Proceedings of the 2nd Faculty of Industrial Technology International Congress
International Conference
Bandung, Indonesia, January 28-30, 2020
ISBN 978-623-7525-37-0

The Usage of Quick Response Code and Captive Portal for Wi-Fi Security and Bandwidth

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Abstract

Internet of Things (IoT) allows different devices to communicate with each other without the compulsion to use outdated-fashioned communication styles such as data cables, external flash drives, and disks. Nowadays, people connect their smartphones to Wi-Fi in the public area by manually inputting a Wi-Fi password on their smartphones, which is regarded as a problem, mainly when the password is complex and confusing. This research demonstrates the feasibility of using the Quick Response (QR) code and the Captive Portal featured in router Tenda W15E AC1200, to guard the Wi-Fi password and to avoid unwanted users from exploiting the Wi-Fi public area. Simulation by using an open source QR code generator software to acquire the Wi-Fi QR code and experimentation from both qualitative and quantitative approaches are therefore necessary. As a result, the safety of the Wi-Fi public area is protected as the password is not revealed to the user.

Keywords: QR code, Wi-Fi, IoT, Captive Portal, Tenda W15E AC1200.

1. Introduction

Currently, wireless technology is the world's leading competitor of wired technology and has become the world's first selling point for transmission technology. The primary reason for this is the simplicity of accessing the Internet of Things (IoT) and smartphones using Wi-Fi to make it effective for people to connect their devices to the Web so that they can access online media, education and social networking with various people around the world. Wi-Fi hotspots are an important part of the wireless infrastructure and are designed to improve user experience. Wi-Fi hotspots are no longer confined to regular top sites, such as airports or hotels, and move quickly to local retail stores, parks, restaurants and shopping centers [1].

Most customers who go to a restaurant just buy one or two cheap foods or drinks to get the restaurant's free Wi-Fi service. Subsequently, these customers take it for granted and end up staying in the restaurant for more than the average stay duration of typical restaurant customers. Although complicated numerical alphabetical letters are possible to be saved by the Wi-fi for its password, they are still insufficient. In research [2], Quick Response (QR) code is used to provide an efficient and secured way of locker loaning services.

The preventative solution proposed by this research is the introduction of a QR code and bandwidth limitation done by Captive Portal. The QR code is a technology that uses two-dimensional (2D) barcode for smartphones scanning to provide faster action [3]. It can deliver the restaurant's Wi-Fi password securely to customer's smartphones. Currently, the QR code is used by huge number of people daily due to its simplicity [4]. Captive Portal's bandwidth limitation is intended for those customers who remain in restaurant for too long to discourage them from exploiting the internet connection speed that reduces other customer's internet connection speed. As a result, the utilization of QR code and Captive Portal can greatly reduce losses for public area Wi-Fi businesses.

2. System design

In this research, QR code is used as it is the most efficient amongst the others barcodes with its ability to store embedded information and to provide smooth reading to the QR code scanner [4]. The Captive Portal feature is available inside the router Tenda W15E AC1200. This feature gives the authentication code to the customers along with bandwidth limitation, time session, and also to prevent any customer from abusing the Wi-Fi speed [5]. It is also capable to remove the access of any verified customers when a certain specified time has passed [6].

The configuration of the Captive Portal for bandwidth limitation and limit time session is shown in the Fig. 1. ZXing barcode scanner ables to scan and decode QR code via the device by using the smartphones‘ camera [7]. However, not all smartphones are able to install the ZXing barcode scanner as it only supports android version 5 (Lollipop) and above [8].

