

Potential Demand Prediction of Automated Parcel Lockers Adoption in Bangkok, Thailand

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Online shopping businesses grow significantly in Thailand. Home delivery is the first choice from a customer perspective, however, with the failure rate, automated parcel locker (APL) appears to be an alternative. This study proposes a multiple linear regression to investigate socio-demographic, behaviors and preferences of customers impacts on probability of using APL in Thailand. The study uses 718 observations from both online and offline surveys in Bangkok. The result shows that the positive impacts for demand prediction are age range (>46 years old), type of accommodation (commercial building and apartment), household living (with parents, and with spouse and child/children, discount price, hours using Internet per day, frequency of online shopping, and APL location types. In terms of location, the condominium has the highest impacts, followed by office buildings. For negative impacts, there are gender (female), age (18-25 years old), PhD education level, income between THB 30,001-45,000, online shopping experience, own a car, occupation (being full time employee and unemployed), have someone stay home during the day, APL location (Shopping mall) and travelling distance.

Key words: *parcel lockers, last mile, last mile deliveries, probability prediction*

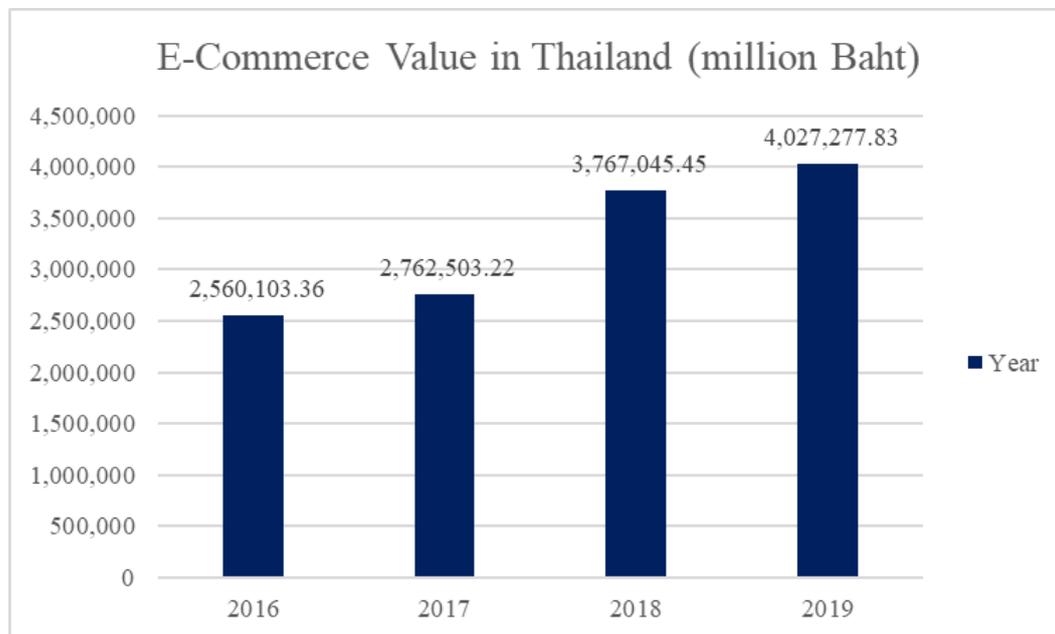
Introduction

In recent years, ecommerce and urbanisation have been flourishing across the world. Last mile delivery has been disrupted from the new business model that focused on customer requirements for fast delivery as well as innovative technology as alternatives such as drones and autonomous ground vehicles. Particularly on parcel delivery, it has been highlighted in the

media and businesses. The report showed that global parcel delivery value was €70 billion, where United States, China and Germany are accounting for more than 40%. Not surprisingly, e-commerce is the largest driver of this growth, accounted for around 7-10%, which market was shifted from B2B to B2C market (Joeress, Neuhaus, & Schröder, 2016). Aside from the benefits, rapid e-commerce growth has resulted in the steady increase of parcel delivery and returns volumes, which has accentuated the pressure on last mile delivery actors (Ferrucci & Bock, 2014).

