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Mapping internet coverage in Malaysia's university campuses: A case study of the Sultan Idris Education University, Perak

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Abstract

ICT revolution has brought changes in the lifestyle of all walks of life including that of the university students. More than ever, the use of information and communications technology is now not only closely linked to higher education but is also imperative to the shaping of that first-class mind fit to function in the present globalization era. The Malaysian government through the Malaysian Communications and Multimedia Commission has regularly maintained its policy to provide quality internet coverage throughout the nation. This study examined student Wi-Fi accessibility at the Universiti Pendidikan Sultan Idris (UPSI) through geographic information system (GIS) mapping in order to establish the Wi-Fi coverage areas for the students. The data employed were Wi-Fi accessibility observations at the identified locations using a tool known as Wi-Fi analyzer included in the mobile phone. That data were subsequently manipulated in the GIS through ArcGIS 9.3 software. Then, kriging interpolation technique was used to form a coverage area that was divided into four types: strong, medium, weak and very weak. The findings showed that more than 80 percent of the coverage was weak or very weak, pointing to the necessity of providing higher levels of campus-wide internet coverage for the benefit of the students.

Keywords: campus internet link, GIS, internet accessibility, internet coverage areas, Kriging regression, Wi-Fi coverage

Introduction

Information communications technology (ICT) today is undergoing enormous changes which involve the use of mobile internet. ICT revolution has brought changes in the lifestyle of all walks of life in the world, including university students. This revolution has changed and improved the computing power in the delivery and dissemination of information globally (Rozinah, 2000). According to Baharuddin et al. (2001) the use of the internet by the public now as an information repository in the process of communication and information dissemination (Nasir, 2007; 2010). The use of the internet has become an important innovation in all fields, especially education (Nasir et al., 2013). Internet use provides a wealth of experience to the students so that they can share their knowledge in learning rapidly in a global context. The internet is slowly becoming essential in shaping the attitudes, perception and even a culture in Malaysia society (Mohd Fuad et al., 2012). In addition, the use of internet in education has provided a lot of information to students as the secondary source, whether for learning, recreation, research and reference material that is beneficial to students (Nasir, 2005). The increasing of the mobile device, such as iPad, Tablet and laptop increasingly promoted the application of Wi-Fi technology. Wi-Fi has become very popular in public places (Yanfu Zhou, 2012). To enable students to access the internet whether at school or higher education institutions, various advanced technologies or the latest software have been introduced. Among the advanced software are LAN web and wireless network. However, the internet can

also be used by using technology such as wireless-fidelity (Wi-Fi). At present, the introduction of new technology, namely Wi-Fi mobile wireless network allows users to be mobile with a laptop, smartphone and equipment that are used to access the internet. Wireless network coverage area is up to 150 to 350 meters from each access point or signal source. Therefore, Wi-Fi coverage will be determined by the location of the Wi-Fi and power. Wi-Fi is becoming as common in urban areas (Sevtsuk et al., 2009). SKMM (2015) reiterated the significance of a good quality of internet coverage to the people living standard. The National Policy of Communication and Multimedia has also been outlined to create a good citizen that has a basic information in increase the level of life and work (SKMM, 2012). In fact, the necessity of high-level coverage is needed in National e-Learning Policy (KPT, 2011).

Study area

Sultan Azlan Shah Campus (SASC), UPSI located in Proton City in the district of Batang Padang (District of Muallim since 2015) in Perak is a newly-built campus dates back to 8MP (2001-2005) to provide the space and facilities to accommodate the increasing number of students in line with the role of university education in the country. Capacity building of the new campus can accommodate a total of 10,000 students with the latest teaching and learning facilities. Figure 1 shows the development phase to phase 1 has been built as a focus area in this study.

