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Growing the congested airports: Satellite passenger terminals

Sarah Al-Hilfi[a], Pavel Loskot[a,]*

[a]College of Engineering, Swansea University, Swansea, SA1 8EN, United Kingdom

Abstract

New models of the passenger and baggage processing are of interest to address the growing demands for air transport while managing the efficiency and utilization or resources as well as the passenger experience. In this paper, a new concept of satellite passenger terminals is discussed which enables to off-load many services from the airport terminals. The satellite terminals can serve multiple airports, and provide a number of benefits to passengers, airports and the local community.

Keywords: Off-loading; outsourcing; passenger processing; passenger terminal; satellite terminal; transport network

1. Passenger airport terminals

The main function of passenger terminals at airports is to provide a transition between the air and surface travel. This is accomplished at the cost of remarkable complexity, since many supporting services have to be offered in order to enable the passenger journey from the terminal entry points to boarding the aircraft. Moreover, these services are provided by different entities including airport and airline employees, and a number of the 3rd parties. The terminals are enclosed by two sectors – the airside area with gates where the security measures are implemented, and the landside access to the terminal. The terminals host sophisticated passenger and baggage processing systems. The terminal design depends on a number of factors such as the number of terminating vs. transiting passengers, and whether it is at the regional airport, or at a major airport hub. Some of the key evaluation criteria for the terminal design and operations are the passenger convenience/experience, the passenger way-finding, connectivity between the terminals, revenue and concession opportunities, the site facilities adjacent to the terminal, operational costs, and overall economic utilization of the terminal site, ACRP (2010).

* Corresponding author. Tel.: +44-1792-602619; fax: +44-1792-295676.
E-mail address: p.loskot@swan.ac.uk

1.1. Terminal services

The terminals offer a number of facilities to accommodate its various functions and operations. The demand for facilities is dictated by the type of airlines operating at the terminal. The regional airport with many point-to-point flights will mainly generate demand for the standard passenger services such as check-in, ticketing, baggage drop-off and screening, baggage reclaim, security, gate management and ground transportation services to/from the airport. The major national or international airport with hub-and-spoke airlines will require additional services such as transport between terminals, baggage transfer, retail and food facilities for connecting passengers and larger hold rooms, although the demand for the basic services is proportionally reduced. Even at large airport hubs, only up to 70% of passengers are transiting, so the standard services need to mainly target the originating and terminating passengers. Moreover, the terminals processing international passengers are required to comply with the immigration and customs regulations of the country. A summary of the airport services related to passenger and baggage processing are provided in Fig. 1.

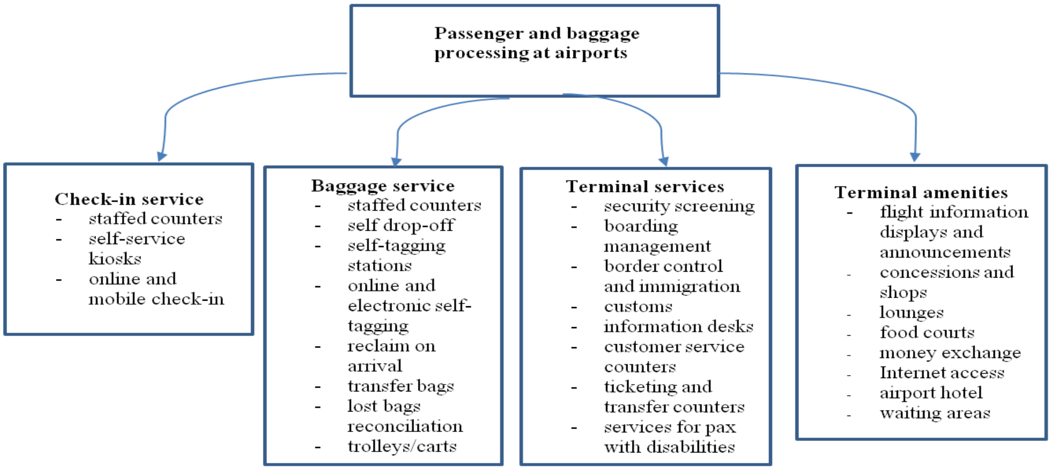

Fig. 1. Outline of services and amenities for passenger and baggage processing at airports.

