Technology Assessment and Prioritization for Small and Medium Airports: A Methodological Approach

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***Abstract*—The air transportation industry is a significant source of employment for millions of people around the world. It is also an indispensable part of the economic infrastructure and as such, the gridlock experienced and forecast at large airports may have major negative impacts on the economy. This research aims to address the increase in demand and resulting capacity issues by considering the implementation of operational concepts and technologies at underutilized airports. The objectives of this work are primarily to off-load the busiest airports by increasing operations at smaller airports, reduce door-step to destination travel time, and provide transportation alternatives. More particularly, this work proposes a methodology to help in the assessment and prioritization of equipment packages and technologies necessary to enable that increase in operations. By associating multi-criteria technology selection techniques to ongoing small airport simulation effort, this work aims at helping airport managers make more informed decisions with regards to equipment offers in order to meet their future technological needs.**

I. Introduction

Though very sensitive to rising fuel prices, and political and economical crises [1], the air transportation industry has not stopped growing over the last decades, both in terms of passengers and aircraft movements [2]. However the passenger traffic is far for being uniform and is mainly concentrated over a few airports, generally in metropolitan areas, meaning that most of the airport infrastructure is currently underutilized. In addition, since 1990 and more significantly after 2000, the major legacy carriers in the U.S. underwent major restructuring and gradual downsizing of their fleet, replacing large aircraft with smaller regional jets. The emergence of regional jets, along with the significant growth in low-cost carriers experienced during these years [3], resulted in the number of operations growing faster than the passenger traffic [4]. This increase in the number of operations is also expected to be reinforced within the next 10 to 15 years with the entry into the market of Very Light Jets (VLJs).

A. The Problem

The trends in passenger and aircraft movements is likely to continue within the next decades [5]. As a matter of fact, the Federal Aviation Administration (FAA) is forecasting a 40 percent increase over today's passenger demand by 2010 [6], with a "45 percent increase in passengers between 2005 and 2017 being accomplished by a 33 percent increase in air carrier operations" [3]. This statistic would imply that the number of operations would grow slower than the number of passengers. This would then worsen the already existing disparity between demand and capacity and reinforce congestion levels at some major airports [4].

Tomorrow's air transportation system will be characterized by an increase in the types of airspace users (regional jets, very light jets, unmanned aerial vehicles, etc.) as well as very few new airports development projects. This leads to the realization that the forecast demand and resulting capacity needs will have to be addressed with innovative uses of the existing airport infrastructure ([4], [7]).

Airports have been identified as the major constraint to growth [8] and different strategies have been proposed to address the capacity issue. These strategies can mainly be divided into capacity increase strategies (addition of new runways, use of new/additional equipment, implementation of new operational concepts, etc.) and demand management strategies (peak period pricing, shifting flights from congested airports to less-busy secondary and regional airports, etc.) [9]. However, no strategy alone can solve the problem. Eurocontrol, for example, in "*The Challenges to Growth*" study published in December 2004 [10] found that even if they use every runway to its maximum capacity, "airports will still be unable to cope with the demand if traffic continues to increase in line with the higher estimates of future growth" [11]. Similarly, there exist divergent opinions with regards to the capability of new technologies and operational concepts to resolve the congestion issue.

II. The Need for a Different Approach

Most of the research conducted in the past has only considered either demand management or capacity increase strategies. However, it has recently been acknowledged that the improvement of the air transportation system should come from the implementation of a combination of

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solutions and strategies Furthermore, each combination of solutions should be evaluated with economic and policy factors/impacts/analysis in mind [12], and not only from a technical perspective.

Secondary and underutilized airports have also been the focus of recent studies ([13], [4], [12], [14], [3], [2]). The development and increase of operations at smaller, underutilized airports now appear as a viable and key means to meet travel demand in congested metropolitan areas. The NGATS Report for example states that "it is essential to enable increased operations at smaller airports in the same region to offload some of the demand on the busiest airport(s) where practical (e.g. air taxi operations)" [14]. In the same report, it is acknowledged that "significant growth at the busiest airports as well as regional and smaller airports is needed to achieve the capacity goal of the NGATS" [14]. In its Report to Congress, the FAA also mentions that "redistribution of traffic among airports to make more efficient use of facilities is another measure that can be used to reduce delays" [3]. In that same report, the FAA stresses that "another factor that helps to limit delay is the ability of carriers to introduce service to outlying, suburban airports, using them to relieve congestion at the principal airport" [3]. The THENA Consortium also recognized that "new secondary airports that are adjacent to main population areas might constitute an additional air traffic channel (with even more rapid growth rates than the hub), especially for short haul, point-to-point routes" [2]. Further, some governments are also more interested in developing secondary airports as illustrated by the British government who refused to expand London Heathrow but gave the priority to the expansion of Stansted airport, the London metropolitan region secondary airport [15].

