A FRAMEWORK IN DEVELOPING A CITIZEN-CENTERED SMART CITY MOBILE APPLICATION AS A PLATFORM FOR DIGITAL PARTICIPATION IN ILOILO CITY

J. Domingo[1], K.A. Cabello[1], G.A. Rufino[1], L. Hilario[1], M.J. Villanueva-Jerez[1], C.J. Sarmiento[1]

[1] UP Training Center for Applied Geodesy and Photogrammetry, University of the Philippines Diliman, Quezon City, Philippines – (jmdomingo3, kecabello, gdrufino, lfhilario, mvjerez, cssarmiento)@up.edu.ph

KEY WORDS: Smart City, Smart City Mobile Application, Participatory Sensing, Digital Participation, Data Privacy

ABSTRACT:
ICT is one of the technological enablers of a smart city which facilitates the developments in various sectors of the community such as in governance, transportation, education, safety, tourism, and communication. Development of smartphone applications have directly contributed to areas of smart living, smart people, smart governance, and smart mobility as it provides several features catering digital services in the city and flexible utilization of the city services. However, smart city development is not merely the creation of digital services for the citizens but instead involves a two-way communication between the government and citizen's collaborative processes and digital participation. The purpose of this paper is to provide a framework for a mobile tool wherein people can easily access the most essential everyday city services and in the same manner provide the city authorities to gather relevant information from the application through review of literature and other relevant documents.

1. INTRODUCTION

The rapid innovation and mainstreaming of Information and Communications Technology (ICT) over the past decade ushered in the demand for ICT-based urban ecosystems. Termed "Smart Cities", these urban ecosystems are increasingly being pushed in developing countries as a driver for accelerated development (Ellsmoor, 2019). The implementation of smart cities ranges from development of web applications to smartphone applications that contribute to the indicators of a smart city - smart living, smart people, smart governance, and smart mobility; as it provides several features catering digital services in the city and flexible utilization of the city (Letaifa, 2015).

However, smart city development is not merely the creation of digital services for the citizens but instead it should involve a two-way communication between the government and citizen's collaborative processes and digital participation (Kunttu, 2019). The scientific way to achieve sustainability and adoption is to go beyond technology demonstrations and understand the main users of the applications—the people and society (Boorsma, 2018). Through "social sensing", data grounded in the behaviour of people are collected and analyzed (Wang et.al). This information is derived and studied from people and/or devices they control such as cellular phones.

While ICT provides a wide range of tools and applications that cater the needs of the citizens, social sensing in smart city development can create a virtual environment where citizens can communicate their needs, thus further supporting communication-collaboration with the government (Stratigea, 2012).

This paper aims to provide a framework in developing a smart city mobile application as a platform for citizen digital participation. The mobile application serves as an avenue in collecting reliable and non-intrusive data on location, movement, networks and social hubs of Iloilo City through social sensing methods. The collected data will then be used as feedback to connect citizen-oriented schemes to the government for a more informed decision-making process of the local government unit.

The specific objectives of this paper are as follows:

1. To design a smart city mobile application that would cater digital basic city services such as in tourism, local business, and emergency;
2. To provide means for collecting human mobility data and feedback system mechanism through the mobile application;
3. To provide an avenue to analyzing the different sensing data affecting Iloilo City
4. To create insight on possible developments and trends on Iloilo City's existing services, policies and management systems and;
5. To provide an avenue for collaboration and partnership with public and private stakeholders.

2. LITERATURE REVIEW

2.1 Gaps in Existing Smart City Frameworks

Smart cities rely on services and information that are made accessible to the people, which is why mobile applications are vital for providing a platform for this as well as having communication and information exchange opportunities (Kunttu, 2019). However, most of the mobile applications are focused in specific domains and are using a siloed approach leading to significant gaps between individual smart city projects resulting to 1) inability to guarantee the consistency of public data and the spatial base for different smart projects in the same city 2) inability to achieve the sharing and integration of different smart systems or data in smart cities; 3) inability to guarantee consistency across different smart project implementations due to different viewpoints of the project implementers or researchers; and 4) inability to guarantee balance across various stakeholders (Government, public administration and company) Li et al (2019). In order to meet the dynamic needs of a city and its citizens, all components of a smart city system should be interconnected to each other, communicate with each other, and effectively share or exchange information and data amongst each

other but current smart city studies generally focus on applications in a single research field area (Li et al., 2019).
Developing a smart city mobile application creates a platform for users to effectively communicate with the local government units regarding the everyday citizen issues including question, suggestion, and feedback on the services that different sectors (e.g., transportation, health care, city services) offer through the mobile application. It is necessary to have "innovativeness, participation, collaboration, and coordination" to address key issues such as lack of collaboration in facilitating the participatory tools and systems across different departments and sectors (Herrschel, 2013).

