

QR Code Supported GIS Web System for University Facility Damage Report

Nur Auni Suraya A. Rahim, Abdul Rauf Abdul Rasam

Abstract: This aim of this study is to develop a Quick Response (QR) code supported web-based geographical information system (GIS) for facility damage report in university buildings. In general, some academic buildings such as facility management system of Faculty of Architecture, Planning and Surveying (FSPU), Universiti Teknologi MARA (UiTM) encounter a problem of technicians spending more time to manually search for information on damaged equipment. Data processing such as scanning, georeferencing, and digitizing of the building plans were performed to create geodatabase file of the building. QR Codes at the different rooms were then generated by utilising QR Code Generator software. The waterfall or SDLC model was applied to produce a web-based system. This integrated system has facilitated the users with Home and Menu pages that benefit the outsourced parties to directly receive damages reports of the faculty. A survey of user satisfaction was also conducted to evaluate the practicality of the system and the result has shown that the system has the potential to be used by the department of facilities management by integrating with existing database system (e-Aduan) towards a better facility damage management. The proposed web-based system application will assist technicians and staff in managing the facility easier.

Keywords: Damage report system, Facility management, QR Code, Web GIS.

I. INTRODUCTION

A facility management unit in a building requires a systematic information system for handling facility damage efficiently. For example, although UiTM has a particular building system to manage the space and facility asset such as e-Aduan, the facility management system of FSPU's building seems to have a problem whereby technicians spend more time to manually search for information about the broken equipment at the manuals maintenance records and they also have to ask the staff in charge for information.

This issue has led to problems such as longer maintenance time and it also creates problems for the technicians. The proposed web-based application with QR Code technology will assist technicians and staff in managing the facility more efficiently.

Costello [1] also agreed that this type of communication structure would reduce the time taken in managing the facility and at the same time the occupants will trust the facility

management system.

Nowadays, as technology is rapidly developing, it is important that Facilities Managers (FM) have access to QR Code technology. Costello [1] has used barcodes for managing their facilities and building information properties. In terms of QR Code and FM, QR Code has higher potential in benefitting the facilities management industries because this technology has the ability to store large information compared to barcode. This type of technology will be able to keep up-to-date maintenance record that can be accessed by maintenance staff and the facility maintenance results are also accessible directly through tablets or mobile phones. QR codes can also provide a rapid, easy, convenient, accurate, and automatic data collection method [5].

Facility manager can record information such as dates, conditions, inspection result, problem descriptions and more. In this case, it would save technician's time in obtaining the information required. For instance, users would not have to search the information manually by searching the maintenance records, but they only need to scan the QR Code and the information is attached to the code. QR Code will be also placed on facility equipment in order to allow communication between technician and facility manager [1]. In order to ensure a smooth upgrading process of the facility management system, the databases or attributes data of building facilities information system are needed. With the databases information, the relation of spatial and data description can be made.

Technically, the QR Code can be scanned by using today's common equipment or gadgets such as smart mobile phones. QR Code is a two-dimension matrix code which has high encryption and decryption speed that can be read immediately by scanners and smart mobile phones. It has error-correction ability and high storage capacity information [11]. Because of its ability to store large amount of information, this QR Code can be programmed to perform various tasks such as link to a website, add an event into the calendar, and send text message. These related applications provide a new level of interactivity for the public [3]. GIS knowledge website systems are needed urgently to automate the path from geospatial data to information and knowledge [2] especially for space management [6], [9], [14] by using web and mobile technologies [8], [10], [15].

Therefore, this study aims to integrate QR Code and a web-based system to create a building facility damage report system of (FSPU) staff. This QR Code invention could also simplify the roles of technicians in handling the facility through the use of this web page.

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The web page contains all the maintenance records of the unit.

Other than that, this system can save technician's time because the information of the equipment is available and there is no need to manually search for it through the manuals and maintenance records prior to inspecting the equipment. All the information would be attached via QR Code on the Internet. Costello [1] was convinced that this type of communication would reduce the time taken to manage the facility and at the same time the occupants will have trust in the facility management system.

