Intelligent Transport Systems in Greece: Current Status and Future Prospects

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Abstract

This paper reviews the development and implementation of Intelligent Transportation Systems (ITS) in Greece by adopting a methodology that uses Key Performance Indicators – KPIs. Based on these indicators ITS implementation in Greece appears to perform in varying ways depending on a number of factors that relate to the local conditions in each urban area. Based on the analysis and quantification of the KPIs selected, the analysis facilitates the identification of some areas on which ITS experts and policy makers should focus for further improvement and speeder implementation. The main problems that are indicated in the study, relate to the fact the large majority of ITS projects implemented in Greece are not adequately documented and do not provide, at least to a limited extent, information over the web regarding their status or their provided services. Another problem area relates to the fact that there are no ITS projects that go beyond the road sector to encompass multiple modes of transport and support intermodality and multimodality. Also, there is a weakness identified for more ITS implementations associated with freight transport and the concept of Mobility as a Service (MaaS).

1. Introduction

Overpopulation, economic development, and the resulting need for increased mobility has been followed by negative consequences in terms of transport safety and traffic or environmental conditions (Spyropoulou et al., 2005; Hanai, 2013). This holds true especially within human settlements of increased density, taking into account, inter alia, the increasing rates of motorization (United Nations ESCAP, 2018). Intelligent Transport Systems (ITS) provide the means for efficient solutions towards the alleviation of the aforementioned challenges and contribute towards the attainment of sustainable urban transport systems and the better utilization of existing – and aging – transport infrastructure (Xiong et al., 2012; Tomas et al., 2013; United Nations ESCAP, 2018). Their vision can be summarized as forming an intelligent mobility landscape, where travellers will be fully informed, accidents and delays will be minimized, environmental impacts will be reduced, while provided services will be affordable, seamless, secure, and aware of privacy limitations (Giannopoulos et al., 2012; Lim, 2012; Kalupová & Hlavoň, 2016).

The power of ITS relies on the knowledge of the conditions prevailing within transport systems. This is achieved by collecting significant quantities of data, ranging from traffic and incident to traffic data (Smith & Venkatanarayana, 2005). These data streams enable the optimization of transport operations via several applications, such as travellers' information, traffic and incident management, and travel demand forecasting (Dabiri & Heaslip, 2018). Therefore, ITS can be perceived as a prominent symbol of smart cities, the overarching framework of which may be distilled into three main layers, namely data collection and management, data analytics, and service provision (Xiong et al., 2012; Dabiri & Heaslip, 2018). Similarly, ITS are in the heart of smart motorways which based on information received from traffic sensors and traffic cameras utilize active traffic management techniques (e.g., coordinated ramp signalling, speed and lane use management) in order to improve traffic flow, road safety, and travel reliability (Boddington et al., 2016; Jallow et al., 2019).

2. Problem statement

Despite the opportunities arising from ITS in terms of optimizing the utilization of existing transport infrastructure and alleviating significant challenges, the degree to which they can achieve their goals heavily depends on their level of deployment. The first objective of this paper is to assess the level of deployment of ITS in Greece. The assessment takes into account existing national ITS activities carried out in the context of relevant projects. The second objective includes the identification of specific areas, on which national policy makers and ITS experts should focus.

3. Methodology

The first step towards fulfilling this paper's objectives is to categorize the various ITS activities or projects conducted over time. A frequently used approach is the classification based on the priority areas suggested by the ITS Directive (2010/40/EU):

- Priority Area I: Optimal use of road, traffic and travel data;
- Priority Area II: Continuity of traffic and freight management ITS services;
- Priority Area III: Road safety and security applications; and
- Priority Area IV: Linking the vehicle with the transport infrastructure.

