Understanding Door-to-Door Travel Times from Opportunistically Collected Mobile Phone Records

A Case Study of Spanish Airports

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***Abstract*—A strategic objective of the European transport policy is the so-called 4-hour door-to-door target, according to which, by 2050, 90% of travelers within Europe should be able to complete their journey, door-to-door, within 4 hours. However, information on door-to-door travel times is scarce and difficult to obtain, which makes it difficult to assess the level of accomplishment of this ambitious target. In this paper, we present a methodology for the measurement of door-to-door travel times based on the analysis of opportunistically collected data generated by personal mobile devices. Anonymized mobile phone records are combined with data from the Google Maps Directions API to reconstruct the different legs of the trip and estimate the travel times for the door-to-kerb, kerb-to-gate, gate-to-gate, gate-to-kerb and kerb-to-door segments. The proposed methodology is illustrated through a case study focused on the door-to-door journeys of passengers traveling to Adolfo Suárez Madrid-Barajas airport from the rest of the Spanish airports. We finish by discussing the room for improvement of the proposed approach and outlining future research directions.**

Keywords- passenger behaviour, door-to-door mobility; mobile phone records.

I. INTRODUCTION

The European Commission´s 2011 White Paper on Transport [1] puts particular emphasis on the need for a multimodal, passenger-centric transport system, able to provide seamless door-to-door travel and facilitate better modal choices. In line with this vision, one of the high-level objectives of the European aviation policy is to ensure that air transport is seamlessly integrated into the European transport network, with the goal of taking passengers and their baggage from door to door predictably and efficiently while enhancing air transport experience and rendering the transport system more resilient against disruptive events [2].

In contrast with this high-level vision, air transport in general, and ATM in particular, have so far, to a large extent, lacked this multimodal perspective, with performance objectives and decision-making processes not always taking into account the ultimate impact on passengers. One of the reasons behind this lack of passenger-centric indicators is the difficulty to gather accurate and reliable data on passengers' behavior, needs and choices. Traditional methods, based on observations and surveys, provide rich travel and demographic information, but they also suffer from a number of major shortcomings: they are expensive and time-consuming, they depend on users' availability and willingness to answer, and data acquisition needs to be planned in advance, which prevents the study of unpredicted events.

The vast amount of spatio-temporal data generated by the use of different types of personal mobile devices in our daily lives (smartphones, public transport smart cards, credit cards, etc.), opens new opportunities to collect rich passenger-focused data and complement traditional data acquisition methods. This paper explores the potential of mobile phone records to extract relevant insights about door-to-door mobility. In particular, we present a methodology to detect the origin and the destination beyond the airport and to measure the experienced travel times during each segment of the trip.

The rest of the paper is organized as follows: Section II introduces the problem of door-to-door mobility characterization and discusses the current approaches for the evaluation of door-to-door travel times; Section III describes the case study selected to develop and evaluate the proposed methodology, which has focused on Spanish domestic flights directed towards the Madrid-Barajas airport; Section IV describes the datasets used in the study and the algorithms developed to integrate and analyze such datasets; Section V presents the main results of the case study; Section VI concludes and discusses future research avenues.

II. THE DOOR-TO-DOOR PROBLEM

The basis for the Door to Door (D2D) concept were settled in the 2020 Vision for European Aeronautics developed by ACARE in 2001 [3], which, in addition to highlighting the need for improving air transport punctuality and reliability of airline timetables, introduces the idea of reducing the time spent at the airport, establishing an objective of no more than 15 minutes in the airport before departure and after arrival for short-haul flights and 30 minutes for long-haul flights. In 2011, a new longterm vision was outlined in the report 'Flightpath 2050 - Europe's Vision for Aviation' [4], which lays out how and where the European research priorities should be set to preserve EU growth and competitiveness worldwide, whilst meeting market needs as well as energy and environmental challenges. One of the high-level goals defined in the Flightpath 2050 report is that, by 2050, "90% of travelers within Europe are able to complete their journey, door-to-door within 4 hours", extending the concept of "time spent in the airports" to a wider and multimodal concept that includes all the stages of the passengers' travel from their origins to their destinations.

The D2D concept can be split into different segments depicted in Figure 1:

- Door-to-kerb: segment of the trip that involves the access to the airport from the origin location of the passenger.
- Kerb-to-gate: segment of the trip that involves the airport processes: check-in, luggage drop-off, security checks and buffer times.
- Gate-to-gate: segment of the trip that involves the airside processes: from the boarding to the disembarking.
- Gate-to-kerb: segment of the trip that involves the arrival airport processes: passport control (if needed), customs and luggage pick up.
- Kerb-to-door: segment of the trip that involves the exit from the arrival airport to the final destination of the passenger.

