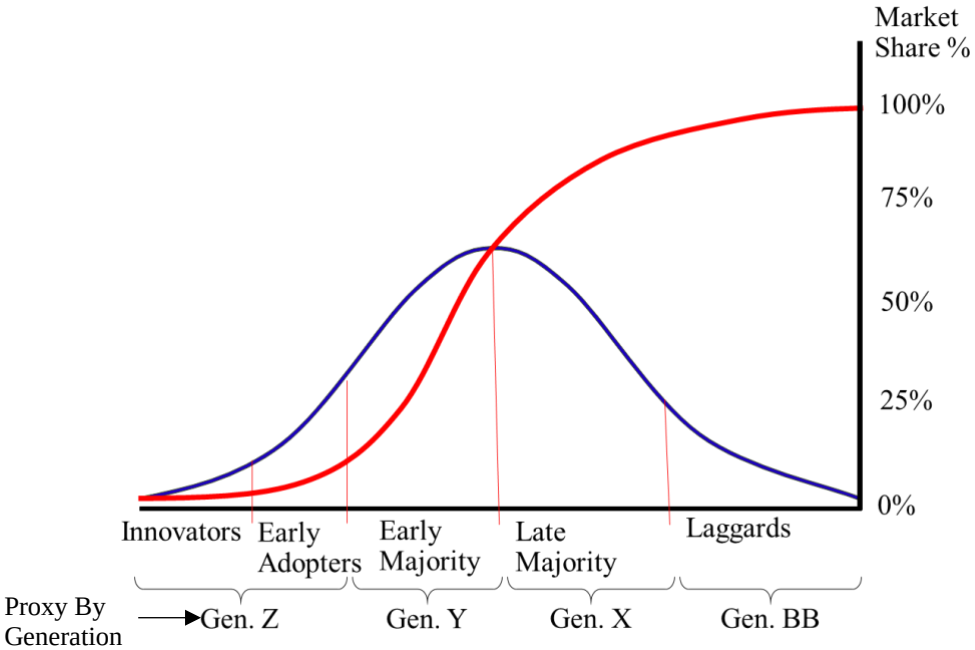
From the development of the platform and electronic payment market, the electronic payment market competition may end up in a monopoly or oligopoly. Only a few electronic payment platforms will remain with complete service. The major factors in the electronic payment decision include the network externality of electronic payments, number of peers, number of cross-platforms, and compatibility effects. With more number of peer stores accepting the e-Payment platform, more number of cross-platforms connecting to the e-Payment platform, and more benefit from compatibility, e-Payment platform would be more convenient for users to use the platform (Krivosheya & Korolev, 2016; Li, McAndrews, & Wang, 2019; Swartz, Hahn, & Layne-Farrar, 2006).

In addition to the network externality effect, electronic payment is also considered a financial innovation. Therefore, the diffusion and acceptance of consumer innovation are important factors in the decision to adopt that innovation. Diffusion of Innovation Theory and Innovation Adoption Process by Roger (2003) can be applied to explain the consumers' decision to use financial innovation.

Diffusion of Innovation Theory and Innovation Adoption Process

Diffusion of Innovation Theory by Roger (2003) explained that the diffusion of innovation follows the adoption process as shown in Figure 3. This figure shows the diffusion in the form of the red S-curve. New innovation starts to diffuse slowly in the first stage. The diffusion then speeds up exponentially in the next stage. Finally, the diffusion rate slows down in the last stage. In the process of adoption, Roger (2003) segmented people who use innovation into 5 groups: Innovator, Early Adopters, Early Majority, Late Majority, and Laggards. Innovators were the first to accept and adopt new innovations whereas laggards were the last group to do so.

Figure 3: Diffusion of Innovation and Innovation Adoption Process



Source: Author adjusted from Roger (2003).

This research categorized consumers who accept the electronic payment financial innovation by age. The Gen Z is categorized as innovators and early adopters while the Gen Y is categorized as the early majority. The Gen X is categorized as the late majority whereas the Baby Boomer is categorized as the laggards. The younger age users, who are

more familiar with technology, are more likely to use e-Payment platform than those with older age, who are not quite familiar with the technology (Beck, Pamuk, Ramrattan, & Uras, 2018; Chen, Huynh, & Shy, 2019; Silva, Ramalho, & Vieira, 2016).

