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Movement Permit & Tracking System (MPTS)

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***Abstract*-The Movement Permit System enables people to obtain permission to move during times of curfew and lockdowns. People can apply for move permits online using common devices such as mobile phones (smart phones that can access the internet), desktops, tablets, and or laptops. The permits are in form of encrypted codes that can be digitally verified using smart phones or manual data input. There are three major components of the system, namely; 1) Permission Request interface where those who want to travel can apply for move permits, specifying their destinations and reason for travel; 2) Permission Approval interface; which can be centralized or distributed to enable quick response; 3) Permission Check interface; where security officials can verify move permits using a variety of means: either by entering token access numbers, or by scanning QR codes printed or displayed on phones.**

Key words- Move permit; Tracking System; Curfew; Lock down; QR Codes

I. INTRODUCTION

Information Systems have world over changed the way people interact. A study by Gasson (2014) reveals that for an information system to be effective, it has to support a number of activities that at the end help people to achieve their organizational and individual objectives. With the threat of the Covid-19 pandemic and other possible epidemics to re-occur in future, it is important that there exists a system that controls and monitors the movement of people, goods and animals.

In the reality of lockdowns and curfews, there can yet be genuinely critical circumstances where existing channels of obtaining permission to move are too cumbersome, leading to disastrous consequences such as loss of lives when permission to take critically sick people to hospital is inaccessible. Lippi *et al.*, (2020) adds that abrupt interruption of physical exercise and prolonged inactivity are some of the leading causes of health challenges such as high blood pressure, fatty liver disease and consequently higher risk of collapsing upon resuming exercise. It should also be noted that even where people get the permission to move, it is crucial that there exists a system to facilitate the tracking of their movement so that in case they contract a virus, at least most of the places they have been to can be traced. Brandon *et al.*, (2020) cautions that direct contact with Covid-19 patients is very dangerous and authorities should put in place very restrictive measures to alleviate the spread of the virus.

The current system for requesting and getting move permits from Resident District Commissioners (RDCs) is too cumbersome for most citizens. The arrangement is limited to non-urgent cases, given the poor work culture of district officers who are required to be on the alert 24 hours a day. There has been cited congestion at the offices of the different Resident District Commissioners (RDCs) which in turn increases the chances of the spreading the deadly virus. Liu *et al.*, (2020) cautions that crowding is one of the leading conditions for the spread of the virus and hence calls for remote human services to reduce human-to-human infections.

Additionally, the RDCs get overwhelmed by the number of movement permit requests via phone calls. There is a need to come up with a system which de-congest the working areas

International Journal of Engineering Research & Technology (IJERT)
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Vol. 10 Issue 01, January-2021

of RDC as much as possible, at the same time giving prompt services to the citizens in need.

The Government of Uganda through the Ministry of Transport and Works made a provision for vehicle owners to obtain COVID-19 stickers to allow their movement. However, this arrangement is prone to many loopholes. According to Golooba (2020) there were frequent arrests of individuals who had forged movement stickers meant for essential services providers. Another case was witnessed by Yiga (2020) who also narrates a couple of other arrests made by police due to forgery of movement stickers. A number of other stories abound in newspapers, the internet and social media about frequent police arrests of fraudsters who provide fake stickers. Other very common stories are about the police netting drivers who fraudulently obtain movement stickers through their relatives and friends. Besides, the stickers tend to have no time limits, and they embed no restrictions on which places the person is allowed to move to. With the Move Permit System, all these problems are pre-empted or highly mitigated. Manual processes of obtaining the move permits are eliminated. Time limits and places to go can be controlled.

Another very serious problem is that with lockdowns citizens may become too desperate and start resisting the restrictions with increasing vigor. An example has been cited in Italy and Naples where locals took to the streets to protest stringent lockdown and curfew guidelines (Darren, 2020). The main objective of this study was to develop a movement permit and tracking system that would enable people access the move permits more easily. We acknowledge the government of Uganda and Makerere University through Research and Innovation Fund (RIF) that financed the activities of this project from inception to its logical conclusion.

