# TOMI: A Framework for Smart Tourism on the Move Innovation

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# TOMI: A Framework for Smart Tourism on the Move Innovation

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## ABSTRACT

Smart technologies advancements, emerging markets competition and sustainability needs have radically changed tourism and transport sectors. The key features of this change are the exploitation of evolving Big Data in the business intelligence context, the development of customized services tailored to the needs of consumers with the purpose of improving their experience, and the development of new business models based on the interaction between business and consumers. This is due to the capacity of smart transport technologies to integrate customers sensing and in this way a novel framework aimed at: i) developing personalized transport services in the tourism sector and ii) creating and delivering patterns of tourist consumer behavior according to specific target groups and market segments at tourist destination or country level is designed and outlined. The proposed "TOMI" framework, exploits tour data analytics, in order to enable the deployment of personalized tour services that will be beneficial for tour operators, travellers and any other interested parties (local stakeholders, tourism entrepreneurs, etc.). The exploitation of the "TOMI" framework for the purpose of organizing tours in a city is also addressed through a case study on the city of Thessaloniki.

## CCS CONCEPTS

• **Information systems~Information systems applications;** • **Information systems~Data analytics;** • **Applied Computing~Transportation;** • Human-centered computing~Social network analysis

## KEYWORDS

tour analytics; road passenger transport services; tourism innovation; smart frameworks; smart tourism; smart transport

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## 1 Introduction

Tourism has widely recognized the need for a more personalized, customer-focused approach recently, which mainly assesses the needs, preferences and requirements of tourists in order to improve travel experience and maximize satisfaction, which are proved to be important [1], [2]. The acquisition of profound knowledge and its proper use, which is achieved through Business Intelligence [3] and Big Data Analytics [4], is a prerequisite for decision making and the design of quality services in the tourism industry [5]. In the time of *Tourism 1.0*, where the presence of Information and Communication Technologies (ICTs) was almost non-existent, the collection of information required long and complex procedures and it was difficult to create precise patterns of tourism profile. Subsequently, the tourism industry, following the rapid ICTs advancements, was transformed from Tourism 1.0 to *Tourism 2.0*, utilizing the capabilities offered by Web 2.0 [6], [7]. As stated by [8] not only the Internet and Web 1.0, but also Web 2.0 and the entire social networks environment had powerful impact on the tourism industry.

Then, the idea of *Tourism 3.0* emerged, which focuses on the promotion of tourist destinations at local and regional level and the active engagement of local actors (i.e., authorities, entrepreneurs, citizens and tourists) in the co-creation of tourism services. In this context, particular emphasis is given to rebranding of local destinations, developing new business

models and tourism activities, storytelling and redefining the role of tour agents [9].

Nowadays, we are living in the *Tourism 4.0* era [10], which describes the trend of the market to take advantage of the content created by users via web or mobile applications with the purposes of creating personalized services and improve travel experience [11]. The main prerequisite for designing and delivering personalized services, which are expected to increase the satisfaction of tourists and lead to lower costs and greater security, is the knowledge acquisition through the exploitation of advanced technologies such as cloud computing, web and mobile applications, virtual reality, Internet of Things, etc. as well as cutting-edge analytics such as artificial intelligence, machine learning algorithms, chat bots, etc. [12–14]. Since the concept of Tourism 4.0 matures, the landscape in travel arrangements that includes accommodation, intermodal transport and tours is changing [15]. A wealth of travel planning and booking options are already available to tourists, who can easily and instantly receive the information they need from various available applications [16]. Moreover, innovative pooled (shared) mobility models that are being developed such as bus pooling, ride pooling, etc., as well as, the efficient transport management through analytics and forecasting methods, lead to reduced costs and resources savings [17], [18]. On the other hand, new challenges are emerging in the tourism market as entrepreneurs will have to adapt to new conditions and redesign their services and marketing policies to meet new requirements, remain competitive and ensure their sustainability. As it is evidenced, the need for travel companies to offer value added services in order to differentiate themselves against the competition is enormous [19].

The shift of the tourism industry on the one hand to the promotion of tourist destinations, introduced by Tourism 3.0, and on the other hand to personalized service co-creation that will improve the tourist experience in the context of Tourism 4.0, are raising challenges for modern cities, which tend to become facilitators of tourism and business activities. Highlighting the strengths and unique characteristics of cities combined with the improvement of tourism services can generate comparative advantages that will distinguish them among other cities in the world's tourism industry. An indicative city example that has exploited these opportunities to become one of the most popular tourist destinations in the world is Barcelona. The capitalization of Olympic Properties and the harbor, which is the fourth cruise port in the world, the provision of high quality public transport, and the preservation of cultural heritage (e.g., Gaudi buildings, Picasso museum, etc.) attract millions of visitors each year [20].

