

Wi-Fi Adoption and Security in Hong Kong

Ken Kin-Kiu Fong^{1,2} & Stanley Kam Sing Wong^{3,4}

¹ University of South Australia, Australia

² Wireless Technology Industry Association (WTIA), Hong Kong

³ University of Newcastle, Australia

⁴ University of Manchester, UK

Correspondence: Ken Kin-Kiu Fong, University of South Australia, Australia. E-mail: ken@fong.com.hk

Received: April 7, 2016 Accepted: April 15, 2016 Online Published: May 20, 2016

doi:10.5539/ass.v12n6p1

URL: <http://dx.doi.org/10.5539/ass.v12n6p1>

Abstract

WiFi is the fastest and most cost-effective way of wireless Internet connectivity. Nowadays, almost all of the mobile phones and an increasing number of home entertainment systems are WiFi-enabled. Being the key enabler of the “Internet of Everything”, WiFi brings including people, processes, data and devices, together and turns data into valuable information that makes life better and business thrive. With all mobile devices, wearable gadgets, home entertainment systems and home automation systems connected together and linked to the Internet, devices can now interact with one another and data be shared among the devices. However, transmitting information across the WiFi network means leaving your computer or devices vulnerable to attack, giving unscrupulous people the opportunity to intercept traffic, selectively eavesdrop on critical communications or even the administrative access and thus the ability to harvest all the information they want. All these threats highlight the growing importance of keeping your WiFi secure from unauthorized access and malicious attacks.

Basing on empirically collected quantitative data, this paper presents a comprehensive study on Hong Kong people’s knowledge about WiFi security and their use of WiFi in connecting the Internet. Findings of the study shed light on the knowledge gaps of Hong Kong WiFi users in using and setting up WiFi connections so that service providers, policy makers and stakeholders can devise appropriate security measures to improve the security of WiFi connection. The study also canvasses and analyses the views of the users on the connectivity and quality of free and commercial WiFi service in Hong Kong. The findings can help government and private WiFi operators to further improve the service provided.

Keywords: WiFi, WiFi security, Hong Kong, connectivity, Internet access, Internet of Everything

1. Introduction

With the era of “the Internet of Everything” upon us, WiFi is probably the most used conduit for the Internet connectivity. More and more home devices are now WiFi-enabled -- a WiFi-ready TV or one which is installed with a WiFi HDMI dongle enables the user to stream content from a smartphone; WiFi connectivity enables the user, while still walking under the scorching sun, to turn on the air-conditioner remotely to cool the room to the right temperature; supply chain control and the monitoring of storage conditions can be implemented more efficiently with the application of wireless sensor network platforms. Although the prices of these smart devices, such as WiFi power switches, WiFi light bulbs or sensors, are still high, with rapid advances of electronic technology, it is foreseeable that they will become more affordable and more widely available in the near future.

To some people, WiFi is a life necessity, like air and water. The first thing a teenager does upon entering a restaurant or visiting a friend is to take out his or her smartphone and search for free WiFi or ask for the WiFi password. While smooth and easy WiFi connectivity is important, it is all the more important for users to stay safe while conducting activities using WiFi.

This report, which is the 4th in a series of research compiled by WTIA, investigates WiFi usage, WiFi accessibility, WiFi security and the knowledge of it in Hong Kong. Data collected from the research will help stakeholders to understand more about the user experience, awareness and perceptions of WiFi service and security in Hong Kong. By way of critical data analysis, it is hoped that the findings of the research will assist both the Government and commercial WiFi network providers to identify gaps in the current service and help

shed light on areas of improvement and future directions.

Conventional paper-and-pen self-administered questionnaire were used to collect data from a total of 202 respondents.

The report is divided into 6 parts: Part 1 is this introduction which sets the scene for the research and outlines the aims of the research. Part 2 is a descriptive summary of the demographic profiles of respondents. Part 3 is about WiFi usage in Hong Kong, covering essential details such as the types of WiFi network for Internet access, user profiles of the seven main types of WiFi Internet access, how respondents use WiFi network, the devices used and WiFi tethering. Part 4 addresses the issue of WiFi security, including respondent perception and knowledge on WiFi security and the types of WiFi security settings they used. Part 5 details the respondent assessment of WiFi Internet access provided by both private and Government service providers. Part 6 concludes the report with a detailed discussion of the research findings. A comparison of this year's findings with those found in previous reports and the insights drawn from the comparison are also presented. Relevant suggestions on how to enhance user awareness as well as to improve the security and reliability of our WiFi connection are also discussed.

2. Profiles of Respondents

A total of 202 respondents filled out the questionnaire. Among them, 1 respondent did not answer the question concerning their gender. Of the remaining 201 respondents who answered the question, 66 (32.8%) of them were female and 135 (67.2%) were male (Table 1).

Table 1. Gender of Respondents

	Sample		Valid Response	
	No.	%	No.	%
Male	135	66.8	135	67.2
Female	66	32.7	66	32.8
No response	1	0.5		
Base	202	100.0	201	100.0

Table 2 below illustrates the frequency distribution and percentage composition of the age of the respondents. Of the 198 respondents (98.0%) who answered the question, the majority (31.8%) of them were aged between 46 and 55. Those who were in the 56- to 65-year-old bracket (25.3%) came second, followed by those who were in the 36- to 45-year-old bracket (21.7%). Figure 1 illustrates the distribution of age among the respondents who answered the question on age.

Table 2. Age of Respondents

	Sample		Valid Response	
	No.	%	No.	%
15-18 years old	4	2.0	4	2.0
19-25 years old	16	7.9	16	8.1
26-35 years old	15	7.4	15	7.6
36-45 years old	43	21.3	43	21.7
46-55 years old	63	31.2	63	31.8
56-65 years old	50	24.7	50	25.3
65 years old and above	7	3.5	7	3.5
No response	4	2.0		
Base	202	100.0	198	100.0

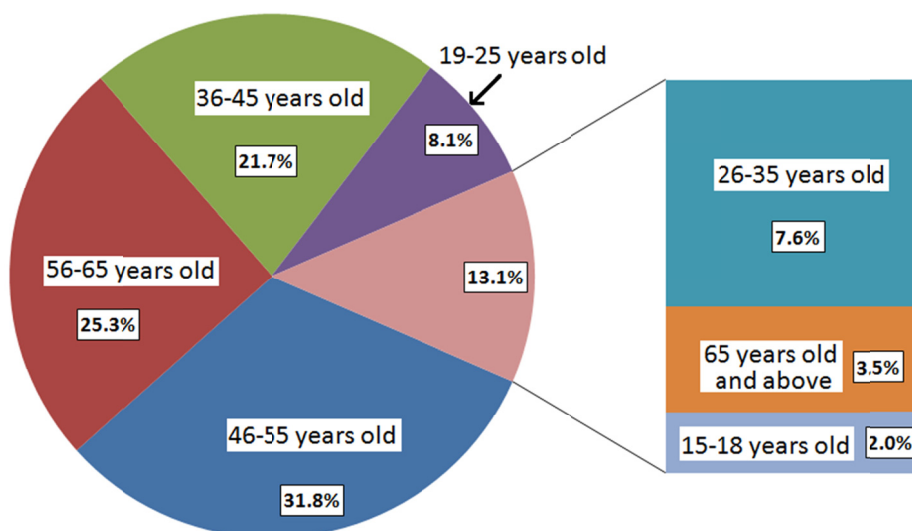


Figure 1. Age of Respondents

Of the 201 respondents (99.5%) who answered the question concerning their marital status, 88 (43.8%) of them were single and 113 (56.2%) were married (Table 3).

Table 3. Marital Status of Respondents

	Sample		Valid Response	
	No.	%	No.	%
Single	88	43.6	88	43.8
Married	113	55.9	113	56.2
No response	1	0.5		
Base	202	100.0	201	100.0

As regards the industry sectors in which the respondents were engaged, 1 (0.5%) of them did not respond to the question. Of the remaining 201 respondents who answered the question, only 61 (30.3%) of them engaged in the IT-related sectors, while the rest (140 out of 201 or 69.7%) engaged in sectors not related to IT (Table 4).

Table 4. Are you working in the IT related field?

	Sample		Valid Response	
	No.	%	No.	%
Yes	61	30.2	61	30.3
No	140	69.3	140	69.7
No response	1	0.5		
Base	202	100.0	201	100.0

Table 5 below illustrates the frequency distribution and percentage composition of the education profile of the respondents. The frequency distribution shows that the majority of the respondents (29.0% or 58 out of 200) had a associate degree. They are followed by those who had completed senior secondary education (24.0% or 48 out of 200) and those who with a bachelor degree (22.0% or 44 out of 200).

Table 5. Education Profile of Respondents

	Sample		Valid Response	
	No.	%	No.	%
Junior Secondary	13	6.4	13	6.5
Senior Secondary	48	23.8	48	24.0
Associate Degree	58	28.7	58	29.0
Bachelor Degree	44	21.8	44	22.0
Postgraduate	37	18.3	37	18.5
No response	2	1.0		
Base	202	100.0	200	100.0

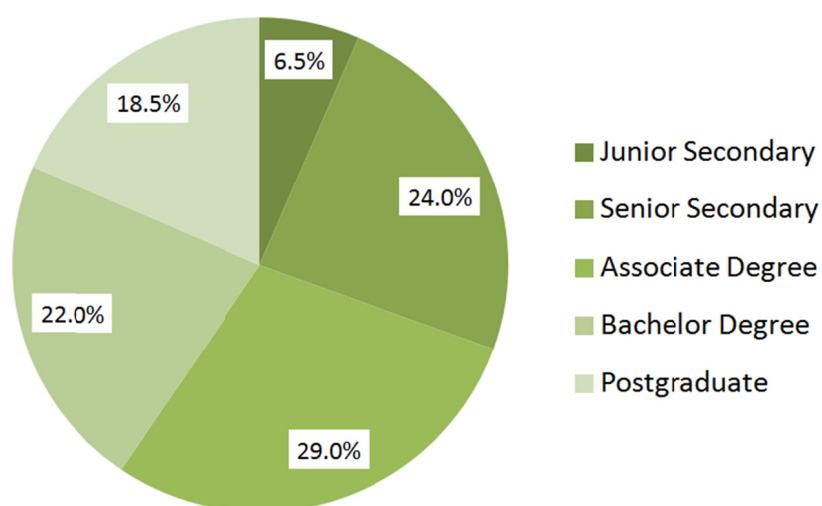


Figure 2. Education Profile of Respondents

A total of 201 respondents answered the question concerning their place of residence. Table 6 below illustrates the frequency distribution and percentage composition of the place of residence profile of the respondents. The frequency distribution shows that the majority of the respondents (34.7% or 70 out of 201) lived in Kowloon. Those who lived in the New Territories (33.3% or 67 out of 201) came second and those who lived on Hong Kong Island (30.3% or 61 out of 201) came third. Only 1.5% (3 out of 201) of the respondents lived on outlying islands (Figure 3).