II. RELATED WORKS

i) Regional Electronic Cargo Tracking System

Uganda Revenue Authority (URA) uses a system known as Regional Electronic Cargo Tracking System (RECTS). RECTS uses Geographical Positioning System (GPS) to trace the movement of trucks from their point of entry into the country right up to the point of exit to curb cargo dumping among many other risks along trade routes. It comprises of satellites, central command centers in each of the revenue authorities in Nairobi, Kampala and Kigali, smart gates and rapid response units. Cargo vehicles in transit are fitted with an electronic seal which in turn keeps communicating with the command centers providing real time updates relating to the cargo. Such updates include the location of the vehicle, movement speed and the state of the container (tampered with or not). A number of individuals called rapid response teams are stationed at different places to respond to system alerts in case the cargo details are violated for example cargo diversion, long stop over, container opening among others (Kiwanuka, 2020). It can be noted that RECTS is only limited to tracking cargo, leaving out people who need to be sanctioned in times of lockdowns and curfews

ii) Dubai Move Permit System

The Government of the United Arab Emirates implemented a web-based system that helps authorities in Dubai city to issue movement permits amid the coronavirus pandemic. The System can receive as many as 1,200 requests per minute. With this implementation, the system continuously updates people's movements to know if the person has violated the movement order. According to Debusmann (2020) residents of Dubai use this system to apply and get a movement permit to exit their homes to buy groceries or visit pharmacies only once in three days. He adds that people applying for the permit in order to withdraw cash from an ATM can obtain the permit once in five days. Debusmann (2020) also notes that members of the general public residing in the United Arab Emirates, excluding employees of vital sectors, must apply online for movement permits before leaving their homes during the sterilization programme.

iii) The Government of Botswana developed and implemented a move permit system to ease application and approval of move permits in light of COVID-19 pandemic (Government of Botswana, 2020). The system enables application and renewal of permits for inter-zonal movement, special and essential services workers and both individuals and businesses/companies. The online application portal enables individuals to apply for or renew their permits once in a day.

iv) Manav & Anupam (2012) in their paper titled 'Implementation of Location based Services in Android using GPS and Web Services' designed and developed an application based on Android that can be used to find nearest address and calculate distance between user location to another address. It can be observed that this application is limited to simply finding addresses and has no control as to who moves to which address or location.

v) Radhika et al., (2012) designed and developed an Android based application that shows the optimal route between two different locations. The application prompts a user to input two different location addresses and then the application calculates the most optimal route. Like the case with the other applications, it can be noted that in this application, the people factor is not addressed.

vi) Mahesh & Guruprasad (2014) designed and developed an android application that can help a user locate the position of a friend or a family member who is nearby. The application works handy with an SMS alert mechanism that sends a popup message to the user when his friends or family member is nearby. The received text messages can be shared with other online users if the initial user wishes so. The limitation with this application is its small scope of coverage in both the geographical coverage and the number of users involved. Works more with having fun than a regulatory tool

vii) Mia Md. Karimul *et al.*, (2017) developed a Mobile Tracking System using Web Application and Android Apps. This application helps parents locate their children and monitor their activities hence securing their safety

III. METHODOLOGY

The design and development of MPTS followed a prototype development approach. The first phase of the project was to develop prototypes for testing the MPTS system. This was done and the prototypes can be accessed here; https://movepermit.info/mps to request for a movement permit. Hypothetical move permits were automatically generated and were valid for a limited time. To verify the

International Journal of Engineering Research & Technology (IJERT)
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Vol. 10 Issue 01, January-2021

permits, an android application with functionality of scanning QR codes and entering permit access tokens was developed. This was packaged in a simple apk which can be downloaded and installed on android devices.

The second phase of the project was on the practical implementation of the system as improvements were being made to the application in consideration of feedback from the tests. As the technical part of the system was being developed and tested, there was a team working on the implementation issues by engaging high level key decision makers, including government officials like Uganda Police, Resident District Commissioners (RDCs) and key private sector actors. This was part of the roll out strategy to ensure smooth implementation of the system.

To facilitate the adoption of the system for various purposes by various institutions, a Movement Permit System API Specification was availed to facilitate integration with other systems. A link to the API specification is also provided on the above web page.