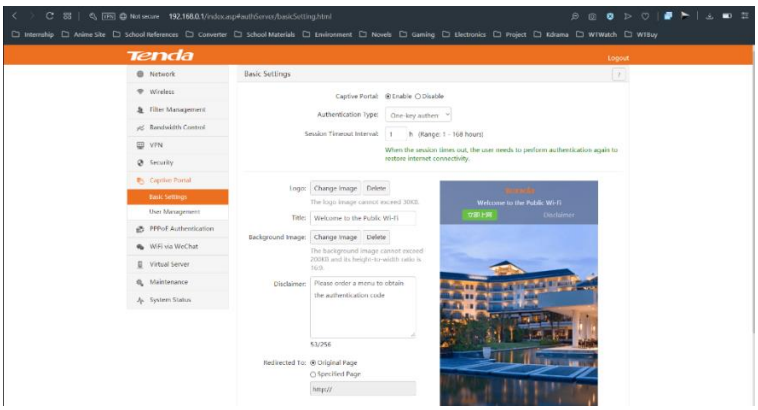

Fig. 1: Configuration of Captive Portal in Tenda W15E AC1200 to Limit Bandwidth and Time Session.

The Fig. 2 represents the block diagram of the system. The system starts when the customer is provided with a QR code. The customer uses a smartphone that has a QR code reader application installed to scan the QR code and obtain the password. The customer is then redirected to the Captive Portal web for the process of authentication done through the router Tenda W15E AC1200. If the verification is successful, the customer is then granted the Wi-Fi internet access with the provided bandwidth speed. If the verification via Captive Portal failed, the customer’s smartphone is rejected from connecting to the public Wi-Fi.

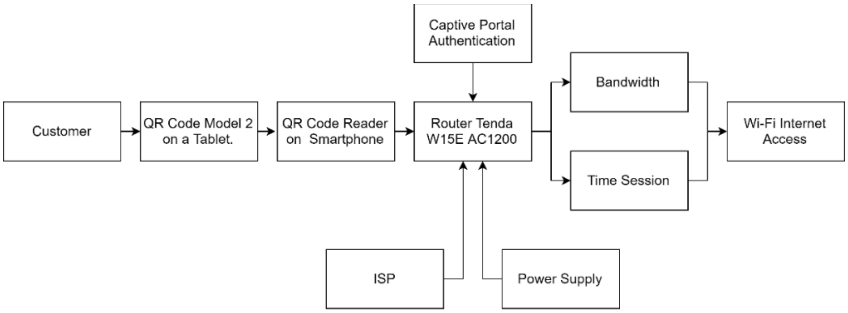

Fig. 2: Block Diagram System.

Fig. 3 shows the flowchart of the system. In this case, there are two situations; customer buys Wi-Fi service and customer does not buy Wi-Fi service.

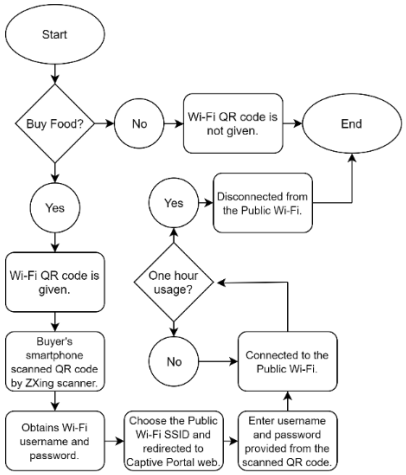

Fig. 3: Flowchart of QR code and Captive Portal Implementation.

3. Testing Results and Analysis

3.1. Survey for the Effectiveness of QR Code and Captive Portal Implementation

The testing experiment is done to find out the qualitative measurement surveys from the public place users. The success criterion in this experiment is reached when the survey result shows that most of the survey takers are satisfied with the system proposed in this thesis. Based on Fig. 4, the results obtained are satisfactory as the percentage of the survey takers who are happy and satisfied with the implementation of these technologies are ≥ 80% in response to thirty-six number of respondents.