In addition to segmentation by age, gender and income were also personal characteristics that affect the acceptance of financial innovations. Generally, males are more likely to try new technology than females (Arango, Huynh, & Sabetti, 2015; Beck, et. al., 2018; Hamza & Shah, 2014). High income users have more exposure to new technology than lower income users (Arango, et. al., 2015). Because of this, the factors that affect the decision to use electronic payment also include age, gender, and income.

From the Two-Sided Market, Network Externality, Diffusion Innovation Theory, and Innovation Adoption Process, it can be concluded that the factors that affect the first step in choosing the electronic payment are the perceived network externality, age, gender, and income of consumers.

(2) Factors that affect the Second Step

After choosing the form of payment with maximum utilities, consumers will choose the payment option in that category from the factors at the point of sale.

Factors at Point of Sale

Other than the electronic payment platform competition that causes network externality, the electronic payment also creates an advantage in the electronic payment network. Bergsten (1966), Garcia-Swartz, Hahn, & Layne-Farrar (2009), Armey, Lipow, & Webb (2014), Arango, et. al. (2015), Krivosheya & Korolev (2016), Magnac (2017), Chen, Huynh, & Shy (2019), Luna, Liébana-Cabanillas, Sánchez-Fernández, & Muñoz-Leiva (2019), and Fabris (2019) concluded the advantages and disadvantages of electronic payments that led to Less Cash Society and Cashless Society in the end. Table 2 shows the Advantage and Disadvantage of a Cashless Society.

Table 2: Advantages and Disadvantages of Cashless Society

Advantages	**Disadvantages**
Reduce fraud and money laundering	Harder access for the senior and the disadvantaged
Convenience in payment	People with low knowledge in technology or low funds may not have access
Reduce the number of illegal transactions	Cybercrime
Reduce cost in making transactions	Lack of Privacy
Safer by not carrying cash	Technological Information Risk
Technology advancement in electronic payments	Lower self-control in spending

Source: Author adjusted from Arango, et. al. (2015), Fabris (2019), and Garcia-Swartz, et. al. (2009)

The Advantages and Disadvantages of Cashless Society pointed out the cost and advantages that the consumers and society will get from cash payment and non-cash payment (Arango, et. al., 2015; Magnac, 2017; Chen, Huynh, & Shy, 2019). However, the research on the decision payment channel has found that the major factor in choosing the payment type at the point of sale includes the availability of payment channels. If the payment channel is not available, the consumers may not be able to choose that option (Arango, et. al., 2015; Bátiz-Lazo, Haigh, & Stearns, 2014). For example, some stores may not accept credit cards; as a result, the consumers cannot pay by credit cards. On another case, even though the payment channel is available, a store may incur a transaction fee. As a result, the consumers may not choose that option as well (Magnac,

2017). For example, the store may accept credit card payment but with a 3% fee. Because of this, the consumers may not choose to pay by credit cards as well.

In some circumstances, one payment platform may promote its platform by offering a reward to the platform consumers. This creates an incentive for consumers to switch to that platform (Arango, et. al., 2015; Chen, et. al., 2019). For example, some credit card companies may promote their cards by offering reward points that can be exchanged for gifts to incentivize customers to use their credit cards.

