Process Automation in Intelligent Transportation System (ITS)

Koorosh Gharehbaghi and Kenneth Farnes

***Abstract*—Collectively, process simulation is an intricate element within an intelligent transport system (ITS); arrange of modeling techniques and subsequent transition operations also form components of such a system. Although the ITS incorporates asset of process automations such as systematic prototypes and simulation, it also integrates computational modeling, and therefore, efficient operational transitions. Processes such as automation, modeling, and operational transitions are at the core of a fastidious ITS.**

Accordingly, these system elements need to be holistically integrated and amalgamated through effective computation-based methods. Fittingly, the main objective of this study is to examine the utilization of process automation- and computation-based methods as the basis for ITS integration perspectives. In doing so, Sydney Metro will be included as a case study to further elucidate such integration processes.

***Index Terms*—Intelligent Transportation System (ITS), process automation, Sydney metro.**

I. Introduction

Generally, the term intelligent transportation system (ITS) refers to attempts made to align technology-based data, information, and interactions toward transport infrastructure discipline. Such procedures consequently improve safety, reduce fuel consumption, and lessen vehicle wear and tear [1]. As Cao [2] correctly pointed out, ITS proposes the fore most innovation in improving convenience and productivity in the transportation industry.

Such innovation would reduce traffic congestion together with improving funding for new transportation infrastructure. Fries *et al*. [3] also argued that ITS could assist in upgrading traffic management systems by improving the reliability of real-time travel and traffic information. Subsequently, other advantages of ITS for relevant infrastructure include [4]

- Incident detection and weather sensors to further reduce vehicle crashes and fatalities;
- Allowing vehicles to communicate with infrastructure systems to improve road access and operation. Such strategies could also manage lane and speed control signs and signals;
- Optimize energy usage there by significantly improving environmental impacts and carbon footprints

Accordingly, the application of ITS is a highly technical and sensible practice which requires careful planning and implementation [5]. Some interesting applications include traffic and transit management schemes and techniques, such as automated traffic signals, incident management, and so on.

Manuscript received March 9, 2018; revised June 1, 2018.

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Consequently, ITS requires careful application of theoretical knowledge. The overall theoretical knowledge on ITS is shown in Fig. 1.

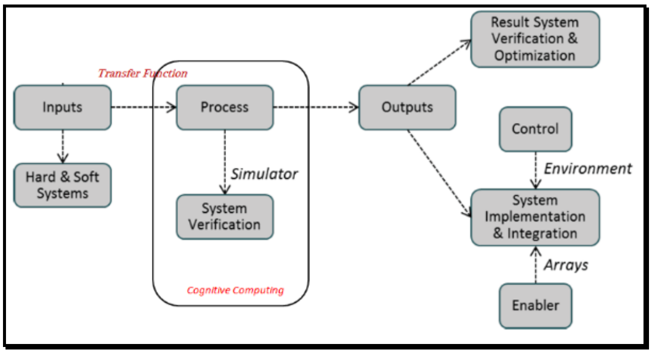

Fig. 1. The overall ITS theoretical knowledge.

Evidently, the overall ITS theoretical knowledge is linked to practical processes and subsequent systems. Accordingly, this approach is closely aligned with system engineering stages where in the process control stage is the most important, in which the overall ITS function segmentation is incorporated. As such, the process stage is at the core of the ITS system.

Moreover, the inclusive performance of this process needs to be constantly developed and maintained to assist with the overall development of ITS priorities. In addition, in determining the ITS performance enhancement, three main system stages must be carefully and holistically analyzed and integrated. This integration process should primarily focus on the evaluation of the state of health and then concentrate on regional or local damage assessment.

Furthermore, the general concept of ITS, as a technique and subsequent tool, is the actual collection of entities that can collaborate holistically. This collaboration is shown in Fig. 2.

Evidently (Fig. 2), the collaborative process of ITS involves the inclusion of roads, people, and vehicles as its central basis. This is because such areas are the primary considerations of any effective ITS framework. Such collaborative processes, however, must be efficiently administered via computational innovations, including information and communications technologies [6]. Such techniques would, therefore, utilize advanced information and telecommunication engineering to further improve the coordination of diverse transportation modes.

