Creating the Future Airport Passenger Experience: IMHOTEP

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Integrated Multimodal Airport Operations for Efficient Passenger Flow Management

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***Abstract*—This poster presents an overview of the SESAR project '*Integrated Multimodal Airport Operations for Efficient Passenger Flow Management*' (IMHOTEP). IMHOTEP's vision is that of a multimodal European transport system where the different modes are seamlessly integrated, so that passengers travel from door to door in an efficient, sustainable and resilient manner. Within this vision, airports will become multimodal connection nodes. To contribute to this vision, IMHOTEP will develop a ConOps and a set of enabling technologies for collaborative decision-making between airports and ground transport modes based on a shared view of real-time passenger flows.**

Keywords-Airport CDM; multimodality; passenger journey; real-time decision-making; disruption management

I. INTRODUCTION

In its vision for Europe in 2050, the European Commission establishes the goal that '90% of travelers within Europe are able to complete their journey, door-to-door within 4 hours' [1]. Aligned with this vision, the European Commission depicts a passenger-centric system that takes travelers from their origin to their destination in a seamless, efficient, predictable, environmentally-friendly and resilient manner [2]. Achieving this vision calls for enhanced modal integration not only in terms of physical infrastructure, but also of business models, operational processes and information systems. Airport Collaborative Decision-Making (A-CDM) is enhancing the efficiency of airport operations due to information sharing and common situational awareness between airports stakeholders but the concept has so far focused on the airside operations. Total Airport Management (TAM) is a more holistic concept that foresees closer integration of landside and airside processes, but leave out of the picture the passenger access and egress legs. The extension of the A-CDM process to the ground transport system has been suggested as an enabler for a better integration between the airport and the ground transport system. A key enabler for this integration is the development of information platforms and services that provide airports and ground transport stakeholders with a common and comprehensive picture of the door-to-door passenger flows. In recent years, the use of personal mobile devices has opened new opportunities for the collection of high-resolution passenger trajectory data with an unprecedented level of accuracy. These data can be blended with the information from different stakeholders not only to monitor passenger flows in real-time, but also to build short-term predictive models and develop look-ahead strategies.

II. OBJECTIVES

The goal of IMHOTEP is to develop a concept of operations and a set of data analysis methods, predictive models and decision support tools that allow information sharing, common situational awareness and real-time collaborative decision-making between airports and ground transport stakeholders. The specific objectives of the project are the following:

1. Propose a concept of operations for the extension of airport collaborative decision making to ground transport stakeholders.
2. Develop new data collection, analysis and fusion methods able to provide a comprehensive view of the door-to-door passenger trajectory
3. Develop predictive models and decision support tools able to anticipate the evolution of an airport's passenger flows within the day of operations and assess the operational impact on both airport processes and the ground transport system
4. Validate the proposed concept and the newly developed methods and tools through a set of case studies conducted in direct collaboration with airports, local transport authorities and transport operators.

III. METHODOLOGY

The proposed research methodology comprises five main stages:

A. Development of the IMHOTEP ConOps and definition of case studies

The IMHOTEP ConOps aims at extending the A-CDM process to include airport access and egress modes. The ConOps will describe the characteristics of the proposed system from the point of view of airports and ground transport stakeholders, through a set of use cases. A set of case studies will be defined, with the airport of Palma de Mallorca and London City airports as final users, to simulate and evaluate the proposed concept.

B. Data collection and preparation

This task includes data anonymisation, cleansing, formatting, transformation, aggregation, conversion, etc., as well as consistency checking across data sources. The data sources used in the project include:

(i) Anonymised mobile phone records. The data contain the registers generated every time a mobile phone interacts with the network. In these the time stamp and position (at antenna level) of the device are recorded. Data also include sociodemographic information of the users, such as age and gender.

(ii) Data on the ground transport system, including the road and rail networks, the transport services, public transport ticketing, smart card data and road traffic counts, among others.

(iii) Airport data provided by participating airports. These data will include data on the airport systems and processes, aggregated data on the use of airport facilities, and disaggregated data on the passenger itineraries in the terminal generated by airport sensors.