Figure 1. *Development phase in SASC*

Data and methodology

The data used are primary and secondary data. Primary data are Wi-Fi coverage data observed at various locations using Wi-Fi analyzer software in the smartphone. Secondary data is data related to SASC

mainly derived from UPSI. The Wi-Fi Analyzer is a software application that is often used in mobile phones and computers to locate and identify the level of the Wi-Fi signal strength detected by the phone via the antenna located nearby. There are several methods that can be used in this software to measure the Wi-Fi signal strength readings through the network diagram (channel graph), time graph method (time graph), positioning network method (channel rating), the list of AP (AP list) and signal meter method (signal meter). In this study, the strength of the Wi-Fi signal from the antenna is measured by using a list of AP and signal meter method. Wi-Fi signal strength level is measured using this application due to the Wi-Fi signal speed in each building is different because of different antenna locations in each building. The reading is based on the Wi-Fi signal UPSINET. Readings were taken in each building for six times - four times reading at the corner of each study building and two readings in the middle of the building. Wi-Fi signal speed readings are taken in units of signal strength (dBm). There are three scale readings of Wi-Fi signal strength in this software – a reading from -100 dBm to -85 dBm, which represents the scale is not strong, a reading of -84 dBm to -60 dBm (medium) and a the signal strength reading of -59 dBm to -40 dBm (very strong). Wi-Fi service coverage mapping and Wi-Fi accessibility mapping phase in the next SASC uses a space interpolation method using kriging techniques.

Results and discussions

Patterns analysis of Wi-Fi

During the field study conducted, the number of antennas and its position at each level of all research stations has also been recorded. It aims to look at the distribution of the antenna in every area of campus and student residence area. The distribution of the antenna varies according to the function of a building in SASC. For example, the focus area of students such as residential and the lecture areas has more antennas than the less focus area of students. Figure 2 shows the distribution of antenna in the SASC building. Block 4 has a number of antennas which is 21 antennas. Block 4 has two antennas at level G, seven antennas (Level 1), eight antennas at level 2 and four antennas at level 3. The total number of antennas more than other areas in Block 4 is the cause of this area received the highest level of accessibility of Wi-Fi coverage by an average of -66 dBm.

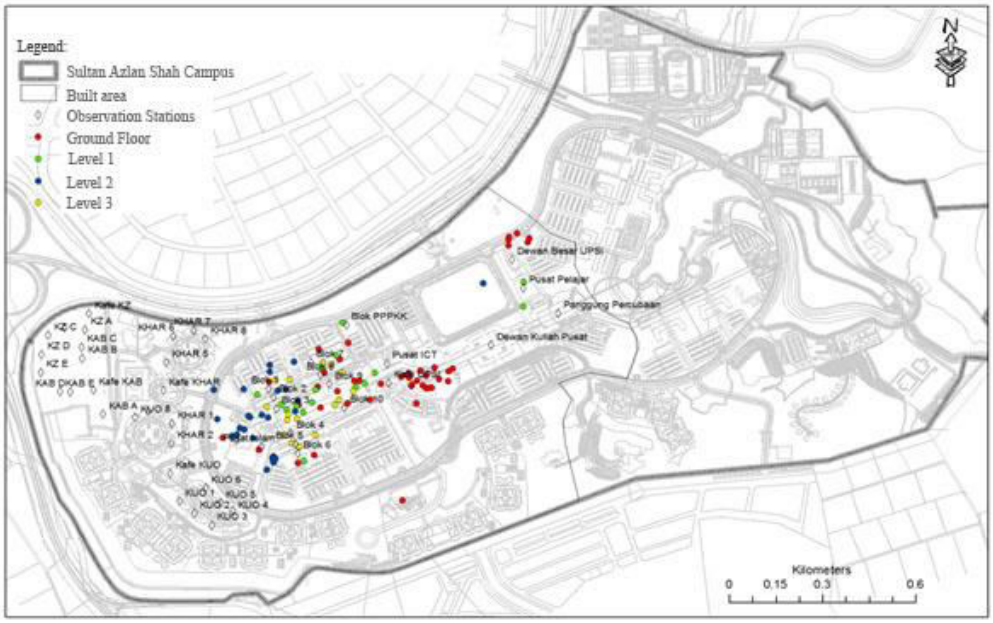

Figure 2. *Location of Wi-Fi antennas*

There are also areas that have no antenna at each level. For example, the area of Block 2, Block 3 and Block 5 has no antenna at level G and level 1. The placement of the antenna is influenced by the importance of the building itself. For the building that houses the lecturers' rooms, lecture hall had more antenna compared with the area which has no interest in administration or teaching. The Central Lecture Hall has 19 antennas around the area. More antennas should be placed here as this area is the focus area for students using the Internet for searching visual input during lessons. In addition, poor Wi-Fi coverage areas such as the Islamic Centre, the Co-Curriculum Centre, Student Centre, PPPKK because of one antenna only.