IV. OVERVIEW OF THE MPTS SYSTEM

The Movement Permit and Tracking System is made up of three main modules namely; *1) Permission Request interface* where those who want to travel can apply for move permits, specifying their destinations and reason for travel; *2) Permission Approval interface;* which can be centralized or distributed to enable quick response; *3) Permission Check interface;* where security officials can verify move permits by scanning QR codes printed or displayed on phones, or by manually entering move permit access tokens where other quicker methods are not working. As people move, their movement will be registered and recorded by a GPS service. At the check points, the traffic officials will be able to scan the QR code to verify the movement permit. With GPS tracking, potential corruption at checkpoints will be checked.

V. TECHNOLOGY BACKGROUND

GPS: The Global Positioning System (GPS) is a utility that provides users with positioning, navigation, and timing services that transmits one-way signals that give the current GPS satellite position and time.

Android: Android is a mobile operating system which offers a unified approach to application development. According to Mahesh & Guruprasad (2014), developers need to develop applications using Android and these applications should run on numerous devices as long as the devices are powered using Android. In this project, Google Maps, PHP, My SQL, HTML, JavaScript are used.

The system also makes use of modern advanced technologies such as Internet, QR-code encryption, GPS tracking, and intelligent systems such as optical card reading and Automatic Number Plate Recognition (ANPR) for vehicles with mobile devices, Google machine learning ML Kit for image processing, computer vision for mobile phones, and applied natural language processing algorithms to extract data from personal identification documents.

VI. SYSTEM ARCHITECTURE

The architecture of the MPTS is divided into two diagrams that is the concept diagram and the block diagram.

i) Concept Diagram

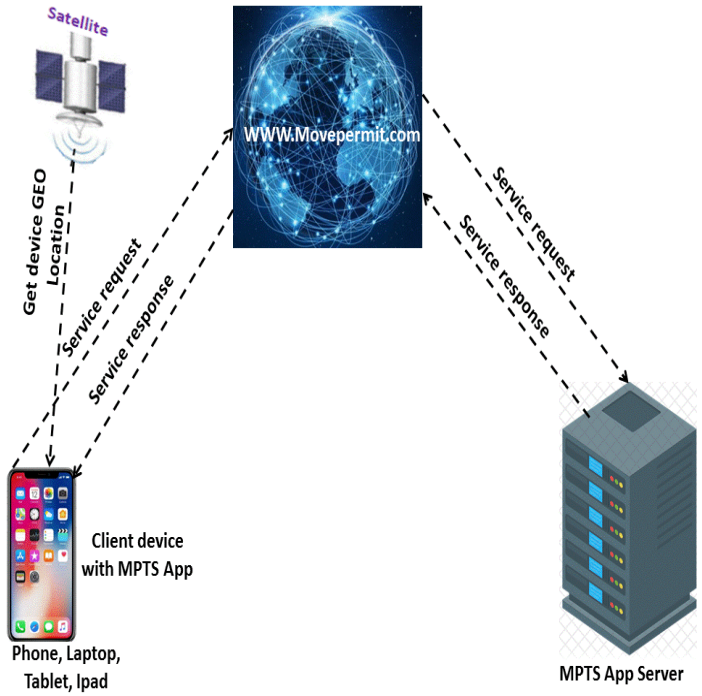


Fig 1: Conceptual Diagram of the MPTS System

ii) Block diagram

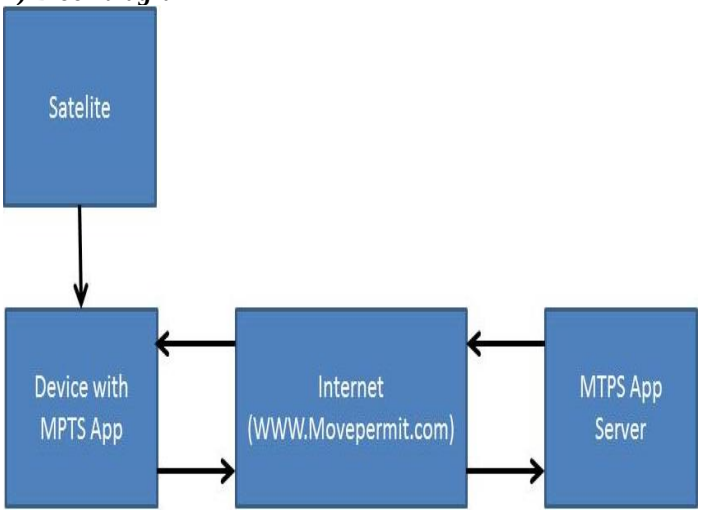


Fig 2: Block Diagram of Mobile Tracking System

The mobile device receives the GPS location signal from satellite. After receiving the signal, the device stores the location in the MPTS web server database.