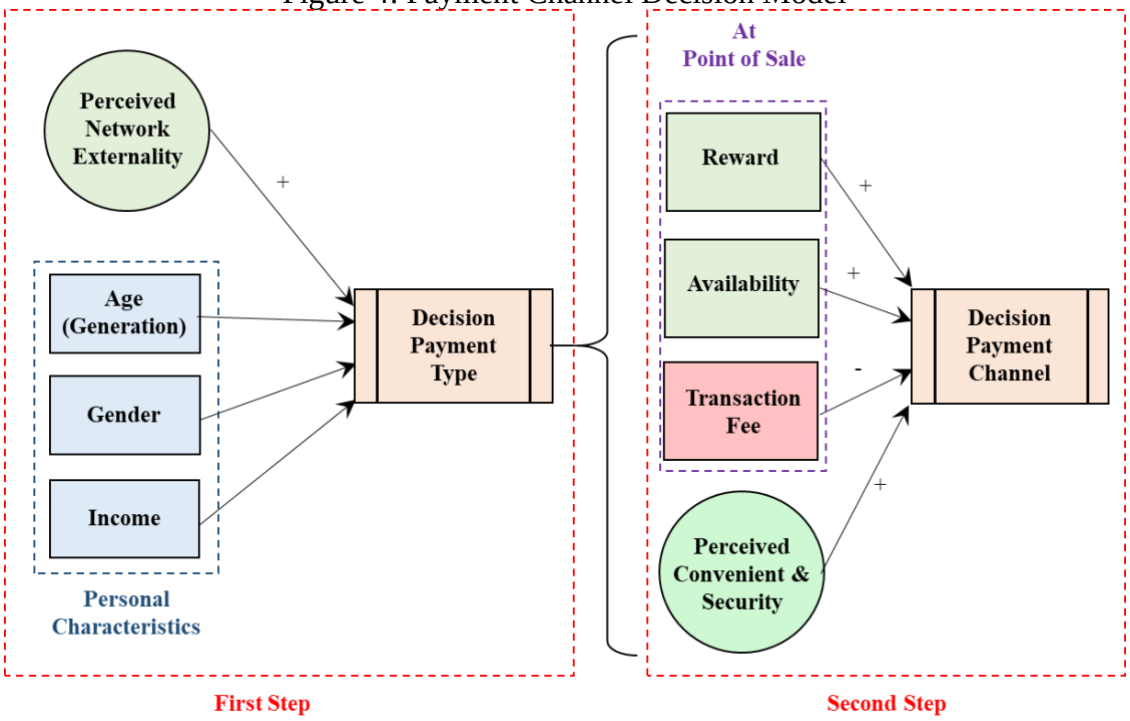
This research assumes that the factors that determine the decision payment channel at the point of sale include Availability, Reward, Transaction Fee, and Perceived Convenience and Security.

Electronic Payment Model

The Decision Making Based on Hierarchical Elimination by Aspect, the Two-Sided Market that forms Network Externality, Innovation Adoption Process that separates adopters into 5 different segments, and the Decision Payment Channel at the point of sale can be applied into the electronic payment model as shown in Figure 4.

Figure 4 explains that consumers perceive the network externality of electronic payment type in 3 different aspects: the number of consumers and merchants in the two-side market, the cross-platform network effects of the electronic payment, and the compatibility of the platform system. The network externality may affect the decision payment type between traditional payment and electronic payment. In addition to this, personal characteristics such as age, gender, and income may play a role in the decision payment type. After the decision payment type is selected, the consumer will choose the payment channel at the point of sale depending on the channel availability, reward, transaction fee, and the perceived convenience and security of that payment channel.

Figure 4: Payment Channel Decision Model



Source: Author's formulations.

From the above conceptual framework, the hypotheses of this study can be stated as:

H_1: The perceived network externality of the electronic payment channels and personal characteristics such as gender, age, and income are the factors that affect the decision payment type (First Step).

H_2: The factors at the point of sale, which include availability, reward, and transaction fee, and the perceived convenience and security of the payment affect the decision payment channel (Second Step).

3. Method of Study

3.1 Sample

Since a complete data set of all payment channels are unavailable, this study employs a field survey study using a self-report questionnaire. In order to obtain all groups of mobile application users with different behaviors, the respondents in this study are randomly selected based on their age groups and most frequently used mobile applications. Age groups consist of Gen Z (age less than 25 years old), Gen Y (age 25 between 40), Gen X (age 41 between 55), and Baby Boomer (age older than 55 years old). A stratified random sampling of 3,000 mobile application users, including Lazada, Shopee, JD Central, GrabFood, FoodPanda, Lineman, and Get[2], are observed using a choice experimental survey questionnaire. Table 3 shows the components of the sample categorized by age groups and their most frequently used mobile application platform.

Table 3: Sample Categorized by Age Groups and Mobile Application Platforms

	Lazada	**Shopee**	**JD Central**	**Grab Food**	**Food Panda**	**Line Man**	**GET**	**Total**
Gen Z	155	125	99	77	149	92	54	751
	20.6%	16.6%	13.2%	10.3%	19.8%	12.3%	7.2%	100.0%
Gen Y	190	167	118	167	132	169	162	1105
	17.2%	15.1%	10.7%	15.1%	11.9%	15.3%	14.7%	100.0%
Gen X	101	76	110	78	69	95	109	638
	15.8%	11.9%	17.2%	12.2%	10.8%	14.9%	17.1%	100.0%
Gen BB	88	64	91	81	52	55	75	506
	17.4%	12.6%	18.0%	16.0%	10.3%	10.9%	14.8%	100.0%
Total	534	432	418	403	402	411	400	3,000
	17.8%	14.4%	13.9%	13.4%	13.4%	13.7%	13.3%	100.0%

Source: Author's calculations.

