REVIEW OF FUTURE CAPACITY NEEDS AT IRELAND'S STATE AIRPORTS

FINAL REPORT FOR THE DEPARTMENT OF TRANSPORT, TOURISM AND SPORT

AUGUST 2018

An Roinn Iompair Turasóireachta agus Spóirt
Department of Transport, Tourism and Sport

Oxford Economics

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August 2018

The modelling and results presented here are based on information provided by third parties, upon which Oxford Economics and CEPA have relied in producing its report and forecasts in good faith. Any subsequent revision or update of those data will affect the assessments and projections shown.

Commercially sensitive and confidential information has been removed from this version at the places marked "[Redacted]".

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EXECUTIVE SUMMARY

The National Aviation Policy, 2015, committed the Department of Transport, Tourism and Sport (DTTAS) to commission a high-level strategic capacity review of Ireland's State airports: Dublin, Cork and Shannon. Oxford Economics and CEPA were selected to carry out this review. Our main findings are outlined in this Executive Summary of the two-volume report.

PASSENGER DEMAND FORECASTS FOR THE THREE STATE AIRPORTS

In our **baseline scenario**, passenger demand at Dublin increases by an average of two percent per year for 2017 to 2050 to reach 54 million passengers by 2050. Passenger numbers at Cork are forecast to reach 4.1 million in 2050, while at Shannon they reach 3.3 million.

Our **downside scenario** simulates two near term global risks scenarios: a "cliff-edge" Brexit leading to WTO trading arrangements between the UK and EU, and a more protectionist attitude towards international trade and investment by the US. These factors are compounded by weaker demographic growth in Ireland and higher oil prices. Under this scenario Dublin's passenger growth averages 1.7 percent per year, with passenger numbers reaching 49 million by 2050. The 2050 forecast for Cork is 3.7 million, while at Shannon it is 3.0 million.

Our **upside scenario** simulates the effects of a positive near-term boost to Ireland's economy as part of the global upturn, together with three longer-term supply-side improvements: faster population growth, faster productivity growth, and greater trade openness. Under this scenario, Dublin reaches 61 million passengers by 2050, while Cork reaches 4.6 million and Shannon 3.8 million.

For **Dublin Airport only**, we also test a sensitivity scenario under which passenger numbers are assumed to grow more quickly over the next five years as the airport continues to develop as a secondary hub. Combining this with our upside economic growth assumptions, we find that passenger numbers increase by a further 1.7 million to 62.5 million by 2050.

Summary of passenger forecasts, by scenario

	Passengers		ATMs	
	Millions	Average annual growth rate 2017-2050	000s	Average annual growth rate 2017-2050
Dublin - 2016	**28**	**-**	**216**	**-**
Baseline – 2050	54	2.0	365	1.6
Upside – 2050	61	2.3	409	1.9
Downside - 2050	49	1.7	329	1.3
Cork - 2016	**2.2**	**-**	**50.9**	**-**
Baseline – 2050	4.1	1.8	71.6	1.0
Upside – 2050	4.6	2.2	75.9	1.2
Downside - 2050	3.7	1.5	68.3	0.9
Shannon - 2016	**1.8**	**-**	**19.1**	**-**
Baseline – 2050	3.3	1.9	32.9	1.6
Upside – 2050	3.8	2.2	36.2	1.9
Downside - 2050	3.0	1.5	30.5	1.4

Source: Oxford Economics

CAPACITY OF EXISTING INFRASTRUCTURE AND PRIORITIES FOR DEVELOPMENT

The tables below identify the **main capacity constraints** identified for each airport, and the **years** when such constraints are likely to take effect. We also suggest the **volume of additional infrastructure needed** to alleviate the expected capacity constraints.

For some infrastructure components, the range of future capacity requirements can be large. This uncertainty is driven by a number of factors, including how near the infrastructure currently is to its capacity; the variation in demand between the lowest and highest passenger growth scenarios; the profile of demand growth over time; and the sensitivity of capacity to changes in demand.

Note: the additional capacity needs shown should be interpreted as an indicator of the degree of shortfall in capacity compared to the current facility, not a recommendation of what should be built. It may be preferable to address capacity issues by other means, e.g. process improvement or technology enhancement, rather than simply adding additional infrastructure of the type already used. Identifying the optimal way to address each constraint would require further detailed airport design work.

Airport capacity requirements to 2050, Cork

Infrastructure component	Year when capacity reached	Additional capacity needs to meet demand to 2050
Immigration area (queue times and crowding)	2020	5 lanes and 50 percent increase in space
Passenger security screening (queue times)	2020-25	3 to 5 x-ray lanes
Boarding gates	2030-35	Up to 3 gates
Stands	2030-35	4 to 6 stands
Departure lounge space (excluding space occupied by food and beverage outlets)	2030-35	60 percent increase in space
Passenger security screening at central search (crowding)	2035-45	50 percent increase in space

Airport capacity requirements to 2050, Shannon

Infrastructure component	Year when capacity reached	Additional capacity needs to meet demand to 2050
Baggage reclaim carousels	2020	2-3 carousels
Passenger security screening (queue times)	2020-25	5 x-ray lanes
Departure lounge space (excluding space occupied by food and beverage outlets)	2025-35	Up to a 75 percent increase in waiting space excl. food and beverage outlets to meet peak demand over relatively short periods
Stands	2035	Up to 12 stands
CBP pre-clearance desks	2035-40	Up to 7 desks
Immigration area (queue times)	2040-45	2 desks

