

<b>Institution: De Montfort University</b>		
<b>Unit of Assessment: 11</b>		
<b>Title of case study: Support for Operations and Security for the Global Air Transport Industry (Modelling, Forecasting and Optimisation)</b>		
<b>Period when the underpinning research was undertaken: 2006–present</b>		
<b>Details of staff conducting the underpinning research from the submitting unit:</b>		
<b>Name(s):</b>	<b>Role(s) (e.g. job title):</b>	<b>Period(s) employed by submitting HEI:</b>
Dr Mario Gongora	Associate Professor	2003–present
<b>Period when the claimed impact occurred: August 2013–present</b>		
<b>Is this case study continued from a case study submitted in 2014? N</b>		
<b>1. Summary of the impact</b>		
<p>Research at DMU in modelling and optimisation has led to worldwide impact by supporting the development of security and operations policies for the global air transport industry. These have enhanced the security screening process of millions of passengers travelling daily through nearly 1,200 international airports. This was achieved through the contributions of Dr Mario Gongora as international adviser, where he disseminated the relevant research outcomes supporting security; leading to an active contribution in the development of the Smart Security programme guidelines disseminated across all airports around the world by the International Air Transport Association (IATA) and Airports Council International (ACI) and steering the industry to develop suitable solutions.</p>		
<b>2. Underpinning research</b>		
<p>This research resulted from the work that Dr Gongora's team conducted in 2000, tracing back the origin of genes from observing only the external traits of individuals. Starting in 2003, and in collaboration with a multidisciplinary research team including geneticists, outcomes from research developed in gene behaviour identification from the developmental traits in animals provided novel modelling tools for 'tracing back' behaviours in 'opaque processes' [R4]. At the core of the modelling and optimisation team from the Institute of Artificial Intelligence (IAI) at DMU, this work generated a branch focusing the same technologies to tracing back customer behaviour from generic data from large venues. This was collated with behaviour modelling and optimisation of operations and resources and was first validated in a commercial application with the collaboration of Birmingham Airport [R5].</p> <p>The commercial exploitation potential became obvious and filled a critical need in the air transport industry -- to be able to enhance security as well as customer service -- which had been seriously conflicting objectives since the tragic events of 9/11. A great deal of work had been done for other industry processes where quality and cost also conflict, but were not as critical as with the safety (life) and screening of passengers, and not applicable to this problem.</p> <p>The success of our application, with further validation using data from other airports and venues, attracted the interest of industry and investors who, after thorough due diligence in 2008, provided seed funding for the creation of a spin-off company (Venuesim Ltd) to commercialise the application of this research. <b>One condition of the investors in the creation of the company was an embargo on any publications (academic or otherwise) of the research directly related to the development of the company's products.</b></p> <p>Aside from this publication embargo, the team continued the research in state-of-the-art Computational Intelligence to support operations modelling and optimisation. The highest profile publications are in areas diverging from those under commercial exploitation, but there is still research closely related which continued to build on the impact and fed the company with new technologies to provide updated impact throughout the impact period [R3, R2].</p>		

The underpinning research remains active to maintain the state of the art of our contribution and provide repeated advances to the industry. For instance, in the case of airports and the original products commercialised by the company, forecasting has reached saturation point (e.g. every commercial product now reaches easily 95% consistent accuracy). The continued impact of the research is currently in novel contributions to dynamic and resilient optimisation. [R1, R6].

### 3. References to the research

The publications were all in international research journals or conferences, all having high standards of peer review. In particular R2 was submitted and published in Q1 high impact journals (in our discipline at time of submission), both reaching a wide audience in the research field. R1, R3, R4, R5 were published and presented in the top 3 international conferences in the field of AI. R6 was published in an internationally recognised journal and conference in a multidisciplinary field.

