

Research Advances in Intelligent Transportations Systems

(The Case of Advanced Public Transportation Systems)

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ABSTRACT

The purpose of this paper is to attempt to provide an overview of the exceedingly differentiated, itemized and multi-disciplinary research in the field of Intelligent Transportations Systems and more specifically the «Advanced Public Transportation Systems APTS».

Towards this purpose, we present the progress and results of a systematic literature review on the topic of APTS. The review is positioned in, and utilizes the literature of, the field of Intelligent Transportations Systems. In the review, we study the following research question: What researches and solutions have been developed so far in the field of Advanced Public Transportation Systems?

The main result of this study is that, we established history time sheet with a global perspective of APTS represented by five main phases, then classified the research and solutions by activity and usage type (Paratransit or Mass transit), followed by a review of current APTS characteristics based on the Right of Way (ROW) and by service type.

Keywords

Intelligent Transportations Systems (ITS); City Logistics; Advanced Public Transportation Systems (APTS); Systematic Literature Review (SLR); Right of Way (ROW).

1. Introduction

Currently cities are considered as the engine of the worldwide economy and to date they are home to more than half of Earth's Population (According to the United Nations). Thusly, urban transport is a key factor in the economic, social and urban development of the city. It is one of the important variables on which all urban planning is based in order to ensure availability, safety, Comfortability and affordability.

In recent decades, the need of mobility within urban area has grown rapidly, leading to a multitude of problems, including severe traffic jams and pollution. This need is expected to continue to grow rapidly in the future, which will further complicate the situation. The traditional approach to face the issues is to extend the infrastructure. However, researchers as well as professionals are interested more on ITS as a solution to face the current and future issues. Since that, their shown and potential benefits have made them more attractive.

2. Background

As literature contains several research studies, experience reports and cases studies on ITS, a systematic overview and synthesis of this growing body of research is still missing. In this paper, we start filling in this gap by giving a systematic literature review of researches on the subsystem APTS. This SLR is considered a valuable addition to the available ITS literature it will allow readers to have a clear picture and overview of research and technologies recently developed in this field.

2.1. Intelligent Transportation Systems (ITS): Driving Factors

The driving factors that affect the efficiency, evolution and adoption of the ITS can be categorised into 5 main parts as presented in the Figure 1, Economic Development of the urban area, the region and the country, Environmental issues generated by the transportation systems, Quality of life, Social Equity and affordability of solutions offered, and Sustainability. As well as, thus factors can be evaluated based on three-dimensions, Resources allocated, Technologies used, and obviously the institutional and Organizational Realities.