Airport capacity requirements to 2050, Dublin

Infrastructure component	Year when capacity constraints start	Additional capacity needs to meet demand to 2050
Stands	2025-35	39 to 89
Terminal 1 baggage reclaim hall	2020-25	Up to 35 percent increase in reclaim carousel capacity, and up to 80 percent increase in space
Terminal 1 boarding gates (Pier 1)	2025-30 (driven by crowding, assuming it is not possible to spread demand to Pier 2)	Up to 10 gates
Terminal 1 boarding gates (Pier 3)	2025-30 (driven by gate availability, assuming it is not possible to spread demand to Pier 2)	Up to 8 gates
Terminal 1 immigration (queue times) [1]	2030-35	10 to 20 passport verification desks
Terminal 1 immigration (crowding)	2030-2035	Approximately 300m^2 to 900m^2 of space
Terminal 1 passenger security screening (queue times)	2035-45	Up to 8 x-ray lanes
Terminal 2 TSA compliant screening (queue times)	2020-25	4-9 x-ray lanes
Terminal 2 bussing gates	2025-35	2 to 4 gates by 2050
Terminal 2, eastern check-in zone	2020	Up to 19 desks
Terminal 2 immigration (queue times)	2040-50	8 desks
Terminal 2 immigration (crowding)	2030-40	233m^2 to 649m^2 of space
Terminal 2 CBP pre-clearance border checks	2030	6 to 13 desks
Terminal 2, western check-in zone	2030-35	Up to 15 desks
Terminal 2 hold baggage screening	2035-40	Up to 4 HBS machines
Terminal 2 baggage reclaim (carousel capacity)	2040-45	20 percent increase
Terminal 2 passenger security screening (queue times)	2035-40	Up to 10 x-ray lanes (unless system can be upgraded to automatic tray return, similar to T1)
Terminal 2 baggage reclaim (area)	2035-45	Up to 40 percent increase in floor space

The findings for CBP pre-clearance are based on the process in place at the time of the research in late 2017 and early 2018. A new system based on biometric facial recognition was introduced on a trial basis in June 2018. It is expected that this will speed up passenger processing. We therefore recommend that the analysis of CBP pre-clearance capacity should be re-visited once the findings of the trial are known.

Runway and road capacities at Dublin

Dublin Airport's **runway** is currently operating at capacity in the early-morning departure peak. The addition of the planned new runway has the potential to alleviate the situation, but the planning

[1] The results of the analysis for the immigration area appear to contradict recent passenger experience of long queues and crowding because: (i) the analysis is based on the near future scenario where planned additional gates have been added, not on the actual situation in 2017 and early 2018; (ii) it is understood that there have been some technical issues with the introduction of e-gates that have reduced passenger flow; and (iii) immigration staffing might not have been matched to the demand profile. Shortfalls in staffing levels will necessarily increase queues and crowding above those predicted from the infrastructure capacity alone.

restriction prohibiting its use in the night period between 23:00 and 07:00 will markedly reduce the benefits. Furthermore, the limit of 65 night flights is below the level operated during summer 2017 and will constrain growth, reducing the number of late-night arrivals and early-morning departures that are valuable to Dublin-based carriers.

Given current forecasts and enabling the most efficient runway operations through, inter alia, ameliorating capacity constraints due to planning restrictions and allowing mixed mode operations, a two-runway Dublin airport could start to show the effects of runway capacity constraints by around 400,000 to 450,000 movements. This point could be reached around 2050 under our upside growth scenario. Effects are likely to include increasing and highly variable delays, as well as reduced resilience to disruption. Given that there are typically long lead times for runway and airspace changes, it could be prudent to start the planning process for additional runway capacity by around 2030. The planning process should not only consider additional infrastructure, such as a third runway and enhanced rapid access and exit taxiways to existing runways, but also include technology and process improvements, such as enhanced arrival and departure managers and time-based separations.

Our analysis indicates the **road system** around Dublin Airport is already under pressure, in terms of traffic volumes and speeds, at peak times—particularly the M1, R132 and R108. While increased passenger numbers at Dublin Airport are likely to exacerbate this situation, the degree to which this is the case will depend on a range of factors, including changes in passengers' preferences for different modes of ground transport. A detailed study is needed to fully understand the impact, both in terms of the overall road network, and on journey times to and from Dublin Airport.

POTENTIAL NEW TERMINAL AT DUBLIN AIRPORT

Timeframe for development of Terminal 3

We consider the timeframe for development of a new terminal, and the case for either (a) avoiding expansion, or (b) incrementally expanding the airport's existing terminals. daa has presented options for expanding the existing terminals, first to an annual capacity of 40 million passengers, then later to 55 million, rather than building a third terminal. The 55 million layout includes a large satellite building west of the existing crosswind runway. There are therefore, two distinct questions: **when, if at all, is a third terminal required**, and **when can it be afforded?**

We find that in the short term, **incremental expansion of Terminals 1 and 2 is desirable**, because a third terminal cannot be available in time to relieve the short-term capacity issues at the airport. Material expansion to a 40 million capacity is very plausible, setting aside issues of surface access—which is subject to relaxing the 32 million planning restriction, put in place to allow evaluation of surface access issues.

It would require a much more detailed study (engineering, architectural and programming) than ours to assess whether daa's plans for further incremental expansion to 55 million are plausible (again setting aside issues of surface access), but in our view considerable disruption to operations may be required to achieve it.

Our findings on **when, if at all, a third terminal is required** are:

- Some incremental expansion is likely to be desirable in the short term, because a third terminal will not be available in time to relieve the short-term issues in the airport.
- Some material expansion of T1 and T2, certainly to 40 million passengers per annum (mppa), is very plausible, setting aside issues of surface access and choice[2] for airlines.
- The timing around a third terminal decision needs to take into account any measures to remodel T1 and T2 beyond approximately 40 mppa. Works at that level are likely to be very disruptive, so if a third terminal is to be built, a decision would be required at the latest in time to avoid the commencement of large scale remodelling of the existing terminals. On Oxford Economics' central forecast, that means by about 2031, which would require a decision on a third terminal early in the 2020s. Actual demand levels and prospects should continue to be monitored to assess whether the timing might change.
- Surface access issues in the wider road network may make it overall a better solution for Ireland to pursue a third terminal in the western part of the airport, rather than allowing much further expansion in the eastern campus. Developing the wider road system to handle traffic generated by different terminal strategies might have substantially different costs, and thus might justify spending more on a terminal layout that reduces wider costs. Detailed study outside of the scope of the present project is required to assess this.
- The government should make an early strategic decision on whether the crosswind runway should be retained. This substantially affects the available development options and their cost and relative advantages.