The distribution of the antenna also varies depending on the blocks and floors of the student residence. Figure 3 shows the distribution and the number of antennas at the residential area and level G. Overall, KUO and KHAR have a lot of antennas in each level as compared with the residential colleges of KZ and KAB. On average, KHAR and KUO have three to six antennas at each level residential building. This is influenced by many factors, the number of students of that area compared with only three antennas only for each level in KZ and KAB. KHAR 1, 2 KHAR, KUO 1, KUO 7 and KUO 8 have recorded the highest number of six antennas at each level. As a result, this area also has a good Wi-Fi coverage and the result from Wi-Fi Analyzer analysis proves that this area had the strongest signal strength of between -53 dBm to -59 dBm. In contrast, to areas such as cafes colleges had only two antennas which are causing a very weak Wi-Fi coverage of between -75 dBm to 90 dBm.

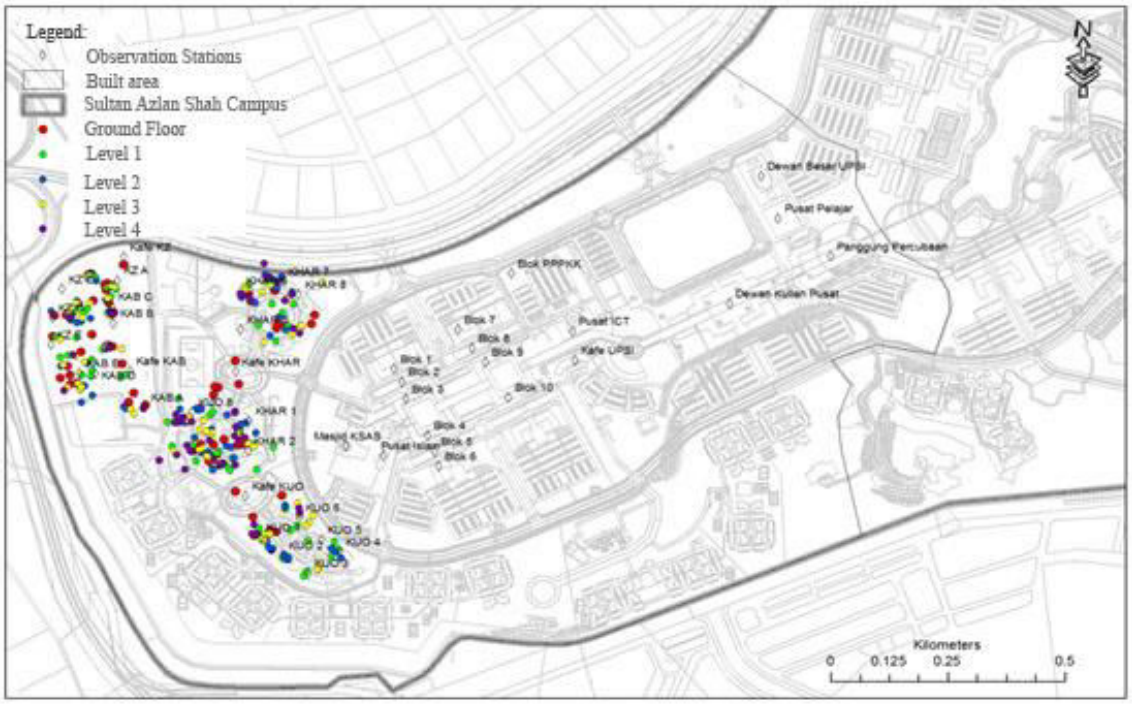

Figure 3. *Wi-Fi antenna in student residential areas*

Campus internet coverage

The level of accessibility at SASC using Wi-Fi Analyzer application shows the signal strength received from the antenna is different between the block and building in SASC. Table 1 shows the signal strength was recorded at all study stations at SASC. The highest reading of the Wi-Fi signal strength is listed in KUO 8 with the signal strength of -45 dBm (reading 5). Meanwhile, for a block with the lowest Wi-Fi signal strength reading is recorded in the area of 6 blocks with a reading of -95 dBm (reading 6). Overall,