Table 6. Place of Residence Profile of Respondents

	Sample		Valid Response	
	No.	%	No.	%
Hong Kong Island	61	30.2	61	30.3
Kowloon	70	34.7	70	34.8
New Territories	67	33.2	67	33.3
Outlying Islands	3	1.5	3	1.5
No response	1	0.5		
Base	202	100.0	201	100.0

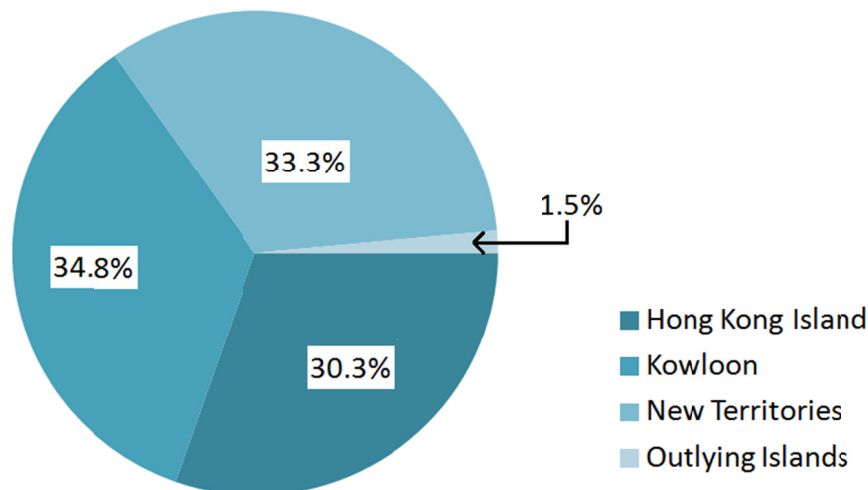


Figure 3. Place of Residence Profile of Respondents

Table 7 below illustrates the frequency distribution and percentage composition of the WiFi experience profile of the respondents. The frequency distribution shows that the majority of the respondents (81.1% or 163 out of 201) had more than 2 years of experience using WiFi. Those with 1-2 years of experience (9.0% or 18 out of 201) came second. 4.5% (9 out of 201) of the respondents had six months to one year of experience using WiFi and 4.0% (8 out of 201) of them had used it for less than six months. Only a small percentage (1.5% or 3 out of 201) of the respondents had never used WiFi before (Figure 4).

Table 7. Experience Profile of Respondents

	Sample		Valid Response	
	No.	%	No.	%
Never used it	3	1.5	3	1.5
Less than six months	8	4.0	8	4.0
Six months to one year	9	4.5	9	4.5
One year to two years	18	8.9	18	9.0
Longer than two years	163	80.7	163	81.1
No response	1	0.5		
Base	202	100.0	201	100.0

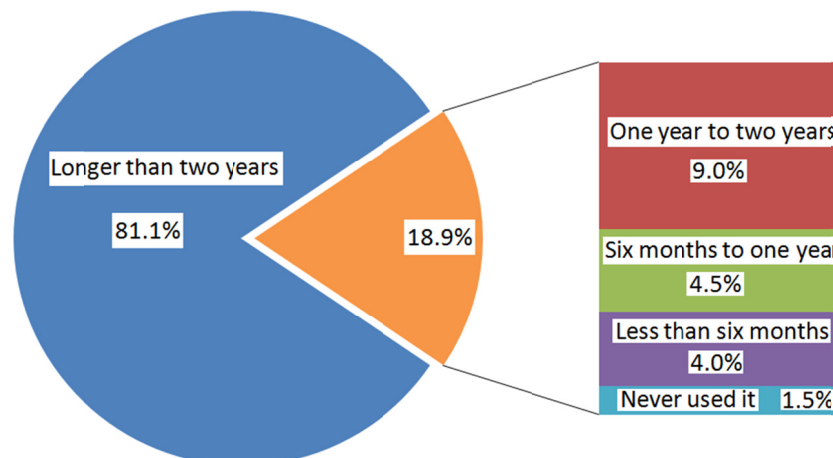


Figure 4. Experience Profile of Respondents

3. WiFi in Hong Kong

3.1 Types of WiFi Network for Internet Access

Of the 198 respondents who reported that they had experience of using WiFi, the types of WiFi network for their Internet access were shown in Figure 5. The Bar Chart below shows that the majority of the respondents (88.4% or 175 out of 198) used WiFi at home, 54.5% (108 out of 198) of them used Free Government WiFi public hotspots (GovWiFi), 53.0% (105 out of 198) of them used WiFi in office, 45.5% (90 out of 198) of them used WiFi in business districts, 44.4% (88 out of 198) of them used WiFi hotspots provided by commercial service providers, 23.2% (46 out of 198) of them used Free WiFi hotspots under the Wi-Fi.HK brand, and 19.7% (39 out of 198) of them used WiFi on campus.

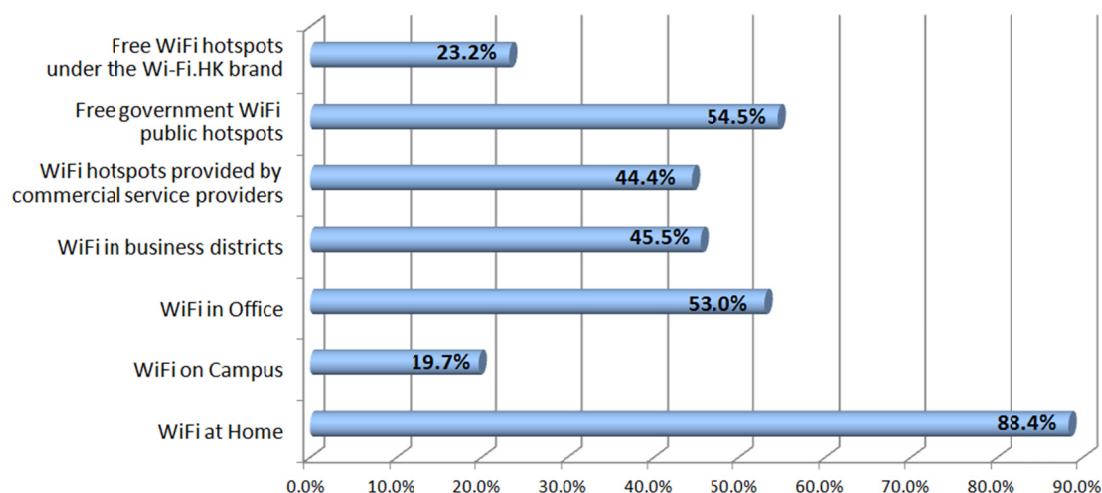


Figure 5. Types of WiFi Network Used for Internet Access

3.2 User Profiles of the Seven Main Types of WiFi Internet Access

3.2.1 WiFi Using Experience Profiles

Table 8 and Figure 6 below show the WiFi using experience profiles of the respondents' in terms of the seven main types of WiFi network. It is clear from the Table and the Bar Chart that the more experienced users (those with more than 2 years of experience of using WiFi) accessed the Internet using WiFi at home (93.3%), WiFi in office (58.9%), GovWiFi (55.8%), WiFi hotspots provided by commercial service providers (49.1%), and WiFi in business districts (47.85%), while the majority of the less experienced users (those with less than six months of experience of using WiFi) accessed the Internet using the GovWiFi network (62.5%).

Table 8. WiFi Using Experience in Terms of WiFi Internet Network

	< 6 months	1/2 to 1 year	1-2 years	> 2 years
WiFi at Home	37.50%	55.56%	83.33%	93.25%
WiFi on Campus	25.00%	22.22%	16.67%	19.63%
WiFi in Office	25.00%	0.00%	38.89%	58.90%
WiFi in business districts	25.00%	44.44%	33.33%	47.85%
WiFi hotspots provided by commercial service providers	25.00%	22.22%	22.22%	49.08%
GovWiFi public hotspots	62.50%	55.56%	38.89%	55.83%
Free WiFi hotspots under the Wi-Fi.HK brand	25.00%	44.44%	16.67%	22.70%

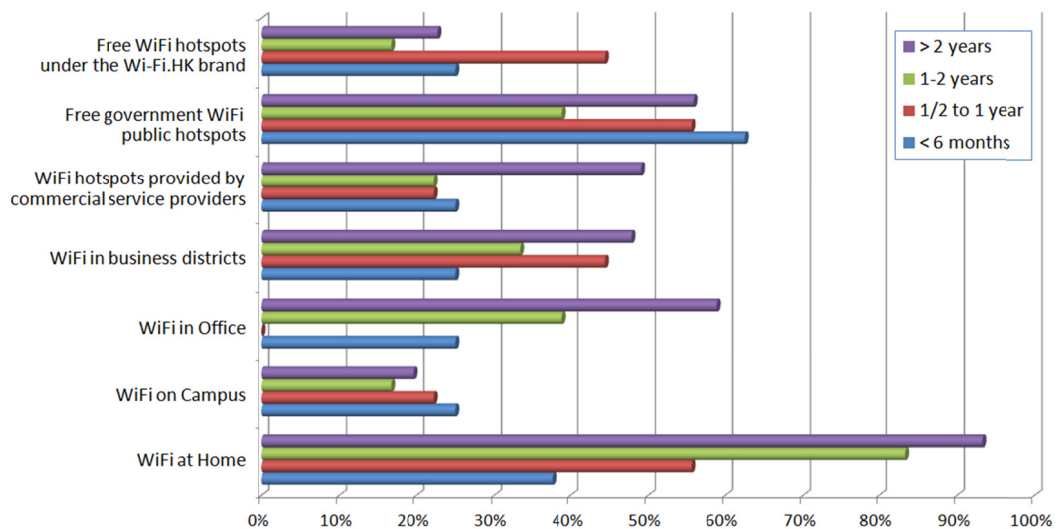


Figure 6. WiFi Using Experience in Terms of WiFi Internet Network

3.2.2 Gender Profiles

Figure 7 below shows the breakdown of the use of the seven main types of WiFi Internet network by gender. The Bar Chart shows that the gender profiles of the respondents across all seven types of WiFi Internet network are similar. The major differences between the two groups are the higher proportion of males (57% and 44.4% respectively) over females (42.4% and 36.4% respectively) in using WiFi in office and WiFi in business districts. The majority of the respondents, both males and females, used WiFi at home (83.3% for females vs. 88.9% for males). The percentage share of female and male respondents using WiFi hotspots provided by commercial service providers (42.4% vs. 44.4%) and WiFi on Campus (19.7% vs. 19.3%) is close. As for the free Government WiFi public hotspots and free WiFi hotspots under the “Wi-Fi.HK brand”, the proportion of female and male users is close too (56.1% vs. 52.6% for GovWiFi and 24.2% vs. 22.2% for “Wi-Fi.HK”).