We have built an illustrative financial model to assess **whether a third terminal should be phased**, and on **what timescale it can be afforded**. Our assessment is based upon the passenger and aircraft traffic forecasts provided in this report, and a base cost for the terminal similar to T2.

[2] When we refer to choice it means choice for airlines, as passengers inherit the airline's choice.

On these traffic and cost assumptions, there appears to **be no strong reason to delay development of a third terminal on grounds of affordability.** Our simulations of regulated charges indicate that airport charges end up no more than 5 percent higher than 2016 charges. This modest increase is driven by demand-led income. Our main concerns are risk within the demand forecasts, which are inevitably subject to a substantial degree of uncertainty, or a materially costlier development. Phasing the terminal would appear to be a wise method of responding to such risk.

Size and location of a new Terminal 3

We find that a new terminal, built in phases and ultimately serving 20 million passengers per year would be an appropriate response to the capacity requirements set out in the table above—"Airport Capacity Requirements to 2050, Dublin". Such a terminal could be specified at about 60,000 m^2. We considered the advantages and disadvantages of three possible locations, although a surface access study would be required to recommend a location:

- **Location 1**: North-East of Terminal 1, currently occupied by maintenance, repair and overhaul (MRO) facilities. This is a constrained site requiring a smartly designed terminal which is likely more suited to the requirements of low-cost airlines. It would be straightforward to integrate with the rest of the airport, although stand location would create complications as traffic grows. Surface access issues may present an overriding problem and require further detailed assessment.
- **Location 2**: North-West of Terminal 1, a site which is also straightforward to integrate with the rest of the airport but does not make an overall addition to stand capacity without the closure of the crosswind runway. Also, as in location 1, surface access issues may present an overriding problem and require further detailed assessment. Additionally, it has the complexity of taking account of the listed infrastructure in the area.
- **Location 3**: West of the crosswind runway between the Northern and Southern runways. This is an unconstrained site where it will be easier, cheaper and less complicated to develop the core terminal and stands, assuming land is made available. But material additional costs would be involved in developing a passenger transport solution to integrate the new terminal with the rest of the airport and to build roads for surface access. These additional costs would be reduced if the crosswind runway is closed. But there would be other, perhaps less obvious, costs in losing the crosswind runway.

Financial and regulatory frameworks

DTTAS has asked us to focus on the possibility of delivering meaningful choice to airport users, and also to specifically focus on an independently operated third terminal. In practice, choice for users means choice for airlines, as passengers inherit their airline's choices. We consider a range of institutional structures for the operation of a third terminal and present alternatives that would allow choice, or a degree of choice, about how the options might be arranged and their broader effects. We use an illustrative financial model to assess what level of charges would allow such institutions to cover their costs.

We study options where the terminal operator may be daa, an airline (or group or airlines), a third-party investor, or an airline/investor consortium. We find the following scenarios to be potentially feasible:

- A status quo with daa operating all terminals;
- A single airline/alliance operator running a terminal for themselves;
- A third-party investor competing with T1/T2, with or without an airline in consortium; and
- A range of models where T3 serves a designated market, typically as build-operate-transfer (BOT) scheme.

We find that scenarios (within some of the above options) where the opening of T3 is used as an opportunity to close and redevelop T1 to be financially difficult, because daa will struggle to cover the inherited cost.

Our key **conclusions on delivering choice** to airlines are that fully commercial competing operation of terminals maximises choice. Airline operated terminals provide choice for those airlines, but not others[Redacted]. Independently operated terminals with a designated market, for example under concession, may have a more commercial attitude to users than present arrangements, but choice is limited because airlines cannot change terminals.

The National Aviation Policy, 2015 outlines the role of State airports, including the government's policy position that *"the three State airports will continue to provide essential strategic infrastructure and services that support the economic and social objectives of the State"*. The Policy also committed the Department of Transport, Tourism and Sport to commission this high-level strategic capacity review of State airports. The Terms of Reference for the review state that it should take account of policy objectives including *"developing Dublin Airport as a secondary hub supporting services to global markets without weight restrictions"* and *"wider government objectives and policies for enterprise, tourism and balanced regional development in Ireland and developments in the global aviation market".*

The objectives quoted in the previous paragraph and their implications are, in some areas, not necessarily consistent with competitively delivered choice within the airport, without any regulation. For example, these objectives might be considered, among other things, as requiring some kind of minimum quality standards for airports which are a main gateway to Ireland, and this would likely require some regulation to ensure it was achieved. One can also interpret these objectives as desiring a high level of air connectivity, although we do not find this objective inconsistent with competitive choice. Connectivity is delivered finally by airlines, and the airport's role in this is mainly to be responsive to airlines' requirements. Our understanding is that Dublin is already perceived by many to be a secondary hub.

Thus we do not find that the government would obtain advantage in directing an independent terminal provider or DTTAS to specify a terminal to serve a specific market. But a terminal operator might choose to serve particular market, or a terminal concession may be configured to serve a particular market.

Finally, we set out a range of legal and regulatory issues specific to an **independently operated terminal model** and consider **transitional arrangements**.

The introduction of a large amount of new capacity risks reducing the demand for an existing asset (and/or labour), which may then be considered "stranded". In the short term this may leave daa in a situation of holding assets which it has relatively large operating costs to keep in operation, and unable to pay its full financing costs. Within a broad range, this can be consistent, within reasonable bounds, with a daa that is viable and successful in the longer term (and there can be compensating benefits in the form of investments made and competition).

Fair and transparent access arrangements to the airport's common user infrastructure are required—this could involve some level of institutional separation of common user infrastructure and other terminals. There is however no international precedent for a such a regulatory/charging system for a fully competing independent terminal, so there is substantial risk in attempting to make the first implementation.