In Asia, e-commerce growth rate is highest, and Thailand is the largest B2C e-commerce growth in the ASEAN, the tremendous increase due to e-Payment and fast delivery that encourage customers to conveniently shop online and it is continually growing. The country's e-commerce sector has expanded at the rate of 7.91%, 36.36%, 6.91% from 2016 to 2019, as illustrated in figure 1.1. For B2C e-Commerce, the growth rate of value is 99.61% from 2018 to 2019, which was the highest rate in the ASEAN. Meanwhile, Euromonitor projected that the Thai e-commerce business has the potential to grow as much as 22% annually until 2022 (ETDA, 2019). The increase in B2C e-commerce in Thailand was reported as a result of domestic market which is accounted for 91.29%, in which in 2019, the value of B2C e-Commerce is reported as 1,410,985 million Baht.

Table 1.1: E-commerce value in Thailand (EDT, 2019).



As last mile delivery becomes an essential source to differentiate business among competitors, motivating retailers and carriers to invest in delivery innovation, such as pickup point, automated delivery solutions, and parcel lockers. However, there is a lack of understanding as to how best to design last-mile delivery models (Lim & Srail, 2018).

Allen, Thorne, & Browne (2007) summarised alternative practices of home delivery which are initiated and categorised as the last mile delivery solution as the following:

- Reception box: permanently fixed outside customer's home
- Delivery box: box owned by retailer or delivery company to deliver goods to customers and after collected by the customer, and the empty box is returned in the next delivery
- Controlled access systems: provide carrier to access to a locked area and leave goods. The key is sealed inside the units in which the carrier can gain access by code.
- The locker of reception box: lockers located in workplace, railway stations where customers collect their parcel from. Lockers are not assigned to specific customers in order to utilise the lockers

Numerous advantages of collection delivery points described are that customers can collect their failed deliveries locally rather than collecting from a depot or terminal, a secure delivery is maintained, redeliveries are reduced which resulted in higher consumer satisfaction. In addition, the impact to environment can be reduced as there are less additional vehicle trips to deliver parcels (Edwards, Halldórsson, McKinnon, & Cullinane, 2010; McLeod, Cherrett, & Song, 2006).

In 2016, Thailand Post installed iBox, Automated parcel lockers to let customers collect their parcel when it is not convenient to pick it up at Thailand Post office or when they are not at home, as there are about 40,000 parcel delivered per day but there is 20% of failed delivery as customers are not at home (Thailand Post, 2018). While the strategic partnership Kerry Express Thailand established in July 2018 with VGI Global Media Public Company Limited, the subsidiary of BTS PLC, enabled it to use BTS Skytrain exclusively to extend its express delivery services and boost same-day delivery service in Bangkok (Kerry Express, 2019). Therefore, it is worth paying attention to the customer willingness to adopt this service. This research aims to provide determinants to predict probability APL adoption in Bangkok, Thailand. The rest of the paper is organised as follows. Following the introduction, section 2 is a literature review, Section 3 proposes methodology. Section 4 reveals result analysis and discussion, and section 5 provides the conclusion and recommendation.

Literature Review

Despite receiving considerable attention in the business environment, parcel locker research appears to be scarce. In fact, although studies have mentioned parcel lockers in various contexts, they have not directed scientific attention toward this technology (Ducret, 2014; Mangiaracina, Marchet, Perotti, & Tumino, 2015; Morganti, Dablanc, & Fortin, 2014; J. W. J. Weltevreden, 2008). Relating specifically to CDP, numerous studies are done on customer's acceptance and what influences them to use it in many countries such as Poland (Efthymiou & Antoniou, 2016; Lemke, Iwan, & Korczak, 2016), Singapore (Efthymiou & Antoniou, 2016), France, Germany (Morganti, Dablanc, et al., 2014; Morganti, Seidel, Blanquart, Dablanc, &

Lenz, 2014), Sweden (Vakulenko, Hellström, & Hjort, 2018), Netherlands (J. W. J. Weltevreden, 2008), Australia (Lachapelle, Burke, Brotherton, & Leung, 2018), New Zealand (Kedia, Kusumastuti, & Nicholson, 2017) and China (Weijters, Rangarajan, Falk, & Schillewaert, 2007). The success of CDP varies from place to place as local conditions are different. For example, there is high rate of using internet and it is also considered as a car dominant city, which might influence customers' shopping behaviour. Moreover, factors influencing the use of CDP in many countries which are different: Population density, cars per capita, number of post office nationwide, number of people working in the post office (Kedia et al., 2017). Distance and location are observed and play significant roles to attract customers to use it (Lemke et al., 2016; Morganti, Dablanc, et al., 2014). Most densely populated areas and transportation nodes (main train and subway stations, highway interchanges and road intersections) are expected to have CDPs. The population on average is located 1.6 km from the nearest pickup points in urban areas, and 6 km in rural areas (Morganti, Dablanc, et al., 2014). Today, 90% of the German population is within 10 minutes of a packing station (Iwan, Kijewska, & Lemke, 2016). Currently, an average packing station has about 76 lockers, but the actual number depends on the location. Most of the stations are in urban areas (Morganti, Seidel, et al., 2014). In the Netherlands, the time to access CDP vary from different providers. More than half of customers can access TNT CDPs within 5 mins by car and 10 minutes for DHL and Kiala (J. W. J. Weltevreden, 2008). As to get efficiency and provide sustainability to the CDP network, the location needs to maximise accessibility for potential customers; thus, CDPs near workplace or customers home such as public transport stations, gas stations, post offices and supermarkets, are considered as suitable locations (Junjie & Min, 2013; Kedia et al., 2017).