One of the problems of this D2D concept is the complexity of measuring the D2D travel time and the duration of each segment, which, in turn, makes it difficult to assess the impact of policies and measures aimed to reduce D2D travel times. Passenger surveys are used to collect information about aspects such as the modes of transport used for airport access and egress, airport catchment areas, waiting times and travel habits, all of them directly related to the D2D concept. Airports (e.g., U.K. CAA Departing Passengers Survey, AENA EMMA surveys), airlines (e.g., Lufthansa Balance Customer Satisfaction Survey), national statistical offices (e.g., International Passenger Survey of the UK Office for National Statistics), governments (e.g., Survey on Tourist Habits conducted by the Spanish Ministry of Tourism) and international organizations (e.g., IATA

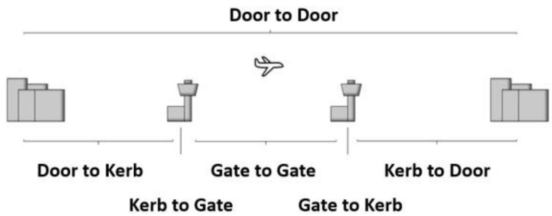


Figure 1. Segments of the door-to-door passenger journey

Satisfaction Survey) collect information about passengers' behavior and experience, including their travel times. However, surveys are costly and time consuming, which reduces the size of the sample and the frequency with which information is updated, limiting the information to punctual observations rather than continuous monitoring. Additionally, traditional surveys do not allow the collection of data about unexpected events such as extreme weather events, strikes, etc., due to the need for data collection to be planned in advance, as well as to the difficulties to interview passengers under certain types of special circumstances (as an example, on the 20th of August 2008, when the fatal Spanair accident occurred, a passenger survey was coincidentally planned in Madrid-Barajas, but the survey was cancelled due to the circumstances). Other data sources such as air traffic databases, travel reservation systems and market intelligence data services also provide valuable information to characterize the gate-to-gate segment, but they typically fail to capture door-to-door origin-destination pairs and travel times.

This lack of D2D related data has recently led to the launch of several European projects aiming to measure D2D travel times and assess the level of accomplishment of the 4-hour D2D target. Examples of relevant projects in this field are META-CDM, TRIMODE, DORA, Mobility4EU, and BigData4ATM. Some of these projects (e.g., DATASET2050) are trying to develop new modelling techniques to fill the gaps in traditional data collection methods, while other projects (e.g., DORA) are proposing the use of innovative technologies for data acquisition, such as app-based surveys. The BigData4ATM project, in which the present work is framed, adopts a different approach, focusing on the extraction of D2D passenger mobility information from large-scale, passively collected datasets generated by personal mobile devices.

III. CASE STUDY

The goal of the present study is to evaluate the potential of mobile phone records to extract information about passengers' door-to-door mobility. More specifically, we aim to develop a methodology allowing the identification of the passengers' origin and final destination and the measurement of the duration of the different D2D trip segments. Taking advantage of the fact that the BigData4ATM project has access to a dataset of anonymized mobile phone records provided by Orange Spain, the data analysis methodology has been developed and tested in the context of a case study focused on Spanish domestic flights arriving in the Madrid-Barajas airport.

Adolfo Suárez Madrid-Barajas is the first Spanish airport in terms of passenger traffic, transport of goods and operations. With 50.4 million passengers in 2016, it occupies the 6th position in the ranking of European airports, and is the largest airport in Europe by physical size along with Paris Charles de Gaulle. To delimit the case study, we focus on the passengers flying to Madrid through direct flights from other Spanish airports in July 2016. The study considers the top 25 Spanish airports, which, according to EUROCONTROL's Demand Data Repository (DDR) [5], account for around 98% of all the domestic flights arriving to Madrid (Figure 2).

