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Factors affecting intention to connect to Internet exchange point in Thailand

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Abstract

In spite of the recognition of Internet exchange point (IXP) as a critical infrastructure that helps drive the digital economy, little research has been done on the reasons why Internet service providers (ISP) and organizations decide to connect to the IXP. This study aims to investigate factors at the firm level which affect the intention to connect to the local IXP. The research is based on an online questionnaire administered to 53 participants who operate ISPs and organizations with autonomous systems (AS) in Thailand. The results show that the intention of the ISPs and organizations to connect to IXP is influenced mostly by policy factors, followed by the feature factor, while the quality factor has the least influence on the decision to connect in the Thailand context. Since the analysis is confined to a small sample size, this comparative result is limited. The study can only identify factors affecting the intention to connect to the local IXP in the Thailand context. The understanding of this relationship is beneficial to the strategic planning and implementation of a successful IXP which will be of sustainable value to the community as a whole.

Keywords: internet peering, ISP, IXP, NIX, neutral Internet exchange point

1. Introduction

The Internet network of computers brings great opportunities to its users and society. Many economies are moving towards a digital society where the Internet plays an important role as an element of infrastructure in the transformation. Access to the Internet brings learning opportunities to people (Watts, 2015) as well as changing the way they communicate and live.

The Internet connection via TCP/IP protocol in Thailand fully started in 1992 with a 9.6 Kbps leased line from Chulalongkorn University to UUNET in the United States of America (Kanchanasut, 2015). At that time there was no Internet service provider (ISP) in Thailand, so Internet traffic was exchanged at a connecting point outside of the country. In 2017, the data from the Nation Broadcasting and Telecommunication Commission (NBTC), Thailand showed that there were 10 international Internet

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gateway service providers serving 45 million Internet users with 5 Tbps of international bandwidth and domestic bandwidth (NBTC and NECTEC, 2017b) while there were 11 domestic Internet exchange points and 42 networks connecting Internet service providers with each other (NBTC and NECTEC, 2017a).

The Thailand Internet map (NBTC and NECTEC, 2017a) showed the complexity and duplication of the connection between local ISPs which required a lot of management resources and caused problems such as domestic traffic being exchanged outside the country, package loss and high latency that led to the high cost of the Internet service.

An Internet exchange point (IXP), a place where Internet service providers connect and peer with each other, is a key component which helps improve Internet quality and performance. The local IXP keeps local traffic inside the country rather than wasting international Internet bandwidth which costs a lot more than local bandwidth in exchanging, so it helps increase Internet speed, reduces latency and reduces costs and makes local Internet cheaper and affordable to more people. The IXP is, thus, recognized as a critical piece of infrastructure to drive the digital economy.

Despite the recognition of the Internet exchange Point as a critical element of infrastructure that helps drive the digital economy, little research has been done on the reasons why Internet service providers and organizations decide to connect to the IXP. This study aims to examine factors which affect the intention to connect to the local IXP. Understanding the factors affecting the intention to connect to IXP gives an advantage in the strategic planning and implementing of a successful IXP which will be of sustainable benefit of the community as a whole. This exploratory research used a quantitative approach with an online questionnaire to study the factors affecting the Thai ISPs and organizations intention to connect to the local IXP. The academic contribution of the study relates to the factors affecting the intention to connect to IXP in the Thai context while the relationship between factors and the intention to connect can also be used to stimulate the development of IXP in Thailand. An additional contribution includes the improvement of Thailand Internet quality and performance. An effective Thailand IXP can serve as a regional hub for the Greater Mekong Subregion in the future.

The remainder of this paper is structured as follows: the first section is a brief description of Internet connection mechanisms detailing the quality measures of Internet connection, route selection and Internet traffic exchange and Internet exchange points. The section concludes with the research's conceptual framework and study hypotheses. The subsequent sections are methods and results. The last section provides a discussion and conclusion with possible implications, limitations, and future research.