In addition, computational technologies entail initiating equipment such as sensors, in-vehicle computers, and so on to improve the overall usage of transportation infrastructure [7]. Such computational technologies would also require the development of specific software applications and artificial intelligence systems together with ubiquitous computing to

doi: 10.18178/ijmlc.2018.8.3.702

be integrated in to a superior ITS framework.

Moreover, the collaborative process of the ITS could be further refined and cultivated via the incorporation of process automation to successfully integrate computational modeling, and therefore, efficient operational transitions.

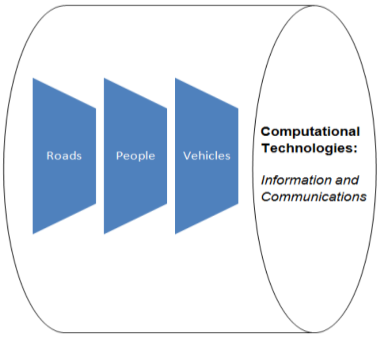

Fig. 2. Collaboration process of the ITS.

II. Process Automation

Typically, automation relates to numerous methods that comprise testing and debugging routines that broaden and improve the general system operations and its consequent performance. In view of this, these methods could be conducted repeatedly, thereby simplifying assorted complex systems [8]. For this reason, automation could be defined as the delegation of control functions to mechanize innumerable systems to produce more efficient goods or services [9].

Moreover, with the utilization of automation, complex processes will require less human intervention and fewer periods to dispense. Besides, efficient automation also improves the overall system performance [10]. As Gharehbaghi [7] correctly debated, automation reduces human involvement and also increases the reliability and efficiency of systems. Such a drastic performance improvement could be attributed to improved system development and subsequently heightened lifecycles [8].

Generic process automation comprises formation, structuring, and integration procedures. Fig. 3 presents a generic process automation scheme.

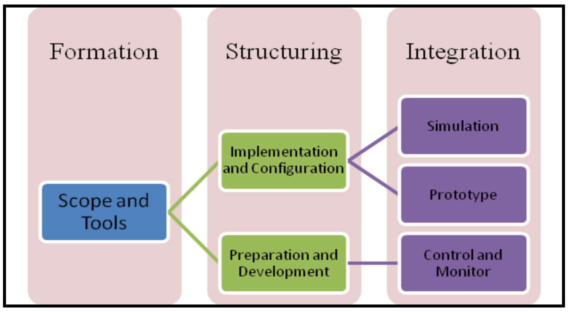

Fig. 3. A generic process automation.

Aptly, automation will increase the productivity and quality together with reducing overall costs. Likewise, automation will ultimately improve safety under working circumstances [11].

As mentioned above, the process automation of ITS includes systematic prototyping and simulation to effectively fabricate efficient operational transitions. Accordingly, such methodology requires vigilant and technical system integration. Fig. 3 shows process automation in ITS.

Fig. 4 shows the collaboration of the ITS. The ITS comprises a collection of sub-systems that execute definite routines according to parameters and considerations; the intelligence stems from the system's ability to learn, adapt to new conditions, and consequently, optimize the operational efficiency.

On the other hand, the inclusion of Information Technology (IT) further integrates computational applications to form the basis of a holistic ITS. To further scrutinize the utilization of process automation as the basis of ITS integration, the Sydney Metro system is reviewed as a case study.

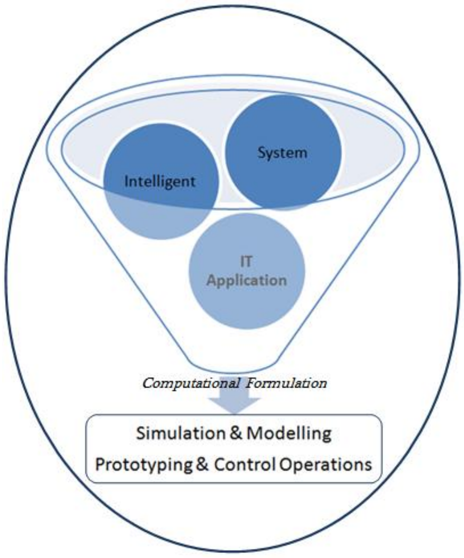

Fig. 4. Process automation of the ITS.

