Original Article

Implementation of a Travel and Mobility Management System for Local Disease Outbreak Control and Mitigation

Ma. Beth S. Concepcion[1], Regin A. Cabacas[2], Rowen R. Gelonga[3], John Christian D. Albances[4], Garry T. Balinon[5], Ryan Vilmor J. Dumpit[6]

[1]Associate Professor, West Visayas State University, Iloilo City, Philippines
[2]Assistant Professor, West Visayas State University, Iloilo City, Philippines
[3]Regional Director, Department of Science and Technology VI, Iloilo City, Philippines
[4]Computer Programmer, Department of Science and Technology VI, Iloilo City, Philippines
[5]Unit Head - MIS, Department of Science and Technology VI, Iloilo City, Philippines
[6]Unit Head - DRRMU, Department of Science and Technology VI, Iloilo City, Philippines

mbconcepcion@wvsu.edu.ph[1], rcabacas@wvsu.edu.ph[2], rowen.gelonga@ro6.dost.gov.ph[3]

Abstract - *What enabled the widespread transmission of Covid-19 in most affected countries that brought about the current pandemic is the loose border control and travel restrictions. Several countries have at least mitigated the onset of transmission with the utilization of application that tracks the arrival and mobility of travellers. As the first line in defence for a local community outbreak, this study proposes a travel and mobility management system that aims to ease the application and coordination of travellers with local government units (LGUs). The proposed work implements a mobile application for travellers and a web-based dashboard for local government units and other important entities. The study is envisioned as a complementary tool in local disease outbreak control and mitigation utilizing the traveller's mobility history (entry and exit points) that can become the basis to easily identify and trace possible close contacts of positive cases.*

Keywords — *Travel management system, Mobility management system, Disease outbreak applications, Local outbreak mitigation.*

I. INTRODUCTION

The Covid-19 virus has expanded to multiple countries due to unrestricted human movements that have eventually led to local outbreaks and the current pandemic. According to Xue et al. [1] and Aleta et al. [2], travel restrictions and intervening actions, if imposed properly at the early stages of the Covid-19 outbreak, might have mitigated the transmission of Covid-19. South Korea and Singapore have been successful in controlling the outbreak and have been at the forefront of utilizing application-based travel management and contact tracing applications. As reported by Business Insider [3], South Korea uses a mandatory government-run smartphone application wherein new arrivals (especially as cases have been identified to be from overseas) must download that to keep track of their location and ask them to report any symptoms. The rapid identification and isolation of cases, quarantine of close contacts, and active monitoring of other contacts have been effective strategies in suppressing the expansion of the outbreak and have implications for several countries experiencing an outbreak, like the case of Singapore [4]. Proof to that, Mueller and Koopman [5] have studied the effect of delay on contact tracing and concluded that if the tracing delay is distinctively shorter than the latency period (infectious period), effort in the detection of more contacts or index cases put in place is adequate in preventing further transmissions and mitigating the outbreaks. This has put the utilization of application-based mobility management applications a helpful tool in mitigating or controlling local outbreaks, especially when adopted by local government units (LGUs).

With the Covid-19 pandemic and the fast-increasing number of local transmission cases, travel for tourism or leisure and non-essential activities have been restricted in most countries around the world. In the Philippines, travel for delivery of essential goods, performing important work functions, and returning to one's home place, which is considered essential travels, has been allowed and acquiring travel permissions have become relatively difficult. Securing travel passes, authority to travel or certification to travel from an assigned agency (e.g. PNP, LGU offices) entails a laborious process of preparing multiple documents and filing them in person, which increases the risk of exposure to the virus and eventually transmission. Furthermore, the poor coordination miscommunication among agencies (LGU

origin and destination of travellers) caused by the manual (existing) process has also become upsetting, especially for Returning Overseas Filipinos (ROFs) whose vacation time is in the country has been consumed in quarantine facilities or hotels.

The implementation of the Mobility and Travel Management System anticipates to lessen the difficulty of application for travel passes, potentially avoid, or reduce the miscommunication and difficulty of coordination among agencies and LGUs as well as reduce (or avoid) the risk of exposure and transmission to the deadly virus. The Travel and Mobility Management System (TMMS) includes a mobile application where travellers (users) can register and apply for a Travel Coordination Permit (TCP) for areas with restricted travels or generate a Travel Pass-Through (TPP) for areas with no restriction. The application and generation of TCP and TPP, respectively, becomes the coordination process of the traveller to the LGU. The LGU, in return, will have the monitoring capability of travelling individuals since TCP needs their approval or TPP generation is recorded in the system. Moreover, the TMMS also includes a mobile scanning application that is used to scan the traveller's TCP or TPP upon arrival at the designated entry point. The TCP and TPP are embedded with QR-code (Quick Response code), which will identify the traveller's validity to travel and record the travel history or mobility.