2. Internet connection mechanisms

2.1 Quality measures of internet connection

The study of Bartolomeo et al. (2015) used round trip delay, hop count, packet loss and jitter as key performance indicators to measure the quality of the Internet connection. The comparative research was done in Italy to compare the quality of the connections with and without the IXP. The result shows that IXP-based paths exhibit a better and more stable performance while the measurements also confirm that IXP-based paths tend to keep local traffic, between users and major service providers such as banks and government agencies in the country.

In addition to Internet performance indicators, Giotsas et al. (2015) proposed methods for measuring and mapping physical locations of connections because the peering information that is currently publicly

available does not provide physical coordinates which will be useful for the analysis of the impact on the connection and traffic exchange when attacks and disasters occur.

2.2 Route selection and internet traffic exchange

The literature review on Internet traffic exchange reveals that there were some costing models in the form of transit (Coucheney et al., 2015; Weiss and Seung Jae, 2004), a transit cost is charged from connected ISPs by ISPs which have content within their network. Other studies presented costing models where ISPs get their revenues from passing traffic from content delivery network providers to the end-users (Ma et al., 2008), the content providers who want to push their contents to the eyeballs pay the cost to the ISPs. Another model supported peering between Internet service providers (Huston, 1999) where there is no transit cost. In terms of business, Thai ISPs and organizations may prefer the cheapest route or connect to the exchange point that has contents to benefit from low cost or no additional cost of peering and traffic exchange. However, there was no previous study on the issue.

On the other hand, the work of Weiss and Seung Jae (2004) showed that a firm based on peering connectivity policy has a positive effect while Meier-Hahn (2016) pointed out that local rules or regulations have a negative effect on the global Internet ecosystem. For Thailand, a study to explore whether organization policy and local rules and regulations affect the selection of an Internet exchange point needs to be done.

In terms of a simulation model as a tool to analyze and to suggest connection and traffic exchange between ISPs, Lodhi et al. (2012) proposed GENESIS, an agent-based model, for peer selection based on the Autonomous System (AS). The model was extended under the name of GENESIS-CBA (Lodhi et al., 2013) which uses 4 constraints, traffic matrix, policy-based routing, geographic co-location constraints and cost of traffic exchange in terms of transit and peers, as a mechanism in the AS selection for peering. GENESIS-CBA is a type of peering selection based on fitness analysis of costs and benefits (Cost-Benefit-Analysis).

The other agent-based network simulation model called ITER (Dhamdhere and Dovrolis, 2010) uses factors of the Internet ecosystem related to the content providers and peering policies which are interdomain traffic flow and routing, provider and peer selection strategies, geographical constraints and the economics of transit and peering interconnections to simulate and suggest the topological structure of the inter-domain connection. The researchers pointed out that the Internet is evolving from the multi-tier hierarchy built with transit to a flat mesh peering inter-domain structure. With the new structure, the transit providers will be able to receive revenue, by utilizing traffic exchange strategies, from the content providers, which is difficult within the old structure.

Recently, besides ISP and IXP, the content provider has been an important player because more than half of todays traffic on the Internet is produced by large content providers such as Google, Facebook and Line since digital life is transforming people's behavior. Users generate a lot of content, videos, graphics and texts and share them massively via social media through those content providers.

Referring to the studied simulation models, only ITER includes the content provider in the model while GENESIS-CBA has not yet incorporated it in the calculation of the cost-benefit analysis. The researchers considered that this was a research gap on which further studies should be done to propose a new simulation model which takes the content provider as a variable in the calculation.

2.3 Internet exchange point (IXP)

The domestic Internet exchange point is a place where the local ISPs directly connect peer-based exchange traffic with each other with no intermediate transit provider resulting in faster local Internet speed due to less

delay/latency. While the local traffic is kept in the country, the international Internet bandwidth that is more expensive is used for necessary international traffic. Therefore, the cost of the Internet will be cheaper for local Internet users. IXP is then recognized as an important piece of Internet infrastructure (Bartolomeo et al., 2015; D'Ignazio and Giovannetti, 2014; Stocker et al., 2016). Nowadays, not only ISPs but the content providers and firms with an autonomous system, a connected group of IP prefixes run by one or more network operators which has a single and clearly defined routing policy (Hawkinson and Bates, 1996), also want to peer at the IXP to receive benefits from traffic exchange with other members of the IXP.