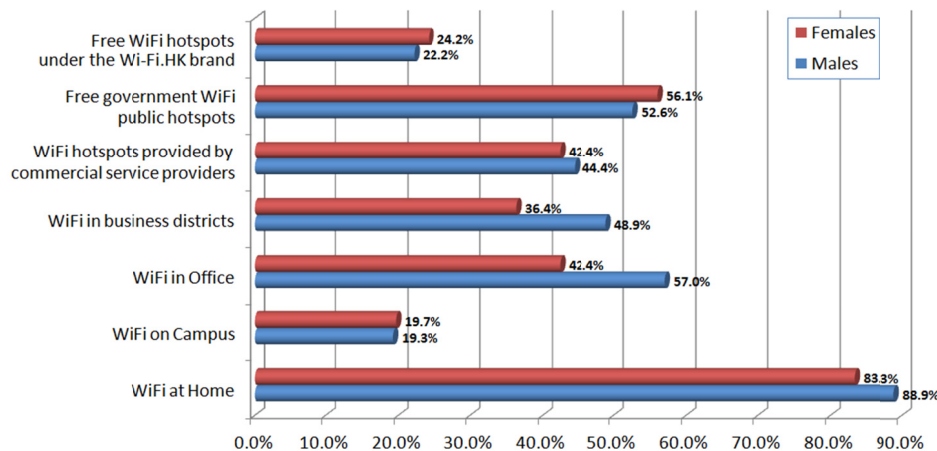


Figure 7. Use of WiFi Network for Internet Access by Gender

3.2.3 Marital Status Profiles

Figure 8 below shows the breakdown of the use of the seven main types of WiFi Internet network by marital status. The Bar Chart demonstrates that, although the majority of the respondents, both single and married, used WiFi at home, there are considerable differences in terms of percentages among the two groups of respondents (79.5% for single vs. 92.9% for married). The Bar Chart demonstrates the predominance of married users over single users who used WiFi in business districts (50.4% for married vs. 37.5% for single) and in office (61.1% for married vs. 40.9% for single). On the other hand, the chart also demonstrates the predominance of single users over married users who used WiFi on campus (23.9% for single vs. 15.9% for married).

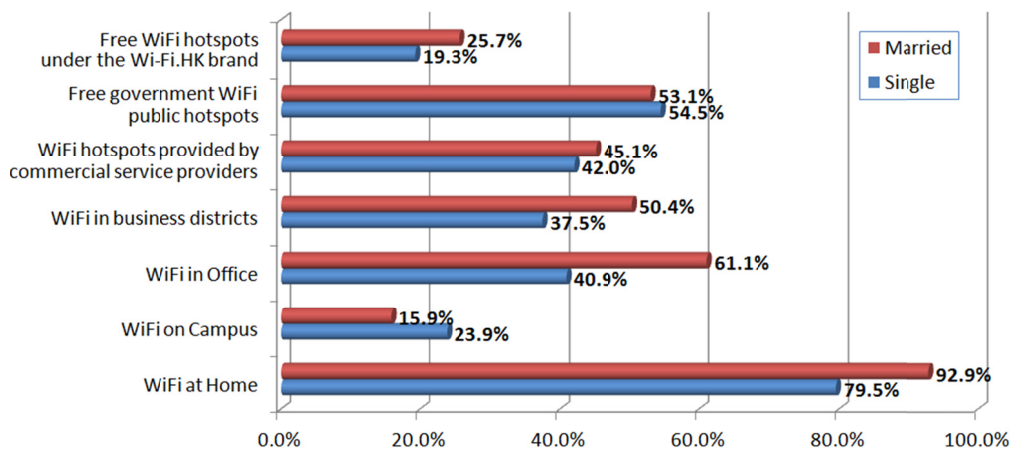


Figure 8. Use of WiFi Network for Internet Access by Marital Status

3.2.4 Age Profiles

Table 9 below shows the breakdown of the use of the seven main types of WiFi Internet network by seven age groups. The Bar Chart in Figure 9 demonstrates the same information in graphic format. All respondents in the 15-18 years old and the over 65 years old age groups used WiFi at home while only 66.7% of the respondents used the same for the 26-35 years old age group. Half (50%) of the teenagers (15-18 years old) and 56.3% of young adults (18-25 years old) used WiFi on campus while more than half of the older respondents (66.7% for the 26-35 years old age group, 62.8% for the 36-45 years old age group and 58.7% for the 46-55 years old age group) used WiFi in office. The data also revealed that teenagers (15-18 years old age group) had greater tendency to use free GovWiFi (75%).

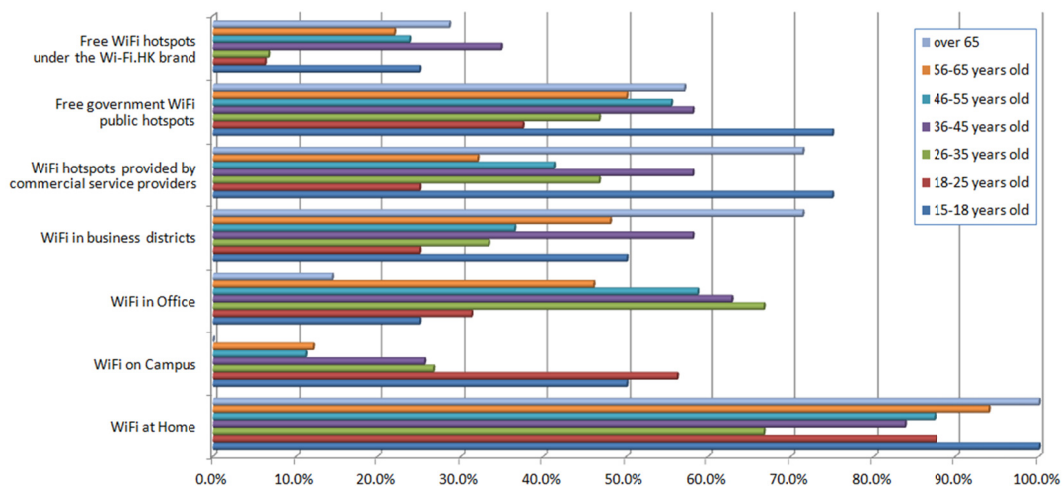


Figure 9. Use of WiFi Network for Internet Access by Age

Table 9. Use of WiFi Network for Internet Access by Age

Age	15-18	18-25	26-35	36-45	46-55	56-65	over 65
WiFi at Home	100.0%	87.5%	66.7%	83.7%	87.3%	94.0%	100.0%
WiFi on Campus	50.0%	56.3%	26.7%	25.6%	11.1%	12.0%	0.0%
WiFi in Office	25.0%	31.3%	66.7%	62.8%	58.7%	46.0%	14.3%
WiFi in business districts	50.0%	25.0%	33.3%	58.1%	36.5%	48.0%	71.4%
Commercial WiFi hotspots	75.0%	25.0%	46.7%	58.1%	41.3%	32.0%	71.4%
GovWiFi public hotspots	75.0%	37.5%	46.7%	58.1%	55.6%	50.0%	57.1%
Free WiFi hotspots under the Wi-Fi.HK brand	25.0%	6.3%	6.7%	34.9%	23.8%	22.0%	28.6%

3.2.5 Education Profiles

Figure 10 below shows the breakdown of the use of the seven main types of WiFi Internet network by education level. The Bar Chart shows that the majority of respondents in all educational level groups used WiFi at home while a relatively small percentage of respondents used WiFi on campus. The chart also reveals that a relatively smaller percentage of respondents with junior secondary school used WiFi in office and in business districts as well as GovWiFi and WiFi hotspots provided by commercial service providers.

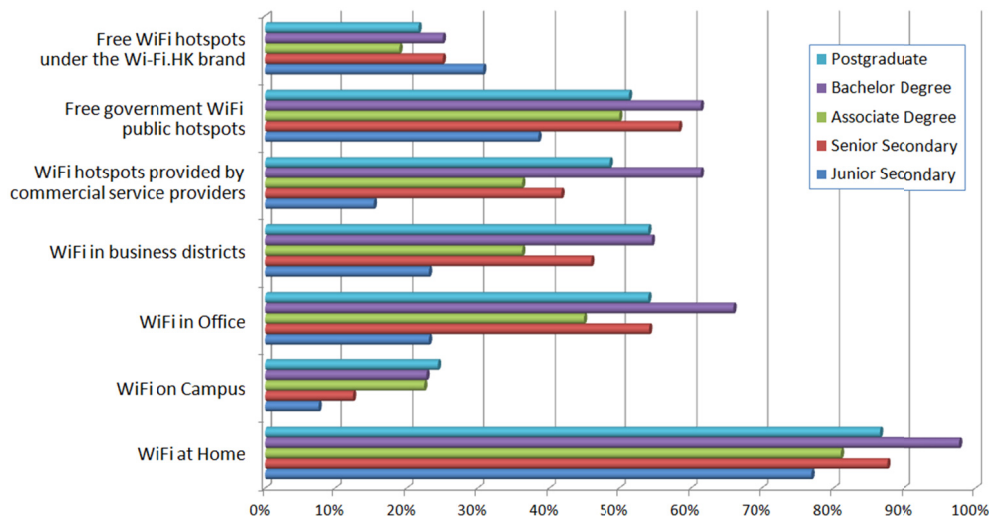


Figure 10. Use of WiFi Network for Internet Access by Educational Level

3.2.6 Place of Residence Profiles

Figure 11 below shows a breakdown of the use of the seven main types of WiFi Internet network by place of residence. The Bar Chart shows that the majority of respondents in all place of residence of the respondents used WiFi at Home.