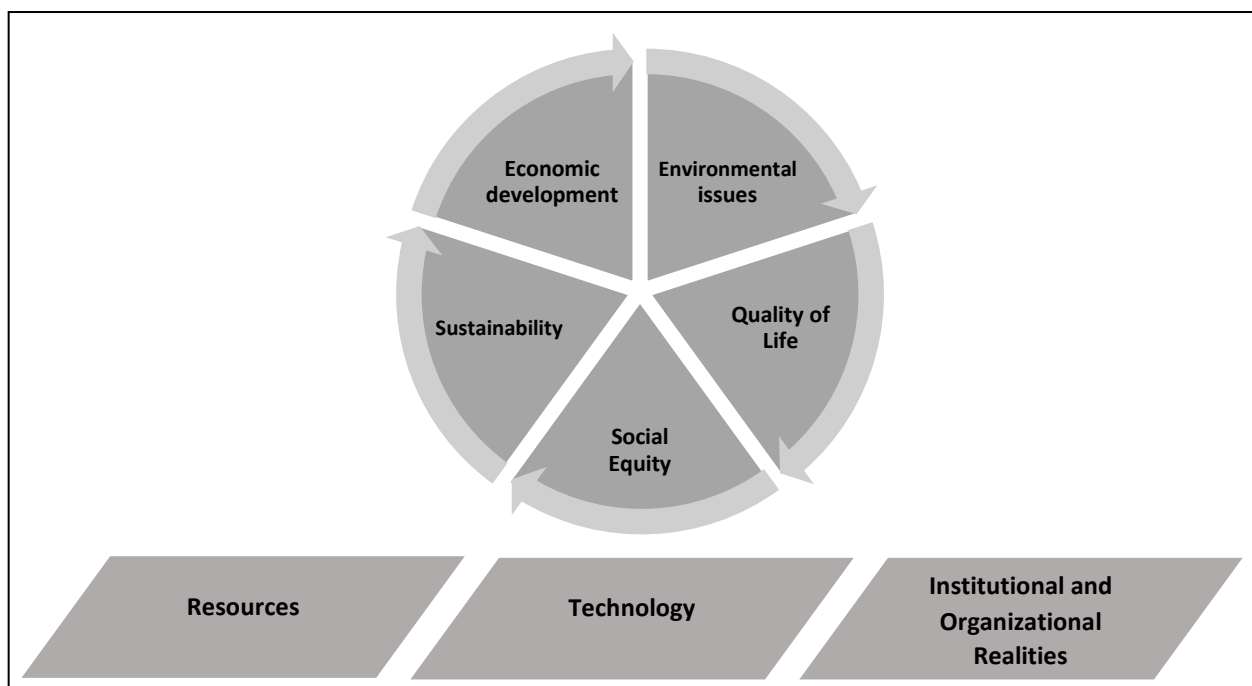


Figure 1. ITS Driving Factors

2.2. ITS Subsystems: The case of APTS

At present deployable ITS technologies and solutions can generally be categorized into nine subsystems (Bunch, James. 2012), as represented in table 1. Under each ITS subsystem category, a variety of ITS elements/solutions exist which are commonly implemented all over the world. In this paper we focus our review on the APTS subsystem, which is essential to the vitality of cities

Table 1. ITS Subsystems Categories (Bunch, James. 2012)

ITS Subsystems	Abbreviation
Advanced Traffic Management Systems	ATMS
Advanced Public Transportation Systems	APTS
Advanced Traveller Information Systems	ATIS
Advanced Vehicle Control Systems	AVCS
Advanced Rural Transportation systems	ARTS
Emergency Management Systems	EMS
Incident Management Systems	IMS
Commercial Vehicle Operations	CVO
Transit Management Systems	TMS

Although, the subsystems are complementary, each one is considered as an essential support to other ones, such as for the APTS, it is highly dependent on the evolution and technologies used in all other subsystems, which led us to consider it in our analysis.

3. Research Method

3.1. Research Question

Systematic literature review is a method of identifying, evaluating and interpreting all available research literature relevant to a specific research question, or topic area, or phenomenon of interest. It is appropriate for summarizing existing research, for identifying gaps in the existing literature, as well as for providing background for positioning new researches (B Kitchenham et al., 2004).

In this paper, we present the results of a systematic literature review on the topic of APTS. The review is positioned in, and utilizes the literature of, the field of Intelligent Transportation Systems. In the review, we study the following research question:

•RQ1: What researches and solutions have been developed so far in the field of Advanced Public Transportation Systems? While Intelligent Transportations Systems could provide many viewpoints to use as research questions, we chose this question because we consider it represent the viewpoints, which are likely to provide actionable insights to researchers as well as professionals and citizens. The research question try to highlight different solutions and characteristics in the existing APTS researches that could be effective in mitigating transportations problems in urban area.

3.2. Research Process

The research process consisted of four key steps represented in Fig. 2, the selection of primary studies was done in two steps first using keyword-based database searches to identify potentially relevant sources, and then manually filtering the search result. The two authors executed the manual filtering process independently. Data extraction was done by qualitative coding of the selected primary studies by the first author. Finally, the results were elicited by aggregating and analysing the coding of the primary documents. The entire process was audited and mentored by the second author.

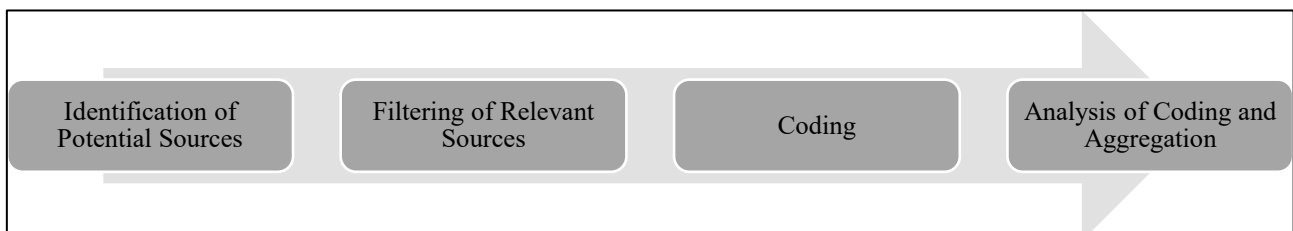


Figure 2. Summary of Research Process

4. Results: APTS Research Advances

In this section, we present our findings. We organized the results, into three main points (Evolution, Classifications and Characteristics of APTS), which are elaborated in this section. The purpose is to give the reader a clear idea about the main technologies and solutions developed so far in the field of APTS.