Since not all passengers are equal, their needs, expectations and levels of tolerance can be very different. Some of the passenger characteristics are: business vs. leisure, domestic vs. international, departing vs. transiting or terminating, and those on scheduled vs. charter flights. Maintaining the passenger experience while their numbers are growing is one of the key development indicators for the airports. The factors affecting the passenger experience at the airport terminals are, ACRP (2010):

- distance travelled and time spent from entering the terminal facilities to boarding the aircraft; and
- subjective feelings and perceptions of convenience as well as difficulties experienced at various service points;
- flexibility, self-reliance, and terminal journey predictability with minimum uncertainty.

In addition, service differentiation to accommodate different types of passengers may generate additional revenues.

1.2. Terminal layouts

The terminals facilities can be centralized or decentralized. For a single airport terminal, the centralized processing of passengers and baggage has a number of advantages including better utilization of the infrastructure and gates, minimum staffing requirements, easier handling of connecting passengers, the same availability of services to all passengers, and simpler surface travel to the airport. The decentralized airport with multiple terminals benefits from increased passenger and baggage processing capacity, albeit at the cost of increased complexity, duplication of facilities, higher staffing and equipment requirements, and more complex management of airport operations. The domestic terminals or terminals serving low-cost carriers have different requirements than those serving national carriers and international passengers. The airport capacity can be increased by expanding and redesigning the existing terminals. When the terminal growths in size, at some point, it may start resembling a decentralized facility. In large terminals, for example, the walking distances may be too large to have only one check-in area and one security check point. In such cases, some facilities would be duplicated to provide multiple paths for different groups of passengers while other facilities can remain centralized. In addition, the terminal facilities are not utilized uniformly throughout the day. The peak hours demanding the terminal capacity can experience much larger volumes of passengers than in other non-peak hours. If the difference between the peak-hour and the average demands is large, efficient and economical utilization of terminal is problematic.

There are 4 standard terminal design layouts how to specially distribute the basic service and processing areas from the curb to the boarding gates at the airport. Linear concept is the most straightforward design with adjacent single passenger processing area separated from a single holdroom area by the security checkpoint. The main disadvantage is the capacity limited by a single security screening checkpoint, limited concession revenues, and limited opportunities for expansion. Pier concept extends the linear concept with a long holdroom concourse with gates on both sides to increase the capacity, but also the walking distances. A network of piers with multiple passenger processing feeds may be sufficient for some busy hub airports. Satellite concept creates an airside concourse with holdrooms, concessions and other passenger amenities which are completely surrounded by apron gates, so overhead or underground connectors from the landside area are required. This concept can provide sufficient capacity to support very busy airports with a mixture of terminating and connecting passengers, and the capacity expansion can be achieved by enlarging the piers, or by building additional satellite concourses. Transporter concept further develops the satellite terminal design to provide complete separation of passenger facilities from those which are required for the aircraft side services. The busses drop off passengers to the aircraft which provides great flexibility for the apron design, and the airport has more flight handling capacity, for example, to serve busy hours without requiring much larger investments to redesign the terminal and increase its capacity. In practice, the airport terminals often combine all these 4 design concepts.

1.3. Terminal management

Managing the passenger flows requires knowledge of the passenger distribution and predicting on-time flight performance. Efficient terminal designs allow mixing of different passenger flows for the maximum utilization of spaces. The staffing levels should be dynamically optimized to provide the service only when there is demand, and to minimize the service queuing. Since passenger processing is organized in flows, the service disruption at one point will affect all other service points. The services prior to the disruption may have to slow down the passenger processing whereas the services located after the disruption will be starved. Hence, accurately forecasting the service demand is vital for the smooth terminal operations. The planners and managers are increasingly relying on mathematical models, historical data, activity patterns as well as real-time information. Collaborative decision making (CDM) systems have grown in popularity in recent years to avoid the network effect of cascading disruptions. For instance, a few minute wait time can be easily amplified by the services network into a much larger delay. The CDM systems exploit data sharing by multiple parties at the airport which has a positive impact on stabilizing the airport processes, better utilization of resources, making the processes more predictable.