III. Intelligent Transportation System (ITS): Sydney Metro System

The Sydney Metro is a part of a complete rail network system, providing fast, safe, and reliable metro train services. This mega transportation infrastructure is Australia's largest public transport project, costing over eleven billion (Australian dollars) and taking up to seven years to complete.

As Gharehbaghi and Sagoo [12] stated, "*This mega infrastructure project is a new stand alone railway network and consists of more than sixty-five km of metro rail from Rouse Hill to Bankstown, connecting the east and west of the greater Sydney via the northwest and south west sub-projects*."

Moreover, they observed that *"the Sydney Metro mega project consists of two stages. The Sydney Metro Northwest, formerly known as the North-West Rail Link, was the first stage of the Sydney Metro system. Metro City and South west form the second stage. Sydney Metro Northwest will be the first fully-automated metro rail system in Australia and is scheduled to open to customers in the first half of 2019. Sydney Metro Northwest will deliver eight new railway stations and 4,000 commuter car parking spaces to Sydney's growing northwest region. Trains will operate every four minutes during peak hours and at least fifteen trains an hour, and this will significantly reduce the waiting time.*"

Fig. 5 shows the Sydney Metro mega project including the existing rail network.

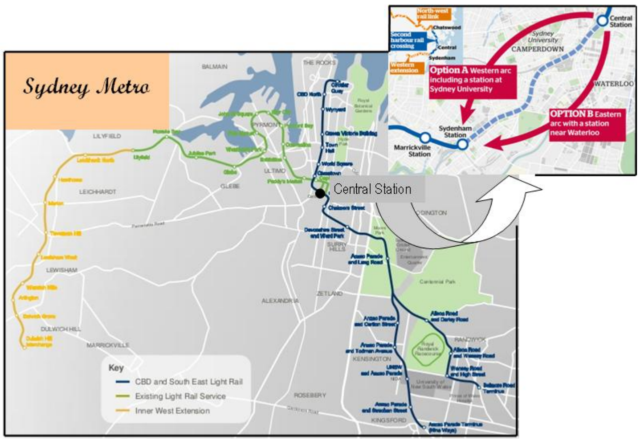

Fig. 5. Overview of Sydney Metro [13].

As evident, the Sydney Metro connects the east and west of greater Sydney. Financing and expenditure in major infrastructure projects are decisive for advanced economies. Subsequently, the relevant authorities need to invest in smart transport technologies to further obtain superior network capabilities. Consequently, technology-based disruption could ultimately have a momentous and enduring impact on all types of transportation networks. Accordingly, there needs to be an effective administration tool to oversee the mobility requirements of the future.

As with any transportation infrastructure project, the ITS provides an essential administration tool. For mega projects, the valuable utilization of ITS is even more important [14]. The fore most benefits of Sydney Metro's ITS are summarized in Fig. 6.

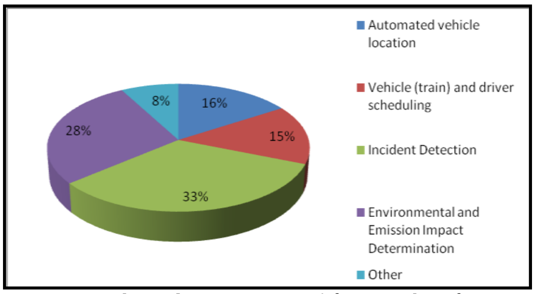

Fig. 6. The Sydney Metro's ITS' foremost benefits.

The two main benefits of the ITS for Sydney Metro are (i) concurrent incident detection and (ii) environmental and emission impact determinations. Such decisions can be attributed to Sydney Metro's close proximity to urban and some sensitive (environmentally delicate) areas.

Fittingly, the fiscal benefits of ITS for the Sydney Metro system comprise operational and subsequent indirect cost savings. Table I lists a synopsis of the ITS of the Sydney Metro.

