Development of Intelligent transportation system from the perspective of local government units, national government agencies and transportation cooperatives

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1. INTRODUCTION

Either in response to increasing urbanization challenges or in pursuit of smart city goals, more cities around the world are applying Information and Communication Technology (ICT) to establish Intelligent Transport Systems (ITS) and thus improve traffic, transportation, and other mobility services (e.g., Billones et al, 2021; ITS Asia-Pacific, 2013).

To support these ITS initiatives, academic and scholarly journals dedicated to ITS have also been published such as the *Journal of Intelligent Transportation Systems* (IF=3.839), *IEEE Transactions on Intelligent Transportation Systems* (IF= 9.551), *IEEE Intelligent Transportation Systems Magazine* (IF= 5.293) and *International Journal of Intelligent Transportation Systems Research* (IF=2.27). Worldwide, ITS research themes include: "intelligent, connected and automated vehicles; big data analytics; sustainable smart cities, multimodal transport of people and goods; safety for drivers and vulnerable road users; policies, standards and harmonization; innovative pricing and travel demand management (TDM); cybersecurity and data privacy" (Sigua, 2022).

ITS deployments are typically associated with effective traffic management; nonetheless, the goal of ITS is not only smoother traffic, but also enhanced safety, better transport planning, better public transport systems and improved environment for improved quality of life (Billones et al, 2021; Sigua, 2022). The purpose of this paper is to provide a viewpoint on the current developments and state of affairs of ITS in the Philippines, and some recommendations on the ways forward.

2. CONCEPTUAL FRAMEWORK FOR ITS DEPLOYMENT

Various frameworks of ITS deployments for smart mobility have been proposed in the literature (e.g., Kim et al, 2015; Billones et al, 2021). In this paper, we use the framework, proposed by Sigua (2022), consisting of seven areas of ITS development / deployment in the Philippines, shown in Figure 1.

Figure 1: Figure 1. Areas of ITS Deployment/Development in the Philippines (adapted from Sigua, 2021)

Although these areas are self-explanatory, we provide in Table a few keywords associated with each area.

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Table 1: Description of ITS Deployment

Area of ITS Deployment	Keywords
Traffic enforcement and management	Traffic flow control and management; Traffic apprehension; and Traffic Information Gathering
Road management	Road maintenance; damage detection and repair
Toll/fare collection	Automatic fare collection system; inter-operability of toll systems
Traffic signal control	Interaction with traffic control system
Traffic information provision	Provision of real-time traffic information as requested by the user
Traffic safety assistance	Road safety
Public Utility Vehicle (PUV) Management	Operations planning and management of jeepney, buses, and other PUVs; Transport network planning; Demand forecasting; Electric vehicle; GHG emission

3. ITS INITIATIVES

Over the years, the Department of Science and Technology (DOST) has been funding ITS-related projects. Table 2 lists down some completed and ongoing ITS initiatives in the Philippines with funding from DOST. Data are obtained from the DOST-PCIEERD database[1], supplemented by other sources such as the agency's internal research database portal.

Table 2. DOST-funded ITS projects (completed and ongoing)

Area of ITS Deployment	Ongoing and Completed Initiatives
Traffic enforcement and management	Contactless Apprehension of Traffic Violators on 24-Hour Basis and All-Vehicle Detection System (CATCH-ALL); Detection and Identification of Legitimate Public Utility Vehicles (PUVs) Along various road netWorks (DILAW); A Vision-Based Vehicle Counter for Traffic Monitoring (VEMON) / TITAN: Vision-based Traffic Information & Analysis
Road management (road maintenance)	Road Infrastructure Design Evaluation and Reporting System (RIDERS)
Toll/fare collection	None
Traffic signal control	Cyber-Physical Transportation System (which monitors, communicates, senses, and actuates traffic information data through different components for an intelligent management of traffic flow in the road network)
Traffic information provision	Sustainable Technology - Assisted Route Planning for Region VI (STARPLAN VI); Development of the Philippine Metropolitan Advanced Traveler Information System (PhilMATIS)
Traffic safety assistance (road safety)	Collection, Recording, and Analysis of Traffic Incidence Data (CREATE); PUVs Patterns and Attitude on the Streets using Artificial intelligence and Data Analytics (PASADA); Motor Vehicle Inspection System with loaded emissions testing and smart features (MVISion); V2X Initiatives for Road Safety (VIROS); Training, Education, and Evaluation of Road Safety Driving Competencies through a Virtual Environment (TESTDRIVE); Drivers Roadworthiness Improvement Verification Education & Readiness for the Philippine logistics industry (DRIVER.PH)
PUV Management – General	Progressive Advancement of Transportation networks through the Integration of vehicular Onboard Technologies with online platforms (ArangKaDATA); Engineering the Public Utility Vehicles (PUVs) Using an OEM Vehicle Platform
PUV Management - Transport / Network Planning	Sustainable Technology - Assisted Route Planning for Region VI (STARPLAN VI); Development of a Customized Local Traffic Simulator (LocalSim); Enhancement of Transportation Management Software (E-TraMS); An Integrated and Optimal Scheduling of a Public Transport System in Metro Manila (PUBFix); System for Optimized Routing for Transport (SORT)
PUV Management – Carbon Emission	Advanced Traffic Pollution Monitoring and Analysis System Based on Data Collected from Air Quality Sensors, Engine Status Sensors and GPS Trackers Installed on Selected PUVs in Metro Manila (ATMAS)
PUV Management – Electric Vehicle	Determination of optimal placement of electric vehicle charging stations; IntElecT: Intelligent Electric Transportation Network