C. Modelling and short-term forecasting of passenger flows

In this stage new data analysis algorithms and predictive models will be developed for the reconstruction and forecasting of the passenger flows. Two activities will run in parallel:

1) Modelling of passenger terminal processes

A set of algorithms will be developed for the detailed reconstruction of the passengers' itineraries inside the terminal through the analysis and fusion of data generated by personal mobile devices and the data collected by different airport sensors. Passengers' itineraries inside the terminal will be used to calibrate a simulation model based on the airport simulation software CAST, a multi-agent simulation framework which allows the modelling of pedestrian flows.

2) Modelling of passenger access and egress

Algorithms will be developed for the detailed reconstruction of the passengers' door-to-kerb and kerb-to-door itineraries through the analysis and fusion of data generated by personal mobile devices and other supply ground transport data. The estimated passenger's access/egress itineraries will be combined with the information on the supply of transport services to/from the airport to build and calibrate a multimodal transport model based on the traffic simulation software Aimsun Live.

D. Development of decision support toolset

This stage will integrate the previously developed models in order to provide a full view of the Passenger Activity-Travel Diaries. The integration will involve the development of the required interfaces to integrate both models; and, the implementation of a set of KPIs to measure the quality, sustainability, efficiency and resilience of the journey. These KPIs will be used by the airport and the ground transport stakeholders to perform what-if analyses and collaboratively decide on the best course of action. Finally, a prototype dashboard will be developed that will allow the users to filter, visualise and analyse the KPIs of their interest.

E. Demonstration and evaluation

The last stage of the project will be devoted to the demonstration, validation and evaluation of the IMHOTEP concept and the newly developed tools. The results of the case studies will be complemented with a feasibility analysis of the proposed concept. The knowledge extracted will be synthesised into a set of guidelines and recommendations on the applicability of the IMHOTEP ConOps and a roadmap for the transition to the SESAR Industrial Research.

IV. Progress Beyond the State of Art

To achieve the goals of the project, IMHOTEP will bring the following improvements in the state-of-the-art:

A. Enhanced understanding of passenger behaviour

Until recently, surveys were the only way of collecting information on long-distance door-to-door mobility. Passenger surveys are expensive and time consuming, usually resulting in limited sample sizes, and the responses are often imprecise. The proliferation of personal mobile devices and IoT sensors has opened new opportunities to overcome these limitations. IMHOTEP will seize this by reconstructing passengers' door-to-door itineraries, with an unprecedented level of accuracy and detail, from the fusion of mobile phone data and other data provided by the partner airports and ground transport operators. And also, by developing new data analysis and classification algorithms for exploiting the information encoded in the mobile phone records for passengers characterisation (e.g., travellers type - business, leisure-, socioeconomic profile, etc.)

B. Integrated modelling of Passenger access/egress and terminal processes

So far, the modelling of passenger behaviour at the airport terminal and in the access/egress legs have been completely disconnected from each other, reducing the look-ahead window of the model predictions and leading to suboptimal operational decisions. IMHOTEP will address this problem by coupling predictive models for the access/egress legs and the terminal processes. The solution will enable what-if analyses based on an integrated view of the passenger itineraries. While in existing solutions the situational awareness of the airport access/egress legs relies mainly on traffic counts, the IMHOTEP models will be fed with more accurate input data on travel demand enhancing the predictive power of the models.

C. New intermodal concepts and passenger information services.

The multimodal information platforms and services are based on the integration of information of different transport services; this integrated view is then provided to the passengers, so that they can act upon it. The IMHOTEP solution will go beyond this by enabling new intermodal concepts based not only on supply information, but also on accurate travel demand information, allowing a more flexible planning of the supply services according to passengers' needs. It will also enable the development of advanced information services that take into account the forecasted congestion levels at different points of the itinerary, thus providing more accurate recommendations.

D. Extension of the A-CDM concept to include ground transport modes.

Finally, IMHOTEP will provide the airport and the ground transport system with a shared and accurate view of the door-to-door passenger trajectories, IMHOTEP will go beyond the current airport collaborative decision-making, providing ATM and ground transport with enhanced situational awareness of the passenger flows and enabling the optimisation of the performance of the multimodal transport system as a whole

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