2. Off-loading airport services

Some of the passenger and baggage processing can be outsourced outside the airport. The resulting off-airport services relieve the demand for these services to be provided on site, at the airport. It is a different concept from service outsourcing where the 3rd party service providers are contracted to deliver airport services, Pružinký (2015). Initially, the motivation for moving some services to the off-airport sites was congestion at the airport processing centers, van Zundert (2010). More recently, the main industry driver is increasing the system capacity to satisfy the growing travel demands while managing the complexity, maintaining the passenger experience, and better utilizing the resources including staffing and infrastructure, IATA (2015). These efforts are coordinated by IATA through several of their programs such as Checkpoint of the Future, Simplifying the Business, Smart Security, ONE Order and Single Token. The idea is to capitalize on rapid proliferation of the IT technologies to digitalize the industry, DTI (2017). For instance, 98% of them carry at least one device with the Internet connectivity while traveling, SITA

(2017). Meanwhile, many airlines are already offering web, mobile or even automated check-in, mobile board passes, location based notifications, missing baggage communications, and baggage status updates. The IT and the Internet are the key enablers to support remote passenger and baggage processing.

2.1. Off-airport passenger check-in

According to SITA (2017), 80% of passengers book flights using the web, 7% use the mobile application, and only 13% use a face-to-face meeting with a travel agent. The 46% of passengers visit the check-in counter at the airport, 33% use web or mobile application check-in, 15% use the self-service kiosk at the airport, and 6% utilize the automated check-in. As most passengers prefer flexibility and self-reliance, the face-to-face check-in at the counter is likely to diminish further. In addition the airline service kiosks can be put into the hotels and railway stations, even though this does not seem to be a widespread practice. The service kiosks at the airports can be used to confirm or change reservations, obtained boarding passes, enter advanced passenger information, and choose seating.

One challenge with online check-in is to submit accurate advanced passenger information. This information needs to be verified at the airport, for example, by scanning the travel document. The online check in is usually enabled only within a certain time window prior to the flight departure. The main advantage of online check in for the airlines is that it frees resources at the airport whereas the passengers can avoid queuing at check in counters.

In addition, the airlines are liable for international passengers to satisfy the entry requirements of the destination country. The valid travel visa and the passenger identity are still checked manually at airports even though there are already face recognition and other biometrics based trials to automate these processes.

2.2. Off-airport baggage drop-off

The dissociation of passengers from baggage is envisioned to significantly enhance the future travel experience, Loskot and Ball (2015). Unlike online check in, the remote baggage drop-off is much more challenging logistically. It is a complex and challenging concept which requires substantial regulatory changes. The baggage dissociation can be considered in several travel scenarios and contexts.

- The baggage dissociation between the destination airport and the journey end-point such as hotel is probably the most straightforward, since it involves minimum security and regulatory restrictions. The companies providing this service already exist in large cities hosting major airports.
- The baggage dissociation between the point of origin such as home and the departing airport has to implement a secure baggage delivery to the airport. The airport drop-off may or may not require the presence of the traveller. In the latter case, the service provider must gain acceptance from the airlines to satisfy the minimum security standards. This service is encouraged by some airlines by providing advanced baggage check in at the airports.
- The baggage dissociation during flight is currently blocked by the IATA regulation requiring that the bags travel with the passenger on the same flight unless special circumstances. There is, however, general support in the industry to eventually dissociate baggage from passengers and, for example, have the bags delivered via dedicated flights to dedicated airports or terminals. The challenge is baggage distribution and reconciliation at the end of the passenger journey, and also the baggage screening by the customs.
- A complete end-to-end baggage dissociation is envisioned as the travel of the future. It is a paradigm shift which is going to affect not only air travel. Such baggage service resembles a parcel delivery, so the bags could be treated as parcels and sent completely independently of the passenger travel. This idea is well aligned with the vision of the Physical Internet, Montreuil at al. (2013).

As pointed out in van Zundert (2010), the actual implementations of off-airport baggage drop-off systems should be considered on case-by-case basis. The IATA Resolution 753 requiring all airlines to track the baggage custody at all service points during the journey is one important step towards the in-flight dissociation. Unlike highly regulated delivery in air transport, the surface baggage delivery to and from the airports is currently unregulated. It creates liability and security problems for the 3rd party baggage couriers. It is likely that adopting some international regulations for the baggage delivery via multi-modal transport would stimulate this segment of industry, COST 318 (1998). The implementation of baggage dissociation is likely to be done in several phases which is still subject to much research, van Zundert (2010). One possibility is to exploit a number of baggage drop-off and collection points throughout the city. Currently, there is no public market research indicating prospective adoption of the new baggage services by travellers. Particularly business travellers may be concerned if they are unable to access their bags immediately upon arrival to the destination airport. Moreover, delivering baggage dissociated from passengers requires careful and complex planning well ahead of the travel. In the next section, we will present a new concept of satellite passenger terminals which can solve or avoid many of these problems.