the highest Wi-Fi reading recorded in the KUO 8 with a reading of -51 dBm. The value recorded in this area is the lowest dBm and shows that the strength of the Wi-Fi signal is the highest among other areas. Furthermore, the overall average reading of lowest Wi-Fi signal strength is recorded in Block 5 with a reading of -91 dBm.

The descriptive analysis shows the frequency reading mode Wi-Fi signal strength is at -76, -78 and -87 of nine times, while the overall mean is -91. The median value was recorded at the value of -76 dBm while the range is -50. Value for the standard deviation data of Wi-Fi signal strength in SASC was 10.3820 while the value of the variant is 107.7872. Based on the table, the level of Wi-Fi Analyzer strength based on the Wi-Fi Analyzer software by a mobile phone showed that there were three levels of Wi-Fi wave acceptance, weak (1), moderate (2) and strong (3). For the Wi-Fi signal strength by Wi-Fi Analyzer in SASC shows only five areas receiving Wi-Fi signal strength at best (strength) at level 3 (-60 to -40 dBm). The reading value and the level of accessibility can be seen in Table 1.

To facilitate the Wi-Fi signal strength analysis to be carried out meticulously in the SASC, a new Wi-Fi signal strength levels have been classified according to the degree of strength in Wi-Fi Analyzer application. Levels that have been reclassified specialized in the study area is at level 1 (very poor), level 2 (low), level 3 (medium-low), level 4 (medium), Level 5 (strong) and level 6 (very strong). Overall, no area in SASC recorded very strong Wi-Fi signal strength which is level 6, while there are only five areas were identified as having a strong Wi-Fi signal strength (level 5) as shown in Table 1. The values of the adjusted coverage can be seen in Table 1.

Table 1. Signal strength and WiFi analyzer strength

Location	Signal strength (dBm)							WiFi Analyzer Strength	Adjusted Signal Strength
	1	2	3	4	5	6	Avg.		
Block 1	-71	-75	-70	-69	-74	-91	-75	2	3
Block 2	-88	-76	-77	-81	-75	-82	-80	2	3
Block 3	-85	-87	-93	-89	-85	-90	-88	1	2
Block 4	-63	-65	-76	-62	-70	-60	-66	2	4
Block 5	-89	-93	-90	-91	-94	-87	-91	1	1
Block 6	-84	-86	-91	-92	-87	-95	-89	1	2
Block 7	-89	-83	-86	-82	-95	-78	-86	2	2
Block 8	-80	-79	-78	-85	-75	-83	-80	2	3
Block 9	-85	-74	-81	-77	-83	-86	-81	2	2
Block 10	-69	-77	-76	-90	-92	-75	-80	2	3
Main Hall	-91	-88	-87	-89	-92	-93	-90	1	2
Cafe	-95	-60	-95	-94	-90	-93	-88	1	2
Mosque	-88	-90	-91	-87	-93	-95	-91	1	1
Centered Lecture Hall	-70	-75	-65	-60	-78	-72	-70	2	3
Islamic Centre	-82	-80	-93	-85	-84	-87	-85	2	2
Pangung Percubaan	-79	-78	-80	-75	-74	-70	-76	2	3
Co-curriculum center	-87	-90	-94	-93	-95	-90	-92	1	1
Student Centre	-87	-91	-81	-92	-80	-85	-86	2	2
ICT Centre	-69	-77	-79	-71	-91	-84	-79	2	3
PPPKK	-78	-79	-73	-76	-77	-74	-76	2	3
KHAR 1	-55	-60	-51	-50	-57	-49	-54	3	4
KHAR 2	-55	-48	-54	-57	-53	-60	-55	3	4