Most of the pickup points are near commuter railway stations where half of the pickup points are located within 400m of a station and within 600m of each regional railway station. In the mobility and access aspects, each network provides customers access by car between 4 minus in urban areas and 8 minus in rural areas (Morganti, Dablanc, et al., 2014). When CDP are located near public transportation terminals or have easy access from the main road, it increases the opportunities for customers to collect the parcels in their daily commute (Kedia et al., 2017). This can reduce travelled kilometers and it could benefit more when CDPs are near the customer's home or workplace as customers tend to use non-motorised modes to collect the parcel (McLeod et al., 2006). A study from Kedia et al. (2017) aimed to examine customer perception on CDPs which helps to formulate policies and plan to sustain urban environments and for the companies to establish successful network of CDPs. CDP acceptance of customers in the study depends significantly from network density, parking availability, spatial location of the CDP. The successful ones are those CDPs that are close to the office or customers' home, as well as the safety factor and operating hours, whereas Morganti, Dablanc, et al. (2014) stated that CDPs that are successful are those near railways or major transport terminals.

Sociodemographic factors play significant roles in customer acceptance also. J. W. Weltevreden & Rotem-Mindali, (2009) observed that gender impacts the intention to use, where females tend to use CDP more than males. Medium education level, experience with online shopping, which are higher number of years, buying online and experiencing other means of home shopping, frequency of online shopping, higher number of hours working in household and distance to CDP by car within 5 minutes (Morganti, Dablanc, et al., 2014). One of the variables that represent the demographic context is population density. Similar variables that represent employment rate, computer ownership, Internet access and level of use are usually included in the assessment process. Madlberger & Sester (2005) however, say that employed status has no significant impact on delivery mode, and these people need products delivered in the evening. They prefer less pickup points than the unemployed or less educated. Product categories impact choice of delivery, where parcel lockers are highly accepted for books and apparel, where computer seems to be highly accepted to be picked up in store. Numbers of research indicated that the majority of customers still prefer home delivery to CDPs (Morganti, Dablanc, et al., 2014; Yuen, Wang, Ng, & Wong, 2018). The adoption rates vary in different countries, 5.5% in Singapore (Yuen et al., 2018), 10% in Germany (Morganti, Seidel, et al., 2014), 18.5% of E-shoppers in Netherlands experience using APL (J. W. J. Weltevreden, 2008) and in Australia, registered users of parcel locker service increased by 146% in 2017, with 3.8 million users (Lachapelle et al., 2018).

The pickup points seem to be most relevant to CDP as referring to easy access, authentication ease, waiting time, time between placing an order and availability and the schedule amplitude. Kedia et al. (2017). A study in New Zealand aimed to address CDP customers' acceptance issues and provided the conclusion of customers' acceptance of several points. The results show that customers prefer using CDP as an alternative to get a failed delivered parcel; incentive is an important factor for customers to use such as discount or different pricing from delivery channels. CDP density is also a main factor to influence the adoption in suburban areas, which is different from Weltevreden (2008) who stated that in a dense area, there are more parcels used, especially in the CBD. Moreover, parking availability make CDP more attractive to use and spatial location as customers want to use it in a suburban area not in the city. This is in contrast to McLeod et al. (2006) which shows that CDPs are preferred to be in the CBD and near the home or office. In addition, safety and security are concerned for the place to collect and drop the parcels like a fuel station. Lastly, hours of operation are significant, as some customers cannot pick up during weekdays.