- [R1] Chitty, D.M., Yang, S. and Gongora, M. (2017) 'Considering flexibility in the evolutionary dynamic optimisation of airport security lane schedules', *Proceedings of the 2017 IEEE Symposium Series on Computational Intelligence*; DOI: 10.1109/SSCI.2017.8285177
- [R2] Miller, S., Gongora, M., Garibaldi, J. and John, R. (2011) 'Interval type-2 fuzzy modelling and stochastic search for real-world inventory Management', *Journal Soft Computing*, 16: 1447–1459; <https://doi.org/10.1007/s00500-012-0848-y>
- [R3] Miller, S., Gongora, M. and John, R. (2010) 'Optimising resource plans using an interval type-2 fuzzy model', *Proceedings of Fourth International Workshop on Genetic and Evolutionary Fuzzy Systems (GEFS 2010)*, Mieres, Asturias, Spain, March 2010; DOI: 10.1109/GEFS.2010.5454158
- [R4] Gongora, M. and Rodas, M.C. (2009) 'Analysis of organized asymmetry development using artificial cellular differentiation models', *Proceedings of the IEEE Symposium Series on Computational Intelligence*, Nashville, TN, USA, April 2009; DOI: 10.1109/ESDIS.2009.4938998
- [R5] Gongora, M. and Ashfaq, W. (2006) 'Analysis of passenger movement at Birmingham International Airport', *IEEE Congress on Evolutionary Computation, CEC 2006*, in IEEE WCCI 2006, 16–21 July 2006, Vancouver, pp 1339–1345; DOI: 10.1109/CEC.2006.1688464
- [R6] Eaton, J., Yang, S. and Gongora, M.A. (2017) 'Ant colony optimization for simulated dynamic multi-objective railway junction rescheduling', *IEEE Transactions on Intelligent Transportation Systems*, 18(11): 2980–2992; DOI: 10.1109/TITS.2017.2665042

### 4. Details of the impact

The details present how, between 1 August 2013 and the end of 2019, Dr Gongora's research at DMU has had significant impact in the security processes of the air travel industry by actively contributing to IATA's and ACI's efforts in guiding airports on maximising security while minimising disruption to passengers, and sustaining significant growth in air travel. This contribution includes security procedures, personnel training and the use of forecasting and optimisation tools to make efficient plans (e.g. rostering) according to throughput management and modelling, as well as guiding the R&D of manufacturers to provide state-of-the-art equipment.

After the tragic events of September 2001, airport security became challenging, creating conflicting processes among different airports and authorities, with no international agreement in place. The industry faced a serious conflict between operating safely while minimising costs and maintaining a high level of customer service. At the time, the team lead by Dr Mario Gongora were maturing their research in holistic behaviour modelling and process optimisation.

To contextualise this research, the team approached airports which quickly recognised the value of this work to allow growth in operations and enhance customer service without compromising security (e.g. with Birmingham Airport, R5). These trials resulted in Dr Gongora and his team becoming renowned worldwide as leading experts in the field.

As a result of Dr Gongora's research and recognition as mentioned above, he was invited to join IATA's 'Checkpoint of the Future' programme (COF) Expert Group (made up of a select number of worldwide experts in airport security and optimisation of operations) to work with their advisory group (made of airport/airline managers and international transport authority executives). The COF evolved into the Smart Security programme when IATA and ACI joined forces to bring their efforts into a single global programme from early 2014.

The contribution of our research to the global air transport industry focuses mainly on the continuous development of the roadmap for the future of airport operations, taking cognisance of the criticality of security, the technologies and processes required to achieve this. The roadmap is delivered via continuously updated guidance documents to which Dr Gongora contributes as part of a select group of international knowledge exchange partners. These documents have emerged as the de facto standard for modern airport operations and security. They are used by IATA's 300 airline members, ACI's airport members (over 1,900 worldwide) as well as airport regulators (in 176 countries), authorities, industry and screening equipment manufacturers [C1, C2, C3].

These guidelines have shaped the evolution of airport security from inefficient, inconsistent (across airports and countries) and disruptive measures, to well-defined and consistent processes in the screening of hand baggage, managing of security point operations and appropriate allocation of resources that have significantly enhanced both security and passenger experience while allowing significant growth in the traffic since its inception (see p 18 of C5, where Keflavik Airport went from queues to the parking lot in 2015 to 99% passengers queuing for less than 10 minutes in 2017, despite much higher numbers).

The impact has affected not only airport processes but in turn has driven the market and developments in industry that follow the evolution in requirements for equipment to support these streamlined and robust operations. The blueprints and guides have enabled regulations and driven enhanced and efficient developments in screening technology (e.g. article 2 in C5).