Figure 2. Airports considered for the case study

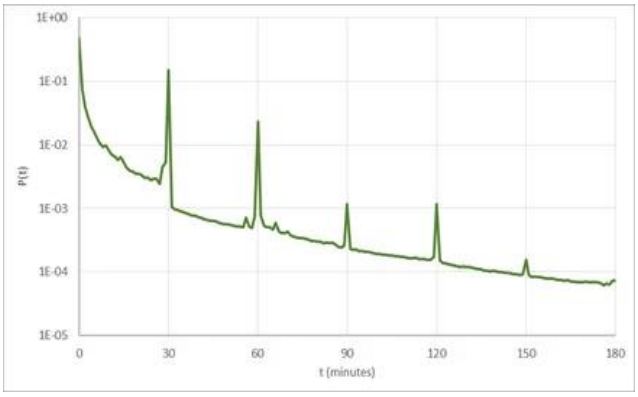


Figure 3. Probability density function of the time between two consecutive data registers

The case study gives us the opportunity to analyze both short-haul and medium-haul flights:

- A typical domestic flight from an airport in the Iberian Peninsula to Madrid takes around 1 hour, similar to many intra-European flights, like Paris-London or Amsterdam-Frankfurt. This kind of connections are the ones with more options to achieve the 4 hours door-to-door objective.
- In order to analyze flights' of a higher duration, the connections with the Canary Islands are also studied, which allows us to analyze flights with a duration of between 2 hours 30 minutes and 3 hours, similar to the connections between Rome and London or Warsaw and Paris, to mention some examples.

IV. Data and Methodology

A. Datasets

1) *Mobile phone data*. The mobile phone data used for this study consist of a set of anonymized Call Detail Records (CDRs) provided by Orange Spain. Orange is currently the second largest mobile network operator in Spain, with a market share of around 27%. A CDR is a data record produced every time a mobile phone interacts with the network through a voice call, a text message or an Internet data connection. CDRs are stored by the mobile network operator for billing purposes. Each of the records available for this study contains an anonymized identifier of the user together with the time when an interaction with the network occurred (a phone call starts/ends, an Internet data session is opened, etc.) and the cell tower to which the user was connected at that particular moment. The registers do not provide the exact location of the users, but the location of the tower to which they are connected, which typically provides an accuracy of around 100-200 meters in urban environments and up to a few kilometers in rural areas, where the mobile network is less dense. To refine the estimation of the user position inside each of these areas, the cell plan has been integrated with a layer of land use information, which assigns users to different areas in a cell with a probability that depends on the type of land use (residential, commercial, industrial, etc.). As for the temporal granularity of the data, it varies from user to user, since the number of registers depends on the level of usage of the mobile device. However, for smartphone users, which constitute the vast majority of the sample, registers corresponding to data sessions are usually generated on a periodic basis without any user interaction, e.g. due to apps running in the background. Figure 3 shows the probability density function of the time between two consecutive data sessions registers. Taking into account these data registers and the registers corresponding to calls, SMS, etc., an average smartphone user who has his mobile phone switched on and with a data connection enabled typically produces a register at least every 30 to 60 minutes, which provides a reasonably good resolution for the analysis of the user's mobility patterns.

2) *Google Maps Directions API*. This API calculates route options and their associated travel times given an origin and a destination. Routes can be obtained for different transport modes, such as walking, private vehicle and public transport. Also, the API accepts waypoints to better characterize the trip. As explained before, mobile phone data do not provide neither a continuous monitoring of the mobile phone user nor exact location information. The Google Maps Directions API can be used to retrieve the different travel options for the different trips (or trip legs) detected for a user, in order to estimate the selected transport mode(s), the chosen route(s), and the associated travel times.

3) *Demand Data Repository (DDR2).* EUROCONTROL's DDR2 [4] has been used to obtain the average flight duration and the number of flights for each Spanish domestic route with destination the Adolfo Suárez Madrid-Barajas Airport during July 2016.

B. Methodology

1) *Generation of activity diaries for long distance travels*. The first studies that explored the use of CDRs for the analysis of activity and mobility patterns were focused on urban

environments ([6], [7], [8]). Although the basic principles of activity detection from mobile phone registers still apply, when analyzing long distance journeys the problem shifts from obtaining an activity diary with as much spatial detail as possible to obtaining an accurate characterization of the semantics of the detected stays allowing the identification of long distance journeys and their decomposition into their constituent legs. For instance, a long stay detected at the airport may be characterized as part of a long distance trip or as an activity on its own (e.g., work activity, in the case of the airport employees), depending on the previous and next positions of the mobile phone. In the present study, a two-step approach has been followed:

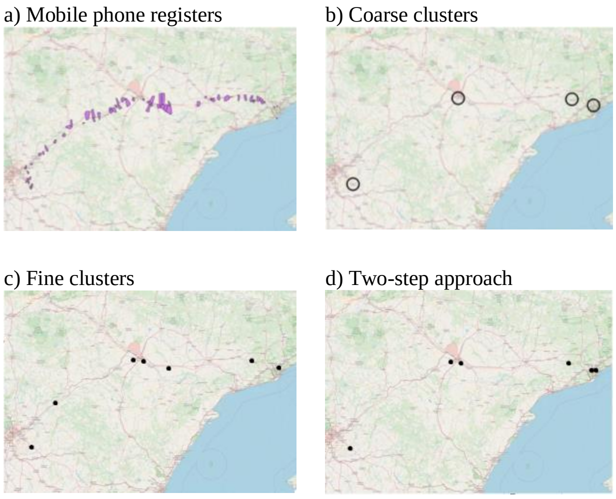


Figure 4. Madrid-Barcelona road trip: use of different cluster approaches

- First, a diary of stays is obtained for each agent. The condition to identify a stay is that the traveler spends a certain amount of time within a defined radius of a location. The Stay Point Detection Algorithm (SPD) described in [9], originally developed to obtain activity diaries from GPS registers, was adapted to reconstruct long distance trips. The process involves two clustering phases: first, we detect coarse, high-level clusters far away from each other; second, we dig into the details of each high-level cluster to obtain the sequence of activities. When only one clustering phase is used, the stay diaries may not produce accurate results: if thresholds are too permissive, detailed activities may be lost, and information about D2D origin/destination may be blurred; if thresholds are too restrictive, multiple false stops may be detected during trips. This phenomenon is illustrated in Figure 4, where a car trip from Madrid to Barcelona with some intermediate stops is shown. In Figure 4.a, the registers left by the mobile phone user during the trip are shown. Figure 4.b shows the results of a single, coarse clustering process, while Figure 4.c shows the results of a single fine clustering process. It can be seen that neither of both approaches satisfies our needs, as the coarse clusters are not detailed enough while the fine cluster artificially splits the trip. The results for the two-step approach are shown in Figure 4.d, where trip is split at typical stopping places for Madrid-Barcelona trips.
- Next, using the Google Maps Directions API and data about the locations of ports, airports and long distance rail stations, the nature of the stays obtained in the previous step is determined. Stays are classified into activities and stops. Activities are those stays that primarily motivate the displacement of the user (e.g., going to work), while stops are stays between the different legs of the same trip (e.g., a stay at the airport previous to a flight, a stop to refuel or have lunch during a car trip, etc.). In the case of plane trips, a very characteristic pattern is observed in the mobile phone registers: the user disappears from the network during a time interval and re-appears at a long distance from the location of the last register before disappearing. Additionally, before and after the interval without registers, the user locations are close to an airport. As a result of the process, the diary of stays is transformed into a diary of activities and intermediate stops, which identifies the origin and destination of each long distance trip and the corresponding intermodal stops, if any (e.g., stops at the airport or high-speed train stations). In the example shown in Figure 4.d, the stays detected in Zaragoza (which is a typical stop, as it is in the middle of the way) and Igualada (around 75 kilometers North-West of Barcelona) are classified as stops.

2) Identification of plane trips. Once the diary of activities and stops is obtained for each of the users in the sample, those users that are relevant for the case study are selected. Since the case study focuses on those passengers that travel from any Spanish airport to the Madrid airport by plane through a direct flight, we select the users whose activity-stop diary includes a long distance trip with two stops at two different Spanish airports, being Madrid-Barajas the destination airport. The following information about each plane trip is obtained:

- Origin of the trip, i.e., the activity previous to the trip. It contains information about the location, the start time and the end time of the activity. The end time corresponds to the start time of the door-to-door trip.
- Intermediate registers associated with the trip from the origin to the departure airport (door-to-kerb leg). The purpose of storing these registers is to estimate the time of arrival to the airport and explore whether we are able to determine the transport mode and the route chosen to access the origin airport.
- Stop at the departure airport: it contains information about the location of the stop (in some cases allowing us to identify the terminal from which the flight departs), the time of arrival to the airport, and the last register at the airport. This last register does not necessarily correspond to the departure time of the flight, as it

depends on the mobile phone activity of the user and the moment he/she switches off the phone.

- Intermediate registers associated with the flight: for most of the users, there will be no registers during the flight, either because they have switched off their mobile phone or because for most part of the flight there is no mobile phone coverage. However, for some users that do not switch off their phones, a small set of registers appears along the take-off and descent trajectories.

- Stop at the arrival airport (Madrid Barajas): similar to the stop at the origin airport, it contains information about the location of the stop and the times of the first and last connections at the airport.