The remainder of this paper is structured as follows; section 2 describes the background and related studies of the proposed work, including the current travel processes in the Philippines, the role of local government units and similar applications. Section 3 discusses the proposed work the components of the travel and mobility management system, and section 4 presents the concluding remarks of this work.

II. BACKGROUND AND RELATED STUDIES

A. Philippines Current Travel Procedures

The Philippines, in the early stages of the pandemic, has imposed travel bans and restrictions but has provided exceptions for essential travels such as the delivery of essential goods, frontline workers, and returning or repatriated OFWs considered as authorized persons outside their residences (APORs) [6]. Though these persons can travel, travel passes and authorizations are needed upon travelling, and the existing process has been troublesome because of the documentary requirements and the manual process as a whole [7]. Furthermore, LGUs tend to have different requirements and processes, which makes it also difficult when travelling to multiple restricted places before arriving at the intended destination. Varying processing and approval time of these travel certifications also varies among LGUs, some may only take an hour or less, but some take days due to the bulk of application or too rigid process. Considering the problems encountered with the travel

requirements, on February 26, 2021, the Inter-Agency Task Force (IATF) has approved a uniform travel protocol for all LGUs through Resolution No. 101[8].

B. The role of Government during Disease Outbreak

Based on its government response strategy and the number of death tolls caused by Covid-19, an article in [9] has recognized the efforts of Taiwan, New Zealand, Iceland, Singapore, and Vietnam as countries that have handled the pandemic well. The timely preparation, science-informed decision-making strategies, and optimal use of technology are among the several factors that these countries have been lauded for their Covid-19 response. These countries' sound decisions and correct policies with stricter implementation are evidence of the government's important role in the mitigation of transmission during disease outbreaks.

Vallejo and Ong [10] narrated the Philippine government responses to the Covid-19 and pointed out key points on several policy decisions such as the declaration of the state of emergency, social amelioration measures, and scientific-based informed decision making. With the use of the modelling technique, the Authors in [11] have identified and evaluated key protocols placed by the Philippine government and emphasized the importance of policy, and decision-makers should invest in providing resources and ensuring correct implementation of these policies. One of the highlighted decisions that could have been a life-saver to those who have perished because of the deadly virus is the travel restriction. As evident in the works of Tiwari et al. [12] and Ozbilen et al. [13], which verify and analyze the risk of exposure of an individual travelling during the current pandemic, some of the findings suggest that the pandemic risk of the outbreak could have been potentially detected at an early stage if travel restrictions have been strengthened and community outbreaks must have been addressed with local public health measures.

C. Travel and Mobility Management Applications

The implementation of appropriate technologies before and during a disease outbreak potentially helps manage the risk and hazardous effects as well as minimize crisis damage. Surveys in [14] and [15] identified multiple technologies that have been helpful in the current pandemic. Among the identified technologies, the utilization of mobile phone applications is highlighted. Most mentioned and available in the literature are the self-screening and contact tracing applications with varying methods and techniques of implementation. In addition, works in [16], [17] and [18] comprehensively provide a survey on several contact tracing applications, their advantages and disadvantages, issues, and challenges in implementation.

During the pandemic, the travel restrictions in several countries introduced difficulty in local and international travel. Several countries like Canada utilizes application for electronic travel authorization [19]. Similarly, Singapore

agrees to utilize travel passes issued through the IATA Travel Pass application [20]. Initiatives like these are not only helpful with expediting the travel requirement submission and verification process but also ensure the safety of travellers. Moreover, these applications are most likely an implicit way of contact tracing.

Searching Google Play Store with the keywords "travel authorization", "travel management", "mobility management" gives you multiple mobile applications used in various countries. Most of these applications have common functionalities, including updated information in border restriction, documentary requirements, application, and status of the application. In the local scene, there have been few implementations of mobile applications for travel authorizations applications or mobility management.

III. TRAVEL AND MOBILITY MANAGEMENT SYSTEM IMPLEMENTATION

The implementation of the Mobility and Travel Management System anticipates lessening the difficulty of application for travel requirements (documents and processes), potentially avoiding or reducing the miscommunication and difficulty of coordination among agencies and LGUs, and reducing (or avoiding) the risk of exposure and transmission to the deadly virus. This work proposes the implementation and adoption of a Mobility and Travel Management System in Local Government Units (LGU) and identifies essential travel entry points (airports, seaports, terminals, etc.) in the Philippines. Fig. 1 shows the general system overview of the proposed work, and the components and functionalities are described further in the succeeding subsections.