In order to predict the probability of potential users and demand, numerous studies have been conducted on delivery alternatives. The related literatures are gathered from delivery alternatives and other fields, as the literatures in APL itself is limited. Different solutions have been applied, different methods to test and predict the changes of behaviours. Linear regression, logistic regression, binary logit model, multinomial logit model are widely used (De Luca & Di Pace, 2014; Joerss, Schröder, Neuhaus, Klink, & Mann, September 2016; J. W.

Weltevreden & Rotem-Mindali, 2009; J. W. J. Weltevreden, 2008). The objectives of prediction are different from studies to studies. Comparative quantitative analysis is used in predictions to provide overall scenarios (Hofer, Flucher, Fellendorf, Schadler, & Hafner, 2019; J. W. Weltevreden & Rotem-Mindali, 2009). The related study investigated the change in customer's mobility behaviour from the use of APL using panel survey and two person groups' application. Quantitative analysis shows 27% reduction potential in emissions and vehicle kilometers per pickup and drop off of parcel (Hofer et al., 2019). J. h r Van Duin, Wiegman, & Arem (2019) provided mathematical modelling to select the right number of APL in van Amstel using 3 methods which are cost effectiveness analysis, multi criteria analysis, and simulations which show the suitable size of lockers that perform better under some considering circumstances, such as higher loading time and a lower number of drivers. It is also mentioned the location of APL which is 5 minutes walking distance average. Some use multiple linear regression to predict the potential to redeliver and delivery results by several alternatives including service points (J. H. R. van Duin, de Goffau, Wiegman, Tavasszy, & Saes, 2016). The rework reduction potential is presented for each alternative.

L. K. d. Oliveira, Morganti, Dablan, & Oliveira (2017) provided an analysis of potential demand of the automated delivery station by using revealed and stated preference methods. Results show that APL has high potential for online shoppers, using willingness to pay to measure; the study also concluded that easy access location and security have significant positive impacts on potential demand. J. W. Weltevreden & Rotem-Mindali (2008) predicted by using binomial logistic regression to identify characteristics of CDP users. Gender, which is female, has higher potential to use the service. Moreover, users seem to be more experienced in online shopping than non-users, in terms of number of hours per week, frequency, and number of years buying online. Household situation and number of working hours in household and distance to CDP play significant role. Furthermore, multiple linear regression is used to examine the location of CDP and which are most frequently used. The model used the number of parcels per CDP. The successful location is in neighborhood centres, city centres and convenience centres. The number of population in the area is also positively significant to the success of the collation in which more people live within 5 minutes by car from CDP, the higher the parcels collected from that location. Multinomial logit model is used widely to predict potential demand (de Oliveira et al., 2017; Meng, Koh, & Wong, 2016). The revealed preference and stated preference data model is considered as a useful model to analyse complex behaviours and predict demand.

Methodology

To predict potential demand for APL in the scope of study, stated preference (SP) is selected. SP is well known as an approach to nonmarket valuation which relies on answering carefully the worded survey questions (Brown, 2003). The answer of SP can be in form of scaled, rating, choices, amounts and other indicators that show preference. The surveys are believed to be a good used in forecasting since it is able to yield stable preferences estimated from stated choice

from hypothetical alternatives (Fujii & Gärling, 2003). Numerous studies have been done using SP, most of them are to investigate and identify preferences on transport policies, its impacts and to predict stakeholders' preference (de Oliveira et al., 2017; Gatta & Marcucci, 2016; Gatta, Marcucci, & Scaccia, 2015; Holguín-Veras, Silas, Polimeni, & Cruz, 2008; Marcucci, Gatta, Marciani, & Cossu, 2017; Marcucci, Gatta, & Scaccia, 2015; L. K. Oliveira, Braga, & Abreu, 2010). Efthymiou & Antoniou (2016) investigated potential demand on carsharing, while L. K. D. Oliveira et al. (2017) conducted a study to predict potential demand for APL in Brazil. Moreover, SP is also used to develop a framework to forecast potential market and impacts of the carsharing system in London (Le Vine, Lee-Gosselin, Sivakumar, & Polak, 2014) and to predict travel demand for a new transport service in Bangkok, Thailand (Dissanayake & Morikawa, 2010).

The first part of the questionnaire included area of living, type of accommodation, household living style, travel mode, home internet access, number of hours using internet per day, online shopping experience, online shopping frequency, and often purchased products. On the preference part, respondents are asked to answer question including 3 different preferred pick-up locations, traveling distance, traveling time, the reason for choosing locations, facility advantage, and probability using APL at 2 different price set: referred price and discount price. The ordered scale is applicable as much as possible, in which the scale is rated 0 to 100. 0 means not likely to use and 100 is most likely to use. The last part socio-demographic includes age, gender, marital status, income, education, and occupation.