Although governments throughout the world have begun to use city service mobile applications as a key component of their smart city programs, city applications have not been quickly adopted by the citizens (Sharma et al., 2018). Perceived usefulness of the technology, ease of use, social influence or expectation, privacy concerns, and trust in the government are identified to be the main factors affecting citizen's reception to the new platforms (Jinghui et.al., 2020). The more benefits that the user can expect to gain from using the application, the more they will likely to adopt it and create an influence in their social groups to use it too.

For a smart city to be successful, all systems must be integrated to achieve effective communication and unification between the different elements of the system, thereby exchanging information and services to each other and making each component useful to one another in a timely, accurate and expeditious manner (Javidroozi et al., 2014).

2.2 Modern Social Participation

Sustainable cities require strong societal comprehension, awareness and connection. Though smart city developments bring out excitement and optimism, some of the initiatives developed were not always successful (Jung, 2019; Smith, 2017) which brings us to understand the behavior of the people and society that interacts in the city (Boorsma, 2018).

Szarek-Iwaniuk et al. (2020) summarized three development stages of smart cities where: 1) technological innovations are implemented, 2) involvement of local authorities focused on new technologies through programs and projects and 3) local residents are part of the process of building modern cities. In Poland, the study showed that this social participation is advantageous in terms of providing greater transparency of governance, emphasis on community needs, enhanced social engagement, and new opportunities for improvement.

Civil participation and ICT can go hand in hand in shaping urban space, improving the quality of life and impacting the decision-making process of the city managers (Granier et al., 2016).

2.3 Mobile Application as Means

Technology has become the dynamic enabler in smart city development and the presence of smartphones has helped adopt the ICT infrastructures built around ongoing smart city initiatives. Municipal or city websites are clearly available for its citizens but it was shown in one case study that more people are accessing the site from their smartphones. Mobile applications now become direct extensions of municipal websites and social media and were found to bring a wider audience for a much faster information dissemination due to portability. (Lev-On & Rosenberg, 2021). Furthermore, studies demonstrate that cities with smart city applications can help reduce cost and efficiently manage the use of resources and physical infrastructures. (Guarana, 2021)

In the Philippines, some of the local governments are also implementing smart mobile applications focused on E-governance and rescue such as *Makatizen* of Makati City, QCitizen of Quezon City, and *Cauayan City Connect* of Cauayan, Isabela.

3. METHODOLOGY

This study is part of "A Link-Up of Geomatics and Social Science Research for the Development of Smart Cities" (LUNGSOD) Project. Iloilo City was selected as the pilot study area for this Project as it is considered a prime pilot area for innovative solutions and has a track record of good governance and public-private collaboration.

The mobile application or so-called LUNGSOD City Connect Application deals mainly with the design and development of citizen mobile applications that would be used to deliver services to the citizens and gather social sensing data from users. The information collected, however, may be used in visualization, analysis and simulation in the command center. The methodology shall include the following components:

3.1 Application Design and Development of the mobile application

Application design and development processes are done simultaneously in the creation of the citizen mobile application. Beyond the design and development perspective, review of literature, close participation of the stakeholders and its target market will be a major influence in modifying the application.

The development of citizen mobile applications under the City Connect platform requires thorough understanding of local needs, priorities, development goals, and strategies. The modules of the mobile application significantly address specific areas of concern and remain sustainable for a long period of time.

Prior to actual development, review of smart-city related programs and projects was conducted to gain insights on how these are being implemented and what can further be improved under Project LUNGSOD. Compilation and review of existing, ongoing, and completed smart city-related projects of other LGUs and agencies, and projects funded wholly or in part by the DOST was also conducted. Existing smart city technology and applications being utilized in other cities and countries were examined as well. Moreover, The Iloilo City Connect application features were designed and developed based on the local development plans, programs, and strategies indicated in the City's Development Plan. Recommendation of local consultants and best practices in other cities and project areas were taken into consideration.