Taking into account that the impact of transport on tourism has been little discussed and that there is a lack of organized and personalized travel services by coaches, inside and outside cities (as discussed later in subsection 2.2), this article aims to propose a novel framework that utilizes tour data analytics and can modernize *Road Passenger Transport Operators (RPTOs)* and support the deployment of customized tour services. The use and benefits of the proposed framework in the tourism sector are addressed in a case study on the city of Thessaloniki.

The contribution of this article is twofold: i) deals with the necessity of data analytics in the field of *RPTOs* with the purpose of acquiring knowledge and designing services for tourists on the move and re-introduces the term *"tour analytics"*, and ii) presents a novel framework along with two new plugins, which were designed in the context of our ongoing project to assist in the modernization of RPTOs and development of customized tour services. The proposed framework, which is extensible, along with the two new add-ons, is expected to directly benefit tour operators and travellers, and indirectly cities and other interested parties.

The rest of this article is organized as follows: *Section 2* deals with tourism analytics, and re-introduces the term *"tour analytics"*, proposing a new definition. The novel proposed *"TOMI" framework* that aims at the modernization of road passenger transport services and the development of personalized tour experiences both inside and outside cities is proposed in *Section 3*. A case study, which examines the exploitation of the proposed framework for the purpose of organizing tours in a city, is presented in *Section 4*. Finally, *Section 5* contains some conclusions and future perspectives.

## 2 From Tourism to Tour Analytics

The purpose of this section is to clarify the terms: *tourism analytics* and *tour analytics*, and to discuss their contribution to the tourism industry.

### 2.1 Tourism challenges addressed through Big Data Analytics

The exponential growth of Big Data [21], which may be structured, semi-structured or unstructured heterogeneous data derived from various sources such as online social networks (OSNs), sensors, telecommunication providers, GIS, etc., has significantly affected the tourism industry [5]. The exploitation of this data, which relates to tourists' choices before, during and after the trip, through data mining and forecasting methods for the purpose of gaining unprecedented insights into tourism, is known as t*ourism analytics* [20], [22]. Such analytics constitute an important tool for any tourism and local stakeholder as provides them with the opportunity to better understand the preferences of tourists, to improve their services and to create competitive and attractive tourism packages.

Tourism analytics, which, compared to traditional methods, offer reliability, new data flows and the possibility of using real-time data and forecasting have been used in several studies [22]. The user-generated content (UGC) posted by users on online platforms (e.g., OSNs, TripAdvisor[1] , Booking[2] , etc.) is definitely one of the most useful data sources as it provides direct and unbiased information about the preferences and opinions of tourists regarding to tourism services [23], [24]. Of particular interest is the work of [25] which focused on data analysis to gain knowledge about *tourist destinations*. The development of the "Destination Management Information System Åre" (DMIS

[1] https://www.tripadvisor.com/
[2] https://www.booking.com/index.el.html

Åre), designed by them, offers interested parties (i.e., tour operators, hoteliers, etc.) the ability to know the behavior and experience of the traveler before and after the trip as it can use platforms like Booking.com. Moreover, Brandt et al. [26] investigated the value of spatial and semantic analysis of OSNs messages in *smart tourism ecosystems*, which is a combination of digital ecosystems and smart tourism networks [27], utilizing 600,000 Twitter messages in San Francisco. Their findings have shown that OSNs analysis leads to the extraction of urban spatial patterns related to the presence, environmental engagement and local involvement of users throughout the city, which are useful for the development of *urban smart tourism*. In addition, Vecchio et al. [28], focusing on *smart tourist destinations*, studied a set of regional tourist experiences for the southern European region, and specifically Southern Italy (Apulia region), in order to derive patterns and value creation opportunities from Big Data. As it was demonstrated by their findings, Big Data generated by UGC on OSNs and its real-time integration and analysis is the most important guide to the value creation process in a *smart tourist destination*. Its exploitation improves decision-making processes, creates marketing strategies with personalized offers, contributes to transparency and confidence in dialogue with customers and stakeholders, and leads to the emergence of new business models. Finally, Marine-Roig & Clavé [20] also focused on *smart tourist destinations*, utilizing UGC in travel blogs and websites that included tourists' reviews over the last decade concerning the city of Barcelona.