II. DATA AND METHODS

Fig. 1 shows the general methodology of the study. The steps consist of research planning, data acquisition, data processing, establishment of database system and mapping, generation of QR Codes, development of web-based system and result as well as analysis to achieve the main objectives of the study. FSPU in Shah Alam was selected as study area that currently comprises 11 academic departments. FSPU building is located at UiTM Shah Alam, Selangor and nearby the commercial centre (Fig. 2).

For the specific methodology, the input or raw data used in this project are the building plans of FSPU and its information or input about the rooms, blocks and the facility's equipment. The detailed building plans of each floor were scanned and digitized in ArcGIS in order to create GIS maps and database system.

Then, to produce QR Codes for facility management, QR Code Generator software was also used. Each code was designed based on the different input and information for each room. After that, web-based application for FSPU's facility management was developed by using Adobe Dreamweaver programming codes and languages.

III. RESULTS AND ANALYSES

A. GIS Map and Database System of Building Facilities

Moving paper data to electronic databases has saved time and money for private and public entities across the world. This study has created GIS map and database to store digital information of the FSPU building facility. Fig. 3 shows several building plans that have been digitized using ArcGIS and this 2D result can help users with the information of rooms at each level and at the same time it serves as a guide for repair activities. Each room is labelled accordingly in order to help users find the room they need more easily.

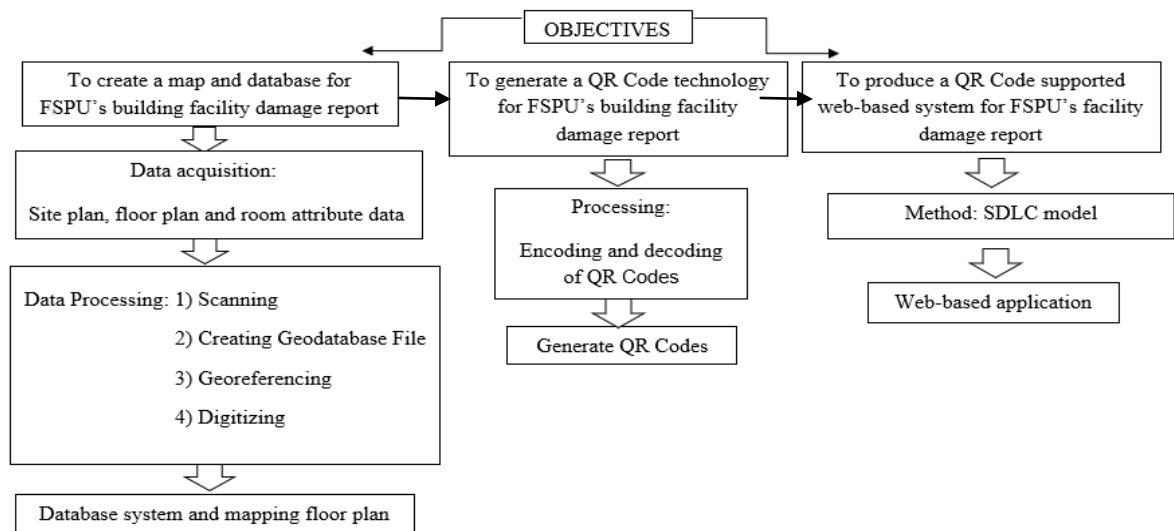


Fig.1. Flowchart of research methodology

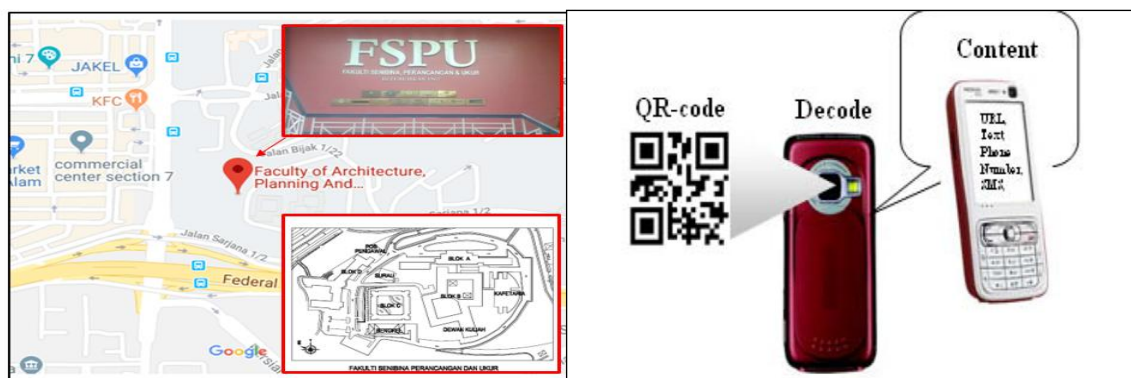


Fig. 2 Study area and tool used ([4] and map from Google map, 2018)