- Intermediate registers associated with the trip from the arrival airport to the final destination (kerb-to-door segment). As in the case of the departure airport, the purpose of storing these registers is to estimate the time of departure from the airport and characterize the egress leg.

- Destination of the trip, i.e., the activity next to the trip. It contains information about the location, the start time and the end time of the activity. The start time corresponds to the end time of the door-to-door trip.

3) Corrections. Due to the characteristics of the mobile phone registers and the way these registers are generated when the user performs a plane trip, some adjustments are still needed such that the extracted information can be used to obtain accurate and relevant results.

- There are some cases where the user switches off the mobile phone some time before the flight departs and/or after the flight lands. This leads to an estimated flight duration that is considerably longer than the actual duration. There are other cases where the user does not switch off the mobile phone during the flight, which may lead to the opposite situation. For both situations, the approach followed is to correct the estimated flight durations by using the actual flight durations extracted from DDR.

- Some cases were detected where the door-to-kerb or kerb-to-door duration was considerably long. These cases were studied in detail. For some of them, the obtained values were consistent with the travel time estimations provided by the Google Maps Directions API. However, for some users disabling their data connections during the night time hours and then reappearing in the network once they have started their trip to the airport, the proposed algorithm erroneously assigns the end time of the activity to the moment the device was switched off, artificially shortening the activity at the origin and increasing the duration of the trip to the airport. To avoid these errors, in these cases the travel time estimations provided by the Google Maps Directions API were used.

V. Results and Discussion

A. Spatial Distribution of Origins

First, we obtained the origins of all the trips considered in the case study. The heat map for these origins is shown in Figure 5. The main trip generators are the airports of Palma de Mallorca, Barcelona and the Canary Islands. The heat maps represent the catchment areas of each airport for flights directed to Madrid. As expected, the catchment areas of the airports located in both the Balearic and the Canary Islands are significantly bigger than the rest, which has implications for the planning of ground connections with airports. Also, it can be observed that the demand for touristic airports seems to be more spatially spread than for other airports.

Next, the distribution of the distance for the door-to-kerb segments was calculated. Figure 6 shows this distribution for all origins and for the specific cases of Barcelona, Mallorca and A Coruña. Some interesting observations regarding airport catchment areas can be derived. For example, it seems that most trips from A Coruña are generated near the city, in a range of around 10km, while in the case of Barcelona this range increases up to 20km. The case of Mallorca is very interesting, as the majority of the trips are originated in the range of 10-20km, while there is an appreciable group of trips generated in the range of 40-50km. This is consistent with what was enunciated before about airports situated in touristic islands having more spread catchment areas.

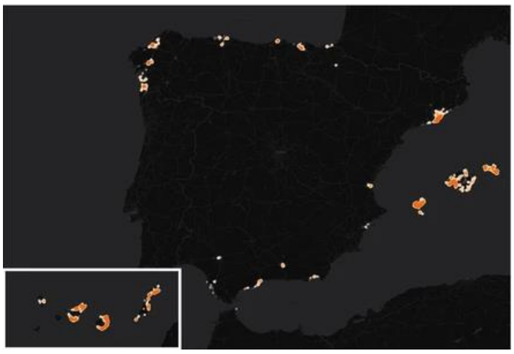


Figure 5. Heat map of the D2D trip origins

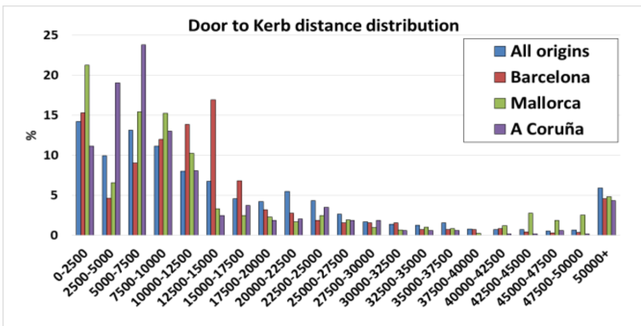
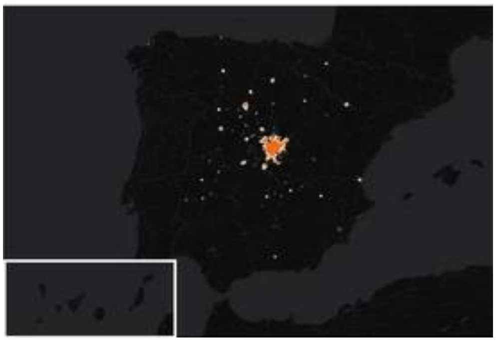