A. Components

The Travel and Mobility Management System (TMMS) includes a mobile application that travellers (users) can utilize to register and apply for a Travel Coordination Permit (TPP) for areas with restricted travel protocols or generate a Travel Pass-Through (TPP) for areas with unrestricted travel policy. The application and generation of TCP and TPP, respectively, becomes the coordination process of the traveller to the LGU. The LGU, in return, will have the monitoring capability of travelling individuals since TCP needs their approval or TPP generation is recorded in the system.

a) Mobile and Web Application

To reach a wide number of users with the ability to access the travel and mobility management application, this study implemented both a web-based and mobile application for travellers. Shown in Fig. 2 is the user dashboard of the web-based version and the mobile version screen interfaces in Fig. 3 to 6. Both the web-based and mobile applications have the same set of functionalities which includes the following:
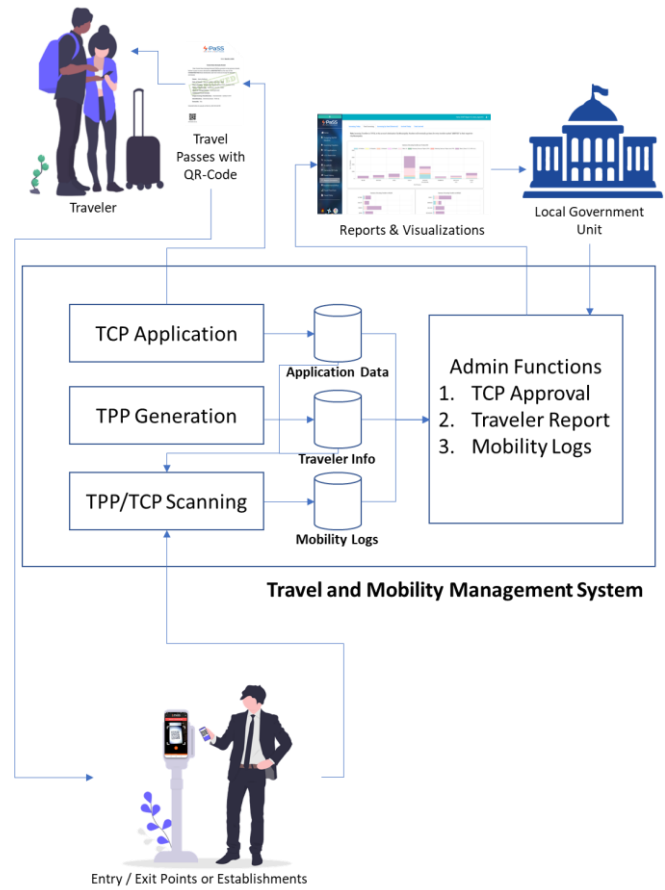

Fig. 1 System architecture of the proposed travel and mobility management system
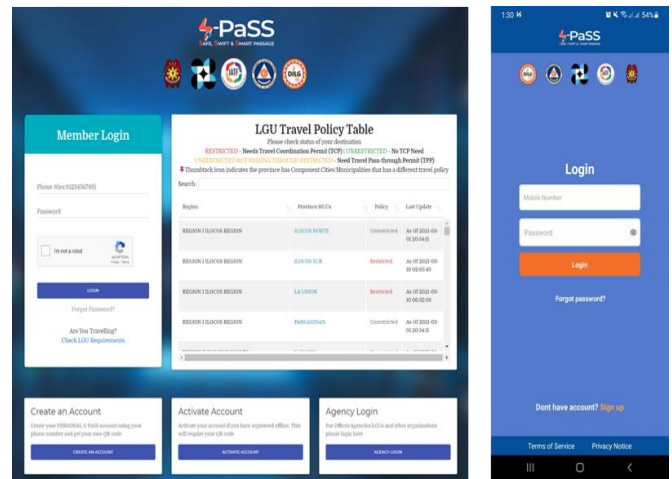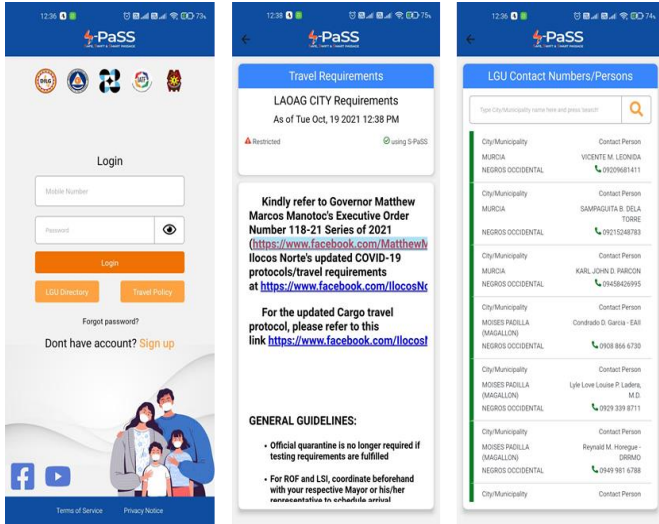