3.2 Instruments of the Study

In order to obtain complete information on the payment channel decision of the respondents with the details of all characteristics of all choices, this study constructs a choice experimental survey questionnaire. Respondents are all asked to make payment channel decisions based on four different scenarios[3] at the points of sale, which consist

[2] In practice, the platforms chosen in this study offer different types of payment channels. To standardize the observed data of all groups of respondents, the choice experiment questionnaire is set up with identical scenarios for all respondents to answer.

[3] In order to determine the impacts of the factors at point of sale on the respondents' decision, this study set up four different scenario of the choice experiment questionnaire. In scenario 1, there is no transaction fee for credit card payment. In scenario 2, there is a transaction fee of 3% for credit card payment. In scenario 3, there is benefit of 1% cashback for e-wallet payment. In scenario 4, e-wallet payment channel is unavailable.

of five payment channels, including cash, credit card, bank transfer, QR-code payment, and e-wallet. With this research design, there is a total of 20 choices per respondent (4 scenarios time 5 payment channels). Data are organized as choice-based panel data of 3,000 x 20 = 60,000 respondent-choices. Additionally, data concerning perception factors of respondents are also observed using a Likert scale.

Table 4 illustrates the results of factor analysis and Cronbach's alpha of Likert scale questions of all perception factors. Percent total variance, factor loading, and Cronbach's alpha of all factors are greater than 0.7, which implies that questionnaires using to measure all factors are valid and reliable.

Table 4: Factor Analysis and Reliability Test of Questionnaire

	Factor Loading	**%Total Variance**	**Cronbach Alpha**
1. Perceived Network Externality of e-Payment		0.7063	0.9479
You can make payment using the e-Payment channel			
at most of the stores	0.8227		
for a variety of products	0.8385		
for a variety of services	0.8430		
on most e-Commerce applications	0.8606		
on most services applications	0.8675		
on most utility applications	0.8683		
conveniently	0.8158		
efficiently	0.8287		
safely	0.8167		
2. Perceived Convenience & Security of Cash		0.8505	0.8206
You think that making payment through			
Cash is more convenient	0.9222		
Cash is more secure	0.9222		
3. Perceived Convenience & Security of Credit Card		0.9349	0.9304
Credit card is more convenient	0.9669		
Credit card is more secure	0.9669		
4. Perceived Convenience & Security of MBanking		0.9370	0.9328
Mobile Banking is more convenient	0.9680		
Mobile Banking is more secure	0.9680		
5. Perceived Convenience & Security of QR Code		0.8348	0.7973
QR code is more convenient	0.9137		
QR code is more secure	0.9137		
6. Perceived Convenience & Security of e-wallet		0.9422	0.9387
e-wallet is more convenient	0.9707		
e-wallet is more secure	0.9707		

Source: Author's calculations.

3.3 Multinomial Logit Models and Nested Logit Models

In order to analyze the data based on the conceptual framework of this study, multinomial logit models and nested logit models are employed.

Multinomial Logit Models

Since there are five alternatives of payment channel to be selected, the dependent variable is a categorical variable with 5 choices. Multinomial logit models assume that a customer decides to maximize his/her utility. Let utility of an individual follows random utility function:

$$U_{isj} = x_{isj}\beta_j + \varepsilon_{isj} \quad (1)$$

where U_{isj}=utility of individual *i* choosing choice *j*; *i* = 1, 2, …, *n* individuals; *s*=1, 2, 3, 4 scenario; and *j*=1, 2, …, 5 payment channel alternatives). Under utility maximization assumption, individual will choose an alternative that maximize his/her utility, the probability that alternative *j* is chosen can be stated as:

$$\begin{aligned} P(y_{is} = j) &= P(U_{isj} \geq U_{isk} \mid x, \forall k \neq j) \\ &= P(\varepsilon_{isk} - \varepsilon_{isj} \leq x_{isj}\beta_j - x_{isj}\beta_k \mid x, \forall k \neq j) \end{aligned} \quad (2)$$

In order to calculate this probability, the maximum number of random variables has to be determined. In general, this requires solving multidimensional integrals, in which analytical solutions do not exist. Therefore, the model assumes that error terms are independently and identically standard extreme value distributed; then, an analytical solution exists. In this case, similar to binary logit, it can be shown that the choice probabilities are:

$$P(y_{is} = j) = \frac{\exp\left(x_{isj}\beta_j\right)}{\sum_k \exp\left(x_{isk}\beta_k\right)} \quad (3)$$

By setting up the based case, the estimated results will be compared with the based case. Then:

$$\begin{aligned} P(y_i = j) &= \frac{\exp(x_{ij}\beta_j)}{1 + \sum_k \exp(x_{ik}\beta_j)}, k = 1, ..., K, \; j = 2, \ldots, 5 \\ P(y_i = 1) &= \frac{1}{1 + \sum_k \exp(x_{ik}\beta_j)}, k = 1, ..., K \end{aligned} \quad (4)$$

The special case where *j*=1 yields the binary Logit model. This multinomial logit model (4) can be estimated using the Maximum Likelihood Estimation (MLE) method.