TABLE I: OVERVIEW OF ITS OF THE SYDNEY METRO

ITS Interface Class	Application Interface	ITS Application	Process Automation
Center to Center	Rail coordination incident management	•Automated vehicle location •Operations management including incident management	•Information and computational technologies to provide holistic simulation and modeling •Information and computational technologies to provide prototyping and control operations
Center to Field	Ramp metering environmental management signaling	•Automated vehicle location •Operations management including incident management	Information and computational technologies to provide holistic simulation and control operations ONLY
Center to Train	Transit train communication	•Automated vehicle location	Information and computational technologies to provide holistic control operations ONLY
Field to Field	Rail intersection	•Automated vehicle location •Traffic signal priority	Information and computational technologies to provide holistic control operations ONLY
Field to Train	Signal priority	•Automated vehicle location •Traffic signal priority •Real-time passenger information pre-trip at stations and in vehicles	Information and computational technologies to provide general control operations ONLY

As it can be observed, the main process automation for the Sydney Metro generally comprises control operations. Although at the higher interface level, simulation, modeling, and prototyping were also implemented. Such decisions were based on the planned strategic direction together with the collaboration of various telecom and road operators, such as RTA and Transport for NSW.

Alternatively, such decisions would reduce the Sydney Metro users' travel time and costs and also help in reducing pollution. Besides, broad-spectrum IT application for this project comprises the implementation of smart cards and electronic ticketing systems.

Such IT applications require the extensive use of an appropriate communications architecture, updated transport network schematics together with appropriate system security. Overall, the ITS in the Sydney Metro is constantly validated and collaborated (via standards and specifications), thereby ensuring an updated and effective system. Accordingly, Fig. 7 shows the overall technology-based benefits of ITS for the Sydney Metro.

Evidently, the overall technology-based benefits of ITS in the Sydney Metro are increased operations, validated and updated records, optimized communications, and steady decision-making processes. Accordingly, these enhancements equate to improved performance, and subsequently, an enhanced transport network. In addition, the paramount and direct advantages of ITS encompassing the process automation framework for the Sydney Metro system comprise the following:

- Reduced error rate due to precise visualization and improved process structure protocols.
- Reduced reliance on multiple systems and platforms to accomplish tasks due to improved servers and optimized archives.
- Improvements in system performance (productivity, flexibility, and quality) and reliability by the use of

superior algorithms, data management, and high information accuracy.

- Reduction in costs via system reusability and long lifecycles.

In addition, indirect advantages include the following:

- More comprehensive ITS, and therefore, the agility to deal with project variations.
- Faster ITS by reducing lead times and increasing productivity.

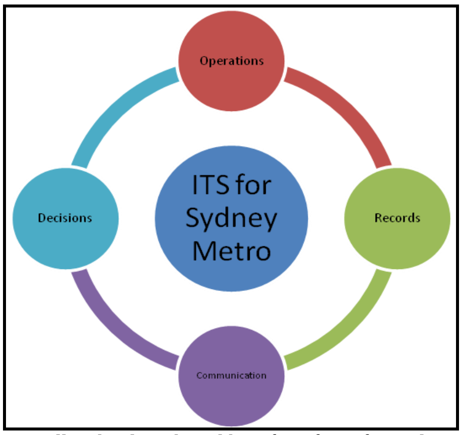

Fig. 7. Overall technology-based benefits of ITS for Sydney Metro.

IV. Conclusion

Commonly, ITS integrates a set of systematic prototypes and simulations. Such integration utilizes computational modeling and operational transitions to further optimize the overall ITS benefits.

Accordingly, an effective ITS must efficiently align various standardization activities globally. Such alignment must incorporate diverse interests from distinctive stakeholders. Moreover, such alignment would further optimize the ITS, subsequently increasing the existing infrastructure capacity.

As this study has demonstrated, an effective ITS must foster and integrate the overall theoretical knowledge together with its collaborative process. Fostering such an amalgamation not only further evolves ITS but also ensures its modernization. Fittingly, this study also exploited the Sydney Metro as a case study to further demonstrate the significance of effective ITS.

Although the main process automation for the Sydney Metro generally comprises control operations, simulation, modeling, and prototyping are also implemented. Such integration would both increase the system performance and improve travel time together with reducing costs and pollution. More importantly, ITS integration would ultimately improve IT communication and subsequent architecture along with optimizing the transport network schematics and appropriate system security.

Finally, this study showed how the ITS for the Sydney Metro system is constantly validated and collaborated, thereby ensuring an updated and valuable system.

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