In general, we can see in Table 2 that all areas of ITS deployment, except fare/toll collection, have been covered.

[1] https://pcieerd.dost.gov.ph/supported-programs-projects/supported-programs-and-projects/completed-projects

4. PROPOSED ITS INITIATIVES FOR RESEARCH AND DEVELOPMENT

In order to identify possible ITS initiatives for research and development (R&D), we conducted consultations with four local government units, one metropolitan traffic management agency in Metro Manila, two national government agencies and a few transport cooperatives. Table 3 enumerates a few of these ITS-related initiatives proposed by our stakeholders during various formal and informal consultations.

We argue that future ITS deployments are most effective when they are aligned with the major programs. As examples of the programs, we enumerate the following: PUV Modernization, Service contracting, Nationally Determined Contribution, Smart City, Electric Vehicle Industry Promotion, and Innovation through Open Data.[2]

Table 3. Proposed ITS initiatives

Program	Proposed Initiative	Description
Smart City	Integrated traffic management system	A local government unit (LGU) proposed a traffic management system which integrates the following: an online ticketing system (similar to Land Transportation Management System or LTMS portal of the Land Transportation Office[3]), a payment system and a contactless apprehension system.
Open Data	Application Programming Interface (API) digital platform	Individual agencies will retain ownership of their data, yet they will be able to share the data by publishing their APIs in the marketplace or platform so that interested parties may easily check the specifications of APIs and possibly consume the data through API calls. Data sharing can be done in tiers. In the future, such a platform, which will be managed by the LGU, can be monetized. A platform or marketplace like this is already implemented in other sectors (e.g., finance/ banking).
Open Data	Technology-assisted collection of traffic- and transportation-related data	Traffic modelers of LGUs use commercial software such as PTV VISUM, Cube and EMME for their modeling of traffic flow and assessment of the impact of certain interventions. Yet what is missing is data such as Household Interview Survey, Origin-Destination survey, traffic counts, etc. Collecting such data is typically carried out manually and routinary, and thus requires a lot of manpower/ personnel. Given that there have been tools/technologies already developed through DOST funding which can automate the collection of data (e.g., CATCH-ALL[4]), there is a need to explore how this data collection initiative by the LGUs can be supported by these tools.
PUV Modernization	Fleet management system	Industry consolidation is one of the major components of the PUV Modernization Program (PUVMP). After the consolidation of operators into

[2] See National Transport Policy, https://neda.gov.ph/national-transport-policy/

[3] https://portal.lto.gov.ph/

[4] https://www.catchall.com.ph/

		one cooperative, all the PUVs will be under one organizational entity, which must be managed as a common fleet. Nonetheless, most cooperatives have no fleet management system; instead, they typically station a staff in key locations, who then contact their office if dispatch of additional units is necessary to cater to demand. There is thus a need to develop a fleet management software (with descriptive, predictive and prescriptive analytics such as live location tracking, demand estimation, dispatch scheduling, etc). STARPLAN-VI[5] is a DOST-PCIEERD funded project which tackles problem on multimodal public transport fleet monitoring and passenger demand, while another project called PUBFIX[6,7] works on demand estimation and dispatch scheduling.
Service contracting	Service contracting platform	At the height of the pandemic, the Department of Transportation (DoTr) implemented service contracting, with a primary aim of providing social amelioration to affected drivers/operators. Post-pandemic, service contracting may also be implemented as a new model of service provision: in this arrangement, a central clearing unit collects the fares from the passengers and pays the operators of public transport depending on compliance with performance metrics. Hence, even areas with low demand may be provided with high quality of service, since revenue does not depend on passenger demand. However, there is no demonstration yet of the feasibility of post-pandemic service contracting model for jeepneys. The aim of this research is to design and implement a system of SC with a transport cooperative, bank, clearing house and public transport agency.
NDC	Digital Monitoring, Reporting and Verification (MRV) system	A digital MRV system is a tool that can help in the evaluation of the implementation of GHG emission mitigation measures, by assisting "policymakers to adjust the measures accordingly in order to achieve the targets committed in the updated Nationally Determined Contribution or NDC" (Arnd,