The pilot study was first conducted online in April 2020 to test the viability of the study and 30 responses were received. The questions were adjusted by providing a brief explanation of APL and its photos. Some questions are modified to be shorter and more precise such as the question that asks respondents to identify probability to use; the scenario gives the precise dimension of the parcel which were illustrated in the subsequent survey. In the second phase, after reviewing the survey questionnaire, the questionnaire was distributed both online and offline and expected to have 900 observations. The questionnaires were distributed by 2 channels: online distribution and face-to-face at the post office and university as only the internet channel might get an optimistic result due to the fact that respondents tend to answer positively (Dillman, Smyth, & Christian, 2011). Google form was used to develop the online survey and shared via email lists and social media. The paper form was filled by individuals and performed at post office and university in which the respondents were invited to do survey voluntarily. The survey was administered between 1st June 2020 to 31th July 2020. Only one answer per respondent was accepted. Data cleaning process took place aimed to discard incomplete or inconsistent responses. After removing those that failed the quality checks, there were 718 observations or 79.7% were used for further analysis. Both descriptive and inference statistics were used to analyse the survey data. As concerns inference statistics, the multiple linear regression model was implemented to calculate the influence of different socio-

economics characteristics and preferences on the probability of using APL, using the stepwise method.

To analyse data, y (probability of using) is transformed into odds as odds are a way of representing probability (Bland & Altman, 2000). However, the odds ratio is limited at the lower end, since it cannot be negative, but not at the upper end, and so has a skew distribution, thus, odds is transformed to log odds to fit in multiple linear regression, which is constructed as:

$$\ln\left(\frac{y}{1-y}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n \quad \text{-----(1)}$$

To interpret the result, odds ratio for the transformed covariate is:

$$\frac{y}{1-y} = \exp(\beta) \quad \text{----- (2)}$$

Result Analysis and Discussion

The sample included 718 observations; sample characteristics are showed in table 1.1. From the total observation, there were 43.2% of male and 56.8% of female living in Bangkok with age ranged from 15 years old. Most of the respondents were at the age of 26-35 years old, which is 45%. Most (48%) were educated to bachelor's degree level, with 35% reporting to be in Master's degree level. The majority of respondents were single (73%), while around 26% were reported as being married. 69% of the participants reported having no experience using APL, while 31% reported having experience using it. In addition, it is reported that most of respondents were full time employees, 43% and 26% were students. On individual income, it was reported that 34% of respondents had less than THB15,000 per month, approximately 19% had an individual income in the range of THB 15,001 to THB 30,000, followed by individual income more than 60,000 (17.5%), THB 30,0001-45,000 (16%) and the last group was around 13% in THB 45,001 – 60,000.

From a behavioural perspective, most respondents lived in their personal housing/landed property (70.2%), follow by condominium (14.2%), apartment (8.9%) and others (which represented residential unit, 6.7%). Most respondents stayed with parents, followed by those who stayed alone (44.3 % and 22% respectively). Others were living with a spouse and living with spouse and kids, approximately 11%. The rest of respondents reported as in others, which represented the extended family, with their parents and children for 12.5%. While when respondents were asked if there was someone staying at home during the day, the proportion are quite similar (54.3% and 45.7%). Almost 80% of respondents had their own car, while 64.3% used a car to commute daily, followed by using public transportation for 33%, and the rest for others, such as a grab taxi or carpool.

Most of respondents (88%) had home internet access and around 72% of respondents used the internet more than 5 hours per day. Among the respondents, 67% had online shopping experience of more than 3 years, and 26% had online shopping experience of between 1-3 years. Most of the respondents reported that they did online shopping (39%) for 2-4 times per month and followed by more than 4 times per month (36%). The highest frequently purchased products were reported to be in clothes, cosmetics and the accessories categories, for 45%, follow by electronic device and IT accessories for 29% and 21% respectively.