3. Concept of satellite passenger terminals

The idea of building satellite terminals to solve the congestion in delivery networks was proposed almost two decades ago, Slack (1999). The satellite terminals were shown to expand the capacity of the cargo transport hubs which are often constrained by the available land and the environmental conditions. Here, we evaluate the idea of satellite terminals for passenger traffic to supplement the capacity of the existing airport terminals by off-loading some of the passenger and baggage processing functions to the new sites, relatively far from the airport. Since off-loading the check-in is more straightforward, the main concern is about off-loading baggage drop-off from the airport terminals. A survey of the existing off-airport baggage check in and drop-off solutions is in van Zundert (2010). For instance, a self-service check in and manned baggage drop-off points operated by Continental Airlines are provided next to the parking lot outside the Houston airport. In some cities such as Frankfurt, Madrid, Los Angeles, Vancouver, and Sydney, the railways connecting the airports are offering remote check in and baggage drop-off at the stations. Similar service is offered by a growing number of airlines including Japan Airlines, KLM, British Airways, Lufthansa, Air France, Continental Airlines, and Qantas Airways. In large cities, the 3rd party private courier companies are offering the baggage collection and drop-off services, usually within the defined regions and subject to an agreement with the specific airline. In several occasions, the off-airport baggage drop-off was offered, but eventually the service was terminated due to unsustainable investment and operational costs, and relatively low adoption rates. Here, we consider the concept of satellite passenger terminals as a new attempt to introduce a sustainable and profitable off-airport passenger and baggage processing services.

The satellite passenger terminal is a facility built in a suitable geographical location, and offering the following services to the airline passengers:

- passenger check-in, pre-departure ID and visa checks
- baggage drop-off, screening, and collection on arrival with optional delivery
- concessions, money exchange, food courts, lounges
- travel agents, information desks, car rentals
- flights information, Internet access, entertainment
- hotel accommodation and long-term parking
- direct shuttle or other public transport to and from the nearby airports.

The viability of satellite passenger terminal is critically dependent on selecting a suitable location. The location can be far away from the expensive areas which are often found near large cities or busy railway stations. The location should have easy surface access from other cities in the region, and there should be plenty of room for a low-cost long-term parking. The location should be chosen to serve more than one airport to increase its utilization, and to improve the economic viability. In order to avoid substantial costs for new shuttle services to the airports from the satellite terminal, the location should exploit the existing railway and bus links. The satellite terminals would be then used as the end-points of the passenger journey, and offer many services which are currently provided at the departure and arrival airports. The anticipated benefits of the satellite passenger terminals are:

- free a substantial processing capacity of the existing airports to extend their life without need for their expansion
- maintain concentration of the passenger and baggage processing infrastructure which is a much more efficient strategy than, for example, providing fully distributed processing with many baggage drop-off points in a region
- encourage travellers to use shuttles and other public transport to the airports to relieve the curbside congestion
- provide the overall better experience for passengers even though their journey to the departing airport now has two segments – a relatively short travel from home to the satellite passenger terminal, and a convenient travel on public transport from the satellite terminal to the airport
- create opportunities for new business models to finance the development of and services at the satellite terminals by the government, airports and airlines

- overlay the cargo delivery to the network of satellite terminals – airports
- stimulate the local economy adjacent to the satellite terminal by creating jobs and business opportunities

Fig. 2 depicts the surface network involving the satellite passenger terminal. Although some (e.g. business) passengers may still prefer direct travel, other passengers should be incentivized to utilize the new facility.

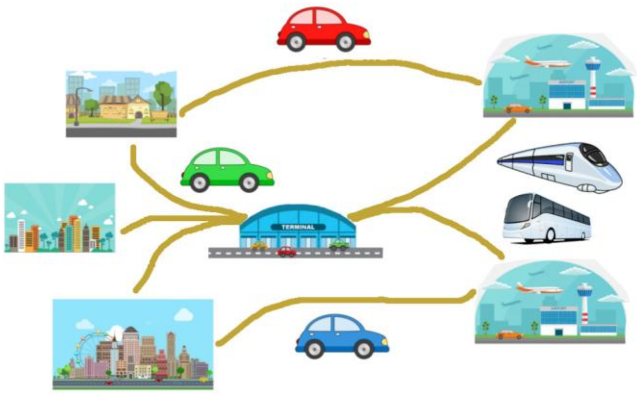

Fig. 2. The surface network of passenger travel to the airports created by the proposed concept of satellite passenger terminals.