Stocker et al. (2016) conducted a study to examine the connection of ISPs and found that even though content is an important factor for consideration, the connecting point for traffic to be exchanged and sent to the end-users is more important. In this sense, Bartolomeo et al. (2015) explain that the traffic exchange at the managed IXP has a positive effect on the main performance indicators such as the reduced number of hops, lower delay/latency, packet loss and jitter and the local traffic between Internet users and the major local service providers, i.e., banks and government agencies, tend to be kept local.

However, the location of the IXP is another significant factor that ISPs carefully consider. The selection should be made for a proper, safe, secure and neutral infrastructure for the co-location to host the IXP as members can then easily and conveniently use any medium provider of their choice to connect to the IXP. Soobron et al. (2014) explored models of setting up a regional IXP for Indian ocean islands using business policies and network structure as selection criteria. Table 1 summarizes variables from that literature review that relate to the intention to connect to the Internet exchange point.

Table 1. Variables relating to intention to connect to the Internet exchange point (IXP)

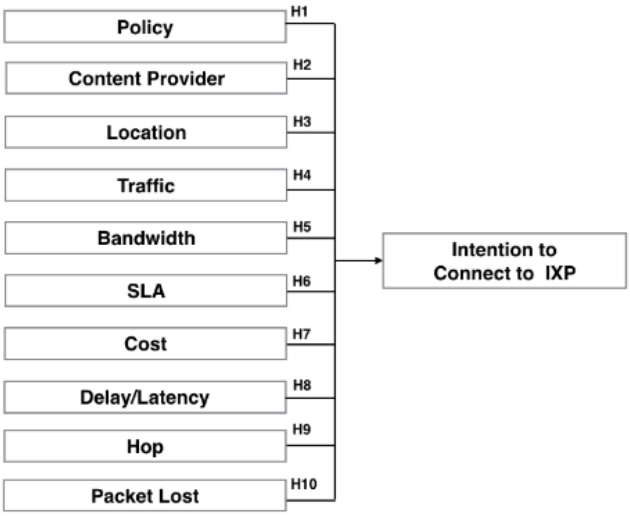
	Delay/ latency	Hope	Packet loss	Policy	Content	Location	Traffic	Cost
Bartolomeo et al. (2015)	X	X	X					X
Coucheney et al. (2015)				X	X			X
D'Ignazio and Giovannetti (2014)	X	X				X		X
Dhamdhere and Dovrolis (2010)				X	X		X	X
Giotsas et al. (2015)						X		
Huston (1999)				X				X
Lodhi et al. (2013)				X		X	X	X
Ma et al. (2008)					X			
Meier-Hahn (2016)				X				
Soobron et al. (2014)	X	X	X			X	X	
Stocker et al. (2016)	X	X	X			X	X	
Weiss and Seung Jae (2004)				X				X

2.4 Conceptual framework and hypotheses

The finding from the literature review reveals that there is still a gap in the existing simulation models causing the decision by the ISPs and firms in Thailand not to use it as a tool for Internet connectivity and traffic exchange selection. This paper aims to explore the factors that affect the intention to connect to an IXP of Thai ISPs and firms with AS which want to manage their connectivity related to their policy. To get an insight from a Thai organization, the researcher did an in-depth interview with an ISP to confirm the variables shown in Table 1 and found out that in addition to the eight variables from the literature review, the ISP considered that there are two more variables, the service level agreement (SLA) and the bandwidth of ports available at the IXP platform that affect the intention to connect to an IXP. Therefore, a conceptual

framework of the study was composed of ten independent variables and one dependent variable, as displayed in Figure 1, with the following hypotheses and research questions:

Figure 1. A resource-based model of social structure



H1: The connectivity policy of the organization (Policy) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H2: The content providers in the IXP (Content) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H3: The physical location of the IXP (Location) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H4: Volume of traffic exchanged in the platform (Traffic) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H5: Available bandwidth of the ports in the platform (Bandwidth) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H6: Service level agreement of the IXP (SLA) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H7: Cost of connection to the IXP (Cost) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H8: Delay or latency of the traffic exchange through the platform (Delay) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H9: Number of hops between the sender and the receiver (Hop) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

H10: Packets loss between the sender and the receiver (PacketLoss) has a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS

Research question 1 (RQ1): What are the variables which affect the intention to connect to an IXP?

Research question 2 (RQ2): What is the correlation of variables to predict the intention to connect to an IXP?

3. Method

3.1 Participants

A total of 53 (N=53) Thai ISPs and firms returned the online questionnaire. All 53 organizations registered their autonomous system with the Asia Pacific Network Information Center (APNIC, 2017). This study collected data in November 2017. Participants in this study varied from owners, executive members, IT managers, network engineers to other employees of the ISPs or firms. The distribution of participants' age ranged from younger than 26 years old to 55 years and older. The type of organizations that returned the most questionnaires was the ISPs at 58.5%; there were 27.7% of business firms, 22.6% of government agencies and 7.5% of other organizations participating in the study. The average age of organizations was more than ten years. Table 2 shows the characteristics of participants and Table 3 the characteristics of the organizations participating in the study.

Table 2. Characteristics of participants (N=53)

Gender	*n*	Percent (%)
Male	46	86.8
Female	7	13.2
Age		
Younger than 26 years old	3	5.7
26-35 years old	14	26.4
36-45 years old	23	43.4
46-55 years old	12	22.6
55 years and older	1	1.9
Position		
Owner	3	5.7
Executive	14	26.4
IT manager	14	26.4
Network engineer	23	43.4
Others	7	13.2

Table 3. Characteristics of organizations participating in the study(N=53)

Type of organization	*n*	Percent (%)
ISP	31	58.5
Government agency with AS	12	22.6
Business with AS	20	37.7

Others	4	7.5
Business age		
Less than 1 year	1	1.9
1-5 years	6	11.3
6-10 years	4	7.5
More than 10 years	42	79.2

3.2 Measures

Ten items in the questionnaire were developed to meet the objectives of the study using information from the literature reviews and the interview with one IOC and one try out. While a 5-point Likert-type scale (from 1 = not at all to 5 = very much) was used to measure, the detailed descriptions are shown in Table 4 with the Cronbach's alphas of the measured items at .818.

Table 4. Measures, means and standard deviations (SD) of variables

Variable	Measure items	Mean	SD
Policy	The connectivity policy of the organization has a positive effect on the intention to connect to an IXP	3.94	0.776
Content	The content providers in the IXP has a positive effect on the intention to connect to an IXP	3.92	0.829
Location	The physical location of the IXP has a positive effect on the intention to connect to an IXP	3.91	0.883
Traffic	Volume of traffic exchanged in the platform has a positive effect on the intention to connect to an IXP	4.19	0.786
Bandwidth	The available bandwidth of the ports in the platform has a positive effect on the intention to connect to an IXP	4.11	0.870
SLA	The service level agreement of the IXP has a positive effect on the intention to connect to an IXP	4.09	0.766
Cost	The cost of connection to the IXP has a positive effect on the intention to connect to an IXP	4.25	0.655
Delay	Delay or latency of the traffic exchange through the platform has a positive effect on the intention to connect to an IXP	4.23	0.697
Hop	The number of hops between the sender and the receiver has a positive effect on the intention to connect to an IXP	3.94	0.795
PacketLoss	Packet loss between the sender and the receiver has a positive effect on the intention to connect to an IXP	4.09	0.741

4. Results

Four types of regression analysis (enter, stepwise, backward and forward) were performed in IBM SPSS Statistics 22 program on the measured items (Policy, Content, Location, Traffic, Bandwidth, SLA, Cost, Delay, Hop and Packet Loss). The results show that all Adjusted R Square was very low, .317 or lower. Therefore, the unstandardized residual was checked and three outliers were identified. After that, four types of regression analysis were rerun without the outliers. The Adjusted R Square from the backward regression (5th model) was highest at .629 with six independent variables that affect the intention to connect to an IXP. The standardized coefficients beta of the variables affirms that Traffic is the variable that affects the intention to connect the most, .402, followed by Policy, Packet Loss, Delay, Bandwidth and Hop with .349, 300, 219, .216, and -.263 respectively.