Apart from the data collected from OSNs and the Internet, data from the telecommunications network utilized in the context of the tourism industry. Leng et al. [29] used call detail records (CDR) as part of the analysis and assessment of tourism strategies at local and national level in the country of Andorra. Furthermore, some scholars combined data from different sources. For instance, Li et al. [30], in order to predict the *travel destination demand* including the *number of tourists* and *hotel occupancy* in Beijing, combined data from Baidu[3] and the Beijing Tourism Association[4].

## 2.2 The necessity of data analysis in the field of Road Passenger Transport

The planning of *OD-transport (origin-destination transport)*, which describes transport from the tourist home to the tourism destination, as well as, of *local transport*, which is the transport at destinations, is particularly important in the tourism industry [31]. The combination of transport modes in the tourism sector leads to the development of both *international* and *local transport networks* creating new opportunities and markets for tourism destinations [31].

With regard to local transport, tourists choose the means of transport taking into account the following factors: i) time limit, ii) distance, iii) status, iv) comfort, v) security, vi) benefit, vii) price, viii) geographical position, and ix) competition [32]. Taxis and cars are expensive and affect negatively the environment regarding energy use, carbon dioxide emissions, poor air quality, and noise [33], [34]. On the other hand, Guiver et al. [35] in their review, investigating the role of buses in environmental, social and economic sustainability in the tourism sector, found out that buses achieve moderate displacement from cars, allow access to the countryside for people without cars and strengthen local economies. Due to these advantages, they suggested the promotion of buses' use and market segmentation to the identification of new target groups. In addition, urban public transport compared to taxis and rental cars offers low cost and low environmental burden. Nevertheless, public transport, due to supply constraints, confronts passengers' congestion and mitigates the travel experience of tourists by returning them to the daily routine [36].

In this respect, the use of private hire buses (or coaches) of multiple sizes and seating capacity is an ideal solution for tourists' transport, as they gather the benefits of public transport and can provide personalized services, improving travel experience [37]. This service falls within the *road passenger transport mode*, which refers to the total movement of passengers using inland transport on a given network [38]. According to Regulation (EC) No 1073/2009[5] , which governs the national and international carriage of passengers by bus or coach, *RPTOs* are authorized to offer road transport services in various sectors, such as tourism, school transport, personnel transport, etc. after obtaining a Community License.

With regard to tourism, RPTOs can offer personalized bus tours to tourists, turning cities into tourism destinations and improving their experience. Lumsdon [39], investigating the factors that influence the development of tourism bus services, suggested a model for the design of the tourism bus networks. According to this model, some of the main factors to be taken into account for the prevalence of tour buses are quality and service delivery, travel integration between transport and tourism operators, driver behavior, marketing and monitoring mechanisms. Consequently, the design of efficient and competitive services requires knowledge that will come from the appropriate data analytics which, to the best of our knowledge are still missing for services provided by RPTOs [39]. Adopting and revising the term of tour analysis used by [40], who used data from the Sydney Household Travel Survey to compare travel analysis and tour analysis in Sydney, we propose the following definition for tour analytics:

*"Tour analytics is data analytics for acquiring profound knowledge and designing transport services for various purposes (e.g., pleasure, business, education, etc.)."*

# 3 Data Aware and Adaptive RPTOs

This section discusses the need for modernization of RPTOs, as well as, the "TOMI" framework, which was designed to address this need.

[3] http://ir.baidu.com/phoenix.zhtml?c=188488&p=irol-irhome
[4] http://www.wta-web.org/eng/hymd_4014/yz/bjsdlyjtyxzrgs/
[5] https://ec.europa.eu/transport/modes/road/passenger-transport_el

## 3.1 Technology transfer for adaptive RPTOs

The purpose of this article is to present the main idea of our ongoing project that aims at the modernization of RPTOs and the development of customized tourism transport services, utilizing tour analytics. The idea is inspired from the Airline industry, where advanced technologies are used for service providing, demand forecasting, and the development of competitive sales policy [41]. RPTOs in most places around the world are in the same state as airlines were in the 70s [42], [43]. Since then, airlines met a tremendous growth in the technological field, in the management efficiency, in scalability and in the field of profit optimization. On the other hand RPTOs have been left behind and in the time that this article is written most of them are even online unreachable [43]. This lack motivated us to adopt and adapt the airline established technologies in road transport developing a novel framework, which is based on an existing platform entitled *"TOMI" platform*, with the purpose of helping RPTOs to increase their product quality, competitiveness, income and to reduce their operating costs. In addition, this framework is expected to offer personalized services to travellers who use it for ticket reservations as well as valuable knowledge to local authorities who want to make use of local transport networks for various purposes and to any other interested party.