Several other organizations and researchers have provided classifications of ITS applications, by following either higher or lower-level approaches. An example of high-level classification may be found in the way that ERTICO (2017) discerns the ITS areas of application, namely connected and automated driving, clean mobility, transport

& logistics, and urban mobility. To the contrary, a detailed approach is that provided by Giannopoulos et al. (2012), who discern the following categories:

- Traffic and Travel Information (TTI)
- Traffic and Public Transport Management
- Navigation Services
- Smart Ticketing and Pricing
- Safety and Security
- Freight Transport and Logistics
- Intelligent Mobility and Co-modality Services
- Environmental and Energy Efficiency

Data collection in the context of this paper relies on the Greek National ITS Progress Report (Hellenic Ministry of Infrastructure and Transport, 2017) as well as the deliverable D3.1.1 of the SEE-ITS project (Katsaros & Mitsakis, 2013) in the context of which a detailed reporting concerning ITS applications has taken place. Available information is used, in order to quantify the following KPIs for the quantitative assessment of the ITS level of deployment in Greece:

- KPI1: number of ITS projects associated with each priority area
- KPI2: number of ITS projects in which the four most heavily involved stakeholders took part
- KPI3: number of involvements in ITS projects per type of stakeholder (by assuming the following types: a) central government, b) local governments and authorities, c) infrastructure operators, d) transport service providers, e) research/academia, and f) private companies)
- KPI4: number of ITS projects associated with each mode of transport (by assuming the following modes: a) road, b) rail, c) air, d) maritime, and e) multi-modal)
- KPI5: the degree to which the outputs of or at least some information for each project are available (by assuming the following values: a) "no information available", b) "limited information available", c) "complete information available")
- KPI6: number of domestic and foreign ITS projects (including national, municipal, and regional projects as well as European and cross-border projects respectively)
- KPI7: number of ITS projects per type of funding (by assuming the following types: a) private funding, b) public funding, c) private-public funding, d) EU co-funding, and e) EU funding)
- KPI8: number of ITS projects associated with urban environments
- KPI9: number of ITS projects implemented in/pertaining to each territorial unit of Greece (by adopting the first-level classification of the European Union)
- KPI10: number of ITS projects associated with each category proposed by Giannopoulos et al. (2012)

KPI1 facilitates the identification of specific priority areas that are not equally covered compared with others. While it would be beneficial to also record the amount of investment in each priority area, data limitations hinder this attempt and, thus, the provided analysis is limited to the number of implemented projects. KPI2 facilitates the identification of a centrality factor indicating the degree to which ITS projects are carried out by a wide range of stakeholders on a national scale or by certain stakeholders. This factor will derive by dividing the number of ITS projects in which a single stakeholder has taken part by the total number of projects in Greece. KPI3 allows the identification of the type of stakeholders that are more or less active in the field of ITS. KPI4 indicates the modes of transport that are supported by the carried out ITS projects. KPI5 provides an indication of whether the outputs of an ITS project are still relevant and supported by their developers. KPI6 showcases the degree to which ITS projects in Greece outreach national borders. KPI7 indicates both the nation-wide willingness-to-invest in ITS and the degree to which European funding mechanisms have been utilized. KPI8 showcases the degree to which ITS projects recognize the intensity of the problems that urban complex environments are facing. KPI9 provides an indication of the spatial distribution of ITS projects in Greece, while KPI10 sheds light on their content.

4. Preliminary results

The analysis of the literature sources mentioned in the second section resulted in the identification of 88 ITS projects in Greece. It should be noted that the quantification of the defined KPIs was not solely based on the content of these sources, but additional explorative research has taken place, in order to verify and enrich provided information. Table 1 includes the results related to KPIs 1 to 4. It is noteworthy that Greece is more active in projects related to priority areas I and II, while it seems quite inactive with respect to priority area IV. While several projects are associated with one priority area, there are also others which are associated with more than one. A prominent example constitutes the creation of ITS observatories or databases related to the process of monitoring ITS activities, which is associated with all priority areas. Similarly, projects encompassing, jointly, the installation of traffic counting devices and weather stations, the development of systems for the detection of incidents via CCTV cameras and the provision of information to drivers via Variable Message Signs (VMSs), and the operation of traffic control centres are associated with the first three priority areas. Furthermore, the four most heavily involved stakeholders are, in descending order, TrainOSE SA, the Hellenic Institute of Transport of the Centre for Research and Technology Hellas (CERTH-HIT), the Greek Ministry of Interior, and Egnatia Odos SA. By calculating the centrality factor corresponding to the most involved stakeholder (CF=16/88=0,182), it can be deduced that the implementation of ITS projects in Greece is not overly centralized, but this needs to be compared with the results