VI. IMPLEMENTATION OF THE SYSTEM

The Movement Permit and Tracking System was implemented with three main modules namely; *Permission Request interface, Permission Approval interface and the Permission Check interface*. The flow chart below presents a summary of how the Movement Permit and Tracking System works.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

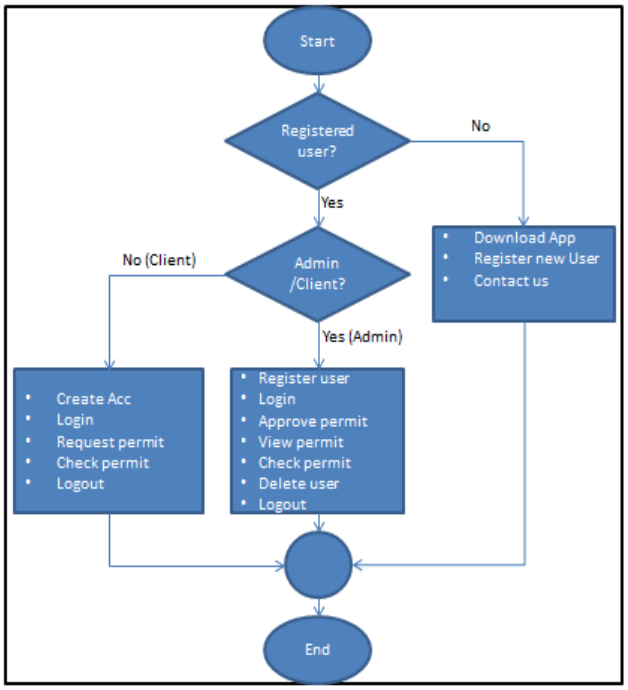


Fig 3: Flowchart of MPTS System

From the Flow chart above, the system interacts with both a registered and an unregistered user. For registered users, they can either be Administrators (Authorities) on the system or just clients (permit applicants). These can execute different roles as per the illustration. Unregistered users on the other hand can as well enroll to use the MPTS.

The different user Interfaces are presented as follows;