Specific arrangements are required to preserve the long-term interests of the airport (such as an airport system controller/planner) to ensure the terminal's location and arrangements do not impede future efficient development of the airport.

A backstop provision for re-regulation if competition ceases to be effective is required, for example, a terminal may gain some market power if the airport becomes relatively full and hard to expand. A provision for competition powers if not covered by general law is also required, for example, if a terminal tries to put another out of business.

REPORT STRUCTURE

The report is split into two volumes.

Volume 1 presents our passenger demand forecasts and analysis of capacity for each of the three State airports, as described in objectives 1 and 2 of the project Terms of Reference. In particular:

- Chapter 2 presents our forecasts of passenger numbers and air traffic movements under a range of scenarios for the three State airports. These forecasts have been prepared by Oxford Economics.
- Chapter 3 presents our findings in relation to the capacity of each of the three State airports and uses the forecasts from Chapter 2 to identify the priorities for and timing of capacity enhancements. This chapter has been compiled by Taylor Airey.

Volume 2 focuses entirely on development at Dublin Airport, as identified in objectives 3 and 4 of the Terms of Reference. This part of the report has been written by CEPA, who have used the forecasts and capacity results from Volume 1 as an input to their work. Specifically:

- Chapter 5 sets out high-level options for developing Dublin Airport, based on both making the best use of existing infrastructure and, potentially, constructing a new terminal.
- Chapter 6 assess the potential financial and regulatory frameworks for a third terminal at Dublin Airport.

ACKNOWLEDGEMENTS

While much of the study has been based on detailed desk-based analysis of economic, financial and airport design information, we have also relied to great extent on a number of stakeholders to provide insights and data. We would like to thank the following organisations for their contributions to the study:

- ACI Europe
- Aer Lingus
- Commission for Aviation Regulation (CAR)
- Cork Airport
- daa
- Department of Business, Enterprise and Innovation
- Department of Justice - INIS
- DTTAS - Tourism
- Economic & Social Research Institute (ESRI)
- Fingal County Council
- Ireland Development Agency (IDA)
- Irish Air Line Pilots Association (IALPA)
- Irish Aviation Authority (IAA)
- Irish Congress of Trade Unions
- Irish Exports Association
- Irish Tourism Industry Confederation (ITIC)
- National Transport Authority
- Norwegian Air International
- Nyras
- Ryan Air
- Shannon Airport
- Stobart Air
- Tourism Ireland
- Tricap Investments

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VOLUME 1

PASSENGER DEMAND FORECASTS, AIRPORT CAPACITY, AND PRIORITIES FOR DEVELOPMENT

1. INTRODUCTION TO VOLUME 1

1.1 CONTEXT

International air transport is a crucial enabler of economic growth and development. The air transport industry itself supports output and employment, both directly and through multiplier effects which arise in the industry's supply chain and as a result of workers' spending. Perhaps much more importantly, however, air travel generates a range of wider benefits which support economic competitiveness. It enables firms to sell their goods and services in global markets and purchase inputs from a wider range of suppliers. This in turn drives competition, specialisation, innovation efficiency, and the diffusion of knowledge and know-how, ultimately enabling consumers to benefit from a wider choice of goods and services.

International air travel also supports inward investment, while air freight links provide an efficient and timely way to import and export goods, particularly those which are time-sensitive or perishable. Air transport also enables leisure travel, enabling individuals to spend time with friends and family, or to visit new places. Inbound tourists support jobs and output in sectors such as hospitality, catering and retail.

However, airports may face capacity constraints which limit the rate of growth of air travel, preventing countries from realising the full extent of the potential economic benefits. Such constraints can ultimately be harmful to countries' long-term economic competitiveness. At the same time, developing new airport infrastructure can take many years, and so it is important to ensure there is sufficient capacity in place to meet not only current demand, but also to accommodate future demand growth.

Within the context of Ireland, the government's policy in relation to airports and aviation is set out in the National Aviation Policy, 2015.[3] Chapter 4.3 of that document outlines the role of State airports, including the government's policy position that *"the three State airports will continue to provide essential strategic infrastructure and services that support the economic and social objectives of the State"*. The National Aviation Policy also committed the Department of Transport, Tourism and Sport (DTTAS) to commission a high-level strategic capacity review of State airports in Ireland (Dublin, Cork and Shannon). Further, the terms of reference for the review stated that it should take account of the policy objectives of *"developing Dublin Airport as a secondary hub supporting services to global markets without weight restrictions"* and *"supporting the roles of Cork and Shannon Airports as key tourism and business gateways for their regions"*. It should also take account of *"wider government objectives and policies for enterprise, tourism and balanced regional development in Ireland and developments in the global aviation market"*.[4]

[3] DTTAS, *A National Aviation Policy for Ireland*, (August 2015).

[4] DTTAS, *Request for Tenders dated 11 November 2016 for the provision of Consultancy Services to Review the Future Capacity Needs at Ireland's State Airports*

DTTAS has selected Oxford Economics and CEPA, supported by Taylor Airey, to carry out this review.

1.2 OBJECTIVES AND REPORT STRUCTURE

The Terms of Reference (ToRs) for the study identified four objectives:

(1) *For each of the three airports, the capacity of the existing and planned infrastructure to meet forecast passenger throughput to 2050 (taking account of appropriate alternative future growth scenarios) should be set out. The analysis should take account of existing and historical traffic patterns; the economic growth outlook; and airport business plans for growth.*

(2) *For each of the three airports, the study should identify the priorities and recommended timeframe for new infrastructure development or adjustments to existing infrastructure to pre-empt any constraints on growth due to capacity, taking account in the case of each airport of existing plans. Infrastructure development should include modifications to the existing infrastructure to maximise capacity.*

(3) *In the case of Dublin Airport only, the study should set out a reasoned recommendation for (1) the timeframe for the development of new terminal capacity – Terminal 3; (2) the options in terms of appropriate size and design; and (3) the optimum location. The study should have regard to the need to promote effective use of the runways, and ensure that the airport as a whole can respond to the needs of users—notably airlines.*