The system is designed to be modular and scalable in order to accommodate developments beyond the Project's period of implementation and to allow other collaborators to build on the foundation set by the Project.

The general process flow for the development of City Connect application is shown in Figure 1 below.

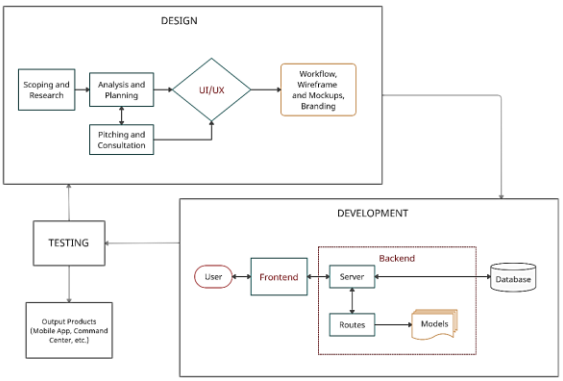

Figure 1. General Process Flow for City Connect Design and Development

The entire application development is divided between the designer & developer and goes through five (5) stages, namely: (1) Conceptualization, (2) Definition, (3) Design, (4) Development and (5) Publishing. (Cuello and Vittone, 2013).

Conceptualization is done to identify the user's needs and problems. Formulation of an idea for an application is a response to preliminary research and concept viability check (whether the concept is executable or not). The definition stage is where the designer and developer defines characteristics of possible users and layout foundations for functionality which will determine the range of the project and design & programming complexities for the app itself. Abstract ideas become tangible in the design process where pre-discussed concepts are created through wireframes and prototypes. A finished visual design is provided to the developer for programming the code. On one hand, the developer brings created design to life and establishes a structure upon which the application's functions will be based. In this entire process, developers also ensure the proper performance of the application and in lookout for faulty functional bugs.

Lastly, the application is finally made available to users during the publishing stage. The app will continuously be under evaluation in terms of behavior and performance which is necessary to to make improvements, correct mistakes, and update succeeding versions.

3.2 Digital Participation: Information Collection and Data Privacy

For the scope of this study, mobile phones, though not built specifically for sensing, will be used as sensors to collect information from the citizens. The camera and GPS devices and other sensors embedded in the mobile phones can then collectively be used to implement participatory sensing from the users through the developed smart city mobile application. The study also looked into all policies involving the data sharing of sensitive and non-sensitive information.

3.3 Data Visualization and Analysis

This mobile application will pave the way for the citizens to not only be users, but become stakeholders with an active role in developing a smarter city just as local businesses are not only viewed as a provider, but as a collaborative partner. The collected information could be used to conduct specific analysis and/or simulations that can be integrated in the city's Command Center to aid in the city's decision-making process. This system will provide a socially-inclusive avenue for the citizens to communicate their ideas to the local authorities.

4. RESULTS

2.1 City Connect Application Mobile Features

The study mainly focused on the four (4) modules namely: Tourism, Local Products, Emergency and Report an Issue. The following are the features developed:

4.1.1 Tourism Module: The Tourism module provides the user a planned and interactive travel experience in Iloilo City featuring a wide variation of tours and experiences, accommodations, food and dining, museums, historical landmarks and cultural heritage sites. The module added a rating facet that allows tourists to leave a review and even attach media in the form of photo or video, giving them the ability to add value to their experience.

Incorporating geospatial data, these features will all be consolidated as layers in the mobile application's map feature showing the pinned locations of specific destinations under each category.

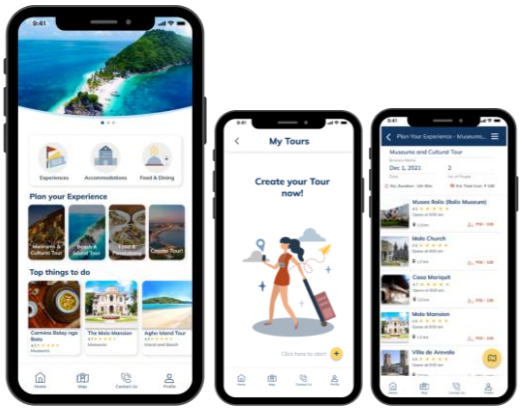

Figure 2. Tourism Module

4.1.2 Local Product Module: The Local Product module aims to promote business and MSMEs specifically to promote the province's local products through the integration of Bakal Lokal, an initiative of Youth First Initiative Philippines, Inc. 's (YFI) in partnership with DOST Region VI through Grants-In-Aid funding program. Bakal Lokal seeks to bridge MSMEs, producers, delivery services, advocacies, and consumers using modern technology and strategies in response to the ongoing national community quarantine.