## 3.2 The "TOMI" framework

The proposed framework that aspires to implement the above idea, enriching the services of the existing *"TOMI" platform* with the addition of two new plugins, is presented in Fig. 1.

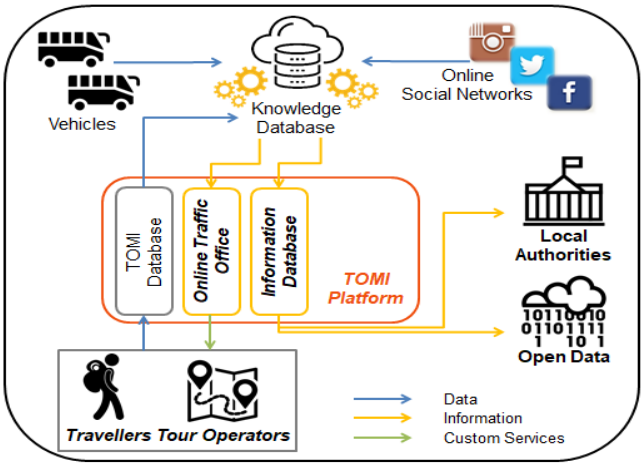


**Figure 1: The "TOMI" framework**

The *"TOMI" proposed platform* was designed on the basis of the already operational private startup solution *Movvin*[6], which develops integrated solutions for RPTOs. The "TOMI" framework aims to act as a one-stop-shop for RPTOs in the field of management bookings, tickets, vehicles, drivers, routes, etc., all of them integrated in a single online and extensible platform. The operator can handle all online and offline bookings in an efficient way, while online booking are handled automatically with plugins that "TOMI" offers. Those plugins can be plugged in static web pages and transform them into online booking endpoint for travellers. In addition, the platform offers to the traffic officer the ability to manage routes and itineraries in a more efficient way in comparison with traditional management tools In addition, the platform offers to the traffic officer the ability to manage routes and itineraries in a more efficient way in comparison with traditional management tool as AI patterns would be used to undertake day-to-day operational functions (optimal route calculation, route design, etc.). Besides that, the platform offers *Rostering Management tools* [44], which are very useful for large operators or for those who want to increase their scalability. At last the platform offers an enhanced *Fleet Management too*[7]*l* for monitoring vehicles and informs the traffic officer, in real time, for its fleet status.

As demonstrated in Fig. 1, heterogeneous Big Data derived from three different data sources will be exploited for the development of the new plugins. These data sources are as follows:

- ***"TOMI" database:*** The "TOMI" platform handles all bookings, all routes, all itineraries etc., from all RPTOs. When a booking is done, "TOMI" tracks down all related metadata to the specific booking for post process analysis and research. Also, RPTOs handle all routes and itineraries through the platform and this enables "TOMI" to have a clearer view of the transportation as a product in all its aspects and in a wider geographical field. In addition, Rostering Management related data is handled and kept in the database for a better and efficient management in wide time periods using cutting-edge Data Analytics technologies.
- ***FCD and IoT on vehicles:*** Vehicles from the collaborating RPTOs are monitored using IoT devices plugged into the vehicle's ECU[8] (Engine Control Unit). This IoT device is connected using OBD2[9] protocol and performs read only operations. It reads all available data from the *vehicle's status* including engine status, engine failures, other vehicles failures, fuel consumption etc. Moreover, the IoT device has auxiliary systems that read GPS signal, inertial movements or specific emission analyzer for real time gas monitoring. This IoT device is equipped with a cellular modem and through standard mobile protocols, such as GPRS, 3G, 4G, it transmits the data into *Knowledge Database*. Each IoT device performs real time streaming of all those data, which are analyzed and broadcasted to the corresponding operator.
- ***OSNs:*** As pointed out by [45], OSNs (i.e., Twitter, Facebook, Instagram, etc.) act as "human sensors", which record human activity, offering volumes of heterogeneous data at a very low cost. The content created and shared by users in these networks is an important data source about their

[6] https://Movvin.com/

[7] https://whatis.techtarget.com/definition/fleet-management
[8] https://www.computerhope.com/jargon/e/ecu.htm
[9] https://www.csselectronics.com/screen/page/simple-intro-obd2-explained/language/en

preferences, opinions and reviews, which can be exploited in many fields, such as marketing, psychology, smart cities, etc. [46], [47]. In the context of the "TOMI" framework, the data coming from OSNs will be used to gain insights into travellers' preferences and satisfaction regarding tours and RPTOs' services.

