I. INTRODUCTION

Most early economic theorists, such as Adam Smith, regarded physical capital as the most important form of capital. Smith regarded human skill and talents as interesting but less central to the dominant analysis.

However, since the mid-1950s, it has become apparent that physical capital (assets) could not explain why some countries performed better than others. Several empirical studies by Kendrick (Kendrick 1974, 1976), Denison (Denison 1967), and others have shown that a large proportion of productivity improvement could not be explained by just the inputs of capital, but also by “residual factors” like wages, employment education, R&D. Recently, researches related to Internet surged because Internet has played an important role in business operation.

This research attempts to investigate the relationship of Internet index and different indicators (both demand-side and supply-side), like GDP, computer literacy, Internet subscribers, and Internet hosts, … in a country. The data in this research consists of Internet countries in Asia Pacific Region. The results of the study may be a useful reference for accessing Internet diffusion limits but also for a country moving toward information society.
II. LITERATURE REVIEW

1. Diffusion Theory

The diffusion model is one classical model used to study the impact of a specific technology. The model is informed by the diffusion of innovation and various economics theories and assumes that non-adopters of an innovation are increasingly likely to imitate adopters.

In other words, one person adopted because he or she observes the success of another person who has already adopted.

However, the number of adopters in a social system has its upper limit. Thus growth rates increases first and then decreases over time to achieve a finite saturation level. Empirical studies shows the model have been used in many disparate fields such as social study, public health, management, sociology, marketing, communication networks to model diffusion through a population of adopters or subscribers.

2. Factors effected innovation diffusion

The diffusion model has been studied for more than 30 years. Researchers found that innovations, Communication Channel, Time to diffusion and social system might effect the diffusion of innovations.

Moreover, for individual adoption, Professor Frank Canclien proposed a nonlinear theory of socioeconomic status and innovativeness, the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas.

From an organization view of innovation diffusion, individual characteristics (Attitude toward change), internal characteristics of organizational structure (Centralization, Complexity, Formalization, Interconnectedness, Organization Slack, Size) and external characteristics of the organization (System openness) are related to organizational innovativeness.

3. Other indicators-Dual acceptance Theory

Recently, there are some researches found other factors may impact on diffusion of innovations. Take innovative theory for example, Internet subscribers may impact on Internet hosts and vice versa.

The Internet is a communication mesh of networked computers with their associated resources, including but not limited to email, ftp, gopher and the web. Organizations and individuals may adopt and use varying subsets of the Internet. In other words, Internet users could communicate with each other through “Internet” such as email, news groups...etc and interact with Internet resources (webs, mail servers, ftp servers).

This interactive process first studied in the 1980s by diffusion researchers. Researchers found that interactive innovations (telephone, fax, email) possess different characteristics from innovations spread in the normal diffusion networks (mass media, interpersonal networks).

The main feature of the interactive process of innovations and adopters is its two-way communication process. In the case of non-interactive innovations, the earlier adopters have a sequential interdependence effect on later adopters. But in the case of interactive innovations, not only earlier adopters influence later adopters but later adopters also influence earlier adopters. Based on interactive innovations, one researcher showed Internet
client-server architecture might cause a new many-to-many communication model.

In dual acceptance theory, diffusion of Internet adopters depends upon Internet servers whereas the diffusion of the web server depends upon Internet users. Chen’s study indicated that if there are only a few web servers, using the web is of little value to users. Similarly, if there are only a few web users on the Internet, creating a web server is of little value to organizations or business. This also implies Internet subscribers may benefit from Internet hosts and have positive impact on increasing upper limit of Internet subscribers.

III. RESEARCH METHOD

This study attempts to use diffusion model to access the relationship of internet diffusion (users) and indicators (factors) that affected internet diffusion. If we could find some significant factors, we might be able to enhance internet diffusion.

1. Diffusion Indicators

From the framework of diffusion theory and available indicators in the world, we select possible diffusion indicators as followed.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Subcategories</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>The innovation</td>
<td>PC per capita</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Telephone per capita</td>
</tr>
<tr>
<td></td>
<td>Communication Channel</td>
<td>Mobile per capita</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Telephone per capita</td>
</tr>
<tr>
<td></td>
<td>Time to diffusion</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Social System</td>
<td>Refer to Organization Category</td>
</tr>
<tr>
<td></td>
<td>Socioeconomic</td>
<td>GDP</td>
</tr>
<tr>
<td>Organization</td>
<td>Leader’s Attitude toward change</td>
<td>Government priority of ICT</td>
</tr>
<tr>
<td>Internal characteristics of organizational structure</td>
<td>Centralization Complexity</td>
<td>Government online service Legal framework of ICT development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Formalization,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Interconnectedness</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Organization Slack Size</td>
</tr>
<tr>
<td>Other theory</td>
<td>Dual Acceptance Theory</td>
<td>Internet Host</td>
</tr>
</tbody>
</table>

Source: this study
2. Data Source

We collect all possible diffusion indicators and data from Asia Pacific area. Some are primary data. Other are secondary data (mostly in Organization categories).