[5] https://www.starplan6.com/
[6] https://ieeexplore.ieee.org/document/7016230
[7] https://www.atransociety.com/2015/pdf/pdfYRF2014/OnProgram/AYRF14-043.pdf

		2022). A digital MRV rolled out nationwide for the implementation of PUVMP, taking into consideration the different components of the program, such as the local public transport route planning (LPTRP), Industry consolidation, fleet modernization, vehicle scrappage etc., will enable policy-makers to monitor the status of PUVMP relative to the committed NDC target and adjust it when needed.
Smart City	Locally developed systems and applications (e.g., smart city platform)	Currently, some command centers use the free tier of proprietary smart city platforms. However, in the next years, the free tier will expire, and the LGU will have to start paying for the license/use. It has been suggested that a locally developed smart city platform be pursued, which can be a cheaper alternative to more expensive imported systems.
EV Industry Promotion	Electric vehicle	According to the Department of Trade and Industry (DTI) (2021), these are the four high-value activities critical to industry development and priorities: (1) electric vehicle assembly, (2) automotive electronics and other parts manufacturing, (3) EV battery, charging, energy storage systems and recycling, and (4) engineering service outsourcing. These technologies include: battery management system, automotive system design and modeling, artificial intelligence applications, etc. Although the development of EV industry is not primarily driven by ITS, we argue that a significant portion of EV entails the deployment of intelligent solutions (e.g., optimal locations of charging stations and smart battery systems).

5. LEGAL, INSTITUTIONAL AND POLICY ISSUES

ITS deployments do not occur in a vacuum. For these deployments to succeed, there ought to be enabling legal, institutional and policy mechanisms in place. We mention only a few issues related to some possible ITS projects, namely API digital platform (institutional issues), fleet management system (policy issues) and service contracting platform (legal and institutional issues).

5.1. API Digital platform

The Implementing Rules and Regulations (IRR) of the National Transport Policy have already mentioned a number of provisions related to data-sharing, inter-operability, open data and standardization, which can support the implementation of APIs for wider access and sharing of data within the transport sector. For example, in Section 14, the IRR states that: "transport-related data will be made available to the public as open data, to encourage the participation of the private sector in the development of apps and other IT-based services that can enhance passenger welfare and convenience." However, even with these provisions already in place, national government agencies and local government units are still at pains to fully implement these IRR provisions. It may be thus necessary to first conduct an in-depth study to examine the readiness and capacity of the institutions, such as the national government agencies (NGAs), LGUs and other units, in implementing data-sharing, standardization and open data prior to proper ITS deployments (e.g., API digital platform and others such as a central database and an inter-operable automatic fare collection systems).

5.2. Fleet management system

With the PUV Modernization and the Service Contracting programs of the Department of Transportation, the use of ITS solutions for managing PUV fleets will only become more common. However, even if the PUVMP requires a fleet management system (mentioned as early as 2019), it was assumed

and thought that that the only requirements were a fleet management seminar and manual dispatch. Recently, it became clear that besides a seminar and manual dispatch, fleet management actually requires engaging an Information Technology (IT) solution provider. However, this entails the specification of standards for fleet management systems. While the LTFRB MC 2021-002 mentioned that standards for fleet management systems will be released (LTFRB, 2021), no guidelines have been issued so far.

5.3. Service contracting platform

It is worth mentioning that service contracting has been rolled out in the Philippines in the absence of institutional arrangements that may support its implementation. Currently, SC in the Philippines comes in the form of social amelioration, or free rides (*libreng sakay*). The real service contracting scheme is not *libreng sakay*. In other countries, fares collected through the automatic fare collection systems (AFCS) go to the Public Transport Authority (PTA), which in turn disburses payments to the operators based on compliance with performance metrics (Sunio et al, 2022). For service contracting to be properly implemented, an institutional arrangement, similar to a government-owned and controlled corporation (GOCC), must be first established by law, with the authority to collect fares from passengers and to provide compensation to the transport operators for the services they provide under service contracting (Sunio et al, 2022). Once this new institutional arrangement is put in place, a technology platform, described earlier, can be rolled out.

6. SUMMARY AND CONCLUSIONS

In this paper, our objective is to offer a perspective regarding the current state-of-affairs and propose an R&D agenda for ITS from the perspective of national government agencies, local government units and transport cooperatives. We examine the existing and proposed ITS R&D agenda in seven areas of deployment: traffic enforcement and management, road management, toll/fare collection, traffic signal control, traffic information provision, traffic safety assistance, and PUV management. We argue that ITS deployments are most effective when they are aligned with the major programs of the government and are supported by appropriate legal, institutional and policy mechanisms.

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