Table 5. Result of backward regression analysis (5th model)

	Standardized coefficients	t	Sig.*	Collinearity statistics	
	Beta			Tolerance	VIF
Policy	.349	3.293	.002	.675	1.481
Traffic	.402	3.608	.001	.609	1.642
Bandwidth	.216	2.258	.029	.823	1.215
Delay	.219	2.045	.047	.659	1.517
Hop	-.263	-2.196	.034	.527	1.898
PacketLoss	.300	2.738	.009	.629	1.590

Note: Adjusted R square = .629, N=50 (without 3 outliers)
* p<.05

Table 6. Pearson correlation matrix

	Intention	Policy	Content	Location	Traffic	Bandwidth	SLA	Cost	Delay	Hop	PacketLoss
Intention		.615**	.520**	.441**	.645**	.397*	.399*	.416**	.345**	.276*	.373**
Policy			.525**	.293*	.550**	.186	.144	.233	.149	.188	.075
Content				.421**	.586**	.099	.212	.305*	.039	.140	.323*
Location					.460**	.255*	.171	.590**	.145	.208	.280*
Traffic						.279*	.287*	.432**	.055	.296*	.189
Bandwidth							.367**	.172	.257*	.330**	.112
SLA								.536**	.460**	.456**	.377**
Cost									.453**	.369**	.513**
Delay										.511**	.436**
Hop											.568**
PacketLoss											

Note: N=50 (without 3 outliers)
* p<.05, ** p<.01

To test the correlation between the variables the Pearson Correlation was employed. As depicted in Table 6, there is a relationship between several pairs of variables. For example, Policy correlates with Content with a Pearson Correlation value of .525 with less than .001 level of significance (p=.000). Therefore, a factor analysis using principal component analysis method with varimax Kaiser normalization rotation was performed on the measured items to ascertain the underlying factors that might affect the intention to connect to an IXP. Table 7 shows the results of this analysis where the factor loadings less than 0.5 were removed.

The result points out that Packet Loss, Delay, Cost, Hop and SLA had a high factor loading value on component 1 so they were grouped as a quality factor (F_Quality), accounting for 27.829%. As Content, Traffic, Policy and Location had a high factor loading value on component 2, they were grouped under a policy factor (F_Policy), accounting for 25.967%. The last component, Bandwidth, was under the feature factor (F_Feature), accounting for 12.466% of the variance after the rotation. With these three factors, a multiple regression analysis was performed using the Enter method and the Adjusted R Square was .558.

Although, the Adjusted R Square from the three factors were lower than the one with 6 independent variables, the four independent variables, Content, Location, Cost and SLA, which were excluded in the regression analysis on independent variables, were included in this analysis on the three factors. As shown in Table 6, the Content, Location, Cost and SLA had a value of Pearson Correlation with the dependent variable, Intention, in a rank of 3rd, 4th, 5th, and 6th, respectively, so they should not be omitted. Finally, the coefficients, β, were used with the predictor factors to make an equation to predict the intention to connect to an IXP: Intention to connect to an IXP = 4.080 + .493 F_Policy + .241 F_Feature + .230 F_Quality with the Adjust R Square value .558.