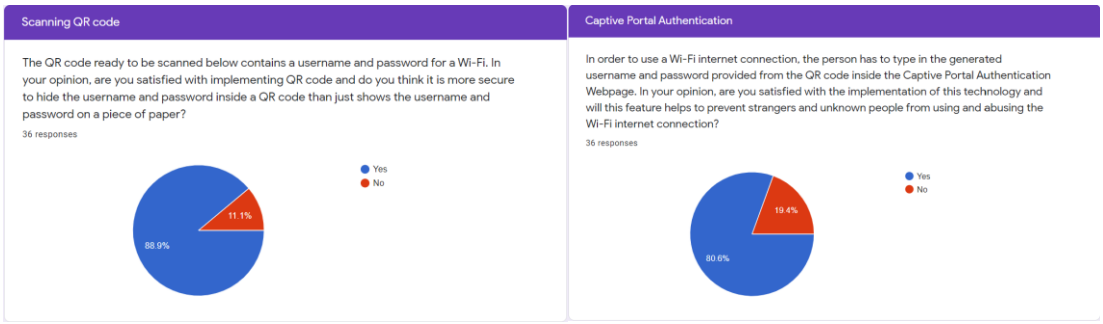

Fig. 5: Survey for the Implementation of QR code and Captive Portal.

3.1. Optimal Distance and Average Time Taken

The testing to find the optimal distance of scanning the QR code is done by providing a range of distance from 0 cm to 200 cm. Meanwhile, the average time taken is earned after the sum of a repetition of three times of taking the time taken to scan the QR code in every tested distance divided by three. The Fig. 5 shows the setup of the devices during the testing experiment of finding the optimal angle and average time taken. The Tab. 1 shows the data obtained after testing the implementation of scanning the QR code through a range of distance and average time taken by a smartphone with ZXing Barcode Scanner installed. The result of scanning the QR code from range 0 cm to 15 cm is unsuccessful due to the location of the QR code is too closed with the smartphone used to scan. Meanwhile, from the range distance of 20 cm to 140 cm, the testing is successful. When the distance is made further than 140 cm, the QR code scanning failed due to its long distance. Based from the Tab. 1, the optimal distance to scan the QR code is at 20 cm with an average time taken of 145.5 ms for scanning the QR code.

Fig. 5: Optimal Distance and Average Time Taken Testing Experiment.

Table 1: The Successfulness of Scanning QR Code to Find the Optimal Distance and Average Time Taken.

Distance (cm)	Time Taken 1 (ms)	Time Taken 2 (ms)	Time Taken 3 (ms)	Avg Time Taken (ms)	Successfulness
0 - 19	-	-	-	-	No
20	157	145	134	145.4	Yes
30	161	165	138	154.7	Yes

40	141	264	148	184.4	Yes
50	204	143	160	169	Yes
60	148	173	145	155.4	Yes
70	211	151	135	165.7	Yes
80	172	173	195	180	Yes
90	160	155	195	170	Yes
100	178	195	196	189.7	Yes
110	232	190	200	207.4	Yes
120	437	611	512	520	Yes
130	342	150	202	231.4	Yes
140	1201	943	2301	1481.7	Yes
141 - 200	-	-	-	-	No

3.2. Optimal Angle Horizontally and Vertically

The testing experiment finding the optimal angle of scanning the QR code is done by providing a range of angle horizontally (X-Axis) and vertically (Y-Axis) from 0° to 360°, respectively. The Fig. 6 shows the setup of the devices to obtain the optimal angle in horizontal X-Axis. Based on the Tab. 2, the optimal angles to scan the QR code within the distance 20 cm are from range 0° to 50° and 310° to 360° horizontally and vertically. Other than these mentioned angles, the result of scanning the QR code is unsuccessful.

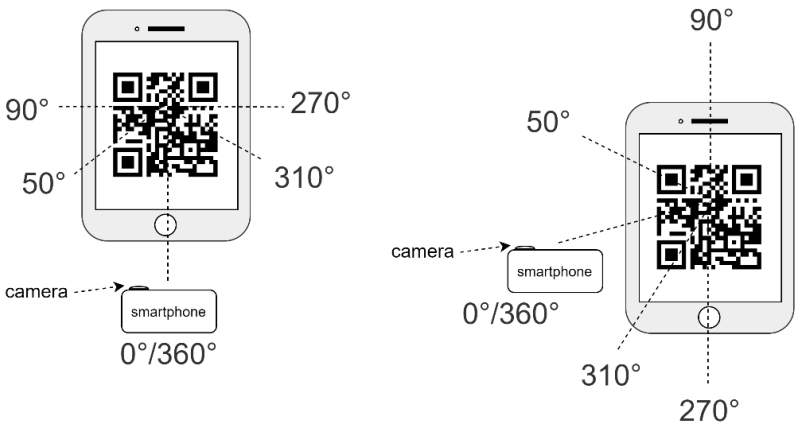

Fig. 6: Optimal Angle in Vertical Y-Axis Testing Experiment.