However, according to the Independence of Irrelevant Alternatives (IIA) assumption, which is a required assumption in multinomial logit models, it implies that the decision between two alternatives is an independent existence of more alternatives. Based on the conceptual framework illustrated in Figure 3, the five payment channel alternatives are not independently irrelevant from the existence of other alternatives, especially in the e-payment channel type, in which all e-payment channels are mostly perceived similarly. Thus, IIA is possibly violated causing the *"Red-Bus-Blue-Bus problem."*

As a result, to analyze the data based on the framework in Figure 3 and solve the IIA violation problem, this study applies nested logit models.

Nested Logit Models

Hierarchical Elimination by Aspect can be derived as nested logit models, which can capture the two steps of payment channel decision making. Follow the utility maximization concept, a decision-maker is assumed to maximize his/her utility that consists of two components.

$$U_{kj} = U_T + U_{C|T} \quad (5)$$

where U_{kj} is total utility obtained from choosing payment type *k* and payment channel *j*. U_T is utility obtained from choosing payment type *T=k*. $U_{C|T}$ is utility gained from choosing payment channel *C=j* conditional on selecting payment type *T=k*. *k* is payment type = 1 for traditional payment type and 2 for e-Payment type. *j* is a payment channel, which in this study consists of 1=cash and 2=credit card for traditional payment type; and 3=mobile banking, 4=QR code, and 5=e-wallet for e-Payment type.

Assuming that decision-maker maximizes random utility function, the model can be stated as:

$$U_{isj} = V_{isj} + \varepsilon_{isj} = z_i\gamma_T + x_{isj}\beta + \varepsilon_{isj} \tag{6}$$

where U_{isj} is a utility that user *i* obtained from choosing payment channel *j* in scenario *s*. V_{isj} is the determinable utility of user *i* obtained from choosing payment channel *j* in scenario *s*. z_i is the matrix of user-specific variables of user *i*, which consist of perceived network externality, gender, age group, and income level. x_{isj} is the matrix of alternative (payment channel) specific variables of user *i* choosing channel *j* in scenario *s*, which include availability, reward, transaction fee, and perceived convenience and security of the payment channel. ε_{isj} is generalized extreme value (GEV) distributed random error of user *i* choosing payment channel *j* in scenario *s*.

The inclusive value of the nests, which are the two payment types (traditional and e-Payment), is defined as the function of the ratio between determinable utility and dissimilarity parameter.

$$IV_k = \ln \sum_{j \in B_k} \exp\left(V_{kj} / \tau_k\right) \tag{7}$$

where IV_k is the inclusive value of the payment type *k*. B_k is set of payment channel alternatives under the payment type *k*. τ_k is dissimilarity parameter of payment type *k*. If $\tau_k = 0$, it means payment channel alternatives under payment type *k* are dependent; thus, the IIA assumption is violated. The nested logit models are appropriated. On the contrary, if $\tau_k = 1$, there is no need for nested logit models.

From the above inclusive value function and random utility maximization, the probability of user *i* choosing payment channel *j* can be stated as:

$$\Pr_j = \frac{\exp\left\{V_j / \tau(j)\right\}}{\exp\left\{IV(j)\right\}} \frac{\exp\left\{\tau(j) IV(j)\right\}}{\sum_k \exp\left(\tau_k IV_k\right)} \tag{8}$$

where $IV(j)$ is the inclusive value of the payment type in which the payment channel *j* is categorized. $\tau(j)$ is the dissimilarity parameter of payment type in which payment channel *j* is classified.

The above nested logit models can be estimated by using the full information maximum likelihood (FIML) estimation method.

4. Research Results

4.1 Characteristics of Sample

Bivariate analysis of the variables categorized by individual characteristics of the respondents are shown in Table 5.