4.1. APTS Evolution

Based on the bibliographic analysis performed, which presents the history of the APTS in each country / region. We have established history time sheet with a global perspective Table 2. Through this time sheet, we have tried to combine the different historical previous works by distributing it into six main periods, which are Preparation (1970-1980), Feasibility study and research (1980-1990), First Generation APTS 1.0 (1990-2000), Second Generation APTS 2.0, Third Generation APTS 3.0, and APTS 4.0 (2015-present). Some main APTS technologies examples are given for each period in order to have a clear idea.

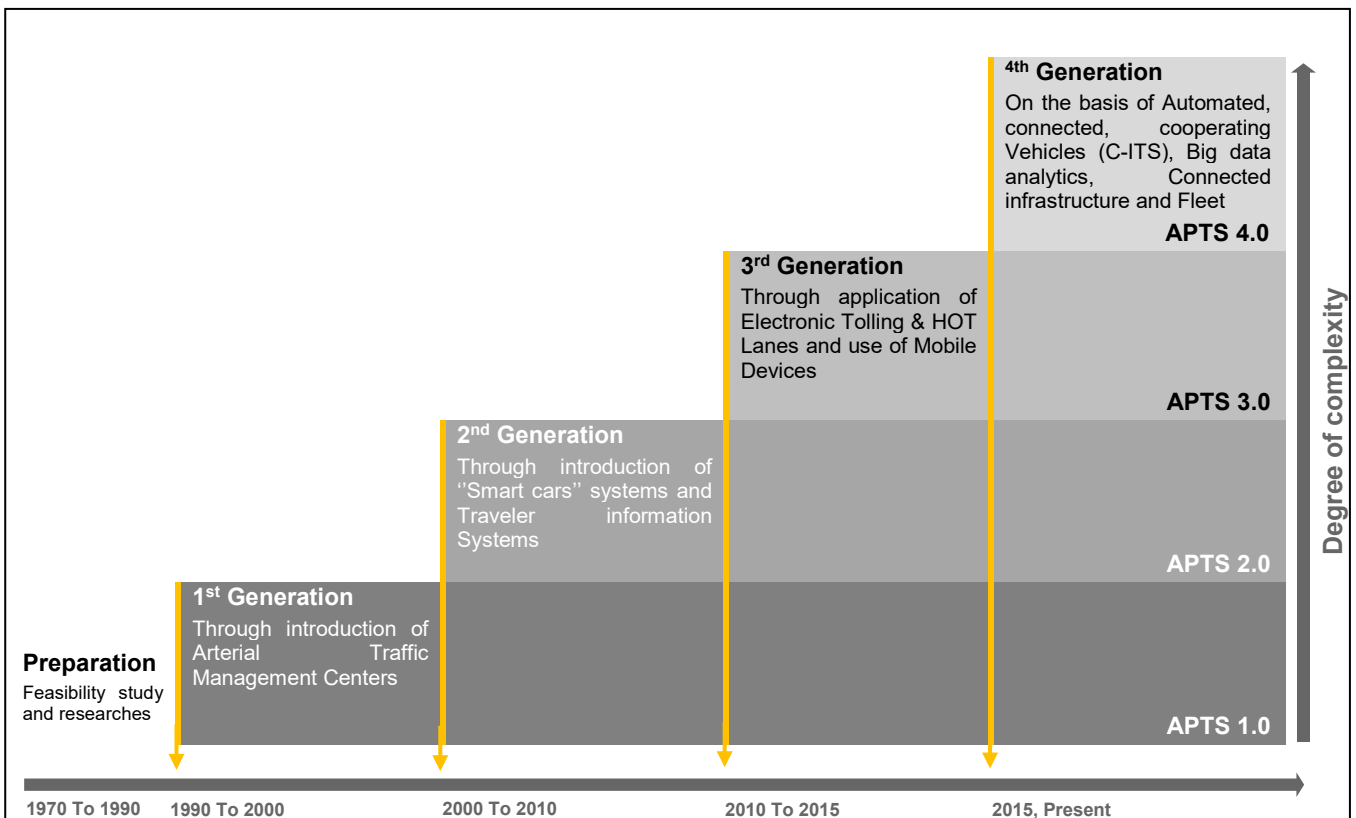


Figure 3. Time Sheet History of APTS Evolution (1970-Present)

4.2. APTS Classification

Public Transportation Systems consists of a family of usages type, which range from Personal Rapid Transit and shared bicycles to urban freeways, metro and regional railways systems. The basic classification of APTS, in light of the kind of their activity and use, is into two classifications.