According results from multiple linear regression analysis, all significant coefficients, and marginal effects are presented in table 1.2 and 1.3. The general fit of the model was evaluated using the R^2 , which varies between 0 and 1, and reported as 0.313. The socio-demographic that impacts probability of adoption are gender, which female is significantly different in adoption of APL from male, and the probability is decreased by 6.5% if the users are female. According to (Morioka, 2014) gender is a key in perception and adoption of information technology, moreover, it is also indicated that men appear to use IT for practical and utilitarian purposes than women (Wells & Chen, 1999). This is different from J. W. J. Weltevreden (2008) where the results showed the adoption is higher in the female. Age is said to be significant (Mitrea et al., 2020).

It is also reported that different age ranges have different impacts, in which age 18-25 has a negative impact on probability of using APL, while an age range of more than 46 has positive impact, AME is ~30%. This means that the probability of using APL will increase for ~30% when users are more than 46 years old. This is interesting as some research indicated that the elderly are interested in self-service technology (Brummelman, Kuipers, & Vale, 2003; J. W. J. Weltevreden, 2008). However, it shows a different range. In this study, age over 46 has higher probability using APL while in the previous study mentioned age over 66. Other studies showed that the use of parcel locker is for young people (Lemke et al., 2016). This is contradicted as people at age 18-25 years have a negative impact (13%) on the probability of using APL. On income aspect, income range 30,001 THB – 45,000 THB has negative impact on probability of using APL; this range of income decreases the probability of using APL by 12% on average, compared to those having an income lower than THB 15,000. This maybe from the fact that that range of income are mostly full-time employees with a tight schedule in a day, or have other alternatives to receive the parcel. While in another study, income is not statistically significantly different (Lachapelle et al., 2018; J. W. J. Weltevreden, 2008). From occupation, being full-time employees and unemployed have a negative impact on probability using APL by 8.4% and 17.5% respectively; as for a full-time worker who has tight schedule and for unemployed are those that stay home which has no problem with home delivery. Education in PhD has also negative impact on probability by 12% on average compared to those below a Bachelor's degree. While J. W. J. Weltevreden, (2008) stated that medium education is a predictor of adoption.

Other types of accommodation, which was stated as residential unit/townhouse and apartment, has a high positive impact on probability of using APL, in which probability will increase by 31.9% and 16.7% respectively, if users are living in those types of dwellings. This is similar to Lachapelle et al. (2018) that the type of house is statistically significant different to an apartment. The reason might be the matter of fact that no one receives the parcel when it arrives, as there is no juristic office operated as the same as a condominium or office building. People that are living with their parents tend to increase probability to use APL by 14%, as those people are mostly young adult (26-35 years old) and in Thai-culture young adults are still living with their parents. However, when there is someone who stays at home during the day, the probability in using APL decrease by 9%, since they have no worries that the parcel will be returned when it has failed to be delivered.

From shopping online experience, when people are having experience shopping online between 1 to 3 years and more than 3 years, the probability decreases by 31.6% and 25.4% respectively, compared to those having experience shopping online less than 1 year. This is different from J. W. J. Weltevreden (2008) that the more people are experienced with online shopping, the more positive affects this APL adoption. This might be the reason that when people are used to a particular delivery, they do not tend to change and adapt to a new method of delivery, as APL is a new service. For online shopping frequency, those who shop online frequently, tend to increase in probability to adopt APL, which is around 21%, compared to those that shop online for less than 2 times/month. From the number of hours using Internet, the longer time of using internet, the more probability of an increase (Mitrea et al., 2020). The result shows that people who use Internet for more than 5 hours/day shows an increase in probability of using APL by 7.5%.

Table 1.1: Sample Characteristics

Characterisitcs	Observations	Frequency	Percentage
Gender	Male	310	43.2
	Female	408	56.8
Age	<18 years	36	5
	18-25 years	222	30.9
	26-35 years	322	44.8
	36-45 years	120	16.7
	46-55 years	18	2.5
Marital status	Single	532	74.1
	Married	186	25.9
Education level	lower than Bachelor degree	90	12.5
	Bachelor degree	346	48.2
	Master degree	252	35.1
	PhD	30	4.2
Occupation	Students	186	25.9
	Full time employees	312	43.5
	Freelance	60	8.4
	Business Owner	84	11.7
	Government official	40	5.6
	Unemployed	30	4.2
	others	6	0.8
Individual income (THB)	<15,00	246	34.3
	15,001-30,000	138	19.2
	30,001-45,000	118	16.4
	45,001-60,000	90	12.5
	>60,001	126	17.5
Type of accomodation	Residential	504	70.2
	Condominium	102	14.2
	Apartment	64	8.9
	others	48	6.7
Frequently purchased products	Cloths, Accessories, Cosmetics	321	44.7
	Grocery	150	20.9
	IT and accessories	207	28.8
	others	40	5.6
Household living	Stay alone	160	22.3
	stay with parents	318	44.3
	stay with spouse	78	10.9
	stay with spouse and child/children	72	10
	others	90	12.5
Online shopping experience	< 1 years	54	7.5
	1-3 years	186	25.9
	> 3 years	478	66.6
Online shopping frequency	once a month	180	25.1
	2-4 times/ month	282	39.3
	> 4 times / month	256	35.7
Number of hours using Internet per day	Less than 2 hours	6	0.8
	2-5 hours	192	26.7
	more than 5 hours	520	72.4
product purchase	Clothing/ cosmetic	321	44.7
	Electnoics/ IT accessories	207	20.9
	Grocery	150	28.8
	others	40	5.6
Household car ownership	Yes	568	79.1
	No	150	20.9
Home internet access	Yes	628	87.5
	No	90	12.5
Commute/travel mode	Private car	462	64.3
	Public transport	238	33.1
	others	19	2.5