(4) *In the case of Dublin Airport only, the study should (1) assess the relative advantages and disadvantages of the funding and operation of Terminal 3 by the existing airport operator in comparison with being operated on an independent basis, (2) set out proposals for any transitional arrangements which might be necessary to avoid stranded assets/labour costs where a new terminal is operated independently, and (3) outline the implications of, and proposals for, an appropriate legislative and regulatory framework to ensure fair competition between the existing terminals and Terminal 3.*

In this first volume of our report, we respond to the questions identified in the first two objectives outlined above. In particular:

- Chapter 2 presents our forecasts of passenger numbers and air traffic movements under a range of scenarios for the three State airports. These forecasts have been prepared by Oxford Economics.
- Chapter 3 presents our findings in relation to the capacity of each of the three State airports and uses the forecasts from Chapter 2 to identify the priorities for and timing of capacity enhancements. This chapter has been compiled by Taylor Airey.

The forecasts and analysis in this section inform the analysis in Volume 2, which covers the third and fourth objectives in the ToRs.

2. DEMAND FORECASTS

AUTHOR: OXFORD ECONOMICS

KEY FINDINGS

In our baseline scenario, passenger demand at Dublin increases by an average of two percent per year for 2017 to 2050 to reach 54 million passengers by 2050. Passenger numbers at Cork are forecast to reach 4.1 million in 2050, while at Shannon they reach 3.3 million.

Our downside scenario simulates two near term global risks scenarios: a "cliff-edge" Brexit leading to WTO trading arrangements between the UK and EU, and a more protectionist attitude towards international trade and investment by the US. These factors are compounded by weaker demographic growth in Ireland and higher oil prices. Under this scenario Dublin's passenger growth averages 1.7 percent per year, with passenger numbers reaching 49 million by 2050. The 2050 forecast for Cork is 3.7 million, while at Shannon it is 3.0 million.

Our upside scenario simulates the effects of a positive near-term boost to Ireland's economy as part of the global upturn, together with three longer-term supply-side improvements: faster population growth, faster productivity growth, and greater trade openness. Under this scenario, Dublin reaches 61 million passengers by 2050, while Cork reaches 4.6 million and Shannon 3.8 million. For Dublin Airport only, we also test a sensitivity scenario under which passenger numbers are assumed to grow more quickly over the next five years as the airport continues to develop as a secondary hub. Combining this with our upside economic growth assumptions we find that passenger numbers increase by a further 1.7 million to 62.5 million by 2050.

Growth in Air Transport Movements (ATMs) is expected to be slower than that of passenger numbers. This reflects that average plane sizes are expected to increase slightly over the forecast period, and that load factors on some current routes mean that more passengers can be accommodated without laying on additional flights.

Dublin airport handled around 90 percent of air cargo at Ireland's airports in 2016. We forecast that air cargo at Dublin will grow by between 1.2 percent (downside scenario) and 1.8 percent (upside scenario) per year to 2050.

Fig. 1. Summary of passenger forecasts, by scenario

	Passengers		ATMs	
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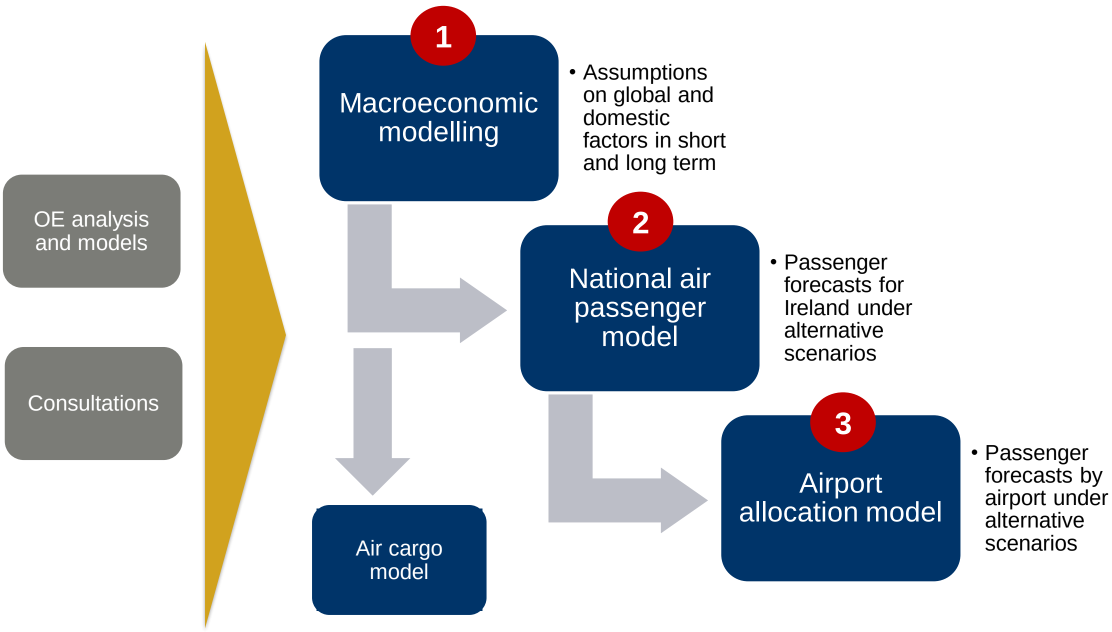
Downside - 2050	3.0	1.5	30.5	1.4

Source: Oxford Economics

2.1 OVERVIEW OF OUR FORECASTING APPROACH

Our approach to forecasting passenger demand at Ireland's three State airports is summarised in Fig. 2, below.

Fig. 2. Demand modelling process



There are three main steps within the modelling process.

First, we used Oxford Economics' global macroeconomic model to develop economic assumptions for Ireland and world regions to 2050. Given the relatively high degree of uncertainty with any forecast over such a long-time horizon, we produced forecasts under "upside" and "downside" scenarios, in addition to a central view. The scenarios were informed by consultations with stakeholders to identify the key long-term drivers of demand for Ireland. A summary of stakeholders' views is presented in the box below. Details of the economic forecasts are presented in Section 2.2.