Table 2: The Successfulness of Scanning QR Code to Find the Optimal Vertical Y-Axis Angle.

Angle in Horizontal and Vertical (°)	Successfulness
0 – 50	Yes
51 – 309	No
310 - 360	Yes

3.3 Captive Portal Authentication

The testing experiment is required to make sure that the username and password generated by the QR code are possible to be used by the customers for login. In the Fig. 7, the customer failed to login through the Captive Portal authentication as the authentication is incorrect. The customer has to buy the service first such as food or drink. Then the customer gets a generated QR code containing the username and password that is to be scanned by the application ZXing barcode scanner. While, in the Fig. 8, the customer is able to login through the Captive Portal

authentication since the customer uses the provided and correct username and password generated by the QR code after scanning it with the ZXing QR code. The customer then gains an internet access for browsing, downloading, and uploading from the public area Wi-Fi for an hour long duration. After one hour of Wi-Fi usage, the customer gets disconnected from the Wi-Fi as the customer exceeded the time limit set from the configuration of the Captive Portal in the Tenda router. To obtain the internet access again, the customer has to buy the service again.

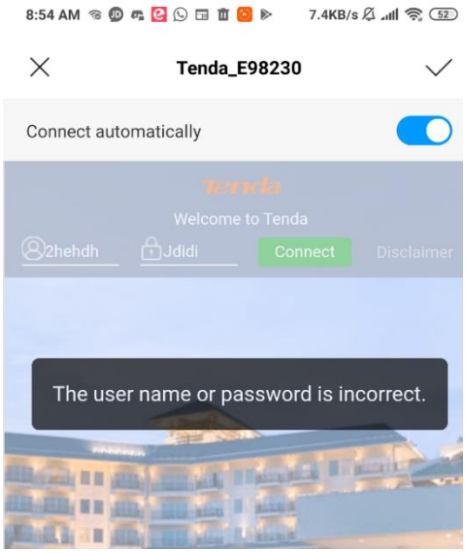

Fig. 7: Failed Captive Portal Authentication During Testing Experiments.

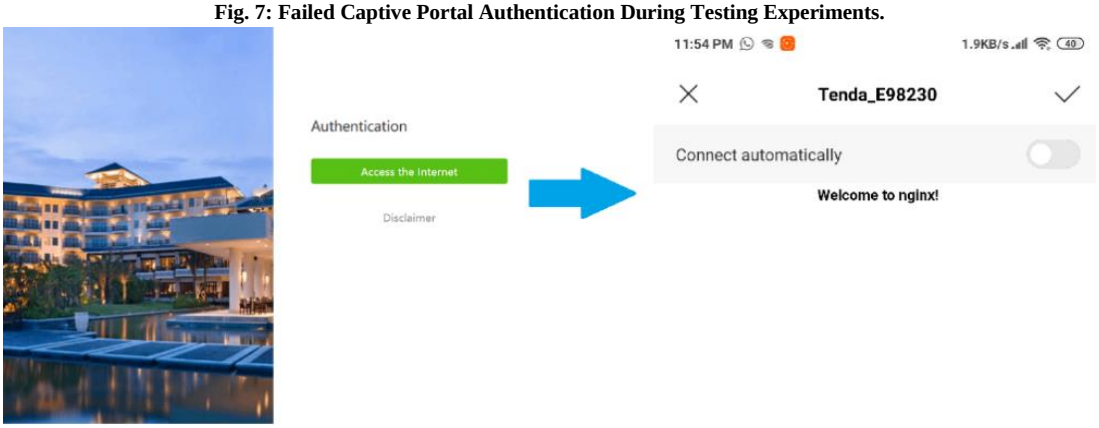

Fig. 8: Succeeded Captive Portal Authentication During Testing Experiments.