In addition, when people have their own car, the probability of using APL decreases by 10%, compared to those who do not, as those who own car potentially have medium to high income and may not be constrained by the home-delivery method. This is different to a study of Lachapelle et al. (2018) that those who do not own automobile are limited to travel longer distances to collect parcels and potentially less likely to use APL, as well as Liu, Wang, & Susilo (2019) reported that those who use car tend to have more probability using APL.

On preference aspects, when the price is set to be a discount, it has a significant highest positive impact by increasing the probability of using APL by 31%, compared to when the price is at a normal rate, which is aligned with a study from L. K. d. Oliveira et al. (2017) that a discount has a positive impact on the probability of using this service. In terms of preference locations, the shopping mall has a negative impact on probability which it decreases probability by 7% from convenient stores. This might be because potential users might not want to fix the date to go to a shopping mall to retrieve their parcel while both condominium and office building have a positive impact, increasing probability of using APL by 38% and 15% respectively. This is expected that some companies have a policy to prohibit employees to deliver their shopping parcels to the office. In addition, though the condominium has a justice office operated for the renters or owners, the working hours are limited to 7pm-8pm. As a result, some of the renters cannot retrieve their parcels in time.

Table 1.2: Result of multiple linear regression for predictors of probability of using APL

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Correlations	Collinearity Statistics
		B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	VIF
	(Constant)	.942	.529		1.781	.075	-.096	1.981		
Gender	Female	-.536	.235	-.078	-2.275	.023	-.998	-.073	-.016	1.227
Age	18-25	-1.087	.285	-.148	-3.816	.000	-1.647	-.528	-.033	1.565
	> 46	2.769	.719	.127	3.852	.000	1.358	4.180	.090	1.139
Education	PhD	-1.052	.368	-.093	-2.856	.004	-1.775	-.329	-.112	1.095
Individual income	THB 30k-THB 45k	-.965	.303	-.105	-3.185	.002	-1.560	-.370	-.089	1.138
Occupation	Full time employee	-.688	.246	-.100	-2.800	.005	-1.171	-.206	-.074	1.339
	Unemployed	-1.437	.578	-.085	-2.485	.013	-2.573	-.302	-.079	1.209
Own a car	Yes	-.825	.334	-.099	-2.472	.014	-1.480	-.170	-.141	1.660
Household living	with spouse and child/children	1.020	.400	.090	2.553	.011	.235	1.805	.015	1.300
	with parents	1.698	.272	.248	6.251	.000	1.164	2.231	.054	1.642
Type of Accommodation	other type of house	2.619	.479	.192	5.470	.000	1.679	3.558	.118	1.290
	Apartment	1.369	.435	.115	3.148	.002	.515	2.223	.088	1.386
Have some one stay home during the day	Yes	-.709	.237	-.104	-2.991	.003	-1.174	-.244	-.066	1.257
experience Shopping online	1-3 years	-2.594	.532	-.334	-4.875	.000	-3.639	-1.549	-.069	4.903
	more than 3 years	-2.084	.518	-.289	-4.022	.000	-3.101	-1.067	.013	5.392
Frequency of shopping online	2-3 times/month	1.748	.338	.251	5.174	.000	1.085	2.411	.031	2.456
	4 or more times/month	1.703	.353	.240	4.826	.000	1.010	2.396	.031	2.577
hours using internet	more than 5 hrs	.613	.255	.081	2.407	.016	.113	1.114	.089	1.171
APL Location Preference	Shopping mall	-.535	.228	-.078	-2.349	.019	-.982	-.088	-.129	1.155
	Office Building	1.046	.491	.071	2.131	.033	.082	2.009	.089	1.143
	Condominium	4.062	1.194	.109	3.401	.001	1.717	6.407	.076	1.067
Travelling distance	Distance to location	-.045	.018	-.081	-2.510	.012	-.080	-.010	-.107	1.085
Price set	Discount	2.539	.211	.373	12.053	.000	2.125	2.952	.376	1.001