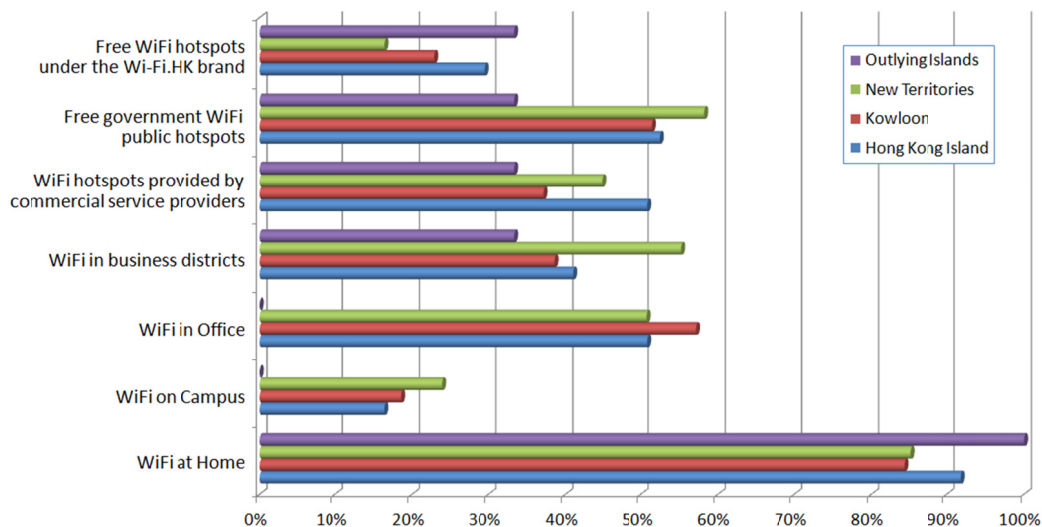


Figure 11. Use of WiFi Network for Internet Access by Place of Residence

3.3 Use of WiFi Network

Table 10 illustrates the frequency distribution and percentage composition of the amounts of time the respondents spent on WiFi connection. Of the 202 respondents who completed the questionnaire, 1 of them (0.5%) did not answer the question on the amounts of time they spent on WiFi connection. Another 1 of them (0.5%) selected more than one answer and is considered as an invalid response. None of them indicated that

they had never used WiFi connection. Of the 200 respondents (99%) who stated that they used WiFi connection (see Figure 12), the 62.5% of them used WiFi frequently (about 4 hours per day, higher than the 54.77% reported last year (Fong and Wong, 2014; Wong and Fong, 2014). On the other hand, the percentage share of occasional users (27.0%), those who used WiFi connection when necessary (10.5%) and those who said they had never used WiFi (0%), lower than last year's reported shares of 31.66%, 11.56% and 1.9% respectively.

Table 10. Time Spend on WiFi Connection

	Sample		Valid Response	
	No.	%	No.	%
Frequently (e.g. 4 hrs/day)	125	61.9%	125	62.5%
Occasionally (e.g. < 10 hrs/wk)	54	26.7%	54	27.0%
Unless necessary	21	10.4%	21	10.5%
Never used it	0	0.0%		
No response and invalid response	2	1.0%		
Base	202	100.0	200	100.0

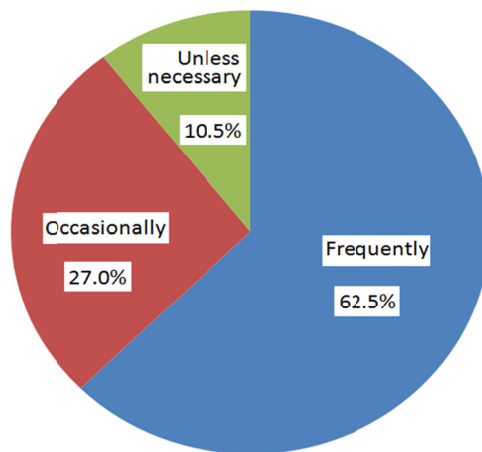


Figure 12. Time Spent on WiFi Connection

Figure 13 shows the kinds of device used by the respondents to connect to WiFi network. It is revealed that the majority of WiFi users used Smartphones (43.5%) and personal computers (31.0%) to access WiFi. About a quarter (23.8%) of the respondents used tablets, such as iPads, to access WiFi. Very few (1.5%) respondents used PDAs to access WiFi.

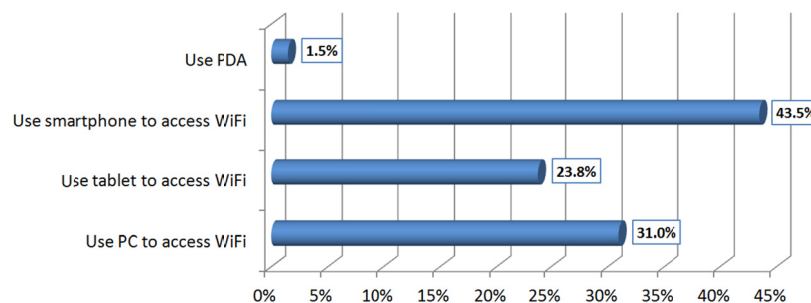


Figure 13. How do you access WiFi?

As shown in Figure 14, only 1.5% of the respondents were not users of Smartphones, which is considerably lower than the 5.3% reported last year. For those who used Smartphones, the majority of them used Android Smartphones (75.1%). They are followed by those who used Apple iPhone (26.9%). Only 5.0% of the respondents used Smartphones other than an Android or an iPhone.

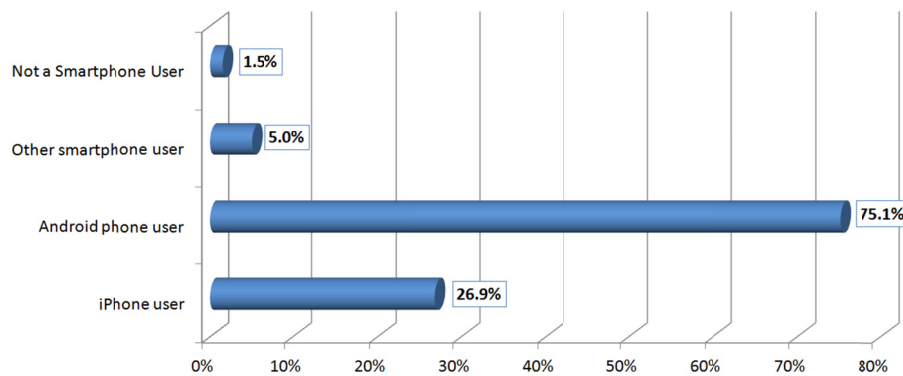


Figure 14. Are you a Smartphone user?

Figure 15 shows the purposes of the respondents in seeking access to WiFi networks. The majority of the respondents used WiFi to obtain information from the Internet (75.1%). They are followed by those who used WiFi to contact friends (76.6%) and to conduct online activities (53.2%). About half (48.3%) of the respondents used WiFi to complete their work. Only about one-third (36.3%) of the respondents used WiFi to support their learning.

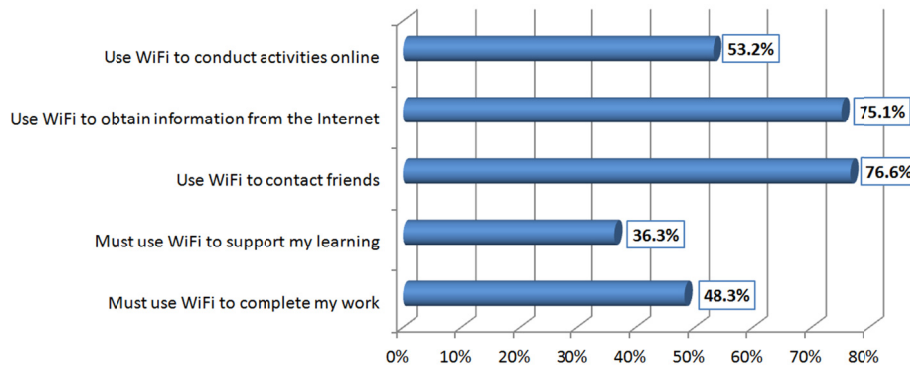


Figure 15. Why do you use WiFi to access the Internet?

Figure 16 below shows a breakdown of the reasons of using WiFi network by gender. It reveals that roughly the same number of male and female users used WiFi network to conduct activities online (54.1% and 51.5% respectively) or to contact friends (76.3% and 77.3% respectively). Male users were more likely to use WiFi network to complete their work (53.3% vs. 37.9%) and support their learning (39.3% vs. 28.8%) than female users. While females users were more likely to use WiFi to obtain information from the Internet (80.3% of females vs. 72.6% of males).

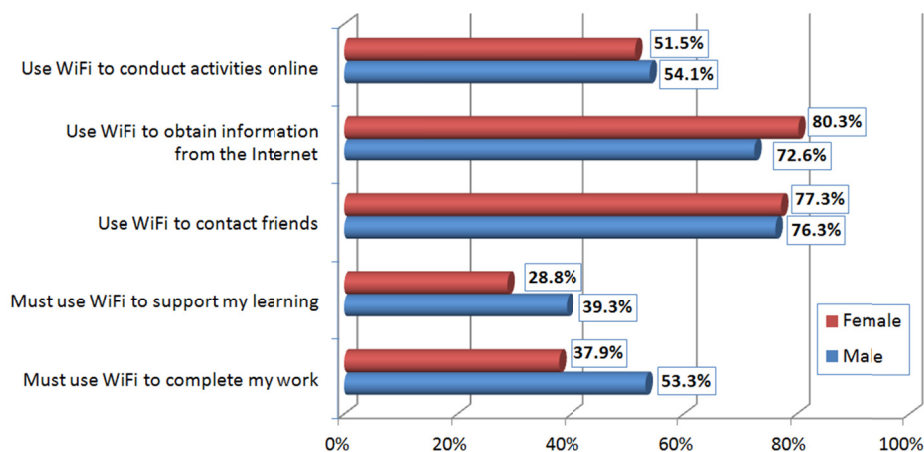


Figure 16. Reason of Using of WiFi Network by Gender

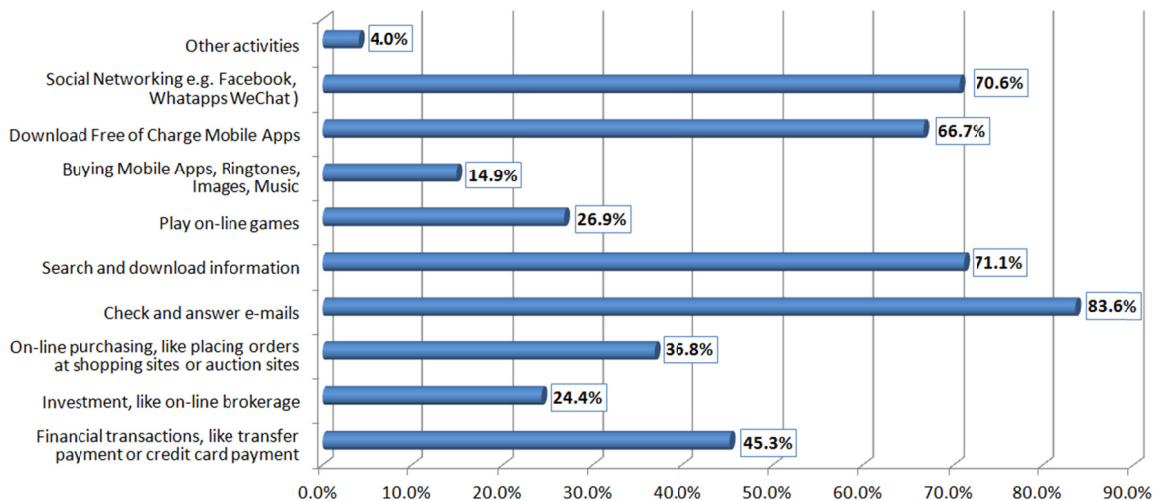


Figure 17. Activities conducted using the WiFi network

Figure 17 shows the activities conducted by the respondents using the WiFi network. The majority of the respondents used WiFi to check and answer emails (83.6%). They are followed by those who used WiFi to search for and download information (71.1%), to access social networks, such as Facebook, WhatsApp and WeChat (70.6%) or to download free-of-charge mobile apps (66.7%). Close to half of the respondents used WiFi to perform financial transactions (45.3%) and to make on-line purchases (36.8%). About a quarter of the respondents used WiFi network to play on-line games (26.9%) or to perform investment activities, for example, on-line brokerage (24.4%). Only a small percentage of respondents used WiFi network to buy mobile apps, ringtones, images and music (14.9%) or to perform other activities (4.0%).