Table 5: Bivariate Analysis of Variables Categorized by Individual Characteristics of Respondents

	Obs.	PNetwork	Perceived Convenient and Security of			
			Cash	Credit	Mbank	QRCode
Platform Frequently Used						
Lazada	534	0.8323	0.6906	0.6840	0.7334	0.7958
Shopee	432	0.8044	0.7269	0.7397	0.7843	0.7858
JD Central	418	0.7704	0.9147	0.8559	0.9444	0.7854
Grab Food	403	0.7895	0.8182	0.8157	0.7832	0.8020
Food Panda	402	0.6997	0.8123	0.8153	0.7280	0.7805
Line Man	411	0.7498	0.8573	0.8428	0.8476	0.8594
GET	400	0.7399	0.7276	0.7944	0.7185	0.7286
F-test		28.0409***	39.8250***	28.4673***	32.2501***	34.6952***
Age						
Gen. Z	751	0.7694	0.8046	0.7850	0.7818	0.7754
Gen. Y	1246	0.7699	0.7786	0.7988	0.7984	0.7999
Gen. X	608	0.7568	0.7932	0.7792	0.7885	0.8067
Gen. BB	395	0.7926	0.7802	0.7712	0.7795	0.7716
F-test		3.4122**	7.8226***	4.4608***	3.0630**	1.9331
Gender						
Male	1195	0.7680	0.8021	0.7928	0.7967	0.7907
Female	1805	0.7715	0.7791	0.7844	0.7852	0.7919
t-test		0.5514	1.0216	0.0340	1.0884	0.7584
Income						
Less than 15,000 Baht	897	0.7559	0.7749	0.7614	0.7578	0.7776
15,001 – 30,000 Baht	1178	0.7711	0.7879	0.8079	0.7923	0.8034
30,001 – 50,000 Baht	475	0.7717	0.7984	0.7979	0.8195	0.7931
50,001 - 100,000 Baht	250	0.7788	0.7856	0.7710	0.7910	0.7741
100,001 - 200,000 Baht	88	0.7841	0.7783	0.8083	0.7955	0.8089
Higher than 200,001 Baht	112	0.8364	0.8698	0.7645	0.8850	0.7950
F-test		4.7514***	5.3266***	5.9098***	7.6275***	5.8220***

Note: * significant at 0.10, ** significant at 0.05, and *** significant at 0.01
Where PNetwork is the user's perceived network externality of e-payment type.
Source: Author's calculations.

Respondents with different frequently used platform have a significantly different perception on network externality of e-Payment channel, and perceived convenience and security of the payment channel. Similarly, different age groups of respondents also lead to different perceptions. These findings help confirm the appropriateness to stratified random sampling of respondents based on their frequently used platforms and age groups. Additionally, respondents with different levels of income also tend to have significantly different perceptions while gender has an insignificant impact on the respondents' perceptions.

4.2 Estimated Results of Multinomial Logit and Nested Logit Models

The estimated results of multinomial logit and nested logit models as shown in Table 6 indicate that the IIA test whether $\tau_k = 1$ is rejected; thus, IIA is violated. Accordingly, multinomial logit models are inappropriate in this case and the nested logit models should be applied instead.

Table 6: Estimated Results of Multinomial Logit and Nested Logit Models

	Multinomial Logit (Cash as Based Case)				**Nested Logit (Tradition as Based Case)**	
	Credit (1)	**MBanking (2)**	**e-wallet (3)**	**QR (4)**	**e-Payment (5)**	**Decision (6)**
PNetwork	-0.236***	0.182***	0.309***	0.066*	0.304***	
Female	-0.318***	-0.048	-0.364***	0.147**	-0.269***	
GenZ	-0.109	0.153**	0.084	0.335***	0.142***	
GenBB	0.153	0.333***	-0.063	-0.310***	-0.127***	
Low Inc.	-0.765***	-0.582***	-0.652***	-0.097	-0.536***	
PCon&Sec	0.441**	0.153	0.427**	0.192		4.405***
Reward	0.090	0.040	2.589**	0.031		1.378***
Trans. Fee	-6.001**	-0.123*	-0.513*	-0.027		-2.489***
Availability						24.431***
Constant	-0.305*	-0.554***	-0.343*	-1.768***		
ePayment_tau					0.266	
Tradition_tau					1.228**	
Observations	12000				60000	
Log-likelihood	-14677				-15279	
Chi-square Test	5564.7***				1304.1***	
Pseudo R^2	0.159					
IIA Test (tau=1)					37.31***	