Note: $F = 15.189$, $R^2 = 0.335$, Adjusted $R^2 = 0.313$, $N = 718$, $p < 0.05$

Table 1.3: Marginal Effects of estimated parameters

Model		Marginal Effects			
		dy/dx	SD	Min	Max
	(Constant)				
Gender	Female	-.065	.055	-.134	-.003
Age	18-25	-.132	.112	-.272	-.005
	> 46	.337	.286	.014	.692
Education	PhD	-.128	.109	-.263	-.005
Individual income	THB 30k-THB 45k	-.118	.100	-.241	-.005
Occupation	Full time employee	-.084	.071	-.172	-.003
	Unemployed	-.175	.149	-.359	-.007
Own a car	Yes	-.100	.085	-.206	-.004
Household living	with spouse and child/children	.124	.105	.005	.255
	with parents	.207	.176	.008	.424
Type of Accommodation	other type of house	.319	.271	.013	.655
	Apartment	.167	.142	.007	.342
Have some one stay home during the day	Yes	-.086	.073	-.177	-.004
Experience Shopping online	1-3 years	-.316	.268	-.648	-.013
	more than 3 years	-.254	.215	-.521	-.010
Frequency of shopping online	2-3 times/month	.213	.181	.009	.437
	4 or more times/month	.208	.176	.008	.426
Hours using internet	more than 5 hrs	.075	.063	.003	.153
APL Location Preference	Shopping mall	-.065	.055	-.134	-.003
	Office Building	.127	.108	.005	.261
	Condominium	.495	.420	.020	1.016
Travelling distance	Distance to location	-.005	.005	-.011	.000
Price set	Discount	.309	.262	.013	.635

Lastly, distance has a negative impact, though small, on probability adopting APL. The result shows that the increase in distance in a small unit, the probability of adoption of APL decreased by 0.5%, which is similar to Liu, Wang, & Susilo, 2017 but reported as a different probability.

Conclusion and recommendation

The present study examines the predictors of probability of using APL. In this study, it aims to contribute to scarce empirical literature. Socio-demographics have high impact to predict the use of APL. The highest positive impact on probability, which encourage the use of APL are being aged over 46, followed by the type of accommodation (commercial building) and discount price. While, shopping experience between 1-3 years has the highest negative impact on probability using APL. Furthermore, the adoption is highly defined by its location. The highest locations are condominiums and office buildings.



The scarcity of APL knowledge and what impacts probability of use is the basis of this study. The results of the study provide an insight for businesses to understand and increase the use of APL. The implication of the study here is for the location where the most impacted location is the living area and working area which are the same as Lachapelle et al., 2018; L. K. d. Oliveira et al., 2017; J. W. J. Weltevreden, 2008. However, it is different from European countries such as France which is located near public transportation, where it is not significant in this study which can imply that the public transportation in Bangkok may not be convenient for potential customers, similarly to Brazil (L. K. d. Oliveira et al., 2017). The finding can also be used to design new implementing and operating strategies for new parcel lockers' networks, such as to adjust marketing strategies to have the right target and attract new customers.

The growth of e-commerce in the recent years led to an increasing of home deliveries, which is known to be a problematic activity from both customers and carriers. Consequently, a new way to do deliveries is suggested, and using APL is one of the offerings. However, in Bangkok this service is still new and not widely adopted. This study aims to provide a model to predict the probability of using APL from socio-demographic, behaviors and preferences. The findings provide a better understanding of what impacts the probability and how much they impact each predictor especially in the right locations. Despite the contribution of this research study, there is a limitation related to the nature of the sample. The age distribution within the sample is not representative of the population, especially when the lowest age range and highest age range are a small share. Another aspect to be mentioned is the probability of using might not lead to an actual behaviour (Lemke et al., 2016; Mitrea et al., 2020). These limitations offer opportunities for further research in the field.

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