i) Home screen interface

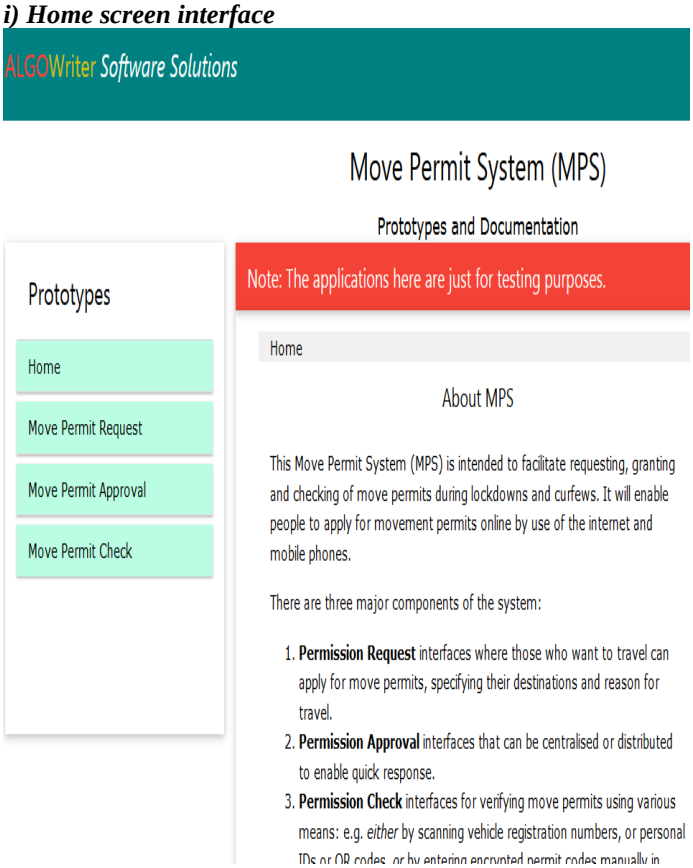


Fig 4: Home screen of the MPTS System

On the home screen, the user can either request for a permit or check the permit. When move permit request is selected, a permit request form, shown in figure 5 is presented to the user.

ii) Permit request Interface

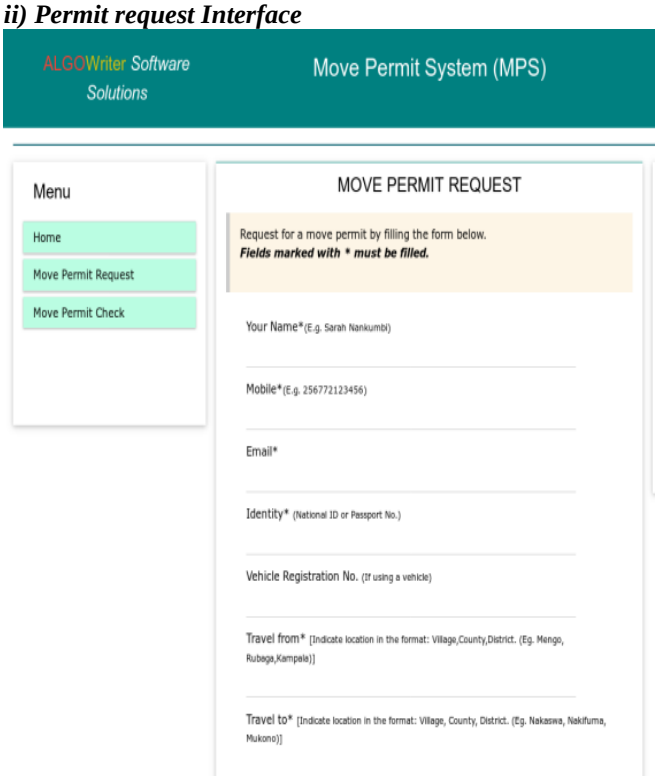


Fig 5: *Permit request Interface*

On this interface, the user (movement permit applicant) fills in a permit request form providing details such as the name, email address, national identification number (NIN), vehicle registration number, places they want to go to and the reason for travel. The completed form is submitted for approval.

iii) Permit check Interface

The permit check interface prompts the user to check the status of a permit by using the permit access token. Permit check interface is shown in the figure 6 below

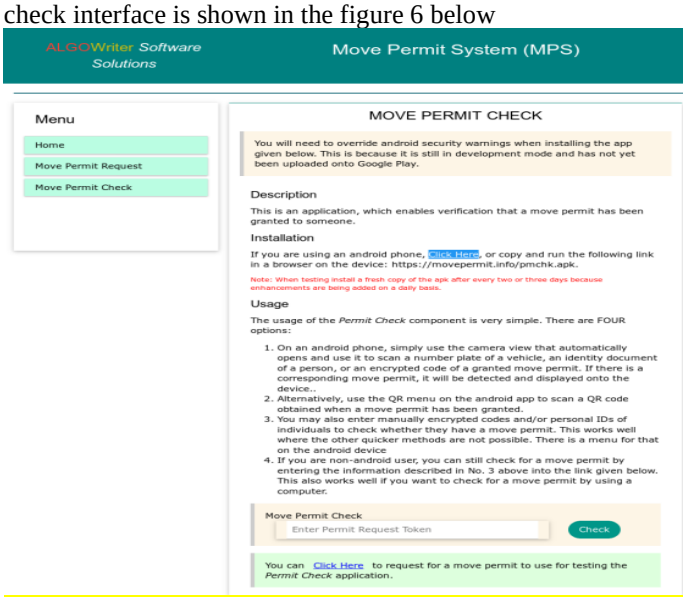


Fig 6: Permit check interface

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

If the token is valid, the permit details including the person it was issued to, the validity of the token, person who issued it, etc are displayed.

iv) Permit approval Login Interface

The authorizing personnel can approve the permit request or reject by first of all logging into the system. The login page is shown in Figure 7.