Fig. 2 Web-based application landing page for travellers showing the LGU travel policy and different types of accounts for different user roles

Fig. 3 Mobile application pages for travellers, (left) landing screen with login and enabling LGU travel policies (centre) and list of LGU directory (right) for outright communication

1) Traveller Registration

The application allows users to register using their mobile number as the username or ID. Each traveller application needs to indicate the type of traveller as stipulated in the IATF Guidelines. This is to keep track that only specific types of travellers (e.g. APORS, OFWs) are allowed in areas that are restricted. Upon completion of registration, the user will be given a Quick-Response (QR) code (shown in Fig. 4) which becomes the unique identification of the traveller in the system. It is important to note that this QR code is different from the travel permits that the LGU will issue to the traveller upon application.
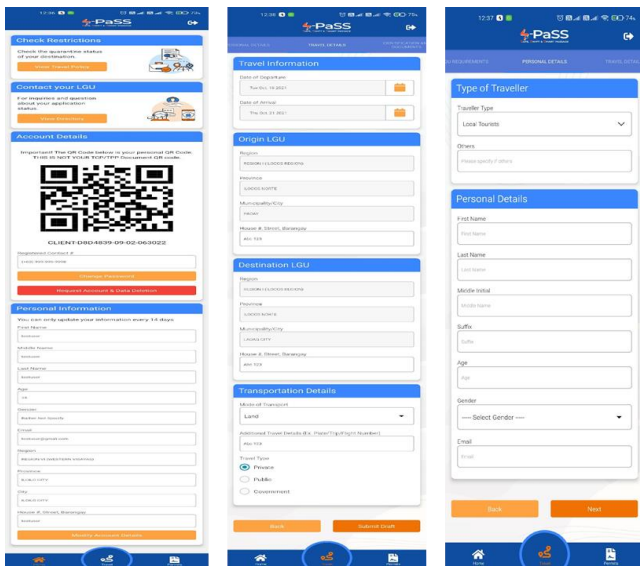
Fig. 4 Mobile application dashboards for travellers, (left) generated user Quick Response (QR) Code, (centre) travel information details form, (right) traveller information form

2) Travel Application

For every travel activity (region to region, province to province and selected city to city), the traveller needs to secure a travel permit, and the system has two (2) different permits based on the guidelines set by IATF, namely; Travel Coordination Permit (TCP) and Travel Pass-Through-Permit (TPP). A TPP is needed for areas that have unrestricted travel status, and the TCP is for areas that have restricted travel status. A series of questions and requirements are asked from the traveller upon the application of either permit, as shown in Fig. 5. In the traditional process, travellers will have to submit the documents, secure and accomplish forms and queue in line at the LGU offices, which poses a greater risk of exposure and transmission of the virus.