Table 7. Result of factor analysis with varimax Kaiser normalization rotation on the measured items

	Mean	SD	Component 1	Component 2	Component 3
Policy	3.97	.772		.726	
Content	4.00	.756		.823	
Location	4.02	.769		.660	
Traffic	4.22	.737		.818	
Bandwidth	4.16	.817			.848
SLA	4.10	.763	.642		
Cost	4.24	.664	.710		
Delay	4.24	.687	.748		
Hop	3.98	.769	.709		
Packet Loss	4.08	.752	.806		
Eigenvalue			3.864	1.743	1.020
% of variance			27.829	25.967	12.466

Note: Extraction method: Principal Component Analysis with N=50 (without 3 outliers)

5. Discussion and conclusion

5.1 Discussion of findings

The results from the factor analysis and multiple regression analysis with the Enter method on the three factors conclude that all hypotheses, H1 to H10, of the study are confirmed. The findings support the prediction that the connectivity policy of the organization (Policy), content providers in the IXP (Content), physical location of the IXP (Location), volume of traffic exchanged in the platform (Traffic), available bandwidth of the ports in the platform (Bandwidth), service level agreement of the IXP (SLA), cost of connection to the IXP (Cost), delay or latency of the traffic exchange through the platform (Delay), number of hops between the sender and the receiver (Hop) and packet loss between the sender and the receiver (PacketLoss), respectively, have a positive association with the intention to connect to an IXP of Thai ISPs and firms with AS.

The factor analysis suggested three separate groups consisting of independent variables which correlate to each other in the same group creating three factors. The first group, packet loss between the sender and the receiver (Packet Loss), packet delays or latency (Delay), costs or expenses of the connection (Cost), number of hops counted when packets travel to the destination (Hop) and the service level agreement of an IXP (SLA), formed the quality factor, F_Quality. The second group named F_Policy was composed of four independent variables, the policy of the organization (Policy), the number of content providers in the platform (Content), the geographical location of the connection (Location) and the amount of traffic on the IXP's

platform (Traffic). The last group was under the F_Feature with only one variable, bandwidth available on the platform (Bandwidth). Therefore, all ten independent variables were grouped into three factors which could be used to predict the intention to connect to an IXP for Thai ISPs and organizations with their own AS.

Regarding prediction, the factors, F_Policy, F_Quality and F_Feature, can be used to predict the intention to connect to IXP at 55.8% of the variance and the remaining 46.2% would depend on other factors which need to be further studied. The strongest predictor is the policy factor, F_Policy, while the feature factor, F_Feature, is the second in the order and the F_Quality, quality factor, is the last factor affecting the intention to connect. The results also reveal that the intention to connect to an IXP had an initial value at 4.080 and if the scale of the organizations' opinion were increased on the measured items of the policy factor by 1 level, the intention to connect would be increased by .493. In the same direction for the feature factor and quality factor, a 1 scale increase for the feature factor and a 1 scale increase for the quality factor would result in .241 and .230 level of the intention to connect, successively, with a 95% confidence interval.

The result of the correlation analysis between those factors affecting the intention to connect to an IXP pointed out that the IXP operator should be able to demonstrate to the targeted organizations the contribution of the IXP to the factors that affect the intention to connect. In the Thai context, the most influential factor on Thai ISPs and organizations with AS is the policy factor followed by the feature factor and the quality factor has the least influence on the intention to connect.

This study finds that in the Thai context, the policy factor has the strongest positive effect on the intention to connect which is in line with the works of Coucheney et al. (2015), Dhamdhere and Dovrolis (2010), Ma et al. (2008), Weiss and Seung Jae (2004) and Lodhi et al. (2013). Thai organizations usually give priority to the policies and regulations of the regulatory agencies such as the National Broadcasting and Telecommunication Agency of Thailand, the regulator issuing ISP and IXP licenses. Organizations preferring a peering policy tend to connect to the IXP to exchange traffic with other members. Therefore, the IXP should provide the option for members to implement their peering policies on the platform. In terms of the content, nowadays, big content providers are the most important stakeholders and more than half of the traffic on the Internet comes from them. The Internet transforms people's lifestyles; photos, voices, as well as video clips which are accessed through online social media daily while the size of the files is increasing explosively. ISPs or IXPs with a content cache in their platform to serve their members will benefit and be more attractive to the customers since to connect as users through access to those is faster and less costly. Therefore, an IXP should provide cached contents of the big content providers as a common service to its members. The traffic exchange on the platform will increase as a result of this service as well.