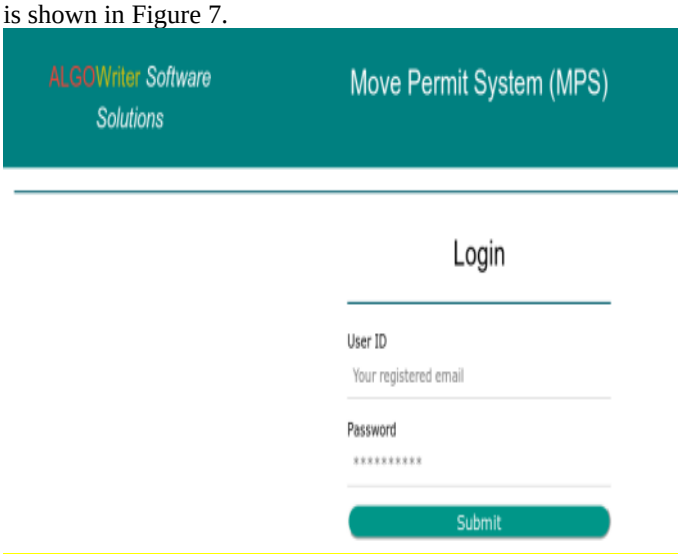


Fig 7: *Permit approval login page*

Once logged in, pending permit requests are displayed and the authority selects the permit to approve. As shown in figure 8

v) Permit approval Interface

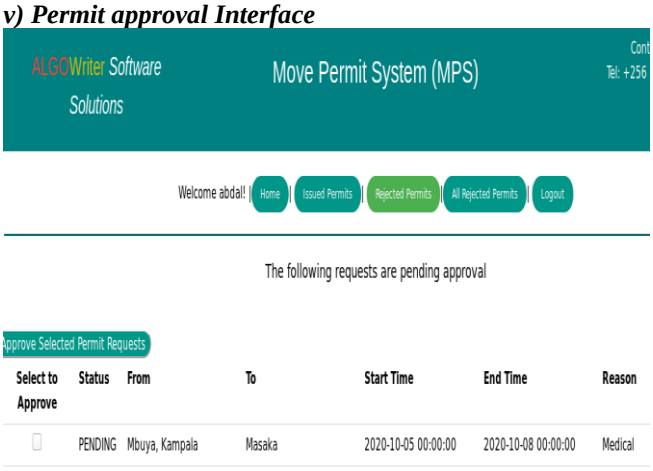


Fig 8: *Approvals interface page*

When a permit is selected for approval, the permit request details are displayed, as shown in figure 9.

vi) QR Code of the approved permit

Basing on the information in the permit, the authority decides to approve or reject the permit and gives a reason why such a decision has been made. Whether approved or rejected, the permit applicant is notified by email or sms. For approved permits, the permit applicant gets a permit access token and a QR Code, with details of the move permit. Figure 9 is a sample QR code.

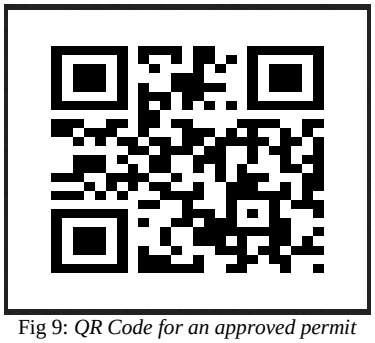


Fig 9: *QR Code for an approved permit*

The applicant can either decide to print out their QR encrypted permit or present it as a soft copy. Another option is to use the token that is also sent to the applicant email which can be entered by the verification authority to check the validity of the permit. In an extreme case if the user doesn't have an email or a smart phone, an arrangement for sending a short message token is available using the USSD option. This option caters for users with feature phones for total inclusion purposes