Location	Signal strength (dBm)							WiFi Analyzer Strength	Adjusted Signal Strength
	1			4	5	6	Avg.		
KHAR 5	-62	-65	-72	-66	-71	-67	-67	2	3
KHAR 6	-60	-68	-73	-62	-75	-63	-67	2	3
KHAR 7	-64	-66	-76	-68	-74	-61	-68	2	3
KHAR 8	-67	-63	-74	-62	-72	-64	-67	2	3
Cafe KHAR	-63	-74	-77	-76	-83	-78	-75	2	3
KUO 1	-55	-51	-60	-58	-49	-45	-53	3	4
KUO 2	-65	-69	-72	-75	-71	-67	-70	2	3
KUO 3	-63	-70	-75	-73	-63	-64	-68	2	3
KUO 4	-62	-72	-73	-67	-65	-65	-67	2	3
KUO 5	-67	-75	-76	-70	-68	-61	-70	2	3
KUO 6	-69	-77	-72	-72	-70	-62	-70	2	3
KUO 7	-60	-64	-57	-63	-59	-49	-59	3	4
KUO 8	-48	-50	-59	-55	-45	-47	-51	3	4
KUO Cafe	-61	-59	-69	-70	-67	-66	-65	2	3
KZ A	-73	-78	-69	-92	-77	-81	-78	2	3
KZ B	-71	-75	-66	-90	-75	-80	-76	2	3
KZ C	-72	-77	-64	-88	-76	-83	-77	2	3
KZ D	-76	-79	-67	-90	-77	-84	-79	2	3
KZ E	-70	-74	-65	-89	-78	-85	-77	2	3
ZA'BA Cafe	-78	-80	-82	-83	-63	-90	-79	2	3
KAB A	-84	-88	-87	-91	-73	-78	-84	2	2
KAB B	-80	-85	-85	-90	-75	-75	-82	2	2
KAB C	-79	-84	-81	-88	-77	-71	-80	2	3
KAB D	-77	-81	-87	-87	-74	-70	-79	2	3
KAB E	-78	-86	-84	-89	-71	-73	-80	2	3
KAB Cafe	-62	-76	-79	-80	-82	-88	-78	2	3

Wi-Fi coverage level

Mapping phase Wi-Fi accessibility in and around the residential colleges of SASC was carried out as well (Figure 4), which saw average levels of accessibility Wi-Fi in SASC are measured using Wi-Fi Analyzer is weak. A total of 36 research stations recorded a weak reading of Wi-Fi, reading between -90 dBm to -80 dBm. Between stations which recorded a weak scale are shown in Block 1, Block 2, Block 4, Block 7, Block 8, Block 9, Block 10, Lecture Hall Center, Islamic Center, Experimental Theatre, Student Center, and Center for ICT and PPPKK. In addition, the whole residential colleges in KAB and KZ also recorded a weak Wi-Fi coverage. In addition, the stations in Block 3, Block 5, Block 6, UPSI Main Hall, UPSI Cafe, UPSI Mosque and Centre for Co-Curricular recorded a very weak Wi-Fi strength. The number and position of the antenna in these areas are few and improper arrangements causing the weaker signal strength. Then, the student focus areas such as areas in KHAR 1, 2 KHAR, KUO 1, KUO 7 and 8 KUO recorded average Wi-Fi scale value. Next to the Wi-Fi service coverage area level, weak level dominates the breadth and the highest percentage (Table 2). Weak levels recorded breadth coverage area of 0.85189 km from the breadth of the whole area of Phase 1 of 1.73861 km2. In percentage, the level recorded 49 percent. Meanwhile, for the very weak level recorded the second highest coverage area of 0.61585 km2 (35.42%).