3) Travel Permit Issuance

Every permit application of the traveller is then routed to the respective entry point LGU for verification, validation, and approval. Since the application and the approval happen in near real-time, this speeds up the process. LGU will be able to monitor the number of arrivals based on the application and can already coordinate with the appropriate entities if special cases are needed (i.e. ambulance, LGU services, etc.). All travel permits approved and declined are saved in the traveller's profile, as shown in Fig. 6. As mentioned, each travel permit has a unique QR code generated that needs to be scanned upon the arrival of the traveller in the intended location.
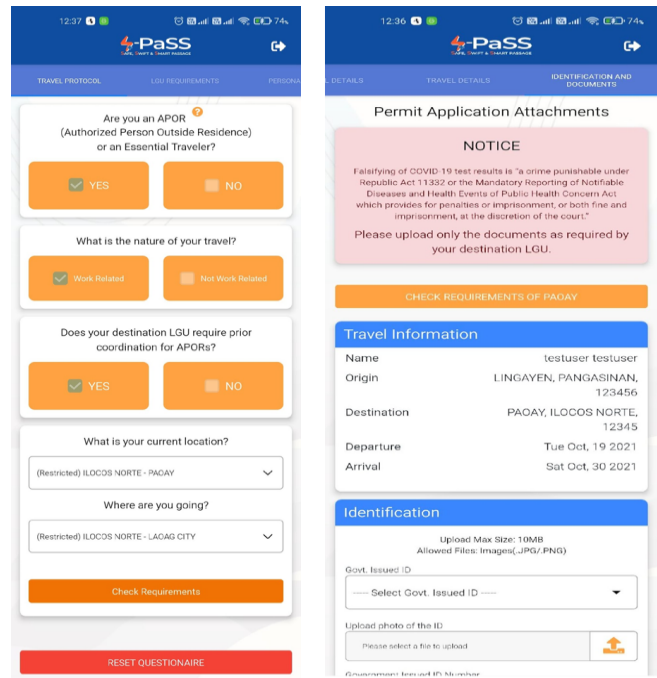
Fig. 5 Mobile application interfaces for travel permit application, (left) questions for verification as required by the guidelines set by IATF and (right) list of attachments needed for the application of travel permits
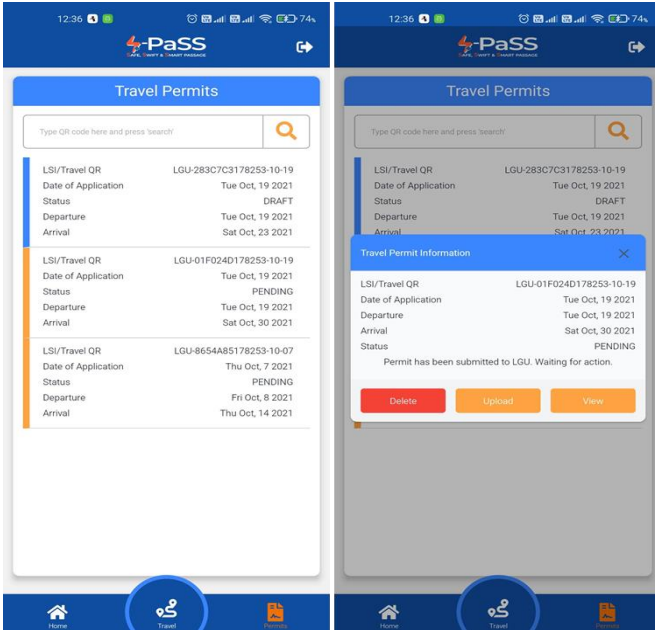
Fig. 6 Mobile application interfaces of the applied travel permits (left) showing their status and (right) function for users to delete, upload, view permits issued by the LGU

B. Travel Entry Scanning Application

At the exit and entry points (airports, sea terminals, border points, etc.) of the travellers, a scanning function also in the form of a mobile application is also available. As mentioned, the TCP and TPP is embedded with QR-code (Quick Response code), which will identify the traveller's validity to travel and record the travel history or mobility upon entry. Figure 7 shows the scanning scenario of the generated travel permit QR code.
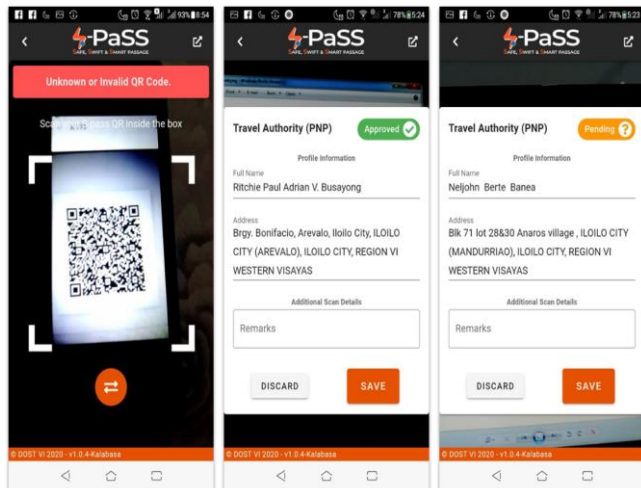

Fig. 7 Scanning mobile application of the proposed work designated on exit and entry points of travellers. The scanning function will be able to identify approved, pending, and denied travel application documents