Table 2°B Different indicators

<table>
<thead>
<tr>
<th>Nation</th>
<th>Internet Users</th>
<th>Hosts</th>
<th>GDP</th>
<th>Tel</th>
<th>Mobile</th>
<th>PC</th>
<th>Government priority</th>
<th>Government online</th>
<th>Legal framework</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>42.73%</td>
<td>12.70%</td>
<td>18481</td>
<td>117.83%</td>
<td>63.97%</td>
<td>51.58%</td>
<td>4.50</td>
<td>5.3%</td>
<td>5.54</td>
</tr>
<tr>
<td>China</td>
<td>4.60%</td>
<td>0.01%</td>
<td>907</td>
<td>32.78%</td>
<td>16.09%</td>
<td>1.90%</td>
<td>5.27</td>
<td>3.5%</td>
<td>4.15</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1.89%</td>
<td>0.02%</td>
<td>695</td>
<td>9.11%</td>
<td>5.52%</td>
<td>1.10%</td>
<td>3.67</td>
<td>2.04</td>
<td>3.63</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>43.09%</td>
<td>5.25%</td>
<td>24383</td>
<td>149.72%</td>
<td>92.98%</td>
<td>38.66%</td>
<td>5.26</td>
<td>5.74</td>
<td>5.43</td>
</tr>
<tr>
<td>Japan</td>
<td>44.93%</td>
<td>6.84%</td>
<td>32554</td>
<td>117.36%</td>
<td>62.11%</td>
<td>38.25%</td>
<td>5.51</td>
<td>3.15</td>
<td>4.15</td>
</tr>
<tr>
<td>Malaysia</td>
<td>26.67%</td>
<td>0.30%</td>
<td>3700</td>
<td>51.21%</td>
<td>12.61%</td>
<td>3.86%</td>
<td>3.28</td>
<td>6.24</td>
<td>6.3%</td>
</tr>
<tr>
<td>Singapore</td>
<td>54.00%</td>
<td>8.17%</td>
<td>20752</td>
<td>125.0%</td>
<td>79.14%</td>
<td>50.83%</td>
<td>6.24</td>
<td>6.3%</td>
<td>6.18</td>
</tr>
<tr>
<td>South Korea</td>
<td>55.19%</td>
<td>1.46%</td>
<td>9023</td>
<td>116.80%</td>
<td>67.95%</td>
<td>55.58%</td>
<td>5.31</td>
<td>4.52</td>
<td>4.96</td>
</tr>
<tr>
<td>Taiwan</td>
<td>38.37%</td>
<td>8.10%</td>
<td>12900</td>
<td>164.78%</td>
<td>106.45%</td>
<td>39.57%</td>
<td>5.98</td>
<td>5.3%</td>
<td>4.36</td>
</tr>
<tr>
<td>Thailand</td>
<td>7.76%</td>
<td>0.12%</td>
<td>1874</td>
<td>22.19%</td>
<td>26.04%</td>
<td>2.78%</td>
<td>5.09</td>
<td>3.17</td>
<td>3.83</td>
</tr>
<tr>
<td>Philippines</td>
<td>2.50%</td>
<td>0.04%</td>
<td>913</td>
<td>21.95%</td>
<td>17.77%</td>
<td>2.17%</td>
<td>4.56</td>
<td>2.25</td>
<td>4.54</td>
</tr>
<tr>
<td>U.S</td>
<td>53.75%</td>
<td>36.83%</td>
<td>35843</td>
<td>114.70%</td>
<td>48.81%</td>
<td>62.50%</td>
<td>5.31</td>
<td>5.43</td>
<td>6.15</td>
</tr>
<tr>
<td>Vietnam</td>
<td>1.85%</td>
<td>0.00%</td>
<td>406</td>
<td>9.19%</td>
<td>2.34%</td>
<td>0.98%</td>
<td>4.68</td>
<td>2.15</td>
<td>3.90</td>
</tr>
</tbody>
</table>

Data Source: ITU, 2002 NRI reports

IV. ANALYSIS AND DISCUSSION

1. Analyze individual diffusion factors

Previous studies demonstrated that innovations, Communication Channel, Time to diffusion, social system and socioeconomic might effect the diffusion of innovations and individual absorption of innovations. The followings are the regression model of diffusion factors and Internet diffusion.