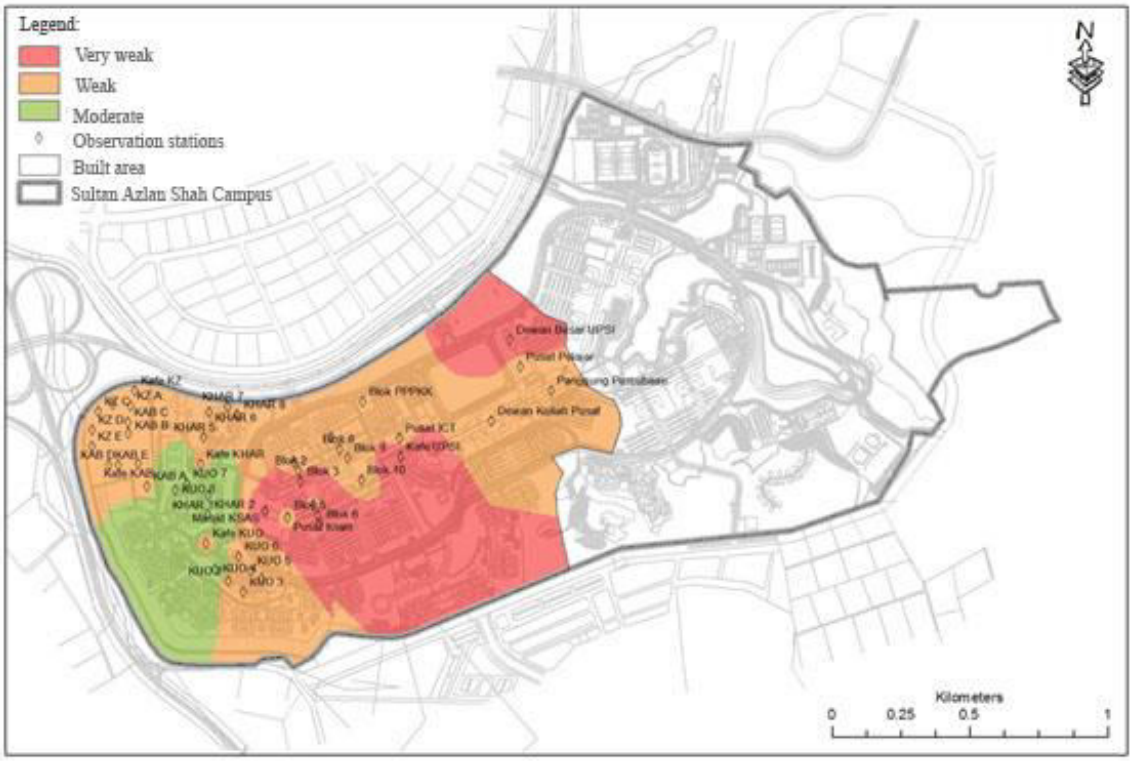

Figure 4. *Accessibility of Wi-Fi level*

Table 2. Wi-Fi coverage level

Wi-Fi Level Coverage	Area ($Km^{2)}$	Percentage (%)
Very weak	0.61585	35.42
Weak	0.85189	49
Moderate	0.27087	15.58
Total	**1.73861**	**100**

The level of Wi-Fi coverage strength is weak recorded in this area affected by the position of the antenna and antenna placement in an area. In areas with very weak Wi-Fi coverage only has a small number of antennas compared with the area that recorded an average Wi-Fi coverage. The position of the antenna that is not systematic, usage of old antenna models such as in the UPSI cafe, buildings in Co-Curriculum Centre, Mosque and Islamic Centre causing these areas to have a very weak Wi-Fi coverage. Areas that are important in terms of administrative and educational facilities as in Block 4, Block 8, Block 10, Central Lecture Hall recorded a moderate level of coverage because the area has a lot of antennas and antenna are positioned at each corner of the building. Moreover, there are some areas in the student residential area, recorded a moderate level of coverage, such as in KHAR 1, 2 KHAR, KUO 7, KUO 8. This is because the area was recently opened and there were only a small number of users compared with a residential area such as the KAB and KZ. The position of the antenna at each corner of a residential area and at every level, causing the moderate Wi-Fi signal compared with only one antenna in the residential cafe.

Conclusion

Overall, the findings indicate that the accessibility Wi-Fi in SASC is still low and needs to be enhanced to accommodate the growing number of students and the development of phase 2 that began in 2014. Failures to provide larger coverage areas will cause the UPSI students to lag behind in Internet access with obvious consequences on their study performance.

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