The second step was to incorporate these economic assumptions within the Tourism Economics / IATA national air passenger model to produce updated air passenger demand forecasts 4,000 country-pair flows under each of the three scenarios. The country-pair forecasts for Ireland were aggregated to four regions: UK and Ireland(domestic), Europe, Transatlantic, and Rest of World. These forecasts take no account of airport infrastructure capacity constraints and therefore represent an 'unconstrained' view of future passenger demand in Ireland. They are presented in Section 2.3.

Third, we developed a bespoke airport allocation model to produce projections at the airport level. The model was based on historical air passenger data for each airport, sourced from CSO Ireland and supplemented with more detailed information from the airports themselves. The model assumed that passenger demand at each airport from 2016 grows in line with Ireland's annual forecast growth rate for each region to 2050. This 'top-down' approach means that differences in forecast passenger growth rates across airports reflect differences in the regional passenger mix in the base year. It ensures that the airport level forecasts are consistent with the 'unconstrained' outlook for passenger demand at the national level.

Once the passenger demand projections to 2050 for each of the three State airports had been completed, we used assumptions relating to aircraft size and load factors to forecast Air Transport Movements (ATMs). There is further discussion of our approach to forecasting ATMs in Section 2.4.4.

Finally, the ATM forecasts were used as an input into our forecasts for cargo demand at each airport. This element of the process is discussed in more detail in Section 2.7.

STAKEHOLDER CONSULTATIONS

Approach

A first round of consultations took place between December 2017 and January 2018. The consultations were used to gather insights and information from stakeholders to identify potential long-term drivers of demand for air travel and the capacity situation at the three airports.

An initial list of 34 stakeholder contacts was provided by DTTAS. These stakeholders were contacted and invited to either participate in a face-to-face or telephone consultation, or provide written input. We subsequently held nine face-to-face interviews and one telephone consultation. Four of these organisations also provided a written response to our questions and we received a written response from a further seven organisations. Each interview was structured around a topic guide designed to elicit the information to inform the modelling work and develop economic scenarios. The topic guide was sent to the stakeholder prior the interview, and to those stakeholders who were invited to provide written responses.

The remainder of this box summarises the consultation findings in relation to drivers of demand. Consultees' views on capacity are presented in Appendix 4: Further evidence from stakeholder consultations.

Macroeconomic drivers

The impact of Brexit and changes in US economic policy were consistently mentioned by consultees as the two key factors affecting the economic outlook of Ireland. Each factor offered both opportunities and risks to Ireland's economy, but there was no clear consensus amongst stakeholders of the overall net effects for Ireland.

Brexit. Three opportunities for Ireland from Brexit were highlighted. First, once the UK has left the EU, Ireland will become the largest English speaking EU country. Second, if migrants choose to go to Ireland instead of the UK, it could boost Ireland's labour supply. Third, Ireland could benefit from the relocation of certain activities away from the UK (e.g. financial services and EU agencies). On the other hand, Ireland's trade with the UK, its most important trading partner, could be hindered; the weakness of sterling since the referendum may lead to fewer UK visitors to Ireland; and there was some concern that Ireland could become more peripheral to EU markets, as much of the trade between Ireland and its EU markets is transported through the UK.

US policy. Some respondents suggested that an expansionary US fiscal policy stance (for example through lower personal and business taxes, higher spending and investment) could provide opportunities for Ireland through its trade and tourism links with the US. But stakeholders also mentioned that more protectionist US policies could lead to lower trade flows and reduced FDI in Ireland. And if US policies were to lead to political or economic instability in the US, that could result in fewer US visitors and lower demand for both leisure and business purposes.

Other macroeconomic factors. On the upside, stronger-than-expected growth in emerging markets could lead to Ireland's economy growing faster than in our baseline scenario. Several downside factors were also identified by stakeholders, however. The EU's movement towards a Common Consolidated Corporation Tax Base could lower corporation tax across EU countries and negatively impact on Ireland, which might suffer a decline in its relative attractiveness to foreign investors (particularly from the US). Higher EU interest rates could hit Ireland's economy hard given its high level of private debt, while increased competition from emerging markets will provide challenges for Ireland's exporters. Finally, supply-side oil shocks could push up prices, and ultimately lead to higher air fares.

Policy drivers

Stakeholders were asked how national and sub-national policies might shape the demand for air travel in future. Three broad areas of policy were considered: aviation, tourism, and FDI.

Aviation. Several stakeholders were aware of the main objectives set out in Ireland's 2015 National Aviation Policy, including to promote Dublin as a secondary hub airport and to maximise the contribution of the aviation sector to Ireland's economic growth and development. However, there was no firm agreement among respondents as to how these objectives aligned with Ireland's latest National Policy Framework which seeks more balanced growth across Ireland's three administrative and planning regions.

Two upside benefits linked to aviation policy in Ireland were suggested. Further development of Dublin as a secondary hub would be expected to increase the number of destinations with direct connections to Dublin, potentially boosting the air transport sector, tourism and, ultimately the economy as a whole through the wider benefits of air connectivity. Two stakeholders also suggested that Shannon might become a low-cost carrier hub for both short-haul and long-haul flights, with Dublin focusing on full service provider airlines.

Risks associated with policy included that it could lead to further expansion of the catchment area of Dublin airport at the expense of Cork and Shannon. This could hinder the growth of the latter two airports and their contribution to local economies. Others commented on the potential for Ireland to miss out on the benefits of traffic growth at Dublin airport if it is not able to increase capacity to meet future demand.

Tourism. Marketing campaigns, such as Tourism Ireland's promotion of the Wild Atlantic Way, along with targeted campaigns at international airports to promote regional Ireland would be expected to support faster growth in the demand to fly to Ireland. However, stakeholders noted that there is a shortage of visitor accommodation in Dublin which pushes up prices, and some were concerned that that too much tourism growth in Dublin may lead to the local population becoming less welcoming to visitors, similar to the experience in Barcelona.