Figure 3. Local Products Module

This module aims to partner with Youth First Initiative Philippines, Inc. to use their project and be part of the mobile application where users will be redirected to the Bakal Lokal website to make their purchases and create an account. With the integration of the Bakal Lokal e-commerce platform, this module supports the vision of Iloilo City for innovation and utilization of smart technologies for the MSMEs. This can also be utilized as part of the program to enhance tourism in the city by supporting and highlighting local products to tourists.

4.1.3 Emergency Module: The Emergency or SOS module allows users to make emergency calls that are direct to the city's emergency response command center. The 911 Emergency button will redirect calls to the Iloilo City Command Center and proper authorities depending on the emergency of the user.

In case of emergencies where a user is incapable of using voice communication, the SOS module also included a chatbot feature. Users may share the current location in order to ease up the reporting process. If confirmed, the chatbot redirects you to a designated live agent fit to address your concern.

Each report contains a comprehensive list of information that includes a reference number, the date and time of the report, its current report status, remarks, address or location of the report, and media attachments if there are any.

Push notifications may also be turned on to have a real-time alert even when the user is not within the mobile application. This module also has a feature containing a list of emergency hotline numbers which may include numbers for police stations, fire stations, medical emergencies, Iloilo City Emergency Response Team (ICER), and DWSD, depending on Iloilo City's Command Center.

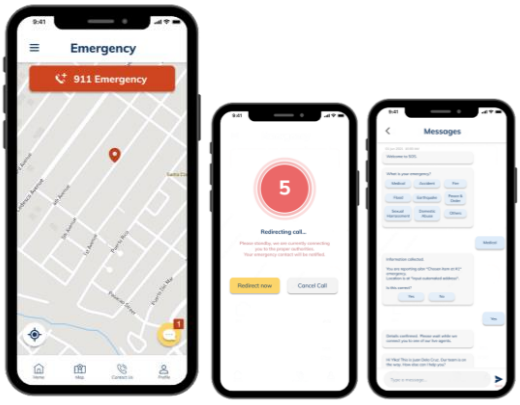

Figure 4. Emergency Module

4.1.4 Report an Issue Module: Report an Issue module allows users to report issues related to (1) City Hall Services, (2) Engineering & Construction, (3) Waste Management, (4) Traffic, (5) Brownout and (6) other more issues that may be relayed that are not included in the aforementioned categories. An Issue History feature is also on the module's mainpage to track users of the status of their reported issues, whether the corresponding body has completed/remedied the issue, still in progress or haven't started it yet.

Exclusively for Report an Issue under *Brownout*, this feature is tailored for the power outages often experienced in the city. Users will be asked to input their location (with the app asking for hardware permissions first) along with the time of power outage. A description bar is also provided to allow users to add more details regarding their brownout.

Same goes with the SOS module, a menu side bar contains accessory features such as a dashboard for issues reported and its status and a hotline directory.

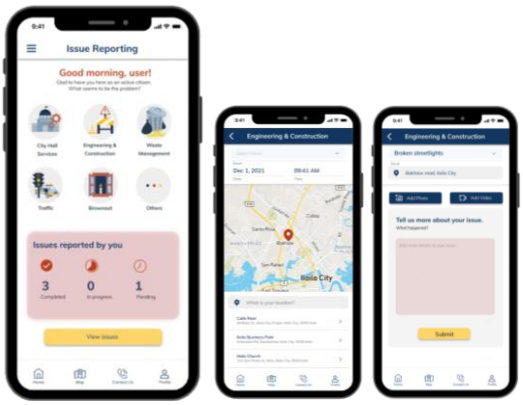

Figure 5. Report an Issue Module

2.1 Digital Participation: Information Collection

Through the four modules - Tourism, Local Products, SOS and Report an Issue, information from the users will be collected. The collected information as shown in Table 1 will be used to conduct specific analysis and simulations that can be integrated in the city's Command Center to aid in the city's decision-making process.