Figure 6. Door-to-kerb distance distribution

B. Spatial Distribution of Destinations

The heat map of the final destination of travelers with origin at all airports, as well as the heat maps of the final destination of the trips with origin in Barcelona, Mallorca and A Coruña airports are shown in Figure 7. The airport with a higher dispersion in final destinations is Palma de Mallorca, while the final destinations for the Barcelona and A Coruña airports are more concentrated in the Madrid Metropolitan Area. This can be explained by the fact that many of the flights from Palma de Mallorca are return flights of tourists. This reinforces the hypothesis that the door-to-door origins and destinations for touristic trips are much more spread than for other trip purposes. Kerb-to-door distance distribution is shown in Figure 8.

a)



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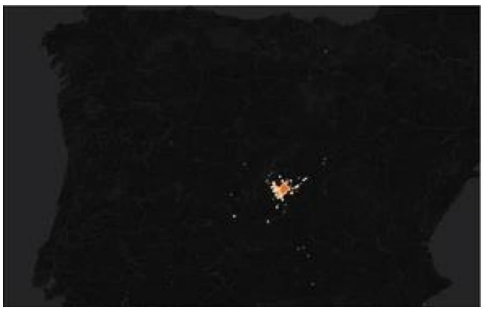

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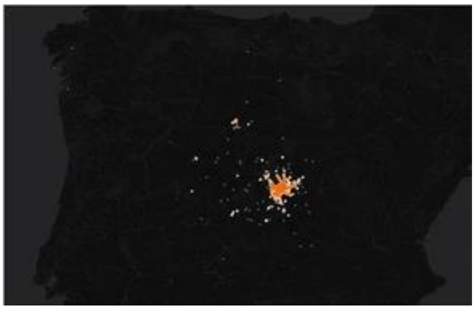

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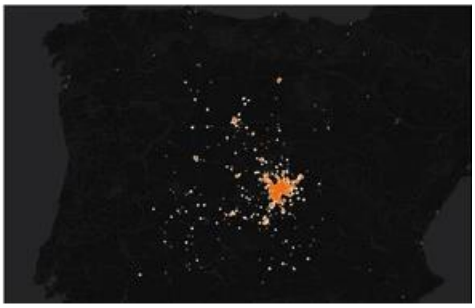

Figure 7. Heat map of the D2D trip destinations: a) all origins; b) trips from A Coruña; c) trips from Barcelona; d) trips from Palma de Mallorca

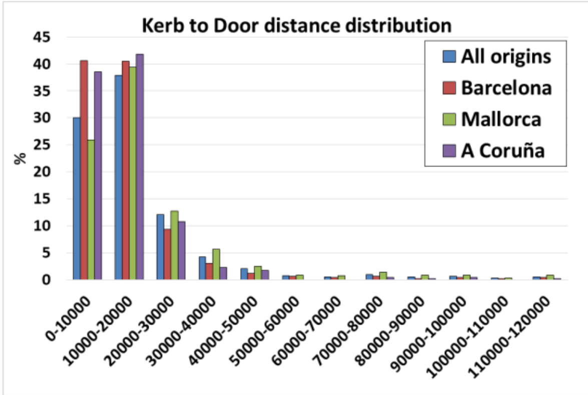

Figure 8. Kerb-to-door distance distribution

C. Door to Door Travel Times

Now we analyze door-to-door trips from a temporal perspective, in contrast with the spatial approach taken in the previous section. Figure 9 presents the distribution of the door-to-door travel times for all the possible origins and for the same three airports analyzed before (Barcelona, Mallorca, A Coruña). The figure shows that the vast majority of trips last more than 4 hours door-to-door.

D. Travel Times per Trip Segment

To gain insights into the distribution of door-to-door travel times, we analyze the distribution of the duration for each segment (see Figure 10). By looking at the distribution for the door-to-kerb segment, we can observe that there is not such a clear pattern as in the case of the door-to-kerb distance distribution. Although Mallorca and Barcelona attract passengers from further distances than A Coruña, this is not reflected in terms of travel time, which may be an indicator that both airports are well integrated into the ground transport network.