- Paratransit (or for-hire transportation) is transportation given by operators and accessible to parties which use them for individual or several trips. Collective Taxi, jitney and dial-a-bus are the most widely recognized modes.
- Mass transit (or public/common transport) consist of transportations that are accessible for use by all people who pay the fees in question. These modes, which work on regular routes and fixed time schedules for examples, LRT (Modern Tram and Metro), bus rapid transit and a few other systems.

Table 2. APTS Classification by Usage Type

ITS Subsystem	Usage Type	Common Designation	Examples of Key technologies / solutions
Advanced Public Transportation Systems (APTS)	Paratransit: For-hire transportation	Demand-responsive transport (DRT) / Dial-a-Ride transit (DART)	UHF RFID technologies for real-time passenger recognition Hyperloop Personal Rapid Transit (PRT) Self-Driving Mini Bus
		Jitney, collective taxi	Micro-transit on demand
		Car sharing and bicycle sharing	Dynamic Ride and Bike sharing Public Road Transport Systems Connected to Mobile Devices
		Charter bus	LRT (Modern Tramway and Metro) Route Destination & Driver Information Display Traveller Information
	Mass transit: Public or common transport	regular route and time schedule	Bus Rapid Transit (BRT) Sky train Regional railways

4.3. APTS Characteristics

This section covers APTS basic characteristics. First, review of characteristics based on the Right of Way (ROW), that represent the type of way on which public transport operate. Then characteristics by service type.

Figure 4 represent the performance of the service level of APTS determined based on the ROW degree, «Category C» represent public transportation that are used in mixed traffic flow, «Category B» represent a dedicated road Physically isolated with a shared intersection with traffic. Further, «Category A» represent public transportation with a fully controlled and exclusive ROW such as Metro and sky train.