2.2 Digital Participation: Data Privacy

In a participatory sensing system, the users' data can be stored in a local data storage (on their device), or uploaded to a centralized cloud server hence, allowing the sharing of data with other users and the developers. Under the Data Privacy Act of 2012, information is categorized as personal information, sensitive personal information, and privileged information (see Table 2.). The processing of sensitive information and privileged information are both prohibited by law.

However, one issue that arises is concerning user's privacy specifically with regards to user's personal information, location, user credentials, and data produced in the application itself (e.g. search logs, history, etc.). One example are the attacks pertaining to user's privacy in terms of location. In the study of Boutsis & Kalogeraki (2013), location attacks were categorized as (1) user identification attacks, where the goal is to expose the user's identity by issuing queries about a spatial region; (2) sensitive location tracking, where the attacker tries to identify one or more locations that the user visits frequently; and (3) sequential tracking attack, that tracks down the user and then analyzing the user trajectories to identify the places that he/she has visited.

In developing a Smart City mobile application, information of users will be collected which falls under sensitive personal information. To address this, the application will implement the following in compliance of the lawful processing of personal information such as providing the users the application's terms and conditions that states the data to be collected from the user upon registration for an account; asking for the user's consent for the developers to access and store the collected information in the application's database prior to processing; personal information is accessible only to bona fide members of these organizations or

their associations; implementing web security measures for the application's database, and collection of location data will be prompted/ asked several times before accessing location enabled features (e.g. using the tourism module).

Module	Data Collected	Analysis to be conducted
Tourism	• GPS traces of users (when access to location is allowed) • Tourist destination reviews (message, attached images/ videos) • Created travel itinerary • Search history of tourist spots	• Mobility data of tourists • Most and least visited tourist sites to know where to put additional effort in promotion
Local Products	• Search history • Primary information of user (name, contact number, addresses)	• Customer demographics (target audience) • Interest checkfor products • Logs for prospect clients
SOS	• Summary of reports - message, sender information, time logs • Message logs with support agent • Location of reports	• Hotspots for emergency • Sensing for crime and hazard mapping
Report an Issue	• Summary of reports - message, sender information, time logs • Location of reports • Concerned government agency	• Feedback (visualization)

Table 1. List of data to be collected in each module

Personal Information	Sensitive Personal Information	Privileged Information
• Names • Location Data • Identification Numbers • IP Addresses • Cookie Data • RFID Tags	• Racial or Ethnic Data • Health Data • Education Data • General Data (marital status, age, color) • Court proceedings • Biometric Data • Social security numbers, tax returns, etc. • Religious and Political Affiliations • Sexual Orientation	• Any and all forms of data which under the Rules of Court and other pertinent laws constitute privileged communication. (e.g. any information given by a client to his lawyer, falls under attorney-client privilege thus considered as privileged information)

Table 2. Categories of Data under the Data Privacy Act of 2012.

5. DISCUSSION

2.1 Alignment with Iloilo City's Comprehensive Land Use Plan (CLUP) 2021 - 2029 and with the 2020-2025 Iloilo City Comprehensive Development Plan (CDP)

Iloilo City envisions a livable, well-governed city built around resilience, sustainability and active participation. With collated literature and several local documents, the City Connect application is designed to support the city's existing structure and implement the LGU's plans and potential projects identified in their Comprehensive Land Use Plan and Comprehensive Development Plan.

The Comprehensive Land Use Plan or CLUP mandated by the Local Government Code of 1991 is prepared by an LGU as the primary basis and framework for the use of land resources in the locality. Included in this document are specific targets and proposed projects of the city, along with their strategies and action plans.

Along with its CLUP, the Comprehensive Development Plan (CDP), on the other hand, is the basis for the city's development plans and investments. In compliance with the DILG-NEDA-DBM-DOF Joint Memorandum Circular No. 1 S-2007, the LGU's CDP shall be made the anchor of such annual component plans as the city's Annual Development Plan and Annual Investment Program. Iloilo City's CDP also contains the 2020-2022 Local Development Investment Program that defines the three-year investment program that will finance the implementation of the 2020-2025 CDP. Same goes with the CLUP, Table 3 summarizes key indicators per sector and which module is most applicable based on the goals set.