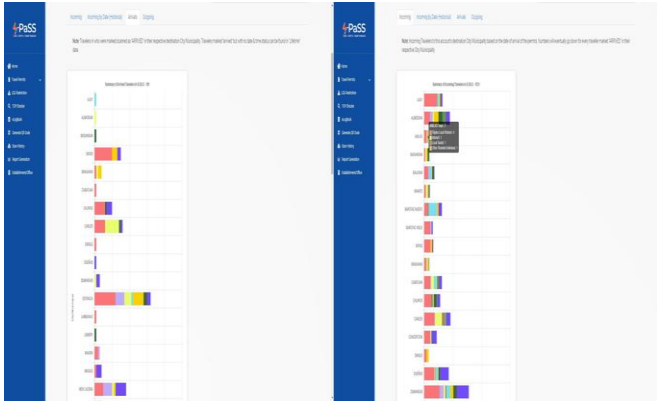## C. Local Government Unit Dashboard

Fig. 8 to 10 shows the admin dashboard and several functions for the LGUs and other authorized entities (Philippine National Police, Department of Health, etc.) These functions are built to facilitate efficient approval and issuance of travel permit applications and monitor the number of travellers arriving and incoming travellers to a specific destination. The admin dashboard also enables LGU to process traveller permit on-site whenever the system is not accessible in the traveller areas (such as remote municipalities with no Internet connectivity). Moreover, the dashboard offers control to provincial level accounts to add/update restriction status and travel requirements for each municipality.
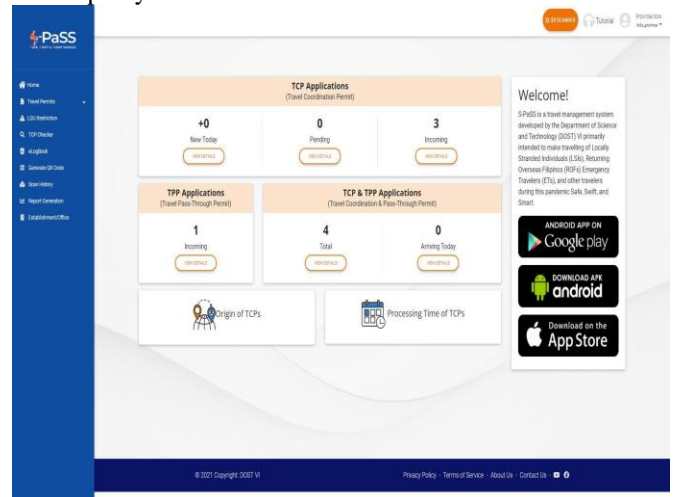
Fig. 8 Local Government Dashboard where they can manage the approval of the application of travellers, and several setting and management reports including the travel history (mobility) of individuals
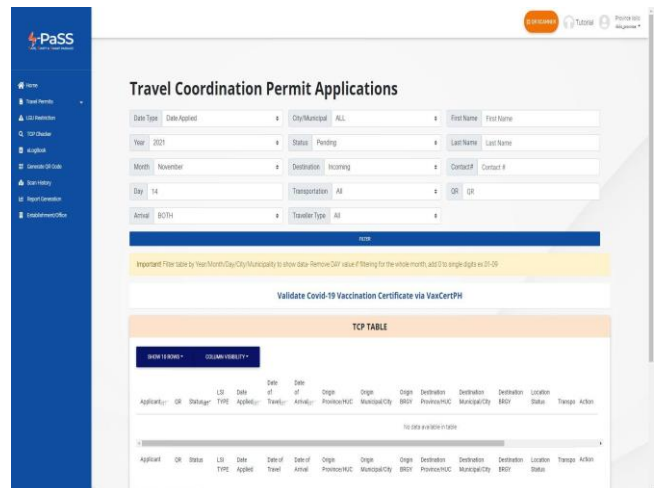

Fig. 9 Local Government Dashboard shows the Travel Coordination Permit (TCP), which is required for travellers upon entry to restricted destinations (mostly with active or increasing cases of Covid-19)

Fig. 10 Local Government Dashboard; (a) generated report of arrivals per municipality and (b) generated report of incoming travellers per municipality

