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A generic system dynamics based tool for airport terminal performance analysis

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ABSTRACT

Decision making for airport terminal planning, design and operations is a challenging task, since it should consider significant trade-offs regarding alternative operational policies and physical terminal layout concepts. Existing models and tools for airport terminal analysis and performance assessment are too specific (i.e., models of specific airports) or general simulation platforms that require substantial airport modelling effort. In addition, they are either too detailed (i.e., microscopic) or too aggregate (i.e., macroscopic), affecting, respectively, the flexibility of the model to adapt to any airport and the level of accuracy of the results obtained. Therefore, there is a need for a generic decision support tool that will incorporate sufficient level of detail for assessing airport terminal performance. To bridge this gap, a mesoscopic model for airport terminal performance analysis has been developed, that strikes a balance between flexibility and realistic results, adopting a system dynamics approach. The proposed model has a modular architecture and interface, enabling quick and easy model building and providing the capability of being adaptable to the configuration and operational characteristics of a wide spectrum of airport terminals in a user-friendly manner. The capabilities of the proposed model have been demonstrated through the analysis of the Athens International Airport terminal.

1. Research scope and objectives

The ever-increasing growth in air transport implies increasing demand for airport services, which further propagates into the need for providing more efficient airport terminal services. The airport terminal constitutes a major element of the airport system, since increased congestion levels in airport terminals may cause delays in flights and deteriorate passenger perception on the level of service offered. Decision making for airport terminal planning, design and operations management is a challenging task, since the airport terminal is a highly complex system, incorporating significant trade-offs regarding alternative operational policies and physical terminal layout concepts. The implementation of an operational concept that may enhance the efficiency of a facility may deteriorate the performance of another, with negative impacts on overall system performance. Consider the following example: if more personnel are allocated to passport control counters, the passport control process can be accelerated, offering higher level of service to passengers. However, this would result in higher passenger accumulation for the subsequent process of security screening, affecting negatively its level of service. Therefore, the focus must be placed on overall system rather than on individual airport terminal processes and facilities.

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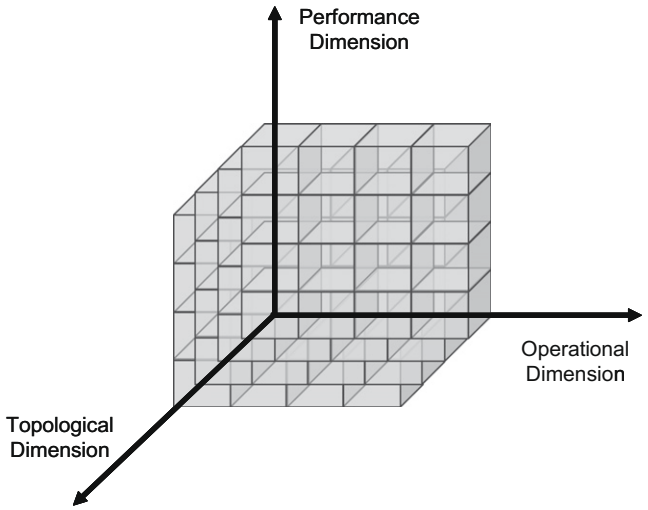

Fig. 1. Airport terminal complexity dimensions.

In a generalized sense, the overall complexity of the problem associated with modelling airport terminal operations relates to three factors as shown in Fig. 1:

(i) the topological dimension, which relates to the complexity deriving from alternative physical terminal layout concepts,
(ii) the operational dimension, which relates to the complexity deriving from alternative operational policies that an airport may follow, and
(iii) the airport terminal system performance dimension, which is determined based on the trade-offs between the above two factors.

Specifically, every unique combination of an operational policy and a terminal layout concept eventually corresponds to the determination of a unique airport terminal system performance.

In parallel, the airport terminal exhibits dynamic behaviour in time and space and is characterized as a highly complex large-scale system, since it involves:

(i) a substantial number of entities (e.g., departing/arriving/transit passengers, well-wishers, greeters, visitors, airport operators, airlines) and types of services (e.g., ticketing, check-in, boarding pass control, passport control, security screening, ancillary services, etc.),
(ii) complex interrelations between successive phases of processing of the various customer groups,
(iii) trade-offs between resources requirements and offered level of service, and
(iv) variability and stochastic events (e.g., seasonality and peaking patterns of airport demand, stochastic flight delays, randomness and stochastic variations in arrival and service operations, stochastic airport users' behaviour) (Manataki and Zografos, 2006).

In this respect, there is an urgent need for a decision support tool that will sufficiently address complex processes and adopt a holistic view and systems thinking approach for airport terminal system analysis. Existing models and tools for airport terminal analysis and performance assessment are either too detailed (i.e., microscopic) or too aggregate (i.e., macroscopic), affecting, respectively, the flexibility of the model to adapt to a wide spectrum of airport terminals and the level of accuracy of the results obtained. Furthermore, there exists lack of models/tools that can be easily, and without the deployment of technical expertise, customized to reflect the configuration of any specific airport. To bridge this gap, a generic, mesoscopic model for airport terminal performance analysis has been developed, that strikes a balance between flexibility and realistic results, adopting a system dynamics approach. The proposed model has a modular architecture and interface, enabling quick and easy model building and providing the capability of being adaptable to a wide spectrum of airport terminal configurations and operational environments in a user-friendly manner. To this respect, the overall objective of this paper is to present the development and use of a system dynamics model for integrated airport terminal analysis, which can be accomplished through the following research activities:

(i) highlighting the need for a mesoscopic model for airport terminal analysis,
(ii) describing the high-level architecture of the proposed model for airport terminal analysis,