This data will be transferred into *Knowledge Database* where will be aggregated and tour analytics will be carried out leading to patterns and insights into itineraries, travellers preferences, vehicles and drivers behavior, etc. Subsequently, this valuable information produced will be transferred into the "TOMI" platform, feeding the two plugins. Finally, the *Online Traffic Office* will provide the traffic offices of RPTOs and travellers with customized services, while the *Information Database* will provide *Local Authorities* (e.g., municipalities, etc.) and *Open Data Platforms* with valuable information.

The "TOMI" framework is expected to have important impact. With regard to RPTOs (tour operators), *fuel consumption optimization* will be performed by suggesting more efficient routes or drive patterns, while in the field of *booking*, optimization in the revenues using will be performed using adaptive fare structure, a well-established technique in the Airlines. Furthermore, last Rostering and Fleet management will be aided by smart optimizers which will help the Traffic Officers to perform scheduling in large scale efficiently. As far as travellers are concerned, personalized services will be developed, while competition among RPTOs will lead to more qualitative and economical tour packages. Finally, local authorities and any other interested parties can make use of the available information, offered by "TOMI", in decision-making and in the design of new services.

## 4 Proof of Concept Design and Plan

Since the "TOMI" framework is in its development phase, a case study is presented, which explores how a city can become a tourist destination through its use.

Situated in northern Greece, Thessaloniki is the second largest Greek city, which hosts the second largest export and transit port and the second largest international airport of the country. Built near the sea, it is a modern metropolis with rich history, cultural and spiritual heritage and cosmopolitan character, which give it a unique beauty and charm. Thanks to its unique history and interconnectivity, and serving as a base for nearby destinations, Thessaloniki attracts millions of visitors, annually [48]. However, despite its cultural wealth and its great potential to become a top tourism destination, such as Barcelona [20], Thessaloniki lags behind in the field of transport and organized tours. The supply of public urban transport for tourism purposes is limited, with the result that the tourist product and the travel experience of the visitors are degraded.

In this respect, the "TOMI" platform combined with the proposed framework seems to be excellent tools for organizing value added tours and improving the quality of tourist services offered in Thessaloniki. Tour operators (i.e., RPTOs) and travellers are expected to benefit from the customized services offered by the Online Traffic Office, as shown in Fig. 1. In particular, travellers' preferences and reviews, the popularity of attractions and points of interest, and information on the fleet state (e.g., fuel consumption, travelled distance, maintenance, etc.) allow RPTOs to organize attractive and profitable packages, adjust demand-based service prices and manage their resources effectively. With regard to travellers, they will benefit from competitive prices and the quality of services tailored to their needs and preferences. Finally, the city will benefit as its sights and culture will be promoted attracting new visitors, new business activities will be created and competitive advantages will be acquired, turning it into a popular tourist destination.

## 5 Conclusions

The article proposes a novel framework, called "TOMI", aiming at bridging the gap in supply of customized transport services by buses in the tourism sector. The proposed framework attempts to modernize RPTOs and lead to the deployment of personalized tour services that will be beneficial for tour operators, travellers and any other interested parties (local actors, tourism entrepreneurs, etc.). Exploiting tour data analytics, the "TOMI" framework aspires to expand the services and impact of the "TOMI" platform on which it is based, with two new plugins which are the following: i) *Online Traffic Office* that will offer customized services to RPTOs and travellers, and ii) *Information Database* that will provide valuable insights into urban tourism to local authorities through an open data platform. These plugins is expected to make an effective contribution to fuel consumption optimization, to travellers' preferences identification and to emergence of new tourist destinations. In addition, in the field of booking, revenue growth is expected through the use of an adaptive structure of fares, while travellers will benefit from competition among tour operators. The use and benefits of the "TOMI" framework in the tourism industry are investigated in a case study on the city of Thessaloniki.

Our future thoughts concentrate mainly on three directions. The first one involves the implementation of the "TOMI" framework through the development of the proposed plugins to be integrated into the "TOMI" platform and its extension through market research and design of new services directly or indirectly related to road passenger transport. The second concerns the thorough discussion of the smart mobility and sharing issues, and the comparison of the proposed framework with the car pooling services. Finally, the latter aims at analyzing the new business models in road transport and the needs that led to their development, as well as assessing the impact of the "TOMI" framework on the value chain of a city and on the operation of RPTOs.

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