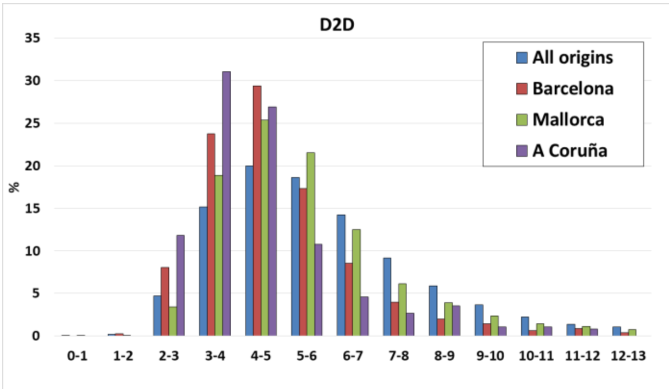

Figure 9. Door-to-door travel times

When looking into the kerb-to-gate segment, differences start to appear: the distribution for Barcelona presents lower stays times at the airport, followed by A Coruña and finally Mallorca. This may be due to both the efficiency of airport processes and the different profiles of passengers. This may also indicate that leisure travelers spend more time at the airport (e.g., due to the check-in process, travelling with children, different perception of the value of time, etc.).

Regarding the gate-to-gate segment, we can observe that A Coruña has the shortest flight time with a time distribution centered between 0.75 and 1.25 hours, followed by Barcelona (1-1.25 hours) and Mallorca (1.25-1.5 hours). This is consistent with the DDR data, where the average duration for the flights is 0.9 hours for A Coruña, 1.2 hours for Barcelona and 1.33 hours for Mallorca. If we look at the distribution for all the possible origins, we can observe two groups: one centered at around 1.25 hours and the other centered at 2.75 hours, the last one corresponding to the flights from the Canary Islands.

Gate-to-kerb distributions are very different from kerb-to-gate distributions, due to the different nature of the processes of each phase. Passengers from Mallorca present a higher duration of the gate-to-kerb segment: assuming that most of them were tourists coming back to their homes, this is likely to be driven by the waiting at luggage delivery. Passengers from A Coruña spend significantly less time than the rest, which may be indicative of business passengers travelling without luggage.

Finally, in the kerb-to-door time distribution it can be observed that trips from A Coruña present lower travel times. This is consistent with the smaller geographical dispersion previously observed. Although centered at around 0.25-0.5 hours, kerb-to-door durations higher than 2.5 hours are observed for all origins plotted. Flights coming from Mallorca are the most significant of the tail of the distribution, which is again consistent with the higher dispersion for touristic trips described in previous subsection.

By looking at the previous findings from a passenger perspective, several conclusions can be extracted about the observed door-to-door journeys. Passengers from Mallorca can be classified as tourists, with a high dispersion on door-to-door origin and destination locations, which leads to high kerb-to-door travel times but not significantly high door-to-kerb travel times, which suggests a good integration of the Mallorca airport with the ground transport network. These passengers also spend more time at the airport. Passengers from A Coruña are mainly business passengers, with door-to-door origin and destination close to both airports, which leads to low kerb-to-door and door-to-kerb travel times and short stays at the airport. Another fact that can be relevant when analyzing the catchment area for A Coruña airport is that Santiago airport is very close, only 60km far away, thus presumably taking passengers from it. Passengers from Barcelona are probably a mix of tourists and business passengers, presenting intermediate characteristics between Mallorca and A Coruña. Also, kerb-to-gate times in Barcelona are the lowest of the three airports, which may be a sign of efficiency in the airport processes.

a)
b)
c)
d)
e)