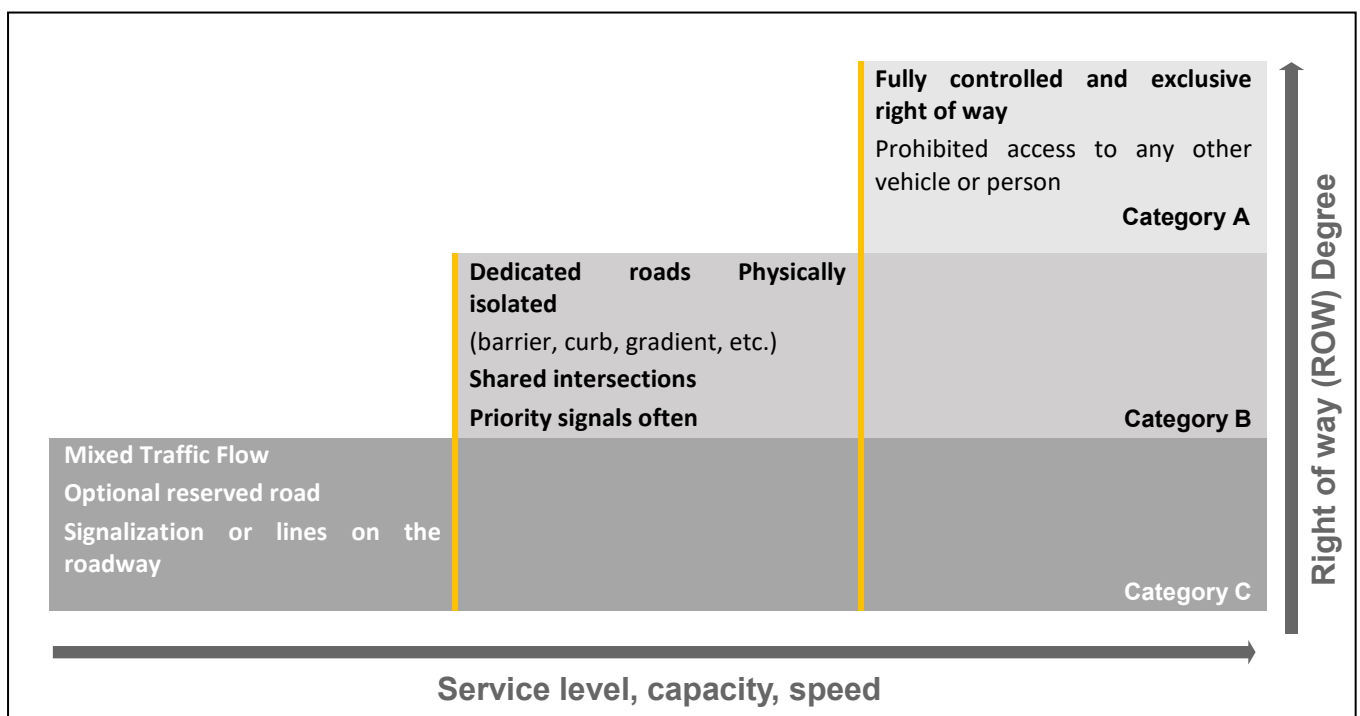


Figure 4. APTS characteristics based on the Right of Way (ROW) Degree

Therefore, Table 3 represent the APTS classified by Three main services Type, by Working hours of transport, by operation frequency & Type of Stops and by Types of roads & Location. For each service some examples are given in table below.

Table 3. APTS characteristics by Service Type

Types of roads & location	Operation frequency & type of stops	Working hours of operation
▸ short distances	▸ local service	▸ regular
▸ city centres	▸ all stops (omnibus)	▸ during the day
▸ campus	▸ accelerated service	▸ weekday service (5 days) or 7-day service
▸ airports	▸ some judgments deleted	▸ peak hours
▸ exhibitions	▸ service by zones	▸ especially from/to the city centre
▸ urban	▸ express service	▸ work trips mainly work trips
▸ intra-urban service	▸ remote stops	▸ special / irregular
▸ regional	▸ parallel service to lines local	▸ special events
▸ regional trains	▸ flexible definitions	▸ emergencies or bad weather
▸ suburban trains		▸ by night
▸ regional express buses		▸ school
▸ long-distance		

5. Discussion

In this section, we first discuss our general observations by a discussion regarding our research question. Then, we present a research agenda for future works.

5.1. General observations

The primary studies identified were almost exclusively research documents. Therefore, we extracted information on the APTS evolution, classification and characteristics. Researchers' bias may have influenced the choice of primary studies and data extraction. The selection of primary studies may have been distorted by misinterpretation of the inclusion criteria. This risk was mitigated by the coordination of the two researchers in designing the inclusion criteria. When inclusion criteria were used later, abstract filtering was done by both researchers independently, and confusing cases were resolved through case-by-case discussions. In the full text filtering stage, the first researcher performed the initial screening by making the decision regarding unambiguous cases. For the less clear cases both researchers read the paper and made independent proposals for inclusion or exclusion decisions. In cases where they agreed, the paper was included or excluded on the basis of their joint agreement. Articles that were not yet clear were discussed and resolved by the two researchers together.

5.2. Future research agenda

In this paper we had a worldwide thought about the recent advances in the field of Advanced Public Transportation Systems. We have observed that there is a massive increase of the number of researches in this subject considering that that it interests each citizen and organizations to search for good feasible solution for transportation in urban area, and thus for both, developed and growing countries; Based on that, we will continue our SLR through opting for an empirical study regarding the relevant challenges and success factors that face APTS implementation in cities. We think it requires significant further study and can be considered as essential and important point to this research.

6. Conclusions

In this paper and through a systematic literature review we analyzed papers describing and presenting qualitative findings of APTS research advances. By extracting and classifying public transport research and solutions developed so far in different countries.

The main conclusion of this study is that, we established history time sheet with a global perspective of APTS represented by five main phases, then classified the research and solutions by activity and usage type (Paratransit or Mass transit), followed by a review of current APTS characteristics based on the Right of Way (ROW) and by service type.

As future research topics, we are working on case studies and surveys on APTS applications challenges, studies on APTS deployment practices & success factors in developing countries.

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Biographies

Fouad JAWAB is a professor of higher education at Fez Higher School of Technology (EST) in Morocco. He is member of the Research Laboratory of Manufacturing, Energy and Sustainable Development and Director of the Research Laboratory in International Management, Decision Making and Logistics (MIDLOG). He has headed the Department of Management Science and Technology and directed the Logistics Management and Transportation training program at the EST, and is currently coordinating the "LOGISTICS" bachelor program. Urban logistics is one of its main areas of research interest.

Youssef EL MOKADDEM holds a master's degree in logistics and platform management, currently, a PhD student at Research Laboratory of International Management, Decision-making and Logistics (MIDLOG) at the high school of technology of Sidi Mohamed Ben Abdullah University-Fez-Morocco. His field of interest is Intelligent Transportations Systems and the challenges of cities logistics. He is, in parallel, a SAP Consultant in the area of logistics and Supply chain management.