GIS databases are important because they are used to relate to each of the features enabling the system to complete complex analysis and queries. Maintenance of data is also completed on the databases in order to keep up with the demand of the data. The shift from paper-based database in this facility to the digital world is in line with the country's aim to be more efficient and sustainable and consequently, this will save time and money in the long run. Moreover, web-based applications and maps can shape the management of database in ways that have not yet been documented. This is a new phenomenon that relies heavily on the data behind the facility application.

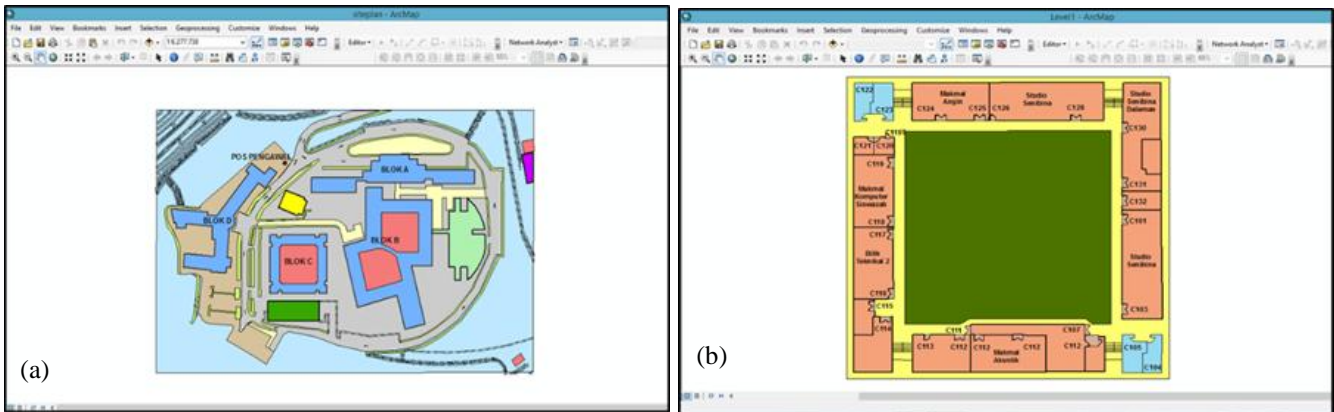


Fig. 3. GIS database of (a) FSPU floor site and (b) Floor plan

B. Application QR Codes Building Facilities

QR Code and Facilities Management, QR Code has high potential in benefitting the facilities management industries because this technology has the ability to store large information compared to barcode. Fig. 4 displays several QR codes that have been generated in the building facilities with information such as detailed damage features and information of the facilities in the space. This application will keep up-to-date maintenance record which can be accessed by the maintenance staff and the facility maintenance results can be keyed in directly through tablets or smart mobile phones.

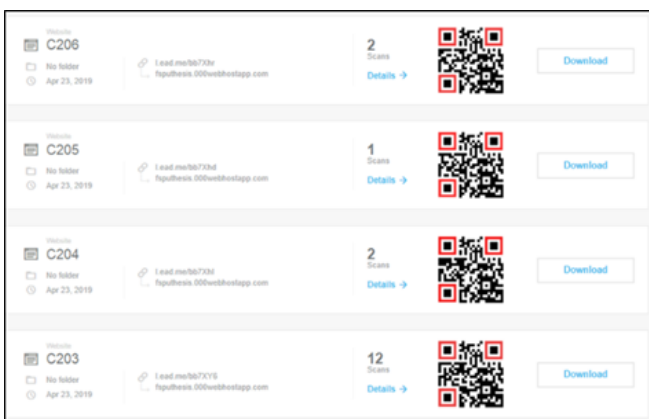


Fig. 4. Some of QR codes generated at FSPU rooms

C. QR Code Supported Web-based system of the Facility Space

This study develops the proposed system to manage the damage of the facility where technicians only need to scan the QR Code and the damage information will be instantly available. QR Codes are pasted on every room door and it requires scanning from the technician to access the information. QR Code technology is linked with this system. As a result, technicians can perform repair activities quickly without having to ask other staff for information about the damage. The system has several main menus for user application as shown in Fig. 5. The menu includes Home