Foreign Direct Investment (FDI). A few respondents reported that current efforts to boost FDI from Asia-Pacific and the Americas may increase passenger demand from these regions. Some companies in Ireland were reported to want direct routes to the west coast of the US and to Canada. One stakeholder reported that the direct flights from Shannon to the US, and from Cork to Europe, helped support FDI in the regions.

Other aviation-specific drivers

Stakeholders were asked how aviation-specific factors might shape the future of air traffic demand in Ireland. Their responses were grouped into four broad themes: external aviation policy; competition between airlines and airports; technology / sustainability; and air cargo.

External aviation policy. Some respondents highlighted that the European Commission's pursuit of further air liberalisation and air service agreements with third countries (e.g. Asia and Africa) could provide Ireland's airports with greater access to new and developing markets, while others saw this development as a risk to growth as increased competition from emerging markets will provide challenges for Ireland's exporters. Risks to Ireland's air transport growth included Northern Ireland scrapping Air Passenger Duty (APD) on short-haul flights.

Competition. Three potential risks were reported by stakeholders. First, there was a suggestion that Dublin may face increasing competition from other airports, particularly other hubs such as Amsterdam, Helsinki, and Reykjavik. Second, airports' non-fare revenues, an important revenue stream used to fund future airport investment, may be at risk from airlines as they branch out into offering car rental, duty free, and door-to-door transfers (reducing the need for airport parking). Some stakeholders also noted that other airports could start to offer US Pre-Clearance, reducing the competitive advantage of Irish airports who currently have this facility.

Technology/sustainability. Improvements in aircraft technology have led to the development of a new class of long-range, narrow-body aircraft. These enable airlines to offer direct flights to a wider range of destinations, both because the new aircraft can travel further than existing narrow body jets, and because they can land at more airports than wide body jets on long haul routes. On the other hand, if more flight time operating restrictions and environmental taxes were introduced, this could increase airfares and reduce the number of flights at certain times of day, acting as a drag on demand.

Air cargo. Ireland's exports of pharmaceuticals, medical technology and ICT goods could grow more quickly than envisaged, and further increase demand for air cargo. This cargo is likely to be transported via the bellyhold of passenger flights as the commercial case for growing dedicated air cargo operations was reported to be weak.

2.2 THE ECONOMIC OUTLOOK FOR IRELAND

2.2.1 Modelling approach

The macroeconomic forecasts for Ireland that underpin our passenger demand projections are generated within Oxford Economics' Global Economic Model. The model is demand-driven in the short run, and supply-driven in the long run. In other words, over the short to medium term, say five to 10 years, household and business confidence, and demand is key. But over this period, we expect economies to return to "equilibrium", that is, a normal pace of growth with a stable labour market and inflation. Beyond this point, growth is determined by supply-side factors, such as the availability of labour, skills, and capital, and productivity growth.

The alternative scenarios we have developed are global in nature, reflecting plausible upside and downside changes in the short run, based on Oxford Economics' Global Scenarios Service. These scenarios also have a longer-term impact as the starting point for future growth is affected, but we also incorporate alternative Ireland-specific growth assumptions relating to population and trend productivity growth, as well as the extent to which Ireland continues to become more open and export driven.

This modelling approach was used to determine both our baseline outlook for Ireland to 2050, and the upside and downside macroeconomic scenarios for Ireland.

2.2.2 Baseline forecast

The baseline economic forecasts for Ireland were prepared in January 2018. Underpinning the economic outlook over the short to medium term is our assumption for Brexit, which was based on progress made in negotiations during the second half of 2017. It assumes that a three-year transition agreement is reached to take effect from March 2019.[5] This ultimately leads to an EU-UK free trade agreement (less open than the single market, but better than WTO rules). Meanwhile the UK government is assumed to take a populist (i.e. relatively tough) approach to immigration.

Within the context of our Brexit assumption, our baseline economic forecast for Ireland is for an average rate of GDP growth of around 3 percent per year for 2017 to 2021, easing to just under two percent in the long run. This long-term growth rate is noticeably weaker than historic rates of growth for Ireland, and reflects that we expect productivity growth to slow to a rate more in line with other high-income European economies as the Irish economy matures. Of the 1.7 percent average annual GDP growth forecast for 2027 to 2050, around 0.5 percentage points come from growth in the labour force and 1.1 percentage points from productivity growth.[6]

[5] This was the working assumption at the time of undertaking the modelling, although a 21-month transition period has since been agreed. This change does not make a material difference to the modelling: the key point is that a "cliff-edge" Brexit is not the mostly likely outcome.
[6] The 0.5 and 1.1 sum to 1.7 percent after rounding.

We expect Ireland to continue to become more integrated with the global economy, and so the growth rates of exports and imports will exceed that for domestic parts of the economy. Consumer spending growth will ease from a rate of 2.5 percent in 2022-2026 to 1.6 percent in the long-run.

Fig. 3. Baseline economic forecasts for Ireland[7]

	Average annual percentage change unless stated otherwise				
	2007-2011	2012-2016	2017-2021	2022-2026	2027-2050
GDP	0.2	7.8	3.0	2.0	1.7
Consumption	0.3	1.5	3.4	2.5	1.6
Investment	-9.1	22.0	-3.7	3.1	1.7
Government consumption	-1.0	1.6	2.6	2.2	1.7
Exports of goods and services	3.6	11.6	2.4	2.7	2.8
Imports of goods and services	1.5	11.7	0.2	3.4	3.1
Unemployment (percent)	10.9	11.9	5.8	4.9	4.8
Consumer prices	1.2	0.4	1.4	2.0	2.0
Exchange rate (US$ per Euro)	1.4	1.2	1.2	1.2	1.3
Total population	1.3	0.7	0.9	0.9	0.8
Working age population	0.7	0.4	0.9	1.2	0.5
Labour supply[8]	0.1	0.2	1.0	1.2	0.6
Employment	-2.1	1.8	1.5	1.3	0.6
Labour productivity	2.3	5.9	1.4	0.7	1.1
GDP per head	-1.1	7.0	2.0	1.0	0.8

Source: Oxford Economics

Passenger demand growth at Irish Airports is not only influenced by economic prospects in Ireland, but also by those elsewhere in the world: just as higher incomes will boost the propensity of people in Ireland to travel overseas by air, so too will it boost travel by overseas residents to Ireland. This is an important element of our modelling approach given that that overseas travel statistics published by CSO suggest that 57 percent of passengers using Ireland's airports are non-Irish residents.[9] Fig. 4 shows our baseline economic growth assumptions for three key drivers of air passenger demand for major economies.