Table 1: Results related to KPIs 1 to 4: Results related to KPIs 1 to 4

KPI1	Related projects	KPI2	Projects	KPI3	Involvements in ITS projects	KPI4	Related projects
Priority area I	75	CERTH-HIT	12	Central governments	22	Road	61
Priority area II	56	Egnatia Odos SA	10	Local governments & authorities	46	Rail	14
Priority area III	18	Ministry of Interior	12	Infrastructure operators	27	Air	4
Priority area IV	6	TrainOSE SA	16	Transport service providers	28	Maritime	4
				Research/ academia	28	Multi-modal	19
				Private companies	26		

Table 2: Results related to KPIs 5 to 8

KPI5	Projects	KPI6	Projects	KPI7	Projects	KPI8	Projects
No information available	43	Domestic	75	Privately funded	27	Urban related	39
Limited information available	16	Foreign	13	Publicly funded	7	Non- urban related	49
Complete information available	29			Privately-publicly funded	8		
				EU co-funded	27		
				EU funded	19		

deriving from other countries, in order to be verified. In addition, the type of stakeholder with most involvements in ITS projects is that of local governments and local authorities, including various prefectures, municipalities, and public transport councils. The involvement of the rest stakeholders is nearly equal. Finally, the vast majority of ITS projects concerns the road sector, to a more limited extent the rail and the multimodal transport sector, and to much more limited extent the air and maritime sector.

Table 2 includes the results related to KPIs 5 to 8. The vast majority of ITS projects implemented in Greece are not adequately documented and do not provide, at least to a limited extent, information over the web regarding their status or their provided services. The unavailability of information in cases of intra-company projects funded by own resources is more excusable, but there exist cases in which various stakeholders (e.g. TrainOSE SA) announce the initiation of the provision of service, indicating their support towards that service. Moreover, Table 2 suggests that the vast majority of ITS projects in Greece is domestic, indicating a limited cooperation with foreign stakeholders. This result is mainly attributed to the fact that the list of analysed projects is exhaustive including several cases of small-scale and local projects (e.g. intelligent driver information systems regarding parking spaces within small urban districts). In contrast, it seems that a significant number of ITS projects has been financially supported from European instruments' sources. Moreover, a significant number of ITS project has been funded by own resources, which reveals a positive perception towards and willingness-to-invest in ITS. Finally, despite the significance of traffic and road safety problems within urban areas, the number of ITS projects implemented within urban environments is outweighed by those implemented at the inter-urban level.

Figure 1 includes the results related to KPI9, suggesting that the greatest number of ITS projects has involved the