Note: * significant at 0.10, ** significant at 0.05, and *** significant at 0.01

Where PNetwork is a user's perceived network externality of e-payment type; Female is a dummy variable, equal to one for female and zero otherwise; GenZ is a dummy variable, equal to one for Gen Z group (younger than 25 years old) and zero otherwise; GenBB is a dummy variable, equal to one for generation Baby Boomer (older than 55 years old) group and zero otherwise; Low Inc. is a dummy variable, equal to one for a low-income group of income less than 15,000 Baht; PCon&Sec is user's perceived convenience and security of payment channel; Reward is a dummy variable, equal to one if the payment channel has a reward and zero otherwise; Trans. Fee is a dummy variable, equal to one if the payment channel has transaction fee and zero otherwise; and Availability is a dummy variable, equal to one if the payment channel is available at the point of sale and zero otherwise.

Source: Author's estimations.

Concerning the estimated dissimilarity parameter of the payment type, ePayment_tau of 0.266 is insignificantly different from zero indicating that payment channel alternatives in e-Payment type; mobile banking, QR code, and e-wallet, are perceived to be similar and can substitute one another. This result also implies violation of IIA and reconfirms the appropriateness of nested logit models. However, cash and credit card, alternatives in traditional payment type, are not substitutable according to significant tradition_tau of 1.228.

According to the estimated results of nested logit models using traditional payment type as based case, the significant overall Chi-square test indicates that all independent variables in the nested logit models can significantly explain payment channel decisions; thus, hypotheses of the study are confirmed. The payment channel decision is divided into two steps as illustrated by the framework in Figure 3. From the estimated result of the nested logit of the e-Payment model (5), the user will firstly choose the payment type and eliminate the unchosen one. Factors affecting the first step decision

consist of the user's perception on network externality of e-payment type, gender, age, and income of the user. Based on two-sided market concept, the perception of a user on network externality of e-payment type has a positive significant impact on the decision to use e-payment type. Follow the concept of innovation adoption process and diffusion of innovation theory, age groups play a significant role in determining the payment type decision. Old age group users are more likely to be laggard users who are less likely to adopt the e-payment innovation while younger age group users who mostly represent the early adopter group of the e-payment users are more likely to use e-payment. Since e-payment channels mostly require high-tech equipment, which are relatively expensive, low-income group users tend to be excluded from this payment type. Additionally, female users seem to accept the e-payment channel slower than male users.

After a decision on the payment type, the second step is to make a decision on the payment channel within the chosen payment type as shown in the Decision model (6). Factors influencing the decision in this step comprise of the user's perception on convenience and security of the payment channel and factors at the point of sale, which include availability, reward, and transaction fee. The availability of the payment channel plays the most important role in determining the payment channel decision. Without a particular payment channel, the user cannot make the payment using a channel. Convenience and security of the payment channel are revealed as second important factors for the user since the payment channel generally involves the user's financial information, which cannot be afforded to be leaked. Users will then choose the payment channel, which they perceive as a secure but also convenient one. Additionally, the benefit and cost of using each payment channel through the transaction fee and reward of the payment channel also significantly influence the user's payment decision. Benefit from the reward earning from spending through the payment channel can help motivate the user to use the payment channel. On the contrary, expense from the transaction fee would prevent the users from using the payment channel. As a result, the two steps payment channel decision hypotheses of this study are confirmed by the estimated results of nested logit models.

5. Conclusion, Discussion, and Recommendation

In conclusion, this study aims to answer how customers make their payment channel decision and which factors have impacts on their decision. Two steps decision-making model based on hierarchical elimination-by-aspect decision-making concept was constructed and analyzed by using nested logit models. The estimated results of the models revealed that the IIA assumption was violated. Based on the network externality concept and diffusion of innovation theory, the first step of payment type decision was influenced by the perceived network externality of the platform, age, gender, and income of decision-makers. Concerning factors at the point of sale, the second step of payment channel decision is determined by availability, reward, and transaction fee. Additionally, perceptions of convenience and security of payment channels also influence the users' decision.