5.2 Creation of Smart City Philippines: A Streamline Framework for Developing Smart Cities in the Philippine Scene

In developing a Smart City in the Philippine scene, the DOST Smarter City framework serves as the skeleton on which concepts about developing sustainable cities and smart city solutions are built on. The framework not only emphasizes data infrastructure and its role in decision making, but also shows the interconnectedness of different components of an effective Smart City system. The integration of the roles of the local government unit, laws, and stakeholders meet all together to develop tools for cities in order to create innovative solutions for complex urban problems. Although science, technology and innovation are necessary factors of development for a Smart City, it is also

important to consider the natural, human and financial resources of the city. Moreover, the different service sectors needed by the city plays a huge factor in determining the approach to developing a Smart City.

Sector	Descriptor	Success Indicator	Module Applicable
Social	Healthy citizenry	Enhanced capacity for risk reduction, disaster management and rehabilitation	SOS
	Secured citizenry	Reduced cases of domestic violence Peace and order situation excellent Decrease crime rate	SOS Report an Issue
Economic	Inclusive research and technology	Promote software, apps and IT-related outputs Partnership with academe for local economic development	All modules applicable
	Inclusive tourism	Move focus from festivals into becoming premier MICE destination	Tourism
	Thriving arts and culture and tourism	Increase in the number of new tourism license issued 15% increase in tourist arrivals Higher demand for local delicacies and souvenirs	Tourism Local Products
	Sustainable & environment-friendly services	Minimal business closure; elevation or expansion of MSMEs	LocalProducts Tourism
	Sustainable & environment-friendly (1) manufacturing and agri-business (2) research and technology (3) arts and culture (4) tourism	Strict implementation of Reduce, Reuse, Recycle (RRR), ordinance prohibiting the use of plastic bags in the city; implementation of Solid and wastewater management in the city	Report an Issue
Environment	Safe environment	Disaster-resilient in 5 years	SOS
	Clean water	Passage of a septage management ordinance within 2 years Passage of sewerage ordinance within 10 years	Report an Issue
	Clean land	Solid waste management; operational sanitary landfill	Report an Issue
Infrastructure	Well-linked	Effective drainage and sewerage system are installed	Report an Issue

Table 3. 2020-2025 Iloilo City Comprehensive Development Plan & applicable City Connect Modules

5.2.1 City's Needs Assessment: The Smart City concept is defined by a holistic approach and balanced partnership between human, social, cultural, economic, environmental, and technological developments leaning towards the same purpose and pursuing solutions to overall better living (Patrão, 2020). In order to achieve this, Smart City implementations need to be evaluated in order to understand the strengths and weaknesses and moreover to know which sectors need improvement.

The main objective for the Smart City Assessment is to obtain feedback for a more guided decision-making process and analysis of whether or not the implementations are in line with the desired direction. According to Huovila (2019), "further developments of indicator frameworks need to be embedded in the analysis of cities' needs" because indicators used in cities tend to be inconsistent from the actual city development goals. As a result, there can be poor evaluation of city planning for the reason of using indicators that are not in line with the goals of the city planners.

To address this, the goals as well as the roles of the different stakeholders involved in developing a Smart City need to be defined. It is very important to understand the current path taken by the stakeholders in each sector so there can be an analysis made on where to start and what we need in order to start. It is with important questions such as "what does the city and/or citizens need?" that help define the scope and pave the way for developments that will perfectly benefit the current state of the city.

In order to have a functional integration of the different stakeholders present in the Smart City system to be developed, an understanding of the benefits of each stakeholder is necessary. Table 4 shows the potential benefits that can spur the stakeholders to commit and take an active role in developing a Smart City system. These factors are important in order to understand the needs of the city and why they should have an active engagement in making their city smart.

In addition to this, a preliminary assessment of the needs of the city, in line with their goals and current condition is imperative for the reason that all these factors will help determine the path and approach that is appropriate for the city. Performing a background study of the city's past, current and future comprehensive development plans is a very crucial step in designing a Smart City system. This step helps determine the areas and sectors of the city that need improvement and how the system to be developed can aid in creating an environment

that makes these developments possible whilst staying in line with the goals and needs of the city.