3.4 WiFi Tethering

When being asked whether they had ever shared their Smartphones as a WiFi Hotspot, i.e. WiFi tethering, the majority (53%) of the respondents answered in the affirmative but 45% of the respondents answered in the negative. A small percentage (2%) of respondents were not sure whether they had ever shared their Smartphones as WiFi hotspots (Figure 18).

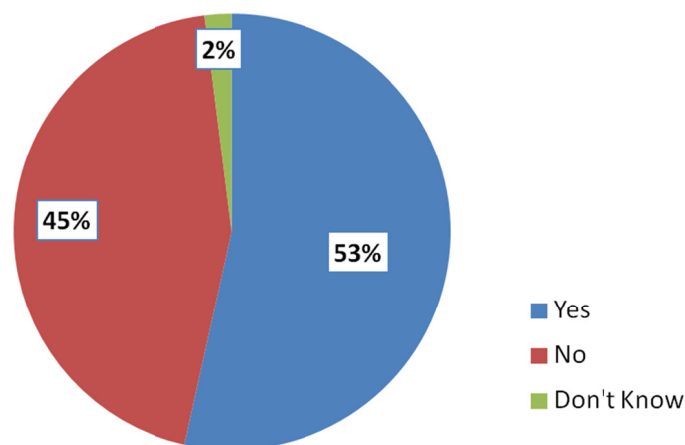


Figure 18. Have you ever shared your Smartphone as a WiFi Hotspot?

4. Using WiFi for Mobile Messaging and Social Networking

4.1 Mobile Messaging

Figure 19 below shows the types of mobile messaging apps used by the respondents. The Bar Chart shows that only a small percentage of respondents (4.0%) did not use mobile messaging. For those who used mobile messaging, a large majority of them (90.5%) used WhatsApp. They are followed by those who used WeChat (43.3%) and LINE (26.4%).

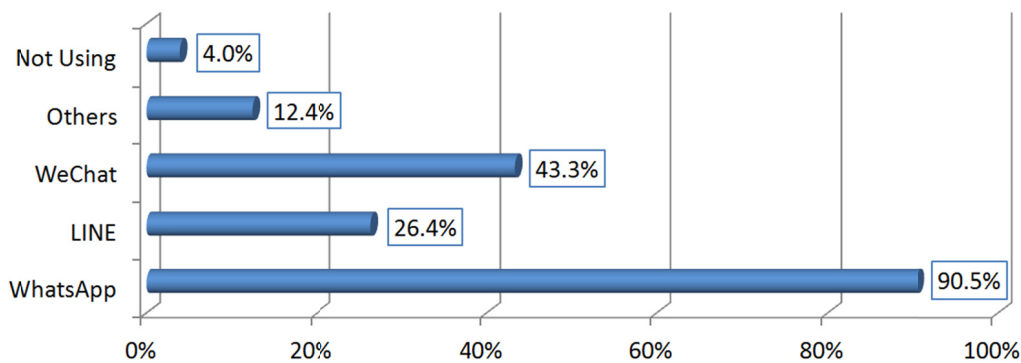


Figure 19. Types of WiFi Mobile Messaging Apps

Figure 20 below shows how the respondents used mobile messaging apps. The Bar Chart shows that a large majority of them (83.8%) used mobile messaging apps for textual communication. They are followed by those who used them for textual plus emoticon (68.0%) and group chats (62.4%). Other uses of mobile messaging apps include voice messaging (49.2%) and voice communication (39.1%).

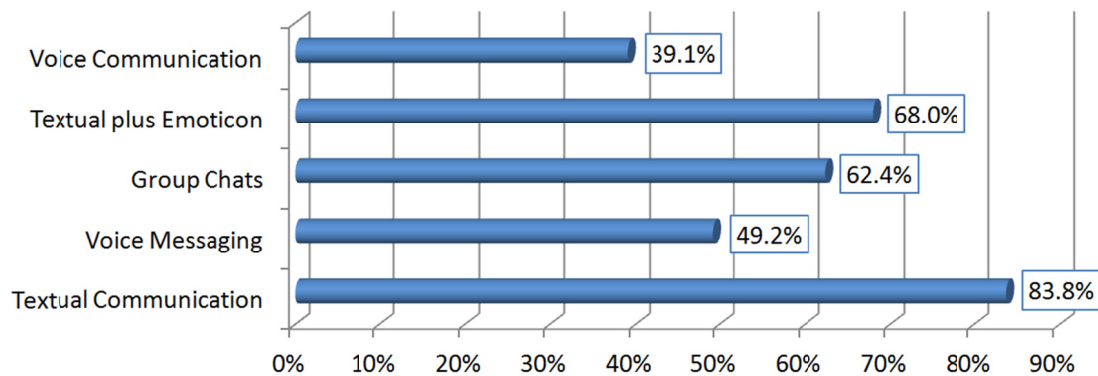


Figure 20. Use of Mobile Messaging Apps Used

Figure 21 below shows the percentage of online time the respondents spent on using mobile messaging apps. The pie chart shows that the majority of them (33.0%) spent 10-25% of their online time on using mobile messaging apps. They are followed by those who spent less than 10% of their online time (23.5%) and those who spent 25-50% of their online time (22.0%) on such apps. Only 13.5% of the respondents spent 50-75% of their online time and only 8% of the respondents spent more than 75% of their online time on mobile messaging.

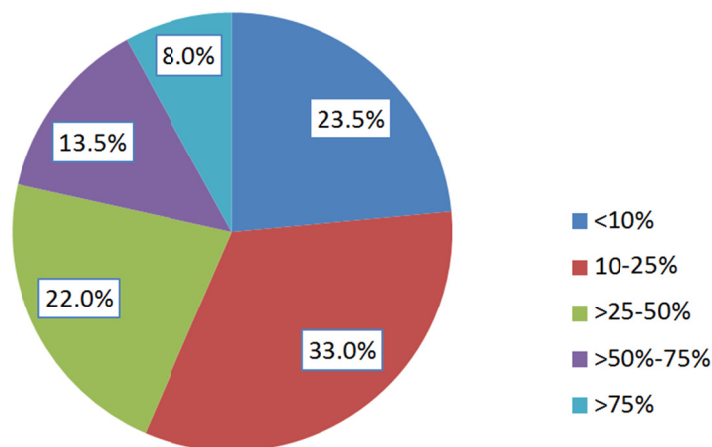


Figure 21. Percentage of Online Time for Mobile Messaging

4.2 Social Networking

Figure 22 shows the types of social networking apps used by the respondents. The Bar Chart shows that only a small percentage of respondents (10.4%) did not use social networking apps. For those who used such apps, a large majority of them (78.1%) used Facebook. About one-fifth of them used Instagram (19.9%) and LinkedIn (17.4%). 13.9% of the respondents used Twitter and 8.5% of them used other social networking apps.

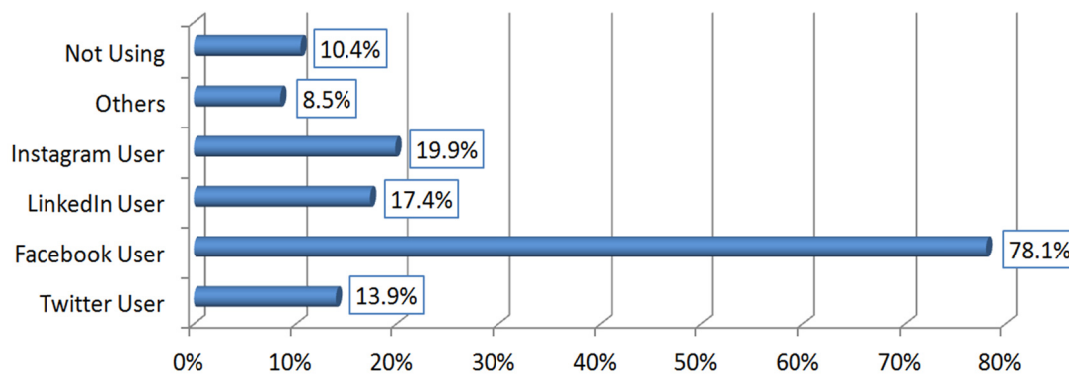


Figure 22. Types of Social Networking Apps Used

Figure 23 below shows the percentage of online time the respondents spent on social networking. The Pie Chart shows that the majority of them (70.5%) spent less than 25% of their online time on using social networking apps. Among them, 35.5% spent less than 10% of their online time on using such apps. 17% of the respondents spent 25-50% of their online time (17%) on using social networking apps. Only 11.0% of the respondents spent more than 50% of their online time on using social networking apps. Among them, 4.5% spent more than 75% of their online time on using such apps.

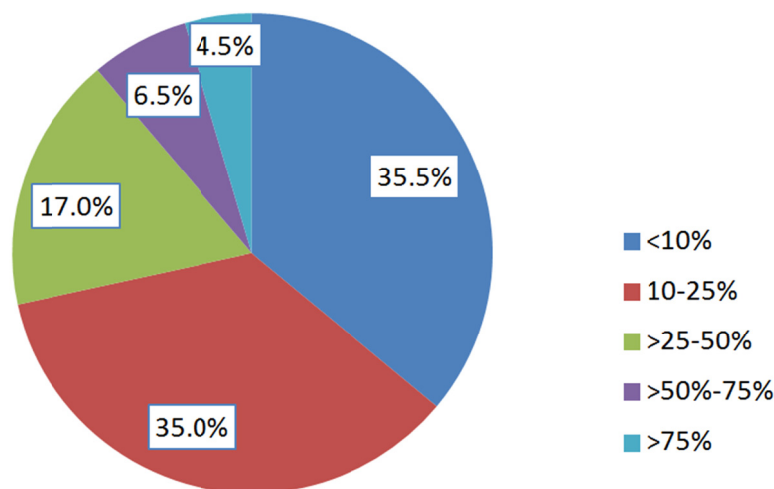


Figure 23. Percentage of Online Time for Social Networking

5. WiFi Security

Table 11 and Figure 24 below show that more than half (55.8%) of the respondents expressed concerns over the use of WiFi to access the Internet as they were worried that their personal privacy might be disclosed as a result. Among them, 24.9% expressed strong concern over personal privacy on using the Internet. On the other hand, only 25.9% of the respondents were not worried about personal privacy on accessing the Internet via WiFi.