Finally, the growing interest for secondary airports also comes from the travelers themselves. More and more travelers are flying from alternate or secondary airports and are motivating their choice by citing reasonable driving time, competitive air fares and time savings [16]. As mentioned in a recent newspaper article, "from 1996 to 2002, the number of passengers departing from Manchester Airport almost quadrupled, to 1.85 million from 500,332. During the same period, passengers leaving from Logan declined by about 10 percent, to 11 million" [16]. This trend has also been observed at other airports such as Fort Lauderdale or Midway [16], confirming that this type of airports offers a viable option to air travel. The growing interest for secondary airports, particularly due to the presence of low cost carriers, also exists in Europe. Brussels South Charleroi airport, for example, saw its passenger traffic increasing from 200,000 travelers to more than 2 million annually in only four years, primarily due to the presence of two of the busiest low-cost airlines [17]. However, while secondary and regional airports may be part of the solution, they often lack the appropriate equipment and technology that would allow for an increase in their number of operations.

Some studies have been focussing on the impact of new technologies and operational concepts on both the National Airspace System (NAS) and airports. However, little work exists that considers both operational concepts implementation and spatial shifting of flights from busy and congested airports to close-by less used secondary and regional airports. Hence, very little work has been carried out that focuses on the technological and operational impacts of technologies on small and medium airports.

Furthermore, small or regional airports differ greatly from large airports, as their budgets, needs and constraints are different. As such, the benefits identified in previous studies to large airports may not be applicable to small and medium airports. Definition and selection of technology or equipment portfolios must be based on thorough benefits assessment as these decisions will require suitable investment strategies. However, the benefits considered shouldn't be limited to performance only, but should include cost and monetary benefits as well. This is particularly important when considering small and medium airports, as their budget and ability to finance equipment investments are more limited than for large airports. Finally, current work on the topic lacks a methodical approach for airport technology evaluation and selection. Smaller airports have different needs and constraints, and all existing or future technologies may not be suitable. Technology and equipment selection should thus be made based on airports' needs, constraints and requirements with regards to their current equipage and operations, but also with regards to the future type of aircraft mix that will be operating at these airports.

A. Approach

This research proposes to address the increase in demand and resulting capacity issues by considering the implementation of operational concepts and technologies at underutilized airports. The methodology developed offers a simulation and multi-criteria decision-making framework to assess and prioritize equipment packages and technologies, based on both performance and economic metrics. The operational concepts and related technologies/equipment considered in the scope of this work are mainly related to Communication, Navigation and Surveillance, both on board and on the ground.

This methodology is divided into three main steps:

- Identifying the gap: this step consists in identifying airport needs, constraints and requirements to reduce the gap between the forecasted demand and the airport capabilities
- Addressing the gap: this step consists in assessing the benefits and degradations of candidate technologies and equipment against both performance and financial factors. A candidate portfolio of technologies is then obtained through a Multi Criteria Decision Making framework.
- Closing the gap: this step consists in ensuring that the technology portfolio defined in the previous step provides the airport with the desired capabilities while remaining within the budget considered.

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B. Research Goals and Objectives

The goal of this research is to provide a parametric, robust, and multi-criteria environment to help in the evaluation and prioritization of technologies and equipment packages for small and medium airports. Such an environment will enable "what-if" games and trade-off analyses to be conducted and will provide scenario-based solutions to the airport managers, hence allowing them to make more informed decisions with regards to equipment offers.

The objectives of this work are four-fold:

- Unburden the demand at the busiest airports by increasing operations at smaller airports
- Improve mobility by reducing door-step to destination travel time
- Provide transportation alternatives
- Gain a better understanding of the functional and emergent relationships between the different technologies and operational concepts at the airside level

C. Challenges

Airports are complicated and complex systems exhibiting many interacting, interrelated and interdependent components. As such, the challenges of this work are directly related to the characteristics of such systems. Challenges can be divided into research and technical challenges. Research challenges include:

- Identifying the appropriate airport measures of performance
- Identifying the appropriate technical and financial factors that the equipment packages/technology portfolios have to be evaluated against
- Identifying the different sources of uncertainties
- Obtaining a proper understanding of technology and equipment interdependencies and interactions

Technical challenges mainly concern the development of the Multi Criteria Decision Making environment and the lack of information available with respect to the different technologies and operational concepts. As a matter of fact, limited work has been conducted on the impact of existing equipment or technology on airport performance. Hence, this lack of data makes the equipment/technology evaluation and impact assessment difficult. Finally, the Multi Criteria Decision Making tool developed in the framework of this research should provide appropriate fidelity and robustness without requiring excessive computer time and resources.

D. Benefits

This research proposes to address some of the recommendations and research gaps mentioned in previous studies. Particularly, this work considers the need expressed by many to:

- Develop "models/tools, operational concepts and methodologies to assist in assessing airport operations efficiency, (...), exploring trade-offs, implications, and interdependencies between several airport performance metrics" [2]
- To account for emerging technologies [18]
- To incorporate both ground-based and airborne systems capabilities ([5], [18])
- And to develop "tools to monitor and quantify implications, measures and effectiveness of the new strategies and solutions proposed" [19]

This research is also relevant to the following NextGen goals and strategies [20]:

- Satisfy future growth in demand (3X current levels) and operational diversity
- Develop airport infrastructure to meet future demand: integrate airport, airspace and air traffic management design, development and deployment
- Develop cost-effective concepts, technologies, and procedures for providing comprehensive air traffic services at small airports

Finally, this work will provide scenario-based robust solutions to the issue of capacity and delay and deepen the understanding of the functional and emergent relationships between the different technologies and operational concepts at the airside level.