![Internet Penetration Rate vs. PC per capita](image)

\[ R^2 = 0.96 \]
Figure 1 Internet diffusion vs. PC

Internet Penetration Rate vs. Telephone per Capita

Figure 2 Internet diffusion vs. Telephone per Capita

Internet Penetration Rate vs. Mobile phone per Capita

Figure 3 Internet diffusion vs. Mobile phone per Capita
2. Analyze Organizational diffusion factors

From the figures above, while the number of diffusion factors increase, Internet diffusion also increases. The best fitting model above is logarithm model. For $R^2$, all models seem acceptable.

From an organization view of innovation diffusion, leader’s characteristics (Attitude toward change), internal characteristics of organizational structure (Centralization, Complexity, Formalization, Interconnectedness, Organization Slack, Size) and external characteristics of the organization (System openness) are related to organizational innovativeness.

Here we select organizational diffusion factors with available data. The followings are the regression model of diffusion factors and Internet diffusion.
From the figures above, while the number of diffusion factors increase, Internet diffusion also increases. The best fitting model here is logarithm model except the regression model of government priority and Internet diffusion.
3. Analyze other diffusion factors

Chen’s study indicated Internet client-server architecture causes a new many-to-many communication model and effect Internet diffusion. The following is the regression model of Internet hosts and Internet diffusion.

![Internet Penetration Rate vs. Host pr](image)

**Figure 8** Internet diffusion vs. Internet Hosts

From the figures above, while the number of diffusion factors increase, Internet diffusion also increases. The best fitting model here is logarithm model. For $R^2$, the regression model seems acceptable.

4. Discussion of diffusion factors

In this study, we select some important and “available” indicators and try to find out the relationship between these factors and Internet diffusion. What’s special with these results?

First, this study applies diffusion theory in nation diffusion. The results support previous research. Some diffusion factors have strong relationship with Internet diffusion. This implied we could increase Internet diffusion by manipulating diffusion factors.

Moreover, from the figures above, almost all regression models are logarithm models except the regression model of government priority and Internet diffusion. It means in the very beginning, the number of diffusion factors increase and Internet diffusion also increase. However, when the number of diffusion factors reach certain level, Internet diffusion stop. The factor “Government priority” is different. The more Government care about ICT development and take it seriously, the more Internet diffusion will be.

The results implied that these diffusion factors are just the fundamental to Internet diffusion. This means if other Internet diffusion factors are ready, the resolution of government is the key to nation Internet diffusion. And the results of this study coincide with the cases in the firm-level diffusion of innovations. The executives are the key to firm’s
changes and innovations.

What’s most meaningful to information society is from this study, almost all regression models are logarithm models, which means if you help to enhance diffusion factors of internet laggard countries a little bit, huge Internet diffusion could occur, and according the network theory, finally benefit all countries in this network.

V. CONCLUSION

This research attempts to investigate the relationship of INTERNET index and different indicators (both demand-side and supply-side), like GDP, computer literacy, Internet subscribers, and Internet hosts. From the framework of diffusion theory and available indicators in the world, possible diffusion indicators are selected.

Some important results are concluded here. First, the results of this study show some diffusion factors have strong relationship with Internet diffusion. This implied we could increase Internet diffusion by manipulating diffusion factors. Secondly, almost all regression models are logarithm models except the regression model of government priority and Internet diffusion. The results implied that some diffusion factors are just the fundamental to Internet diffusion; government’s attitude is the key to nation Internet diffusion.

Although this study demonstrated some interesting results, to state that these factors are the keys to Internet diffusion would be going too far. Some future works would be needed. More research should be taken in organizational innovation diffusion theory and nation innovation diffusion theory to find proper diffusion factors. Also, more data should be taken into consideration.

REFERENCES

Chen, Hsiang, Dual Acceptance of Web Diffusion: A case of Clients and Servers, 26th Annual conference of the Canadian Association for information Science.


Prescott, M.,B, Slyke, Craig Van, The Internet as an Innovation, the Second Americas Conference on Information Systems (1996).