Dr Gongora's team regularly contribute to industry events, e.g. Airport IT and Security conference in Amsterdam, December 2018, where Dr Gongora was invited to talk about operations optimisation and resilience to the global airport community [C7, C8]. Dr Fabio Caraffini was invited to IATA/ACI's NEXTT (New Experience Travel Technologies) event in June 2019 at EUROCONTROL Headquarters, Brussels, to plan for Air Transport Security – 2040 and Beyond.

In January 2019 Dr Gongora was appointed as the Adviser for Artificial Intelligence to the Latin American community of Risk and Security Management (COLADCA with over 15 member countries and over 2,000 members and companies) [C6], contributing to the security policies for Latin America.

During 2020 Dr. Gongora with his team at DMU contributed significantly to ACI's efforts to support airport operations during the pandemic as well as recovery during the gradual easing of restrictions. The most significant impact of this contribution was the latest ACI Handbook: "Low-Cost Low-Tech Optimization Measures for Security Operations Handbook" which identifies solutions and wider applications of simpler and more affordable security initiatives, to ensure optimal use of resources amid complex times and increasing regulatory demands [C9].

#### **5. Sources to corroborate the impact**

- [C1] Reference letter from IATA HQ office in Geneva to corroborate membership of the expert group and subsequently becoming one of a select members to provide significant contribution to the blueprints and guidelines (doc: Mario Gongora reference.pdf).
- [C2] Full document of the Smart Security Blueprint 2017, to illustrate the work where we provided a significant input as part of a small select team as indicated in C1 (doc: Smart\_Security\_Blueprint\_v1\_2017.pdf).
- [C3] Letter from ACI confirming participation, commitment and work done up to date following IATA's handover, as well as the impact the research has had on this contribution.

- [C4] One of many ACI's Implementation Guides acknowledging DMU as contributor; this can be found on p 4 'Contributions' (doc: Smart-Security-ACBS-CT-Implementation-Guide-v0.1.pdf).
- [C5] Two international articles from the industry to complement C4, confirming the critical and worldwide impact this has had in the airport industry and their equipment manufacturers.
- The article in one of the international Leading Airport Magazine, ACI EUROPE Airport Business: 'Life in the Fast Lane' tells the point of view of airports and stresses how critical is this optimisation and automation; p 4 of this article mentions the early adopters (hundreds by now) with airports such as Amsterdam Airport Schiphol, London Gatwick, Kansai Airport in Japan, Atlanta's Hartsfield-Jackson, Chicago O'Hare and Toronto Pearson Airports in North America. On p 18, the case study of Keflavik Airport shows how basically 9,000,000 people (passengers) have significantly benefited as the result of following these guidelines in 2017 alone. In URL: <https://www.tsi-mag.com/life-in-the-fast-lane/>
- The article in Transport Security International (ASI: the only dedicated global journal for airport and airline security and regarded as "must-read" by most professionals): 'The Arrival of Rotating CT...' confirms from the equipment manufacturers point of view the impact the ACI guidelines and the use of AI have had in the R&D roadmap of the industry to provide the appropriate equipment to airports. In URL: <http://www.airport-business.com/2019/11/arrival-rotating-ct-passenger-checkpoint-undoubtedly-defining-moment/>
- [C6] Letter from COLADCA inviting and appointing Dr Mario Gongora as AI advisor for the Latin American Risk and Safety community, recognising our impact on the air transport industry (doc: CE-230 DR.GONGORA).
- [C7] Website of Airport IT & Sec conferences, Mario Gongora, speaker Airport IT & Sec. profiles saved by them in URL: [https://www.internationalairportreview.com/speaker\\_profile/68762/mario-a-gongora/](https://www.internationalairportreview.com/speaker_profile/68762/mario-a-gongora/)
- [C8] Website, industry listing of speakers in Amsterdam. Speaker at Airport IT and Security Conf. Dec2018 at Schiphol. In10times.com URL: <https://10times.com/profile/mario-gongora-28299260>
- [C9] ACI's 2020 "Low-Cost Low-Tech Optimization Measures for Security Operations Handbook" released at the end of 2020 to airports worldwide. In the "Contributions" page DMU is acknowledged along other high-profile international experts and Knowledge Transfer contributors. (Confidential, available on request)