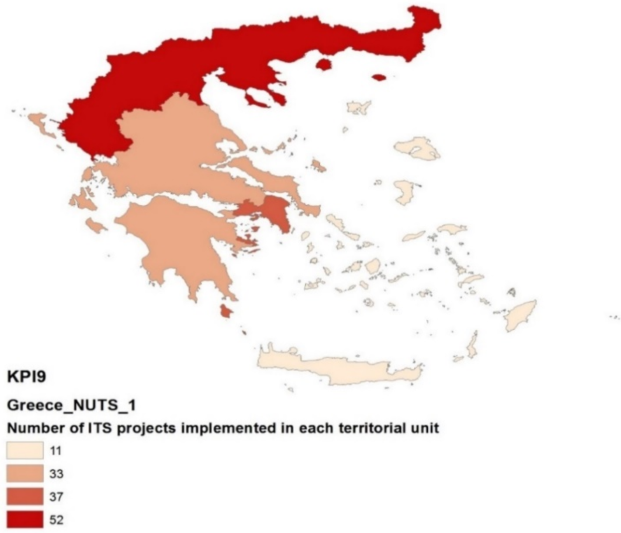

Fig. 1: Results related to KPI9

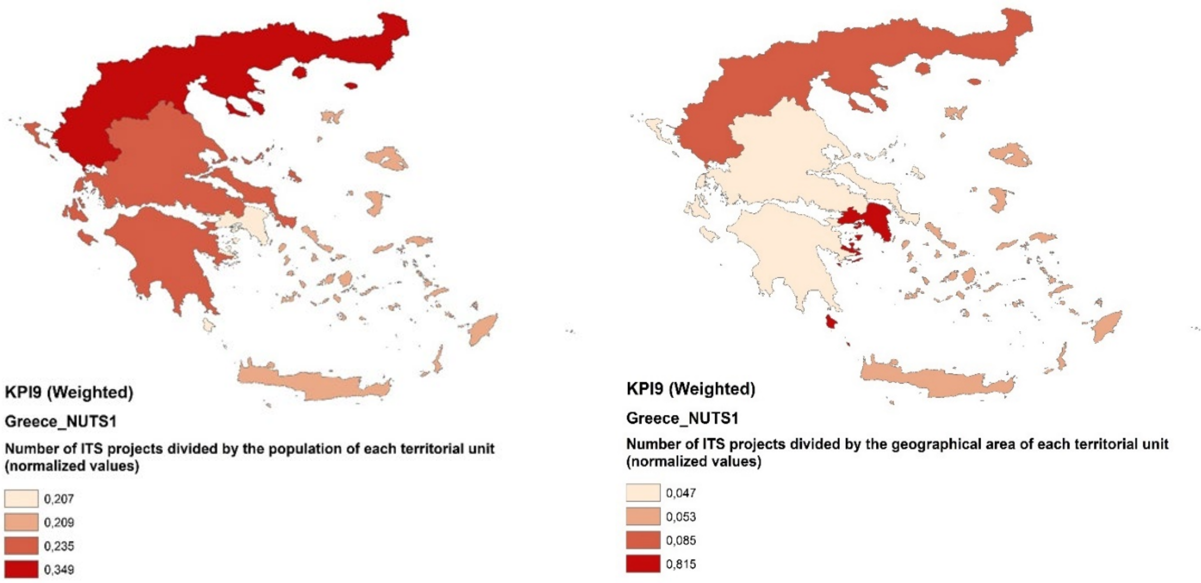

Fig. 2: Results related to KPI9 weighted by the population (left) and the geographical area (right) of each territorial unit

territorial unit of Northern Greece. This is associated with the fact that two of the most heavily involved stakeholders are in this unit (i.e., CERTH-HIT and Egnatia Odos SA). However, this result is not indicative of the density of ITS project implementation in each territorial unit. Such an assessment may be supported by weighting the number of ITS projects by the population or the geographical area of each territorial unit. According to Figure 2, the population-based approach leads to a conclusion that the densest application of ITS takes place within Northern Greece. This is attributed to the high relative number of ITS projects involving this territorial unit and its moderate population. On the other hand, the geographical area-based approach leads to a conclusion that the densest application of ITS takes place within the territorial unit of Attika. This is because said unit's geographical area is extremely lower compared to the remainders. Despite the rationale that both approaches may hold, the normalization of KPI9 based on the population of each unit seems more meaningful, considering that, as already described in the first section, increased population in urban districts is associated with several challenges that ITS aspire to alleviate. In this respect, at least for the city of Athens, the deployment of urban related ITS needs to evolve.