III. Conclusion

This research proposes to address the increase in demand and resulting capacity issues by focussing on the implementation of operational concepts and technologies at underutilized airports. By doing so, this work considers both demand management and capacity increase strategies. This work also addresses the lack of a structured approach for airport technology evaluation and selection by proposing a methodology for the assessment and prioritization of technology for small and medium airports, with technologies and operational concepts being evaluated with respect to both airports performance, and economic needs and constraints. The multi-criteria decision making environment proposed will provide airport managers with the ability to conduct tradeoff analyses, and make more informed decisions with regards to technology offers. Finally, this work is relevant to NextGen goals and strategies and proposes to address some of the recommendations and research gaps mentioned in previous studies.

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References

[1] C. Gresnigt, "Future needs and trends from an airline point of view," in *Presentation of the 1st THENA Workshop: European Airports: Current Problems and Challenges*. Brussels, Belgium: IATA Europe, February 2002.

[2] T. N. on Airport Activites (THENA), "Airport capacity and efficiency - final synthesis," Fifth Framework - Promoting Competitive and Sustainable Growth, Tech. Rep., 2003.

[3] FAA, "Report to congress - national plan of integrated airport systems (npias) (2007 - 2011)," U.S. Department of Transportation - Federal Aviation Administration, Tech. Rep., 2006.

[4] P. A. Bonnefoy and R. J. Hansman, "Emergence of secondary airports and dynamics of regional airport systems in the united states," MIT International Center for Air Transportation., Department of Aeronautics and Astronautics - Massachusetts Institute of Technology - Cambridge, MA 02139 USA, Tech. Rep. ICAT-2005-02, May 2005.

ISBN: 978-0-615-20720-9

[5] S. Consortium, "Air transport framework - the current situation," SESAR Consortium, Tech. Rep. DLM-0602-001, July 2006.
[6] G. L. Donohue, "U.s. air transportation: An approaching perfect storm," *Aerospace America*, pp. 26–32, August 2006.
[7] T. M. C. US Department of Transportation, Federal Aviation Administration and C. for Advanced Aviation System Development, "Capacity needs in the national airspace system - an analysis of airport and metropolitan area demand and operational capacity in the future," U.S Department of Transportation, Federal Aviation Administration, The MITRE Corporation and Center for Advanced Aviation System Development, Tech. Rep., June 2004.
[8] S. Hasan, "System wide modeling for the jpdo," November 2006.
[9] K. G. Zografos and M. A. Madas, "A critical assessment of airport demand management strategies in europe and u.s.: A comparative perspective," in *Transportation Research Board Annual Sunday Simulation Workshop*, Washington, D.C, January 2003.
[10] Eurocontrol, "Piata - performance indicators analysis tool for airports," 2004.
[11] Eurocontrol and A. Europe, "A vision for europe aviation," EUROCONTROL and ACI EUROPE, Tech. Rep., 2005.
[12] G. Hunter, K. Ramamoorthy, P. Cobb, A. Huang, M. Blake, and A. Klein, "Evaluation of future national airpsace system architectures," in *AIAA Modeling and Simulation Technologies Conference and Exhibit.*, no. AIAA Paper 2005-6492, San Francisco, CA, August 2005.
[13] P. A. Bonnevoy and R. J. Hansman, "Investigation of the potential impacts of the entry of very light jets in the national airspace system," MIT International Center for Air Transportation (ICAT), Massachusetts Institute of Technology, Cambridge, Massachusetts 02139 USA, Tech. Rep. Report 2006-02, 2006.
[14] H. Swenson, R. Barhydt, and M. Landis, "Next generation air transportation system (ngats) air traffic management (atm) - airspace project," National Aeronautics and Space Administration, Tech. Rep., 2006.
[15] P. Forsyth, "The impacts of emerging aviation trends on airport infrastructure," *Journal of Air Transport Management*, vol. 13, pp. 45–52, 2007.
[16] B. Estabrook, "Smaller airports are growing in stature," *The New York Times*, December 2003.
[17] W. Underhill, "Low-cost airlines redrawing europe's map," *Newsweek International*, March 2006.
[18] Eurocontrol, "Air traffic management strategy for the years 2000+: Executive summary," Eurocontrol, Tech. Rep., 2003.
[19] T. N. on Airport Activites (THENA), "Synthesis report on airport simulation modeling," Tech. Rep., September 2003.
[20] JPDO, "Next generation air transportation system integrated plan," Joint Planning and Development Office, Tech. Rep., 2004.

ISBN: 978-0-615-20720-9