It is also found that slightly more respondents believed that using WiFi to access the Internet was safer than those who believed otherwise (42.1% vs. 31.0%). When asked whether they believed the security measures provided by WiFi were adequate, slightly less respondents believed that the security measures was adequate than those who believed otherwise (33.5% vs. 34.5%).

Table 11. WiFi Security

	Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree
It is not a concern to me that using WiFi to access the Internet would disclose my personal privacy, for example, my physical location	3.0%	11.7%	11.2%	18.3%	23.9%	7.1%	24.9%
I believe the security measures provided by WiFi are adequate.	3.0%	14.5%	16.0%	32.0%	19.5%	7.0%	8.0%
I believe using WiFi to access the Internet is safe.	6.6%	19.3%	16.2%	26.9%	17.3%	7.1%	6.6%

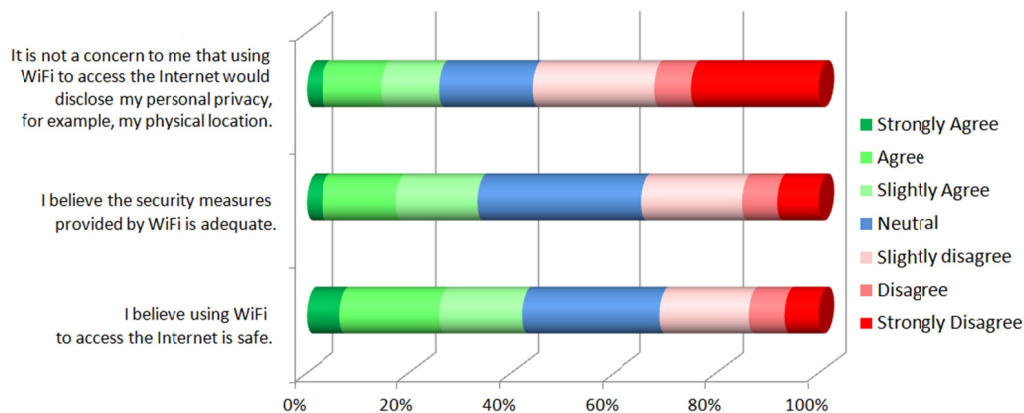


Figure 24. WiFi Security

Table 11 and Figure 25 below are a breakdown of the respondents' perceptions of WiFi security by gender. It reveals that, females, in general, were slightly more concerned about WiFi safety and personal privacy on using WiFi network to access the Internet. When responding to the statement "I believe using WiFi to access the Internet is safe", 44.4% of males agreed to the statement while only 34.8% of females did. When responding to the statement "I believe the security measures provided by WiFi are adequate", 37.0% of males agreed to it while only 25.8% of females did. When responding to the statement "it is not a concern to me that using WiFi to access the Internet would disclose my personal privacy, for example, my physical location", 34.1% of males agreed to it while only 22.7% of females did.

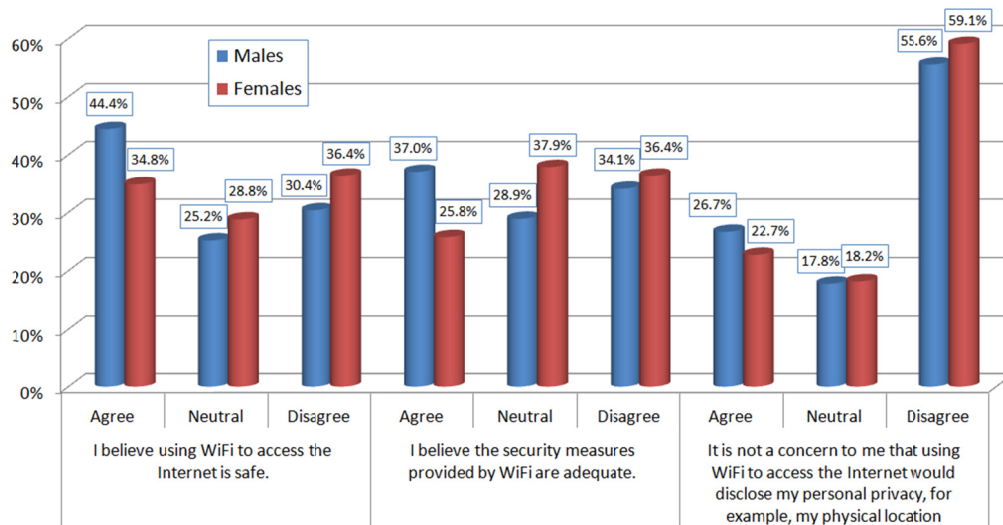


Figure 25. Respondent Perceptions of WiFi Security by Gender

Table 11. WiFi Security

	Male			Female		
	Agree	Neutral	Disagree	Agree	Neutral	Disagree
I believe using WiFi to access the Internet is safe.	44.4%	25.2%	30.4%	34.8%	28.8%	36.4%
I believe the security measures provided by WiFi are adequate.	37.0%	28.9%	34.1%	25.8%	37.9%	36.4%
It is not a concern to me that using WiFi to access the Internet would disclose my personal privacy, for example, my physical location	34.1%	17.8%	55.6%	22.7%	18.2%	59.1%

Figure 26 below shows the types of WiFi standard that the respondents used at home. It shows that the majority (42.6%) of the home WiFi users did not know what kinds of WiFi standard they were using. For those who knew the standards they used, most of them (29.2%) used 802.11n. They are followed by those who used 802.11g (18.3%). The shares of home WiFi users who used older standards, i.e., 802.11a standard and 802.11b standard, were 6.9% and 12.9% respectively, while the share of home WiFi users who used the latest standard, i.e. 802.11ac, is 14.4%.

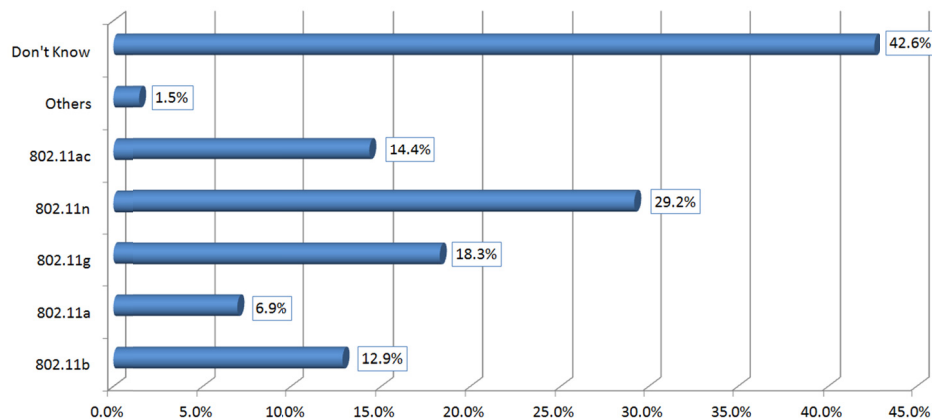


Figure 26. WiFi Standards Used by Home WiFi Users

Figure 27 below shows the types of WiFi encryptions used by the respondents at home. It shows that 33.2% of the home WiFi users did not know what kinds of WiFi security they were using. For those who knew what kinds of WiFi security they were using, 5.9% of them did not use any WiFi encryptions on their home WiFi networks. For those home WiFi users who used WiFi security, the majority of them (38.6%) used “WPA/WPA2 using AES”. They are followed by those who used “WPA/WPA2 using TKIP” (18.8%). 7.4% of the home WiFi users used WEP (Wired Equivalent Privacy).

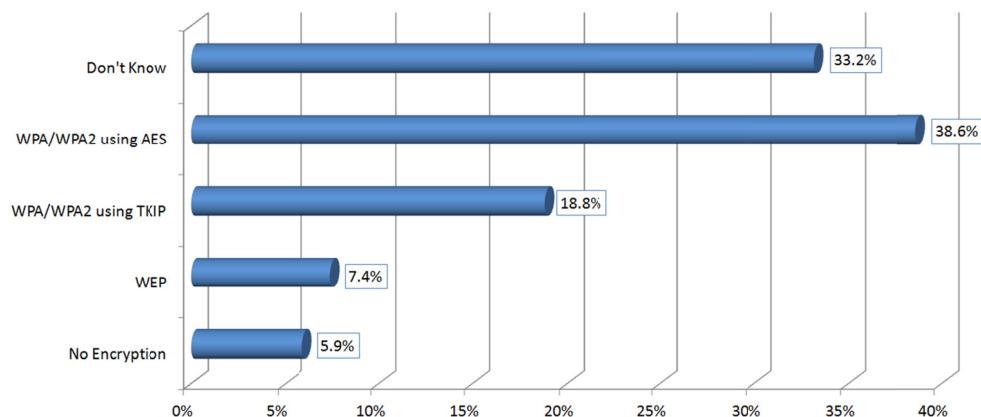


Figure 27. WiFi Encryptions Used by Home WiFi Users

Figure 28 shows that 22.8% of the WiFi users did not know what kinds of authentication protocols they were using at home. For those who knew what kinds of WiFi authentication protocol they were using, the majority of them used WPA2-Personal (aka WPA-PSK or Pre-Shared Key mode) or WPA-Personal. Only a small percentage of the respondents used WPA-Enterprise (6.4%) or WPA2-Enterprise (5.0%) at home.

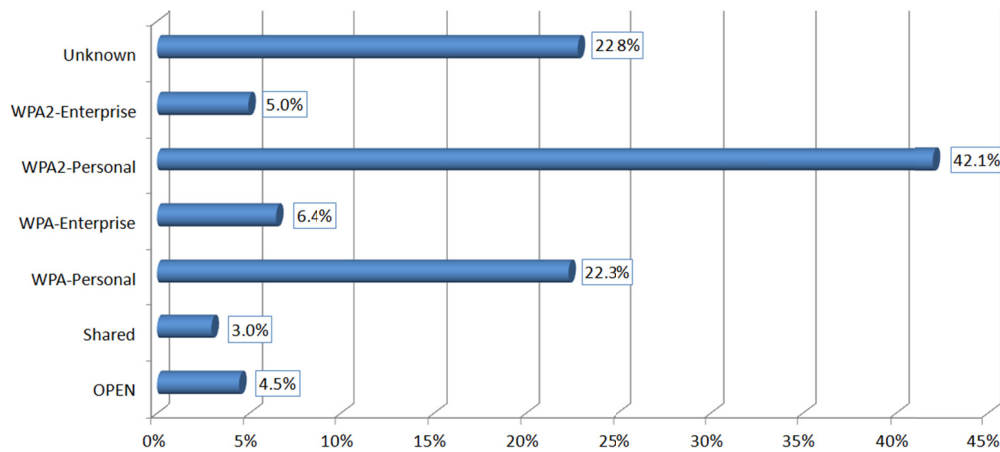


Figure 28. WiFi Authentication Protocols Used by Home WiFi Users

In responding to a follow-up question on the safety of WEP encryption technologies, among the 7.4% of WiFi users who were using WEP at home, the majority of them (64.3%) indicated that they were not aware of the fact that the WEP technology they were using was unsafe. The percentage is slightly higher than the 53.7% of respondents who were not using WEP encryption. It is also found that 35.7% of the WEP users knew that the WEP technologies were unsafe (Figure 29).