page, Menu page, Plan menu and others. Home page for this system requires users, i.e. FSPU staff to log in. They are required to key in their staff ID in order to allow them to move to the next page of the system. After the “submit” button is pressed, the “Menu” page will appear. On this page, users can choose the website sections they need. The menu button consists of Plan, QR Code, Facility Information, Gallery and About FSPU. Navigation is an important part in system design because it can help users understand what the website is about without viewing all pages.

D. Users Feedback on the System Applications

The result was analysed to determine the effectiveness of this system. The reliability of this system among staff and technicians was identified by using an online survey application, surveymonkey.com. This application was used to draft the questions and distribute them to the respondents via URL link. Twenty (20) respondents were involved in the survey and they were FSPU staff and technicians.

Before the question was distributed, the web-based system as published first by using 000webhost application. The purpose of publishing this website first is to allow respondents to view and judge the system. A total of 10 questions were asked in the questionnaire, including "Do you think this website helps you to handle the damage of the facility?", "If you are a technician, does the QR code system shorten your time to search for damage information and to carry out repair activities? ", and “How would you rate this website?”



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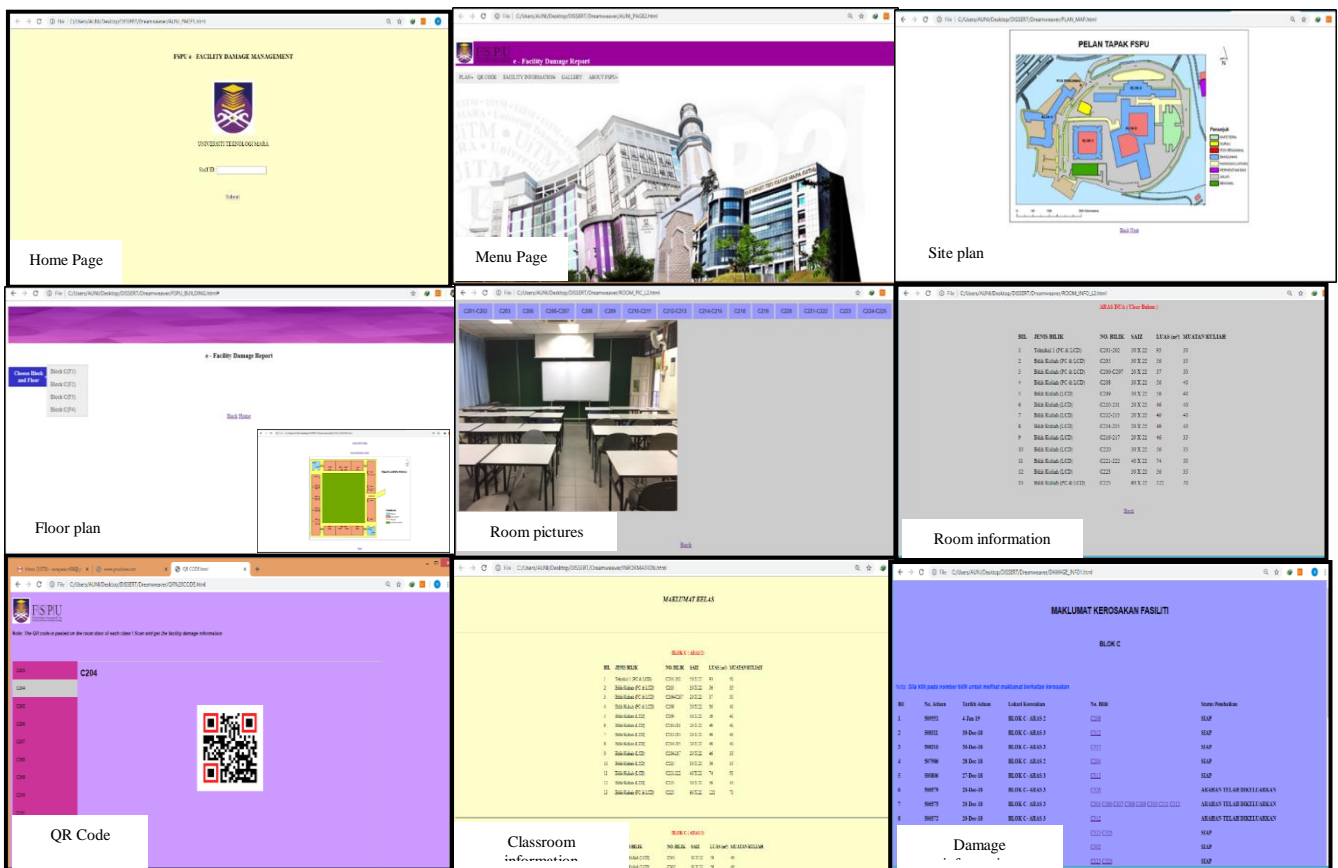