The two fundamental issues in designing the satellite passenger terminal are the location and sizing. In the sequel, we consider the former problem, and discuss a strategy how the terminal location can be selected.

3.1. Selecting the location of satellite passenger terminal

Planning the locations of satellite passenger terminals is easier than a similar problem of placing the sortation centers and hubs in the parcel distribution networks. In the former case, the number of suitable locations is likely to be rather limited. Hence, the location of the satellite terminal can be selected by prioritizing a list of possible sites. For instance, we can follow the following procedure.

- The candidate list of sites comprises smaller stations on the principal routes, since these stations are much more likely to offer development opportunities at reasonable land prices than large busy stations along the same routes.
- We can decide on a list of airports which would be served from the satellite passenger terminal. These airports may require larger processing capacity, or they are suffering from the surface congestion at the airport. It is beneficial if the selected airports have established public transport links in order to avoid additional CapEx costs.
- The satellite terminal would serve passengers from a certain geographical area. In particular, the travel to the airport via a satellite terminal should provide more convenience and the improved passenger experience. For instance, the travel time to the satellite terminal should be much shorter than the direct travel to the airport. The overall travel time to the airport is also very important factor to consider.
- The satellite passenger terminal can be located just outside large cities with multiple airports (e.g., as in London, and Paris), or in between multiple major airports to prioritize the travel time.

The exact procedure and which aspects should be prioritized in selecting the best location for the satellite terminal is dependent on the specific circumstances. In order to illustrate this procedure, we consider the case of locating the satellite terminal to serve travelers in Wales and England when they use one of these 8 airports (IATA codes): MAN, BHX, EMA, BRS, LHR, LGW, LTN, and STN. We assume the candidate site locations to be smaller stations on the following principal or regional routes operated by the National Rail: Newport – Chester, Newport – Gloucester, Hereford – Worcester, Shrewsbury – Wolverhampton, and Shrewsbury – Crewe. Table 1 lists the minimum traveling times from the selected stations to a given airport using a combination of the existing bus (B), train (T), and London subway (S) connections. The last column values in Table 1 are the average traveling times to the 8 airports from the selected train stations. The average times vary from about 2.5 hours to 3.5 hours. In order to further narrow down the site selection, we consider data in Table 2 which gives estimates of the population sizes from the selected train stations. The data in Table 2 assume the population sizes of the 63 largest cities in the UK.

Table 1. The minimum traveling times and modes of surface transport from the selected train stations to the 8 UK airports.