vii) Approved permit

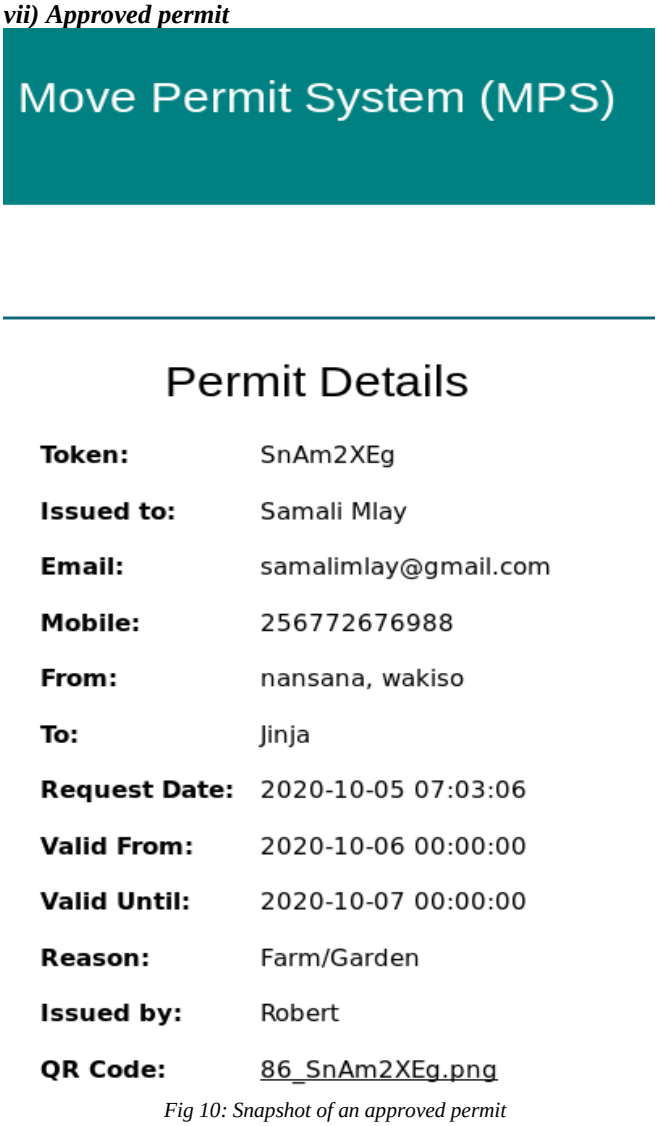
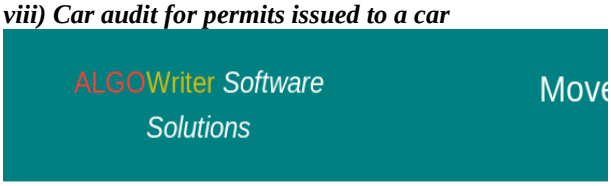


Fig 10: Snapshot of an approved permit

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

The Interface above shows a screenshot of the details of an approved permit. It is accompanied by both a QR code link and a token both of which give the permit details. The corresponding QR code for the above permit is presented in fig: 9

viii) Car audit for permits issued to a car



Enter Vehicle No.

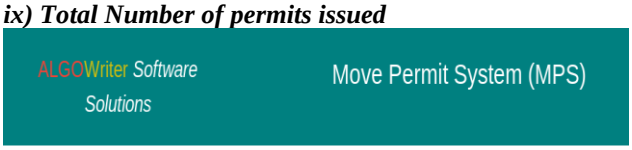
THE TOTAL NUMBER OF PERMITS ISSUED TO THIS VEHICLE IS: 3

Issued to	Mobile	Status	Issued by	Permit Details
Abdal Kasule	772640578	APPROVED	admin	FTU3h0Yy
kasule	78965345	Approved	Samali	0zMXfSqx
abdal	6789065	APPROVED	Robert	izSyhHGY