This study found that payment channel decision making follows Tversky (1972) hierarchical elimination by aspect concept, which is confirmed by the violation of IIA. The e-payment alternatives are perceived to be substitutable; therefore, the two steps decision-making model is applicable in this case. The finding revealed that the first payment type decision making step is influenced by perception on network externality concerning e-payment of decision makers. Similarly, Li, et. al. (2019) and Bardey, et. al. (2014) found that most e-payment system successfully developed its own network

externality effects that help gain more acceptance, adoption, and usage, respectively. However, Arango-Arango, Bouhdaoui, Bounie, Eschelbach, & Hernandez (2018) argued that cash is still the most convenient payment channel regardless of the rapid development of technology. Older people are more comfortable and familiar with cash. Unlike the elder generation, the younger generation, especially Gen Z, are more likely to be familiar with today's technology, including electronic payment systems; thus, they are more likely to choose e-payment channels. Accordingly, this study also found that age, gender, and income of decision-makers have influences on their decision, which is consistent to the findings of Humbani & Wiese (2018) and Bátiz-Lazo, Haigh, & Stearns (2014).

The second step found that decision making of the payment channel was finally determined at the point of sale, which is conforming to the studies using the USA big data of Arango, et. al. (2015) and Armey, Lipow, & Webb, (2014). Several studies also found that if the payment channel at the point of sale is unavailable, customers will finally be forced to choose another payment channel (Chen, Huynh, & Shy,2019; Luna, Liébana-Cabanillas, Sánchez-Fernández, & Muñoz-Leiva, 2019). Concerning motivation strategy, the rewarding system is another factor at the point of sale that affects payment channel decisions. Armey, Lipow, & Webb, (2014), Arango, Huynh, & Sabetti (2015), and Martikainen, Schmiedel, & Takalo (2015) found that many payment channel providers had successfully employed the rewarding system to motivate their users to continue spending through their payment channels. On the contrary, the transaction fee had also been revealed as an obstructing factor at the point of sale that discourage customers from using the payment channel. Magnac (2017) found that customers will decide not to use an ATM if it requires a transaction fee. Cohen, Rubinchik, & Shami (2019) concluded that the major obstruction of a cashless society is the transaction fee of using the e-payment channel. Additionally, the final decision of choosing a payment channel is also influenced by the perception of convenience and security of the payment channel. Humbani & Wiese (2018) explained that the avoidance of carrying the coin is another major reason why customers decide to choose e-payment. However, regardless of its convenience, De Reuver, Sørensen, & Basole (2018) and Fabris (2019) argued that the successful e-payment system must require the development of information technology along with the high-security system of customer information. Several studies, including Bendell (2015) Worthington (2006) Wolman (2012) and Garcia-Swartz, Hahn, & Layne-Farrar (2009), found that major obstruction of cashless society comes to the fear of electronic fraud through the e-payment system. No matter how convenient the e-payment channel is, customers are still aware of its security.

According to the above findings, government officials and regulators who are responsible for regulating the payment policies, especially the Bank of Thailand, should update and control the security of the electronic payment channel system. If fraud from an electronic payment channel occurred, consumers would lose confidence in the channel. As a result, the evolution of a cashless society in Thailand would be hampered and become inefficient. Electronic payment channels can eliminate transaction costs from traditional payment channels such as cash or credit card.

Many different e-payment applications can cause network externality and increase market power. Therefore, the agency in charge should monitor them so that they would not abuse consumers or merchants.

From the study, the development of electronic payment channels required creating network externality by increasing the number of peers. The electronic payment platform providers will try to attract more consumers to use their platform by offering customers rewards, discounts, or cashback. Currently, several electronic mobile application platforms such as convenience store delivery applications, supermarket shopping application, online gaming application, and streaming application have

included the e-Payment channel as an alternative payment to their application users. During the introduction of the new payment channel, most applications offer various complimentary such as discounts or cashback, to the users. Therefore, consumers should take advantage of these opportunities to choose the most beneficial channel because the benefits will eventually diminish. After the applications have successfully created network externality, the application will start to reduce the incentives.

The merchants should consider accepting a variety of electronic payments, especially the ones with no transaction fee on both customers and vendors (e.g. QR Code), to prevent losing the sale opportunities. In addition, the merchants must be concerned about their internet security if they have electronic payment channels.

The study has shown that the consumers would select the payment channel at the point of sale in the final step based on the availability of that channel. If the provider wants its platform to be successful, it should expand its network of a merchant by reducing transaction fees to be lower than its competitors. It should also eliminate the transaction fee for its consumers and create incentives such as offering rewards, discounts, or cashback to consumers. In addition, the application system of the payment channel must be developed with a high level of security against electronic fraud in mind.

Future researches may consider using big data of the actual transactions to explore the consumer behavior on selecting payment channels and the marketing strategy factors of different payment platforms to attract consumers.

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