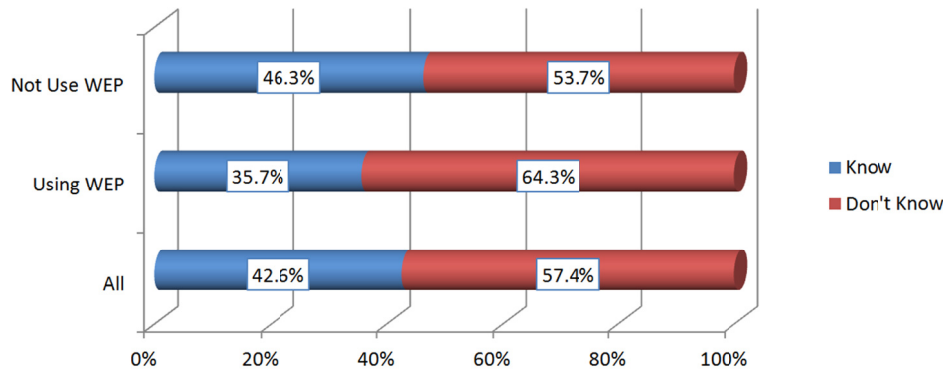


Figure 29. Use of WEP vs Knowledge on WEP

Of the five (5) respondents who said that they were aware of the fact that WEP technologies were not safe, one of them did not give the reason. Of the remaining four (4) respondents, one of them said that he did not know the importance of setting up security, three (3) of them said that they still used WEP WiFi encryption technologies because they didn't know how to setup the security setting.

6. WiFi Security Knowledge

Table 12 and Figure 30 below show a breakdown of respondents regarding to questions on knowledge of WiFi security. In responding to the question of whether they had good knowledge on WiFi security, 48.0% of the respondents believed they had, which is much higher than those who believed they didn't have (18.7%). In responding to the question of whether they know how to use the security setting in WiFi, 52.0% of the respondents believed they could. The percentage is much higher than those who believed they had no idea (26.7%). In responding to the question of whether they know how to explain WiFi security to others, 47.0% of the respondents believed they could, higher than those who believed otherwise (31.3%). In responding to the question of whether they knew how to teach others to use the security setting in WiFi, the percentage share of those who believed they knew it and those who believed otherwise are more or less the same (37.9% vs. 37.4%).

Table 12. WiFi Security Knowledge

	Strongly Agree	Agree	Slightly Agree	Neutral	Slightly Disagree	Disagree	Strongly Disagree
I have good knowledge on WiFi security	7.6%	22.7%	17.7%	33.3%	7.1%	6.6%	5.1%
I know how to use the security setting in WiFi	5.4%	25.2%	21.3%	21.3%	16.3%	4.5%	5.9%
I can explain WiFi security to others	5.1%	18.2%	23.7%	21.7%	15.7%	8.1%	7.6%
I know how to teach others to use the security setting in WiFi	5.1%	17.2%	15.7%	24.7%	20.2%	5.6%	11.6%

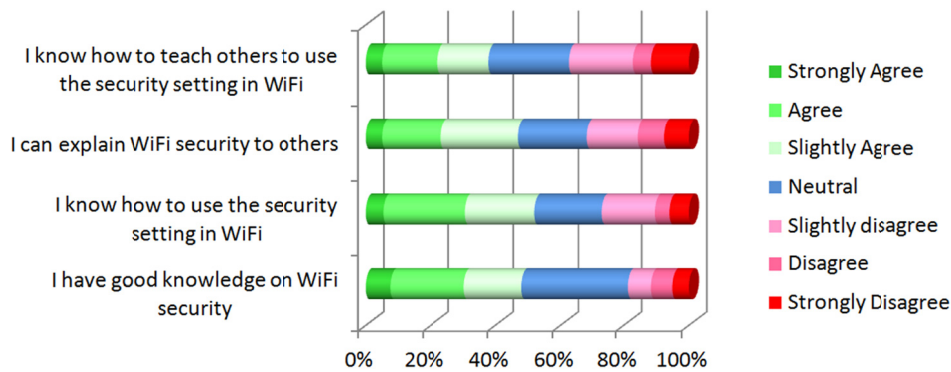


Figure 30. WiFi Security Knowledge

7. Public WiFi Access

Figure 31 below shows the respondents' comments and suggestions on the public WiFi hotspots provided by commercial service providers. Unstable service quality (62.9%), inadequate WiFi access points (60.9%) and inadequate bandwidth (46.5%) are the top three comments given by the respondents. These are followed by inadequate transparency in service pricing (29.7%) and high service charge (27.7%).

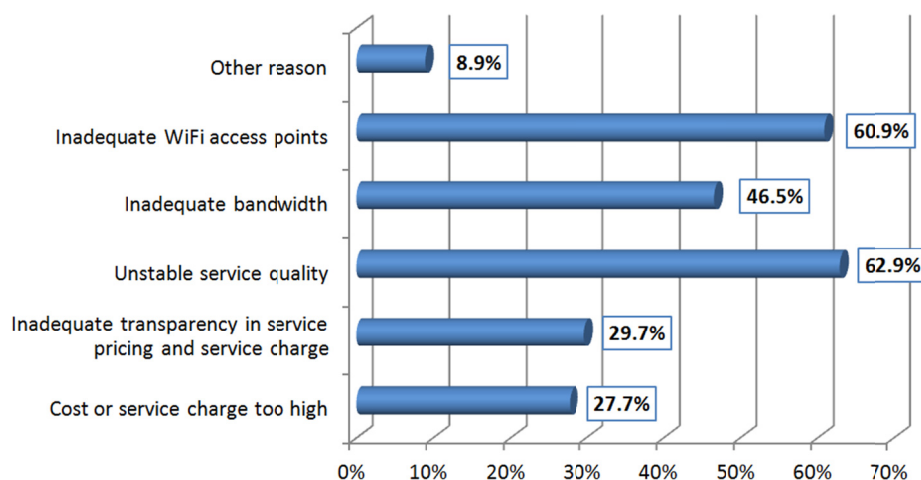


Figure 31. Respondent Comments/Suggestions on Commercial WiFi Services

Figure 32 below shows the respondents' comments and suggestions on the public WiFi hotspots provided by the HKSAR Government known as GovWiFi (HKSAR Government, 2015). Inadequate WiFi access points (75.7%), unstable service quality (58.4%) and inadequate bandwidth (52.5%) are the top three comments given by the respondents. These are followed by inadequate contents or services (23.3%).

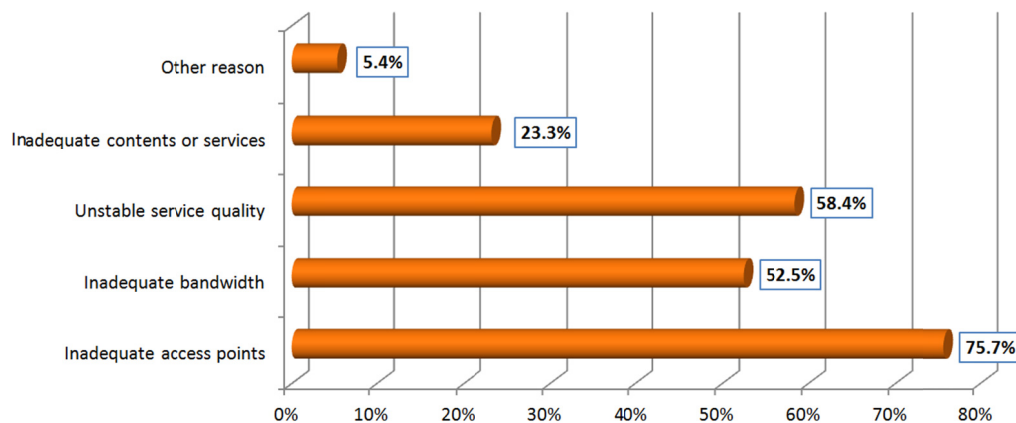


Figure 32. Respondent Comments/Suggestions on GovWiFi

8. Discussion

To mobile device users, Internet connection which is always on means mobility, flexibility and convenience. To a city, seamless Internet connection can be a make-or-break factor in its ability to attract tourists, investment and to win out in global competition.

Setting out to examine WiFi usage, accessibility, user knowledge and security in Hong Kong, this report seeks to provide an evidence-based and empirical assessment of user perceptions on the above fundamental issues of WiFi usage, technology, security and way-forward in WiFi development in Hong Kong.

8.1 WiFi Usage

This report reveals that most of the respondents use WiFi network to obtain information from the Internet and to contact friends. The finding echoes with the respective findings obtained by Google Inc., Facebook and WhatsApp Inc., in which a soaring number of searches and expanding number of active users are reported (Edwards, 2014; Griffiths, 2015).

The Internet forms an important and integral part of our lives because there is a huge amount of information and resources on it for work, entertainment, social networking and more. Looking for a place for dinning? Go online to read the ratings and comments before choosing your restaurant. How to get from one place to the other? Click on the KMB (Kowloon Motor Bus) or NWFB (Citybus & New World First Bus) apps to find the shortest, fastest or cheapest route.

Communicate in real-time with friends and peers by means of mobile devices is important too. When taking the public transport or wandering in the street, it is easy to notice that over half of the people are either texting, checking social networks, listening to music, or doing something with their mobile devices. To have access to social media and to be “always on” either stationary or on the move is nothing but a way of life for most people now.

The research finds that about half of the respondents use WiFi to access the Internet to conduct online activities or to complete their work. But as we have warned in our previous reports, increased accessibility brings increased vulnerability. The best defense against vulnerability threats is for individual users of mobile devices to remain as vigilant and as informed about the possible risks as possible. Findings of this research shows that there is a rising awareness about WiFi security issues among WiFi users in Hong Kong. This year, 24.90% (as compared to last year’s 12.2%) of the respondents express strong concern over the possible disclosure of personal privacy due to the use of WiFi to access the Internet. More and more users are concerned about the security issues associated with the use the unsecure public WiFi hotspots and are taking tangible steps to mitigate the threats. This increase in awareness can be partly attributed to the efforts of SafeWiFi and the Government in promoting cyber security education, and partly to trade initiatives in boosting awareness of current cyber trends and threat tactics among users in Hong Kong. We must not, however, be complacent about this as the research shows that about one-quarter of the respondents are still not fully aware of the importance of WiFi security. The industry must continue to work closely with the Government to constantly looking for ways to maintain and improve WiFi security awareness in the community.