Fig 11: Audit of permits issued to a car

For control reasons, authorities can be able to extract information regarding the number of permits issued to a particular car as shown in the figure above

ix) Total Number of permits issued



THE TOTAL NUMBER OF PERMITS ISSUED IS: 50

Issued to	Mobile	Status	Issued by	Permit Details
Samali Mlay	256772676988	APPROVED	Robert	SnAm2XEg
Musiime Andrew	256781851424	APPROVED	admin	4L92TbUR
musa moya	256773123456	APPROVED	admin	oxTAG9tv
Male Kayongo	256777123456	APPROVED	admin	3SoenYia
JOYCE ADIKINI	256706784315	APPROVED	admin	onmJCLTy
Adikini	256706784314	APPROVED	admin	JStsLgK
JOYCE ADIKINI	256706784313	APPROVED	admin	grNPvUc8

Fig 12: Total number of permits issued

From the above interface, it's possible for higher authorities to extract and know the total number of permits issued by a particular official. This could be for monitoring and evaluation reasons

x) Mobile verification Interface

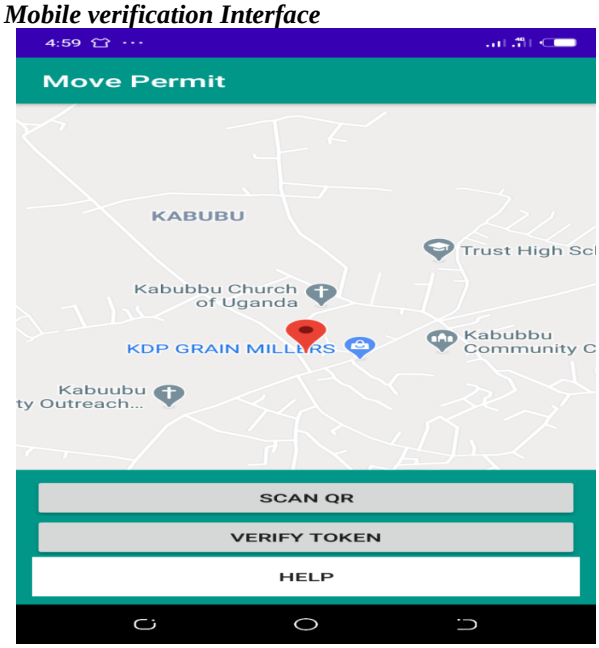


Fig 13: Permit verification interface

Using this interface, front end authorities manning roadblocks can easily check the permits using smart phones. This is done by scanning the QR code presented by the traveler and then the system verifies if the applicant is valid by cross checking in the MPTS database and return details to the authority. The system also enables auto tracking of the movements at locations where the permits are checked.

VII. ADVANTAGES OF THE MPTS SYSTEM

The key benefits of the system are summarized as follows:

- Ease of requesting for movement permits from any location using mobile devices.
- Ease of granting permits through an electronic dashboard.
- Ease and very low cost of verifying the permits by use of smart phones rather than complex radar or camera surveillance systems.
- Ease of GPS monitoring and tracking locations to which people with permits move.
- Ease of controlling the duration and location of permits granted.
- Ease of scalability and adaptation of the system to other applications such as monitoring animal permit movements, verifying number plates of vehicles registered by ministry of transport, parking lot and anti-car theft management etc.
- High flexibility to adapt the system to very many other applications.

VIII. LIMITATIONS OF MPTS SYSTEM

- GPS connection may be a challenge in enclosed places like buildings.
- The application requires Internet connection to send and receive data.
- If too many users are accessing the web at the same time, the app may be slower.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 10 Issue 01, January-2021

- We had hoped to develop the system to be used in feature phones as well (*Kabiriti*) but we met a challenge of acquiring a USSD code due to the high costs.

IX. CONCLUSION

This Movement Permit and Tracking System has been designed, developed and is functional. It is very efficient; a user can easily use this application. Anyone can apply for a movement permit and authorities can go through the application details and decide either to approve and issue a movement permit or reject the application. The application is freely available on Google play store and does not need any extra devices. We have tested the different modules of the application on a number of Android devices and different browsers, experimented it with a number of users and it works properly. We hope users will reap big using our application.

X. RECOMMENDATION AND FUTURE WORK

- To work with Telecom companies to enable requests and receipts of the movement permits by use of USSD codes in order to make it easier for all kinds of mobile phone users to access the system.
- To try out the system on a wider range.
- To implement the system in a variety of other local Ugandan languages.

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