D. Local Disease Outbreak Control and Mitigation

Even with the "herd immunity" slowly being realized by the Philippines through the proactive vaccination rollouts, cases of transmissions of the virus are still evident in several areas. Still, travel to and from destinations poses the risk of being exposed, and transmission leads to local outbreaks. The LGU dashboard of the Travel and Mobility Management System has several functionalities that are relevant to aid in the control and mitigation of local disease outbreaks. Fig. 11 shows the functionalities to add more establishments (entry and exit points) to help in the stringent evaluation of traveller arrival and departures. In severe situations, this can be utilized as checkpoints for granular lockdowns and check that only essential travel with approved permits is allowed for entry and exit. Moreover, Fig. 12 depicts the eLogbook that can be utilized as contact tracing records whenever positive cases are identified. Lastly, as contact tracing becomes finding possible contacts like looking for needles in a haystack, a Mobility History scanning function is also integrated with the system, as shown in Fig. 13. This can narrow down the possible contacts of the person identified "positive" with the virus by tracking the entry points and the mobility history through the system logs.
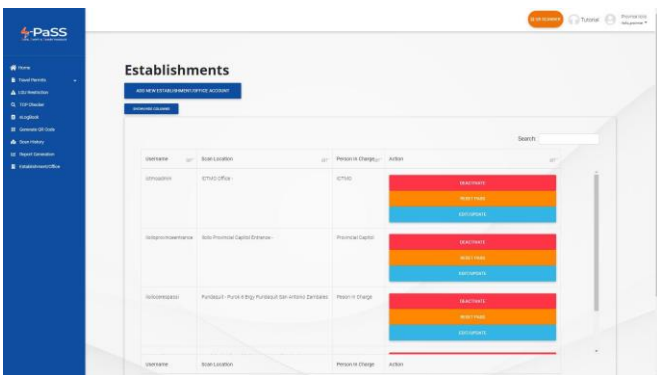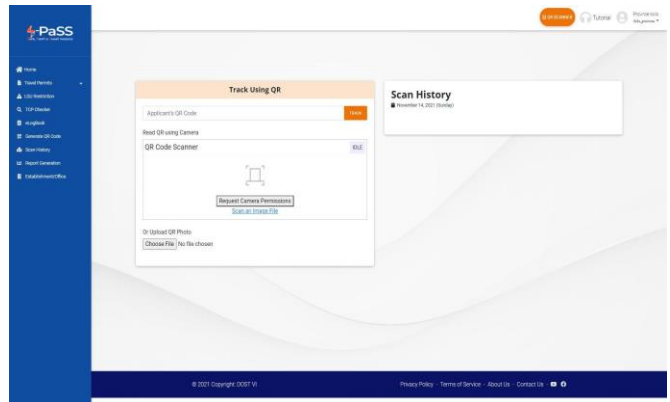

Fig. 11 Adding and Updating of Entry and Exit points (establishments) as another functionality in the LGU Dashboard.
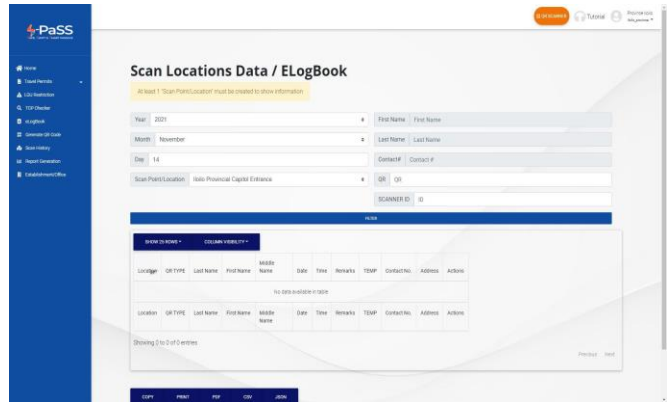
Fig. 12 ELogBook that can be used to scan or search for people present in a specific location for easy and effective contact tracing

Fig. 13 Mobility History tracking for individual traveller to refine entry and exit points or destination spots that can be used in cases that traveller is identified as "positive" of Covid-19

IV. CONCLUSION

With the Covid-19 pandemic and the fast-increasing number of local transmission cases, travel for tourism or leisure and non-essential activity has been restricted in the Philippines. Understandably, the restrictions were necessary to mitigate the transmission of the virus. Travel for delivery of essential goods, performing important work functions and returning to one's home place, which is considered essential travel, has been allowed through the issuance of travel permits. However, acquiring travel permits have become relatively difficult for most travellers and securing them from the assigned agency (e.g., PNP, LGU offices) entails a laborious process of preparing multiple documents and filing them in person, which increases the risk of exposure to the virus and eventually transmission. This work presented a travel and mobility management system to ease the traveller's application of travel permits through the implementation of a mobile application system and secure that exposure to virus and transmission is avoided. Moreover, the monitoring of

traveller's application for travel permits issuance of travel certifications has also been integrated into the system. This also eases the facilitating and coordination of travellers with their respective LGU destinations. Lastly, built into the system are several functionalities (e.g., eLogbook and mobility history) that would be helpful in the tracing of close contacts whenever positive cases were identified and eventually leads to the control and mitigation of local or community outbreaks.

As of this writing, the proposed work has undergone pilot implementation, and the researchers will evaluate the implementation and adoption of the system if certain revisions and/or iterations are necessary. This investigation will aim to provide insights for LGU on the correction of policies, protocols, implementation, actions, and interventions not only for the current pandemic but also whenever a disease outbreak relatively occurs, especially in the monitoring and coordination of essential travels.

ACKNOWLEDGMENT

REFERENCES

[1] L. Xue, S. Jing, W. Sun, M. Liu, Z. Peng And H. Zhu, Evaluating the Impact of the Travel Ban within Mainland China on the Epidemic of the Covid-19, International Journal of Infectious Diseases. 107 (2021) 278-283.

[2] A. Aleta, Q. Hu, J. Ye, P. Ji And Y. Moreno, A Data-Driven Assessment of Early Travel Restrictions Related to the Spreading of the Novel Covid-19 within Mainland China, Chaos, Solitons & Fractals. 139 (2020).