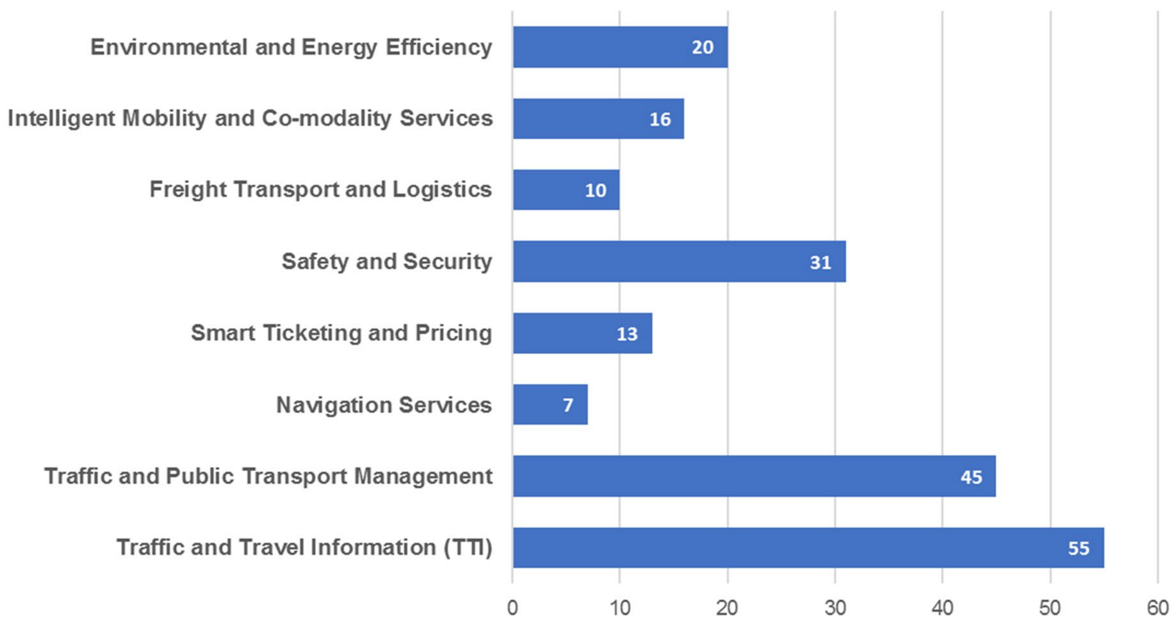

Fig. 3: Results related to KPI10

Figure 3 includes the results related to KPI10. It is noteworthy that the most projects in Greece are associated with the provision of traffic and travel information services (info-mobility) and the support of traffic and public transport management. To the contrary, the categories that are associated with the less projects are those related to the provision of navigation services, the provision of freight transport and logistics services, and the provision of smart ticketing services.

5. Conclusions

This paper constitutes an attempt to review the deployment of ITS in Greece by adopting a quantitative KPI-based methodology. While Greece appears to perform in a varying manner based on the adopted KPIs, this analysis facilitates the identification of some areas, on which ITS experts and policy makers should focus. The first area relates to the further promotion of ITS projects associated with the priority area IV of the ITS Directive. Such a recommendation is not only related with the number of projects implemented under this priority area, which may not be the most representative indicator, but also with the fact that this priority area is associated with recognized trends of the mobility sector, i.e., vehicle connectivity (KPMG, 2019; Völkers, 2019). Therefore, the promotion of projects related to this priority area is expected to lay the ground for and enhance the readiness of Greece to support Cooperative, Connected and Automated Mobility (CCAM). The second area relates to the promotion of ITS projects that go beyond the road sector, encompassing multiple modes of transport, thus supporting intermodality and multimodality. Such a goal also raises a discussion of whether the traditional emphasis of ITS service provision to lie within the road transport sector (Arndt, 2008) has yielded the expected impacts. The third area relates to the promotion of ITS projects associated with complex urban environments and the alleviation of the difficulties they steadily face, thus supporting the realization of Sustainable Urban Mobility goals. The last area, based on the results of KPI10, relates to the promotion of ITS projects associated with freight transport and the concept of Mobility as a Service (MaaS). Such a recommendation is both attributed to the key importance of logistics sector in Greece as well as the crucial principles upon which MaaS is founded including, inter alia, multimodality and intermodally, the personalization of mobility services, and their integration into common user-friendly bundles.

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Keywords

ITS, ITS in Greece, KPI, ITS implementation