8.2 Use of WiFi for Mobile Messaging and Social Networking

With the growing popularity of mobile online messaging and social networking, we tasked ourselves in this year's research to look deeper into the different aspects of mobile Internet usage. Last year's report (Wong and Fong, 2014) found that 8.3% of the respondents claimed that they did not use mobile online messaging. However, this year, the percentage of people who make the same claim is halved to only 4%.

The research reveals an increased percentage of users across all categories of WiFi-enabled communication as compared to last year. The number of WiFi users using mobile messaging apps for group chats has increased to 62.4% from last year's 51.0%. While those who use voice messaging and voice communication via WiFi has increased to 49.2% and 39.1% from last year's 43.4% and 31.2% respectively.

On the front of mobile online messaging services, last year it was found that 88.1% of the respondents used WhatsApp. This year, the percentage increases to 90.5%, signifying the growing dominance of WhatsApp in the mobile messaging market of Hong Kong. While for the share of WeChat users in the market, there has been a slight decrease from last year's 45.2% to 43.3% this year.

Similar to mobile messaging, only a small fraction of respondents (8.8% in 2014 and 10.4% in 2015) claim that they do not use social networking services. Among those who use such services, the majority of them use Facebook. Though the share of Facebook remain at the leading position of 78.1% in 2015, the trend appears to be on the decline when compared to the 86.9% reported in 2014.

One possible reason for the decrease of Facebook usage could be the growing popularity of Instagram, which is included for study for the first time this year, in Hong Kong. The result shows that 19.9% of the respondents use Instagram, placing it second in popularity after Facebook.

The proliferation of mobile devices and the need for real-time messaging and social networking via WiFi mean that users are storing more important and sensitive information on their devices than ever. Users would naturally want to keep their personal information secure online, and this urge is demonstrated by the rising awareness about WiFi security among the respondents. This year, 31.0% (as compared to last year's 18.0%) of the respondents claim that they are aware of the security risks of using WiFi to access the Internet. However, our research also finds that about one-third (34.5%) of the respondents are not satisfied with the security levels of the WiFi hotspots they are using. It is suggested that WiFi providers, both Government and commercial, must take concrete steps to raise the security levels of the WiFi hotspots so that sensitive data, including personal contacts, photos, passwords, location tracking software, even details about users' behaviours and search histories, can travel safely through WiFi channels.

8.3 WiFi Security – Knowledge and WiFi Tethering

Unlike the previous two studies, this year's study reveals that respondents are in general more aware of the security risks of using WiFi to access the Internet. Last year only 18% of respondents thought that it was not safe to use WiFi to access the Internet, this year the percentage increases to 42.1%. Moreover, last year only 47.2% of the respondents expressed concern over the possible disclosure of privacy due to accessing the Internet via WiFi, this year the percentage increases to 55.8%. Possible explanations for the increase in security concern could be attributed to wider reportage of WiFi threats and the efforts of the industry, including those of the Hong Kong WTIA's, in promoting WiFi security through all possible channels to the community.

As for the adequacy of security measures of WiFi networks, this year, it is found that only 33.5% of the respondents feel that the security measures are adequate, much lower than the 49.8% and 48.4% reported in 2013 and 2014 respectively. Meanwhile, the share of respondents who believe that WiFi security measures are inadequate has increased for the second consecutive year. 34.5% of the respondents believe that the security measures are inadequate this year, representing a considerable increase from the 20% and 23.5% reported in 2013 and 2014 respectively. Though the findings show movements in both directions, they are good news to the Government and WiFi security practitioners as perception of inadequacy indicates good awareness which lets users to see the threats. This awareness will in turn create impetus for practitioners to change and take steps to mitigate the threats.

The last two reports revealed that there was a big gender difference in respondent perception of WiFi security in Hong Kong. In 2013, 47.1% of the male and 60.5% of the female respondents expressed concern over the possible disclosure of personal privacy due to accessing the Internet via WiFi. In 2014, it was found that the difference persisted but was narrowing (47.3% for male respondents and 52.5% for female respondents). This year, the gender difference becomes less prominent (55.6% of male respondents verses 59.1% of female respondents). One of the explanation could be the widespread coverage of news on smartphone related security

risks by both traditional and social media which helps bring the message of WiFi safety out in the open (Feng, 2015; Reisinger, 2015).

With the proliferation of mobile devices, WiFi tethering is becoming increasingly common in Hong Kong. It is revealed in this year's study that 53.0% of the respondents use WiFi tethering to share WiFi connection, a slight increase compared to the rate of 50.0% two years ago. The possible reasons for the growth could be attributed to the increasing tethering capability of mobile devices and the growing popularity of low-cost Wi-Fi-only tablets. Nowadays, most Smartphones are equipped with built-in "hotspot" functions, allowing users to gain access to the Internet and share the connection with other devices or users without paying for additional data plans. But with this convenience also comes the risks to network attacks and therefore it is suggested that greater promotional efforts should be made to educate users on the safe use of tethering. WiFi users should be reminded that they should only share their Internet connection with trusted devices. If they have to use a "tethered" connection, they have to take steps to make sure that the owner of the "tethered" device will not sniff their traffic and steal their information.

8.4 Encryption and Extra Security Measures

On the question of WiFi encryption, 33.2% of the respondents indicate they do not know what kind of WiFi encryptions technology they are using. The percentage is much higher than the 17.8% and 17.1% reported in 2013 and 2014 respectively. One possible explanation for the growth could be that many new models of router are preset to use "WPA/WPA2 using TKIP" or have "WPA/WPA2 using AES" as default, which provides users with decent protection without worrying too much about the setting.

Of those who know what kind of encryption they are using, 5.9% of them admit that they have not used any encryption to protect their WiFi network, a drop of over 3 percentage points from last year's 9.1%. Moreover, the percentage of respondents using WEP has also reduced, from last year's 12.1% to this year's 7.4%. The drop might indicate a rising awareness of WiFi security among users in Hong Kong.

Meanwhile, the percentage of respondents using "WPA/WPA2 using TKIP" encryption technology is 18.8%. Those who are using the most advanced "WPA/WPA2 using AES" encryption technology is 38.6%. Again, this indicates that more targeted measures must be taken to help those who are not using or still using less secure encryption mechanisms to know more about the importance of protecting the confidentiality and integrity of their data, as well as the value of using more advanced encryption and keying mechanisms.

8.5 WiFi Accessibility

Similar to the last two reports, inadequate WiFi access points, inadequate bandwidth and unstable service quality continue to top the list of problems that frustrate WiFi users in Hong Kong. These problems are found in both public WiFi access services run by commercial service providers and those provided by the HKSAR Government.

Having said that, the "inadequate access points" problem of commercial WiFi services has shown a slight improvement by 4.4 percentage points, from 2014's 65.3% to this year's 60.9%. Meanwhile the "inadequate access points" problem of GovWiFi service has shown a slight deterioration by 5.3 percentage points, from 2014's 70.4 % to 75.7% of this year. As both Government and commercial WiFi access providers have pledged over the years to increase investment in hotspot infrastructure, it is quite disappointing to see that more than half of the respondents still find GovWiFi services and commercial WiFi services inadequate in terms of the number of access points provided. One of the possible explanations could be that the expanding investment lags behind the rapid growth and demand for personal wireless devices and the growing user expectation of staying connected wherever they go.

For three consecutive years, the findings with respect to respondent perceptions of GovWiFi accessibility echo those in the Director of Audit's report on GovWiFi service (HKSAR Audit Commission, 2013). This demonstrates that the Government has to do more to improve the GovWiFi service, in particular, its coverage, bandwidth and service quality.

Providing free WiFi access in public places is a global trend. New York City is providing free WiFi Internet access service to both residents and visitors so that they can "stay connected as you make your way around town" (www.nycgo.com/articles/wifi-in-nyc). In Europe, from Barcelona to Helsinki, free WiFi is common throughout the urban area as well as in many parts of the countryside, and residents and travelers alike can gain WiFi access in cafés and bars either for free or with purchase. In Asia, South Korea is planning to install 10,000 hotspots for free WiFi connection throughout Seoul by 2015. Singapore has been providing free WiFi to all tourists since 2006 and the highest access speed is up to 2Mbps using Wireless@SG. Shanghai has set a goal of becoming a

“wireless city” by 2015. It is installing more and more public WiFi access points to provide the “i-Shanghai” free WiFi Internet access to all residents and visitors. Taipei is working to provide free Wi-Fi service in major indoor or outdoor public places throughout Taipei City. To catch up, Hong Kong needs to do more and do better in terms of free WiFi coverage, reliability and security. As this and previous reports show that over half of our respondents think that WiFi connectivity has been, and still is, inadequate overall, there is a genuine need for the Government and the commercial service providers to give serious attention to the issue and take concrete measures to address the problem of persistent user perception of inadequate WiFi services.

References

- Edwards, J. (2014). The iPhone 6 Had Better Be Amazing And Cheap, Because Apple Is Losing The War To Android. *Business Insider*, May 31, 2014. Retrieved from <http://www.businessinsider.com/iphone-v-android-market-share-2014-5>
- Feng, C. (2015). Security loopholes in Android OS, social media putting 550m users' data at risk, Hong Kong researchers say. *South China Morning Post*, 10 July, 2015. Retrieved from <http://www.scmp.com/tech/social-gadgets/article/1835424/security-loopholes-android-os-social-media-putting-550m-users>
- Fong, K. K. K., & Wong, S. K. S. (2014). Hong Kong Wi-Fi Adoption and Security Survey 2014. *Computer and Information Science*, 8(1), 74-94. <http://dx.doi.org/10.5539/cis.v8n1p74>
- Griffiths, J. (2015). WhatsApp rolls out voice calls for Android, iOS coming soon. *South China Morning Post*, Published 31 March, 2015. Retrieved from <http://www.scmp.com/lifestyle/article/1752566/whatsapp-rolls-out-voice-calls-android-ios-coming-soon>
- HKSAR Government. (2015). *Programme Overview: Government Wi-Fi Programme*. Retrieved from <http://www.gov.hk/en/theme/wifi/program/>
- Reisinger, D. (2015). Most Android phones at risk from simple text hack, researcher says. *CNET*, July 27, 2015. Retrieved from <http://www.cnet.com/news/researcher-finds-mother-of-all-android-vulnerabilities>
- Wong, S. K. S., & Fong, K. (2014). *Report on Wi-Fi Adoption and Security Survey 2014, Hong Kong*. Hong Kong: Hong Kong Wireless Technology Industry Association.

Copyrights

Copyright for this article is retained by the author(s), with first publication rights granted to the journal.

This is an open-access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/3.0/>).