Fig. 5. Several main functions of the system

For the question “Do you think this website helps you to handle the damage of the facility?”, the 19 respondents responded yes while 1 respondent said no. Then, the next question on whether the QR code system shortens their time in searching for damage information and carrying out repair activities received positive response. So, it can be concluded that this web-based system helps staff and technicians in managing the facilities at FSPU building. Based on Fig. 6 below, the highest percentage is 65% that represents “very good” and the lowest percentage is 5% which indicates “poor”. It can be concluded that most respondents agree that this application has a good potential to be implemented in the faculty.

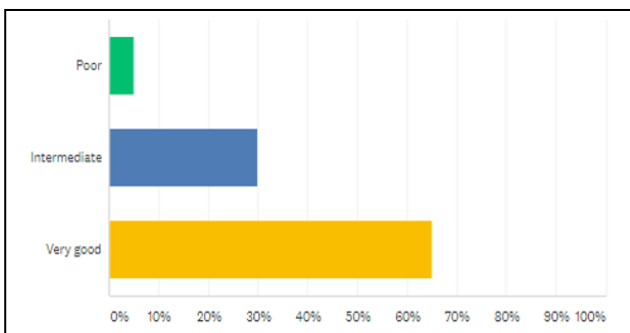


Fig. 6. Positive feedback on the proposed system from the respondents

E. Application of the System to Process the Damage Reports of the Facilities

In order to obtain the damage report, technicians need to scan the QR Code for each room. The information received once the technician scans the QR Code are the description of Building, level, space, complaint number, date of complaint and details of the damage/problem. The information is taken directly from e-Aduan system.

For example, in searching for the damage report for level 2 of block C, after scanning, the damage information for the affected room will be displayed immediately and technician can perform the maintenance activity and go to the location. The damage data will be updated by the facility manager and staff in order to facilitate the facility management system. Upon completion of repairs, the technician will inform the staff that he has successfully completed the task.

Then, the staff will update the system by changing the status of completion. Conversely, if the repairs have not been successfully completed, the technician will still notify the staff and the status being issued is the same as original status which is "instructions are issued".

Fig.7 demonstrates the flow of the application of the system to process the damage report in the facility. As stressed by [7], facilities management is the administration of the spaces and assets where it involves the building and its structures. Assets can be defined as room area, floor area, vertical penetrations as well as employee. Besides, a facility management system (FMS) includes material inputs such as the planning control and organization of infrastructure and maintenance and building for real estate.