	MAN	BHX	EMA	BRS	LHR	LGW	LTN	STN	Avg. T.
Newport-Chester:									
Pontypool	BT,3:10	BT,2:51	BT,4:15	B,1:44	BT,3:07	BTS,3:50	BTS,3:52	BT,4:13	03:22:45
Abergavenny	T,2:29	T,2:39	T,3:49	BT,1:54	T,2:51	TS,3:34	BTS,3:42	TS,3:53	03:06:23
Leominster	T,1:50	T,2:13	BT,3:47	BT,2:42	T,3:39	TS,4:09	BT,4:15	TS,4:23	03:22:15
Ludlow	T,1:39	T,2:01	BT,3:35	BT,2:31	T,3:49	TS,4:03	BT,4:17	T,4:26	03:17:38
Craven Arms	T,2:15	T,1:53	BT,3:27	BT,2:47	T,3:47	TS,3:55	BT,4:10	TS,4:18	03:19:00
Church Stretton	T,1:37	T,1:44	BT,3:18	BT,2:55	TS,3:51	TS,3:55	BT,4:06	TS,4:12	03:12:15
Gobowen	B,2:12	T,1:56	BT,3:18	BT,3:27	TS,3:45	TS,3:49	BT,4:00	TS,4:04	03:18:53
Ruabon	B,1:54	T,2:08	BT,3:42	BT,3:44	TS,3:33	TS,3:37	BT,3:48	TS,3:52	03:17:15
Wrexham	B,1:17	T,2:15	BT,3:23	BT,3:51	TS,3:25	TS,3:29	BT,3:40	TS,3:44	03:08:00
Newport-Gloucester:									
Severn Tnl. Junction	T,3:33	T,2:18	BT,3:18	BT,0:59	T,2:36	TS,3:19	TS,3:27	TS,3:38	02:53:30
Chepstow	T,3:20	T,1:41	BT,3:05	BT,1:41	B,2:05	BT,3:40	TS,3:49	TS,4:04	02:55:38
Lydney	BT,3:38	T,1:42	BT,2:58	BT,1:38	BT,3:03	TS,3:51	BT,3:49	TS,3:58	03:04:38
Hereford-Worcester:									
Ledbury	T,3:04	T,1:31	BT,2:57	BT,2:51	T,3:49	TS,3:42	BT,3:40	TS,3:49	03:10:23
Great Malvern	T,3:23	T,1:28	BT,2:48	BT,2:32	T,3:06	TS,3:40	BT,3:24	TS,3:47	03:01:00
Worcester Foreg. St.	T,3:02	T,1:07	BT,2:31	BT,2:10	T,2:45	TS,3:19	BT,3:03	TS,3:35	02:41:30
Droitwich Spa	T,2:38	T,0:56	BT,2:23	BT,2:26	TS,3:07	TS,3:10	BT,3:13	TS,3:22	02:39:23
Shrewsbury-Wolverhampton:									
Wellington	T,2:04	T,1:00	BT,2:23	BT,3:04	TS,3:10	TS,3:15	BT,3:10	TS,3:29	02:41:53
Telford Central	T,2:02	T,0:53	BT,2:15	BT,2:57	TS,3:03	TS,3:08	BT,3:03	TS,3:22	02:35:23
Cosford	T,2:27	T,0:59	BT,2:09	BT,3:02	TS,3:11	TS,3:15	BT,3:22	TS,3:30	02:44:23
Shrewsbury-Crewe:									
Whitchurch	T,0:59	T,1:48	BT,2:58	BT,3:48	BT,2:49	TS,2:59	BT,2:59	TS,3:08	02:41:00
Nantwich	T,0:50	T,1:35	BT,2:45	BT,3:35	BT,2:40	TS,2:50	BT,2:50	TS,2:59	02:30:30

Table 2. The estimates of the population sizes (in millions) within a given distance from the selected train stations.

Distance (miles)	25	50	75	100	125
Newport-Chester:					
Pontypool	0.6	1.8	4.8	7.1	11.3
Abergavenny	0.6	1.8	4.7	8.1	14.3
Leominster	0.0	3.0	6.3	12.8	28.6
Ludlow	0.2	3.2	7.3	14.0	18.2
Craven Arms	0.2	3.2	7.1	14.0	17.5
Church Stretton	0.2	3.0	9.1	15.2	17.2
Gobowen	0.0	2.0	9.7	14.4	16.4
Ruabon	0.0	4.5	9.4	13.7	16.6
Wrexham	0.3	4.5	10.4	13.4	16.6
Newport-Gloucester:					
Severn Tnl. Jun.	1.3	1.7	5.3	7.9	20.3
Chepstow	1.4	1.7	6.5	9.0	22.3
Lydney	1.1	1.7	5.9	9.2	25.9

Distance (miles)	25	50	75	100	125
Newport-Gloucester:					
Ledbury	0.1	4.3	7.1	10.8	27.8
Great Malvern	0.1	4.3	6.8	14.4	29.0
Worcester Fr. St	2.6	3.3	7.4	14.3	29.0
Droitwich Spa	2.5	3.1	7.3	15.0	28.9
Shrewsbury-Wolverhampton:					
Wellington	0.2	3.8	11.1	16.2	17.5
Telford Central	0.5	3.8	10.9	16.2	17.6
Cosford	2.7	4.1	10.8	16.4	27.5
Shrewsbury-Crewe:					
Whitchurch	0.5	6.9	13.3	14.1	16.9
Nantwich	0.6	8.5	13.3	13.8	17.3

Finally, by comparing the travel times to the airports and the population sizes potentially served by different locations of the satellite terminal, we can narrow down the selection from the original 21 locations to the following 3 stations: Droitwich Spa, Cosford and Nantwich. Fig. 3 shows (in red color) the National Rail routes considered for choosing the satellite terminal location. Assuming Nantwich station, Fig. 4 shows the latitude and longitude map of cities (in magenta color, the disk size corresponds to the city population size) and the airports. The dashed co-centric circles in Fig. 4 have the radiuses of 25, 50, 75, 100, 125 and 150 miles, respectively.