[3] (2021). A. Holmes, South Korea Is Relying on Technology to Contain Covid-19, Including Measures that Would Break Privacy Laws in the Us — and So Far, It's Working, Business Insider. [Online]. Available: www.Businessinsider.Com/Coronavirus-South-Korea-Tech-Contact-Tracing-Testing-Fight-Covid-19-2020-5.M.

[4] (2021). Y. Ng, Evaluation of the Effectiveness of Surveillance and Containment, Centers for Disease Control and Prevention. [Online]. Available: www.Cdc.Gov/Mmwr/Volumes/69/Wr/Mm6911e1.Htm.

[5] J. Müller and B. Koopmann, The Effect of Delay on Contact Tracing, Mathematical Biosciences. 282 (2016) 204–214.

[6] (2020). IATF Resolution No.79. Philippine Official Gazette Website. [Online]. Available: www.Officialgazette.Gov.Ph/Downloads/2020/10oct/20201015-Iatf-Resolution-79-Rrd.Pdf

[7] (2021). A. K. Santos, A Guide to Covid-Related Travel Requirements in the Philippines. [Online]. Available: www.Traveling-Up.Com/A-Guide-To-Covid-Related-Travel-Requirements-In-The-Philippines/.

[8] (2021). Uniform Travel Protocols for LGUS Approved – Presidential Communications Operations Office. Presidential Communications Operations Office Website. [Online]. Available: www.Pcoo.Gov.Ph/News_Releases/Uniform-Travel-Protocols-For-Lgus-Approved/, Retrieved November.

[9] (2021). J. Hong, R. Chang, And K. Varley, The Covid Resilience Ranking, Bloomberg. [Online]. Available: www.Bloomberg.Com/Graphics/Covid-Resilience-Ranking/

[10] B. M. Vallejo and R. A. C. Ong, Policy Responses and Government Science Advice for the Covid 19 Pandemic in the Philippines: January to April 2020, Progress In Disaster Science. 7 (2020).

[11] L. Ocampo and K. Yamagishi, Modeling the Lockdown Relaxation Protocols of the Philippine Government in Response to the Covid-19 Pandemic: An Intuitionistic Fuzzy Dematel Analysis, Socio-Economic Planning Sciences. 72 (2020).

[12] A. Tiwari, M.K. So, A.C. Chong, J.N. Chan and A. M. Chu, Pandemic Risk of Covid-19 Outbreak in the United States: An Analysis of Network Connectedness with Air Travel Data, International Journal of Infectious Diseases. 103 (2020) 97–101.

[13] B. Ozbilen, K.M. Slagle and G. Akar G, Perceived Risk of Infection while Traveling During the Covid-19 Pandemic: Insights from Columbus, Oh Transportation Research Interdisciplinary Perspectives. 10 (2021).

[14] A. Asadzadeh, S. Pakkhoo, M.M. Saeidabad, H. Khezri and R. Ferdousi, Information Technology in Emergency Management of Covid-19 Outbreak, Informatics in Medicine Unlocked. 21 (2020).

[15] W. He, Z.J. Zhang, and W. Li, Information Technology Solutions, Challenges, and Suggestions for Tackling the Covid-19 Pandemic, International Journal of Information Management. 57 (2020).

[16] A.B. Dar, A. H. Lone, S. Zahoor, A.A. Khan and R. Naaz, Applicability of Mobile Contact Tracing in Fighting Pandemic (Covid-19): Issues, Challenges and Solutions, Computer Science Review. 38 (2020).

[17] S. Altmann, L. Milsom, H. Zillessen, R. Blasone, F. Gerdon, R. Bach, F. Kreuter, D. Nosenzo, S. Toussaert, and J. Abeler, Acceptability of App-Based Contact Tracing for Covid-19: Cross-Country Survey Study, Jmir Mhealth and Uhealth. 8(8) (2020).

[18] N. Ahmed, R.A. Michelin, W. Xue, S. Ruj, R. Malaney, S.S. Kanhere, A. Seneviratne, W. Hu, H. Janicke, H., And S.K Jha, A Survey of Covid-19 Contact Tracing Apps, IEEE Access. 8 (2020).

[19] (2021). Electronic Travel Authorization (Eta) - Canada.Ca. Canada E-Travel Authorization Website. [Online]. Available: www.Canada.Ca/En/Immigration-Refugees-Citizenship/Services/Visit-Canada/Eta.Html.

[20] (2021). Iata Travel Pass Initiative. Iata Travel Pass Initiative Website. [Online]. Available: www.Iata.Org/En/Programs/Passenger/Travel-Pass/.