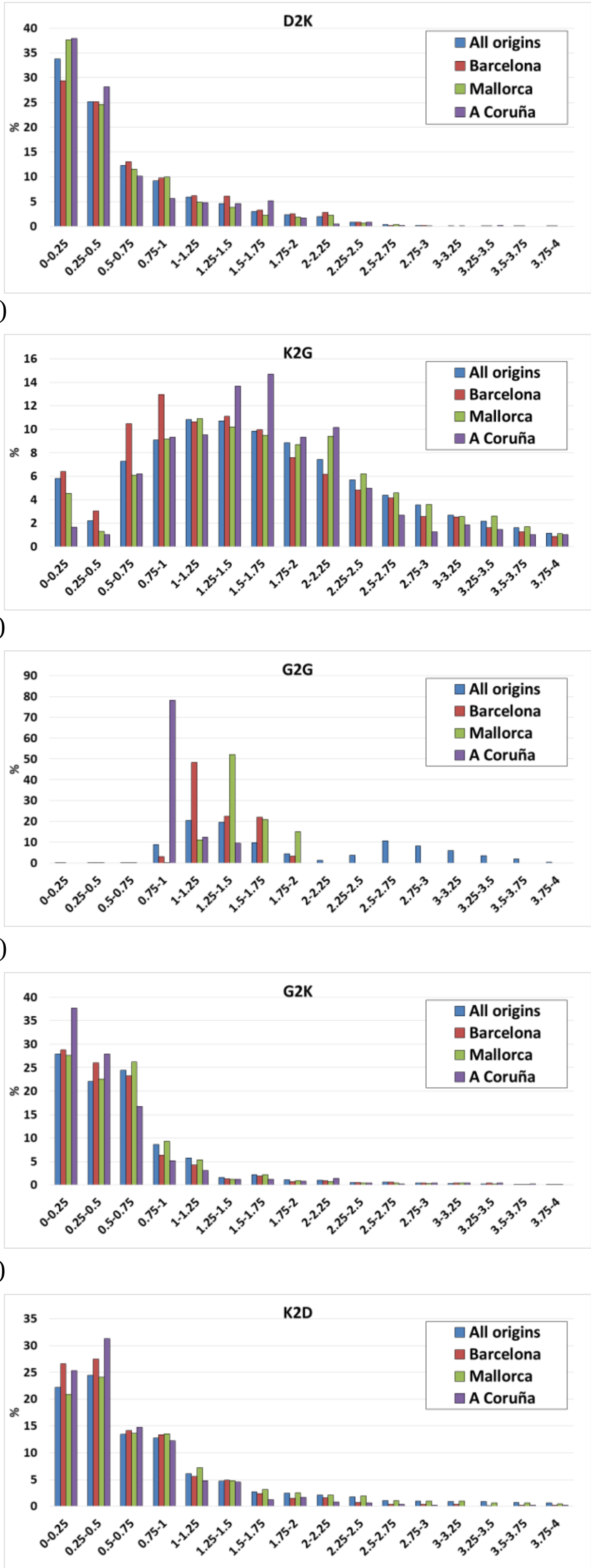

Figure 10. Travel time distribution per trip leg: a) door-to-kerb; b) kerb-to-gate; c) gate-to-gate; d) gate-to-kerb; e) kerb-to-door

VI. CONCLUSIONS AND FUTURE DIRECTIONS

The case study presented in this paper shows that mobile phone data can be a useful source of fine grained passenger information. By analyzing the registers produced by mobile phone users, it is possible to obtain valuable insights into door-to-door travel times, which are very difficult to measure by using more conventional methods. Future research directions are outlined below:

- The estimation of short distance travel modes and route choices may be relevant, for example, for demand forecasting models that consider different choices for long distance trips (e.g., different competing airports, competition between air transport and high speed train, etc.) where airport accessibility is a key determinant of travelers decisions. The mobile phone registers generated by the user during his airport access/egress trip can be used to produce information about the transport mode used and the routes followed by airport users, e.g. by using map matching techniques. In the cases where the spatio-temporal resolution provided by mobile phone records is not enough to identify modal/route choices, a data fusion approach could be explored, by merging mobile phone records and Google Maps Directions API data with other sources, such as public transport smart cards.

- In this study, data from DDR was used to obtain an estimation of the average flight duration from each origin airport to the Madrid airport. However, as mobile phone data provides data about individual trips, it may be possible to extract a sample of passengers for each flight. This would add another level of disaggregation to the door-to-door study, allowing us to extract mobility patterns at different times of the day (e.g., do people increase their buffer time at the airport for early morning trips?). Also, it would be possible to analyze how door-to-door travel times are impacted by air traffic delays.

In the next stages of the BigData4ATM project, the following research questions will be addressed:

- Extend the analysis to other airports. It is reasonable to assume that the results presented here are not directly applicable to other Spanish airports. It is therefore interesting to extend the analysis to other airports in order to analyze how different types of airports interact with the ground transport network.

- Analyze off-peak period. In this paper we have studied the month of July 2016. It is expected that, if the same methodology is applied to another period, the results will vary, not only due to the different availability of flights, but also to the change in the type of passenger, with a lower share of leisure travelers.

- Analyze the impact of disruptions. The methodology presented in this paper allows the assessment of the effect of air traffic disruptions on every segment of the door-to-door trip, which would help us gain a more comprehensive understanding of how door-to-door passenger journeys are affected by delayed flights.

- Evaluate the 4-hour door-to-door target. The proposed methodology will be used to evaluate the level of achievement of the 4-hour-door-to-door target for Spanish domestic flights. It is expected that this will help improve the knowledge about how the air transport network is embedded into the transport network, providing useful inputs for the planning of transport policies, infrastructures and services.

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