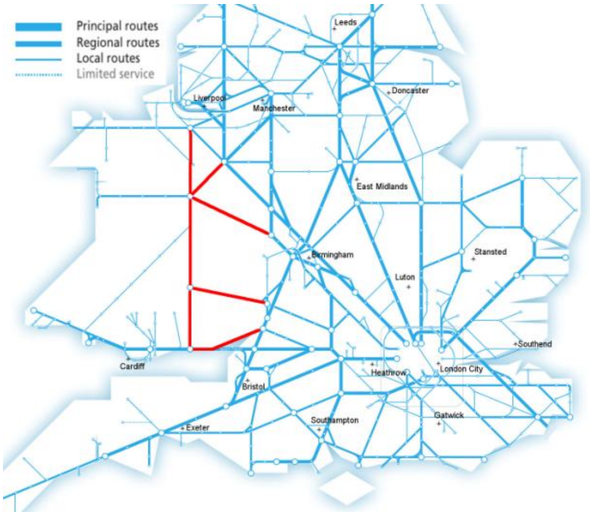

Fig. 3. The National Rail network and the rail stations considered.

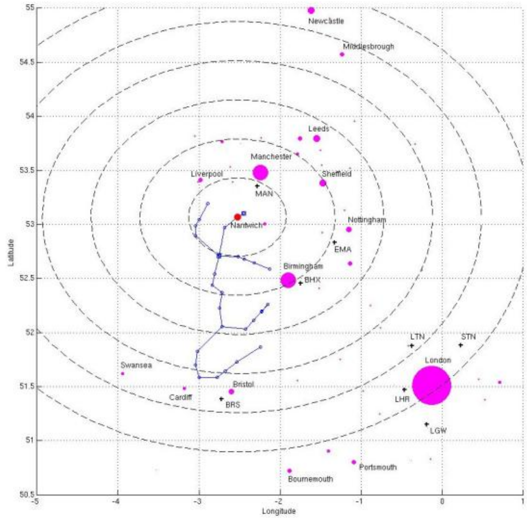

Fig. 4. The latitude and longitude map of the airports and cities.

4. Conclusion

The rapid growth of passenger volumes requires new business and operational models for processing passengers and baggage. Satellite passenger terminals can be a solution to effectively outsource the passenger and baggage processing functions from multiple terminals. The passengers passing through these terminals would be treated as transferring or transiting passengers at their actual departing and arriving airports. We illustrated that the best location for these terminals can be selected by prioritizing a list of candidate locations. However, in order to make these terminals economically viable, suitable business models are required to fund their development and operation.

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References

ACRP Report 25, 2010. Airport Passenger Terminal Planning and Design. Transportation Research Board. Volume 1 & 2, pp. 423 & 84.

Civil Aviation Authority, 20xx. CAA Passenger Survey Report 20xx. URL: http://www.caa.co.uk/Data-and-analysis/UK-aviation-market/

COST 318, 1998. Interactions Between High-Speed Rail and Air Passenger Transport. Final Report, pp. 344.

Digital Transformation Initiative (DTI), 2017. Aviation, Travel and Tourism Industry. White Paper, pp. 40.

House of Commons, Transport Committee, 2016. Surface transport to airports. Report, pp 45.

Daileda D. A., 2009. Considerations for Selecting a Terminal Configuration. FAIA, FAA White Paper.

IATA, 2017. IATA Resolution 753/A4A Resolution 30.53. Implementation guide, pp. 57.

IATA, 2015. Simplifying the Business. White Paper, pp. 24.

Kazda A., Caver R. E., 2015. Airport Design and Operation. Emerald UK. 3rd ed., pp. 596.

Loskot P., Ball P., 2015. Innovative Baggage Delivery for Sustainable Air Transport. In Proc. InAir'15, Amsterdam, Netherlands, Nov. 2015.

Montreuil B., Meller R. D., Ballot E., 2013. Physical Internet Foundations, in "Service Orientation in Holonic and Multi Agent Manufacturing and Robotics". Springer Berlin Heidelberg, 151-166.

Pružinký M., Mihalčová B., 2015. Outsourcing within airport services. Journal of the Maritime University of Szczecin 44(116), 162-169.

SITA, 2017. Air Transport Industry Insights. The passenger, airline and airport IT trends surveys. Annual Reports.

Slack B., 1999. Satellite terminals: a local solution to hub congestion? Journal of Transport Geography 7(1999), 241-246.

van Zundert H. C. W., 2010. Off-Airport Baggage Check-in. TU Delft. Master Thesis, pp. 206.