Stakeholder	Potential Benefits
City Authorities	● Monitoring performance to improve the international image and competitive position of the city in the eyes of investors, as well as creative citizens and the public ● Justify the value of smart city investments and interventions ● Identify strengths and weaknesses and guide smart city planning ● Track progress in achieving pre-defined goals and targets and identify the position of the city in its efforts towards smartness ● Understand the socio-economic and environmental implications of smart city projects ● Understand the technical requirements of smart city projects ● Learn from the experiences of peers (when assessment involves benchmarking) ● Identify and showcase best-practice cases to learn lessons from ● Enhance governance transparency ● Stimulate discussions among various stakeholders that may result in improved mobilization of resources
Investors and Funding Agencies	● Evidence-based evaluation of the completed or ongoing projects ● Scientific means for prioritizing funding allocation ● Enhanced ability to make decisions regarding the best sites for future investment ● Ability to identify and capitalize on new business opportunities
Researchers	● Develop new strategies for improvement of smart city performance ● Simplify the complexities of the smart city concept
Citizens	● Enhanced awareness about the benefits of smart city projects ● Ability to make informed decisions when it comes to future investments ● Motivation to engage in smart city development activities and to communicate their desires and priorities to city authorities

Table 4. Potential multiple benefits of Smart City Assessment for different stakeholders by Sharifi (2019)

5.2.2 Data Inspection and Gathering: After a preliminary assessment of the city's needs, target goals, ongoing and planned projects and investment plans, data gathering now comes with identifying which data are readily available that can be used and analyzed. Intensive, continuous and close coordination with multiple stakeholders such as local authorities (i.e. City Planning and Development Office (CPDO) and City Disaster Risk Reduction Management Office (CDRRMO)), research and academe (i.e. regional DOST and local universities) and citizens (i.e. local startups, cooperatives and business groups) must be engaged to ensure that whatever system is to be designed and implemented in the city, there will be no duplication of local initiatives started. Instead, integration can be held as an option. This may pave the way for further collaborations prospered through rapport building and widespread information dissemination of the smart city project.

Initial gathered datasets that the city may provide such as spatial and non-spatial related data will also be further analyzed to see what type of method and analysis can be implemented to find possible factors that affect specific sectors and how suggested solutions can be imposed.

5.2.3 Scoping and Research for Each Sector: Aside from touch-based talks with involved entities, a more defined goal is set with what features should be included in a smart city project. Like on the City Connect, the modules to be included in the mobile application should be identified based on the target sectors to be addressed. These sectors are aligned on the indicators of a smart city (see Table 5).

Smart City Indicator	Sectors Involved
Smart Economy	● Business ● Small-Medium Scale Enterprise (SMSEs)
Smart Environment	● Energy ● Natural Environment
Smart Governance	● Local Government Unit (with citizen participation)
Smart Living	● Tourism ● Cultural facilities ● Health ● Social services ● Public safety
Smart Mobility	● Transportation ● Urban Planning
Smart People	● Education ● Workforce (workshops and trainings)

Table 5. Sectors involved in each smart city indicator. Based on the indicators of a smart city by Letaifa (2015)

As mentioned in Sec 5.1, the developers should consult with the city's goals which can be found in the CLUP, and CDP. Proper coordination with the city government officials is also a must.

After the identification of the goals for each sector, research is to be conducted on how these goals can be translated to a smart city mobile application feature. These features can be from existing smart city applications from other countries that can be enhanced to fit the target city's needs. Features to be implemented can also come from existing local research projects or businesses that can be integrated into the system for a more collaborative approach. In the case of Project LUNGSOD, coordination with the Iloilo City Government is underway. Some challenges are met considering the situation during the pandemic, but discussions and collaborations with the technical personnel, planners and decision makers are also part of the design process of the City Connect application.

6. CONCLUSION

Smart cities are generally viewed in extremely heterogeneous settings in which a variety of different sectors and contributors coexist such as citizens, technologies, the environment and public administrations whose goal is to create smart city initiatives to break down the walls that divide these sectors who operate independently and moreover, have an integration

of the different project contributions in the different fields into a one common structure with data transparency and sharing between the different systems involved (Garcia, 2021). Approaching challenges from a user-centric perspective has been a topic of interest in the literature for years; however, it is also crucial to understand that technology is not the ultimate goal for achieving a smart city but rather it is only one of the components of building a user-centric system.

The framework in developing a smart city mobile application presented in this paper proposes a streamlined process for a citizen-centered application, that will provide a two-way communication between the citizens and the government. The system offers multiple services addressing the identified needs from each sector - tourism, local products, emergency response, and reporting an issue to local authorities. Incorporating participatory sensing from users, specific sets of data will be collected from users from each module to conduct and provide analysis and simulations that will be integrated to the city's command center. These analyses and simulations aim to help the Iloilo City's LGU to provide sound and data-driven solutions.