The geographical location of the connecting point is important for the Internet infrastructure because places with good infrastructures that are secure and suitable, positively affect the intention to connect as members can be neutral, conveniently and comfortably bringing their communication circuit to connect to the IXP (Soobron et al., 2014; Stocker et al., 2016). It is consistent with the results from this study that geographical location has an effect on the intention of Thai organizations to connect. Therefore, the IXP should provide point of presence options that suit customer need as this will help increase the intention of the targeted ISPs and firms to connect.

Regarding the feature factor or bandwidth available to the members, even though there is no study from the literature reviews taking this variable into consideration, this factor is countable in the Thailand context. Proper and sufficient options to serve different sizes of prospect will be more attractive to Thai organizations with AS. For example, a small ISP might want to start the connection with a small port such as 1Gbps. Once the organization grows bigger and generates or consumes more traffic, it can move to a bigger port of 10Gbps or increase the number of ports. As the bandwidth of ports affects the device required to serve the connection,

the targeted members can easily make their decision if they can launch the connection using their existing devices.

For the quality factor, the simulation models Genesis-CBA (Lodhi et al., 2013) and ITER (Dhamdhere and Dovrolis, 2010) propose the cost of connection as a variable in the models which is in line with the analysis of this study which points out that the cost of connection is considered to effect the intention to connect of the ISPs as it will consequently affect the price of Internet usage of end-users of the ISPs. The delay and latency of the packets transmitted over the platform are an important element since they reflect the quality of the Internet connection, especially in Thailand. The Thailand Internet User Profile 2017 (ETDA, 2017) reported that, on average, Thai Internet users spent more than six hours online each day while social media and entertainments (movie, music and online games) are in the top rank of access and delay and latency which are very important for these kinds of activity. Therefore, it is congruent with the study of Bartolomeo et al. (2015), and this study, as ISPs and organizations in Thailand will consider this variable affects the intention to connect to an IXP. The IXP, then, should be able to prove that connecting to the IXP will improve user experiences due to lower delay/latency, the number of hops and packet loss to gain the intention to connect from the ISPs and organizations.

5.2 Research implications

1. This research sheds light on the factors affecting the intention to connect to the local IXP in the Thai context which can be used for the strategic planning and implementation of a local IXP to achieve the intention to connect with the targeted group, Thai ISPs and organizations with AS, which is a sustainable benefit to the whole Internet community in Thailand. As the most influential factor on Thai ISPs and organizations with AS is the policy factor followed by the feature factor and the quality factor has the least influence on the intention to connect, the local IXP operator should put their focuses on the policy factor, the feature factor and the quality factor sequentially.

2. The understanding of the relationship between the factors and the intention to connect can be extended to develop an application that helps ISPs and organizations decide to connect based on the factors of their choices resulting in reducing operation processes and time, decreasing costs as well as increasing the quality of Internet usage, which will benefit the whole Internet community in Thailand sustainably.

5.3 Limitations

The samples were organizations with AS which are very specific. Also, in order to respond to the questionnaire, the participants needed to understand or work in the field or be related to the Internet connection and traffic exchange such as the company's owner, executive officer, technical manager or network engineer. Besides that, some organizations may have to consider that the information required for the study should not be disclosed to the public. With a time constraint, the sample size was small, 53 participants. Thus the analysis to compare the results of different types of organizations could not be done.

5.4 Future research

As the analysis is limited because of the small sample size, its results will be confined to comparing those from other countries. Future research should be done with a larger sample size so that the segmentation model can be tested. Since this study focused on the Thai context, scholars may apply the model to a different country or may test the segmentation model for different countries having different backgrounds. Further

study to find more factors to increase the prediction variance from 55.8% should also be done to improve the current model.

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