3.4 Internet Speed and Devices Connected

The testing to find the behavior of the Wi-Fi internet speed after the bandwidth is limited to 700 KB/s for downloading and 300 KB/s for uploading, and after the number of devices connected is increased. The testing is divided into two scenarios; download speed comparison during browsing only and when downloading a file and upload speed comparison during browsing only and when uploading a file. When the Wi-Fi is only served for browsing only, the internet speed remains the same of 700 KB/s regardless of the number of devices connected. However, when the Wi-Fi is used for downloading, the internet speed of the Wi-Fi decreases as the number of devices connected increases. When the number of devices connected is ≤ 10. The average download speed for downloading remains ≈ 700 KB/s. But when the number of devices connected is 50, the average download speed is 269.5 KB/s as shown in the Tab. 3. When the Wi-Fi is only served for browsing only; not uploading, the internet speed remains the same of 300 KB/s regardless of the number of devices connected. However, when the Wi-Fi is used for uploading, the internet speed of the Wi-Fi decreases as the number of devices connected increases. When the number of devices connected is ≤ 10. The average upload speed for uploading remains ≈ 300 KB/s. But if the number of devices connected is 50, the average upload speed is 240.8 KB/s as shown in the Tab. 4.

Table 3: The Average Download Speed with Respect to the Number of Devices Connected.

Download Speed = 700 KB/s		
Number of Devices	**Average Download Speed (KB/s) Browsing only**	**Average Download Speed (KB/s) Downloading**
0	700	700
10	700	700.5
20	700	632.3
30	700	479.4
40	700	343.8
50	700	269.5

Table 4: The Average Upload Speed with Respect to the Number of Devices Connected.

Download Speed = 300 KB/s		
Number of Devices	**Average Upload Speed (KB/s) Browsing only**	**Average Upload Speed (KB/s) Uploading**
0	300	301.2
10	300	301.2
20	300	288.5
30	300	273.4
40	300	343.8
50	300	269.5

4. Conclusion

The Wi-Fi username and password for Captive Portal authentication are given to the customer via the generated QR code. Captive Portal effectively prevents unknown people from connecting to Wi-Fi and limiting the Wi-Fi bandwidth internet speed. Based on the qualitative approach taken, more than 80% of the 36 respondents agreed and satisfied with the implementation of QR code and Captive Portal. Based on the quantitative approach taken, the optimal distance and angle to scan the QR code via ZXing barcode scanner are 20 cm with an average time taken of 145.4 ms, and 0° - 50° and 290° - 360° horizontally and vertically, respectively. The Wi-Fi internet speed is inversely proportional to the number of devices connected when the Wi-Fi is used actively for downloading and uploading.

5. References

D. Arora, S. W. Neville and K. F. Li, "Mining WiFi Data for Business Intelligence," *2013 Eighth International Conference on P2P, Parallel, Grid, Cloud and Internet Computing*, Compiegne, 2013, pp. 394-398.

R. M. Negara, R. Tulloh, N. Hadiansyah, and R. T. Zahra, “My locker : Loaning locker

system based on QR code,” IJEAT, 2019.

C. Aktas, The Evolution and Emergence OF QR Codes. Cambridge Schoolars Publishing, 2017.

S. Tiwari, "An Introduction to QR Code Technology," *2016 International Conference on Information Technology (ICIT)*, Bhubaneswar, 2016, pp. 39-44.

Tenda, AC1200 Wireless Hotspot Router W15E User Guide, available at: https://gzhls.at/blob/ldb/e/e/9/8/407d3ed2892923da607ab50c4335c3029b1b.pdf, accessed on November 5, 2019.

B. Fleck and B. Potter, *802.11 Security*. O’Reilly, 2002.

M. Zaslavsky, About ZXing, available at: https://stackoverflow.com/tags/zxing/info, accessed on April 1, 2019.

R. Tulloh, R. M. Negara, Y. E. Y. Prasetya and S. Saputra, "HERO: Maximizing Student Potential to Mobilize Community Empowerment Activities Around Campus," 2019 International Conference of Artificial Intelligence and Information Technology (ICAIIT), Yogyakarta, Indonesia, 2019, pp. 431-436.