REFERENCES

Boorsma, B. (2018). A new digital deal: beyond smart cities, how to best leverage digitalization for the benefit of our communities. Rainmaking publications.

Boutsis, I., & Kalogeraki, V. (2013). Privacy preservation for participatory sensing data. 2013 IEEE International Conference on Pervasive Computing and Communications (PerCom). doi:10.1109/percom.2013.6526720

Burke, J. A, Estrin, D., Hansen, M., Parker, A., Ramanathan, N., Reddy, S., & Srivastava, M. B. (2006). Participatory sensing. UCLA: Center for Embedded Network Sensing. Retrieved from https://escholarship.org/uc/item/19h777qd

Ellsmoor, J. (2019) Smart Cities: The Future of Urban Development, Forbes

Garcia-Font, V. (2021). Conceptual Technological Framework for Smart Cities to Move towards Decentralized and User-Centric Architectures Using DLT. Smart Cities 2021, 4, 728-745. https://doi.org/10.3390/smartcities4020037

Granier, B.; Kudo, H. (2016). How are citizens involved in smart cities? Analysing citizen participation in Japanese"Smart Communities". Inf. Polity, 21, 61–76.

Herrschel, T. (2013). Competitiveness and sustainability: Can 'smart city regionalism' square the circle? Urban Studies, 004209801347824

How Smart Cities Are Using Apps to Extensively Impact Our Everyday Lives. (2021). Guarana - Technology Trends. Retrieved from https://www.guarana-technologies.com/tech-trends/impact-smart-cities

Huovila, A., Bosch, P., & Airaksinen, M. (2019). Comparative analysis of standardized indicators for Smart sustainable cities: What indicators and standards to use and when? Cities, 89, 141-153

Javidroozi, V.; Shah, H.; Amini, A.; Cole, A. Smart city as an integrated enterprise: A business process centric framework addressing challenges in systems integration. In Proceedings of the 3rd International Conference on Smart Systems, Devices and Technologies, Paris, France, 20–24 July 2014; pp. 55–59.

Hou, J., Arpan, L., Wu, Y., Feiock, R., Ozguven, E., Arghandeh, R. (2020). The Road toward Smart Cities: A Study of Citizens' Acceptance of Mobile Applications for City Services. Energies. 13. 2496. 10.3390/en13102496.

Jung, J. (2019). From Smart City to Intelligent Community. ICF Canada

Kanhere, S. S. (2013). Participatory Sensing: Crowdsourcing Data from Mobile Smartphones in Urban Spaces. Lecture Notes in Computer Science, 19–26. doi:10.1007/978-3-642-36071-8_2

Kunttu, I. (2019). Developing smart city services by mobile application.

Letaifa, S.B. (2015). How to strategize smart cities: Revealing the SMART model. Journal of Business Research, 68(7), 1414–1419. doi: 10.1016/j.jbusres.2015.01.024

Li, C.; Liu, X.; Dai, Z.; Zhao, Z. (2019). Smart City: A Shareable Framework and Its Applications in China. Sustainability 11, 4346. https://doi.org/10.3390/su11164346

Patrao, C., Moura, P., de Almeida, A. (2020). Review of Smart City Assessment Tools. Smart Cities. 3. 1117-1132. 10.3390/smartcities3040055.

Rosenberg, H. & Lev-On, A. (2021). Mobile applications in local government. Electronic Government an International Journal. 17. 1. 10.1504/EG.2021.10034454.

Sharma, S.K.; Al-Badi, A.; Rana, N.P.; Al-Azizi, L. Mobile applications in government services (mG-App) from user's perspectives: A predictive modelling approach. Gov. Inf. Q. 2018,35, 557–568.

Smith, K. (2017). The Inconvenient Truth about Smart Cities. Scientific American. https://blogs.scientificamerican.com/observations/the-inconvenient-truth-about-smart-cities/

Stratigea, A. (2012). The Concept of "Smart Cities". Towards community development? Network and communication Studies, p.375-388. doi.org/10.4000/netcom.1105

Szarek-Iwaniuk, P. and Senetra A. (2020). Access to ICT in Poland and the Co-Creation of Urban Space in the Process of Modern Social Participation in a Smart City—A Case Study. Sustainability 2020, 12, 2136; doi:10.3390/su12052136

Wang, D., Abdelzaher, T., & Kaplan, L. (2015). Social sensing: building reliable systems on unreliable data. Morgan Kaufmann