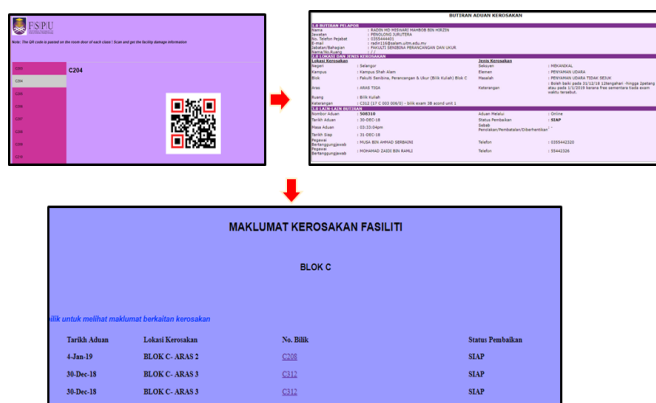


Fig. 7. Flow of damage report process

IV. CONCLUSION

A university building needs an efficient system to manage the facility's problems systematically. The facility management system of university buildings (such as FSPU) seem face a problem whereby technicians spend more time to identify equipment faults. The integration of the proposed GIS web system with QR Code technology allows easier data access compared to the existing manual method. This facility-based system will benefit the outsourced parties such as contractors and technicians where they can directly receive reports of damages. Previously, they received the damage information manually from the facility manager or staff and this requires more time and repair work cannot be done immediately. Thus, this system offers an alternative way to solve the problem. The development of GIS comprehensive SQL database, 3D-BIM [11]-[13], and augmented reality mobile apps [10] in the proposed system are also highly recommended in this study for further system application.

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REFERENCES

1. B. Costello, D. P. J. Weidman, C. Farnsworth "Quick Response Codes & Facility Management," 2012.
2. D. L. Denso, "GeoBrain- A Web Services based Geospatial Knowledge Building System," 2004.
3. Dong-Hee, Shin, J. Jaemin, and C.B. -Hee, "The psychology behind QR codes:User experience perspective," *Computers in Human Behavior.*, pp.1417–1426, 2012.
4. K.C.Liao and W.S. Lee, "A Novel User Authentication Scheme Based on QR-Code," *Journal of Network.*, vol. 5, no. 8, pp. 937-941, 2010.
5. L. Chuan and Chu, "Applying QR Code Technology to Facilitate Hospital Medical Equipment Repair Management," *International Conference on Control Engineering and Communication Technology.*, pp. 856-859, 2012.
6. K. Zainuddin, K., E. Mokhtar, and K. Yusof, K, "Developing a UiTM (Perlis) Web-Based of Building Space Management System: A Preliminary Study in Locating a Specified Space/Room Area Using Open Source GIS Tool." *Elsevier Ltd.*, vol. 20, pp. 154-158, 2011.
7. M. Motuka, "GIS in Facilities Management: A Case Study of the U-block at the Kenya Polytechnic University College," M. S thesis, University of Nairobi, 2008.

8. S. Al Shehri, and M. Al-Oqeely, M, "Building a Microcontroller Virtual Lab using Web-based and Mobile Agents Approaches," *Journal of King Saud University – Computer and Information Sciences*, vol. 14, pp. 39-60, 2002.
9. V.K. Bansal, and M. Pal, "GIS based projects information system for construction management" *Asian Journal of Civil Engineering (Building and Housing).*, vol. 7, no. 2, pp. 115-124, 2006.
10. Y. Wei Kao, G. Heng Luo, and H. Tang Lin, "Physical Access Control Based on QR Code." *International Conference on Cyber-Enabled Distributed Computing and Knowledge Discovery*, pp. 285-288, 2011.
11. C. Mirarchi, A. Pavan, F. De Marco, X. Wang and Y. Song, "Supporting Facility Management Processes through End-Users' Integration and Coordinated BIM-GIS Technologies" *ISPRS Int. J. Geo-Inf.*, vol. 7, no. 5, pp. 191, 2018.
12. E.M.Wetzel and W.L.Thabet, "The use of a BIM-based framework to support safe facility management processes" *Automation in Construction.*, vol. 60, pp. 12.24, 2015.
13. P. Pishdad-Bozorgi, X. Gao, C. Eastman and A.P Self, "Planning and developing facility management-enabled building information model (FM-enabled BIM)," *Automation in Construction.*, vol. 87, pp. 22-38, 2018.
14. A. R. Abdul Rasam, F. A. Hanif, A. M. Samad and R. A. Hadi. "Spatial information management system for building energy consumption," *2013 IEEE 3rd International Conference on System Engineering and Technology*, pp. 295-299, 2013.
15. A. R. Abdul Rasam, A. H. Azlin and N. M. Saraf. "Mobile Apps and Web GIS-Based Accessible Health and Social Care System for People with Disabilities," *2018 IEEE 8th International Conference on System Engineering and Technology (ICSET)* Bandung, 2018, pp. 85-90.

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