[7] GDP, consumption, investment, government consumption, export and import growth rates are expressed in real terms (i.e. after adjusting for inflation).

[8] Labour supply = (working age population) *(participation rate).

[9] "Overseas Travel Statistics", in *CSO* <https://www.cso.ie/en/statistics/tourismandtravel/overseastravel/> [accessed 26 June 2018]

Fig. 4. Baseline economic assumptions for other major economies

	Average annual percentage change, 2017-2050		
	Real GDP	Population	Real GDP per head
United Kingdom	1.4	0.3	1.1
United States	1.7	0.6	1.0
Germany	0.7	-0.2	1.0
France	1.1	0.2	0.9
Spain	0.9	-0.1	1.0
Italy	0.4	-0.1	0.5
China	4.1	-0.1	4.2

Source: Oxford Economics

2.2.3 Upside scenario

Our upside scenario drew on some of the main themes identified during the consultations, as well as Oxford Economics' own analysis. It simulated a near-term shock to Ireland's economy (as part of a global upturn) and a number of more fundamental supply-side improvements.

First, we simulated a stronger-than-expected acceleration in global trade and investment than in our baseline forecast for the years 2018-2020. This impacts broadly across both advanced and emerging economies, but as a particularly open economy Ireland is especially well-placed to benefit. Specifically, Ireland benefits around twice as much as the UK in a world trade upside, in terms of the proportionate impact on GDP growth.

We then added an assumption that Ireland sustains faster productivity growth than other high-income Eurozone economies for longer. Much of Ireland's productivity growth through the 1980s, 1990s, and 2000s can be ascribed to "catch-up", but the economy is now one of the richest in the Eurozone. Our baseline forecast is for productivity growth to cool to rates seen in other high-income Eurozone economies. But continued inflows of investment from high-income countries outside the EU (e.g. the US), or because of firms switching operations from the UK, could allow Ireland to outperform well into the 2020s.

In a longer-term perspective, we also assumed that as the only English-speaking member of the EU, and with a robust economy attracting FDI in high-wage sectors (e.g. financial services), Ireland becomes an increasingly popular destination for inward migration, leading to stronger growth in the working age population. To simulate this, we adopted population growth rates from the CSO M1F2 scenario from the 2013 Central Statistical Office population projections.[10]

[10] "Population and Labour Force Projections", in *CSO* <https://www.cso.ie/en/media/csoie/releasespublications/documents/population/2013/poplabfor2016_2046.pdf> [accessed 26 June 2018]
The M1 scenario assumes net migration returns to positive by 2016, rising steadily thereafter to plus 30,000 by 2021, and remains at this level thereafter. The F2 scenario sees the fertility rate decrease to 1.8 by 2026, and remain constant thereafter.

In such a scenario, Ireland would likely become more trade intensive (i.e. import and export more goods and services per unit of GDP than in a baseline without greater inward investment and migration). A more trade-intensive economy also supports higher productivity growth.

In our upside scenario the rest of the world economy is largely impacted in the short term, with less significant impacts in the long-run. This is driven by the nature of our scenario approach. The short-term drivers of our scenarios include several key risks known to exist in the global economy now, but because of the obvious uncertainty around global economic shocks in the 2020s-2040s, the long run is primarily driven by the fundamental determinants of growth in Ireland itself. In our upside scenario, GDP is around 1 percent higher than baseline in the UK by 2023, with this difference persisting into the long-term. The impact is larger in economies more integrated into world goods trade, including Germany (+2.9 percent), the United States (+2.3 percent) and China (+2 percent).

2.2.4 Downside scenario

In the downside scenario, we simulated two near-term global risk scenarios, and supplemented them with two longer-term drags to Ireland and the global economy.

The first near-term shock is a tilt towards protectionism and anti-immigration, starting in the US, but spreading to other major economies. In addition to pushing key economies close to a recession in the short-to-medium term, there are also important long-term impacts on growth around the world from a "retreat from globalisation" as other countries retaliate to new US tariffs. US growth is hurt in the long-term from weaker demographics (due to more restrictive immigration policies), and given the US' role as a key engine of global growth this spills over heavily into global growth, US import demand and US outward FDI. The last of these channels has relevance for Ireland given its close trading relationship with the US.

The second near-term shock is a breakdown in Brexit negotiations, leading to the UK making a hard exit from the EU. Specifically, "phase 2" negotiations break down, resulting in adoption of WTO "most favoured nation" rules (as opposed to our baseline assumption of a transition agreement and eventual free trade agreement) in March 2019 with little chance for firms to anticipate and prepare. The disruption to trade flows has important near-term effects for Ireland.

The disruption from the UK moving to WTO rules also has longer-term impacts on Ireland's economic prospects. We estimate that UK GDP growth in a WTO scenario, coupled with a tilt to more populist controls on immigration to the UK, would reduce GDP by four percent versus a "no Brexit" baseline in the UK in 2030, with negative spillovers to Ireland.

We supplemented this scenario with a slower rate of population growth in Ireland in the medium to long-term (specifically growth rates from the M2F2 scenario from the 2013 Central Statistical Office population projections, applied to the most recent historical data).[11] This reflects perceptions of Ireland as a less attractive destination for migration given the impact of "hard Brexit" on economic opportunities. Reflecting that migrant workers (especially those in FDI-intensive sectors) often have higher productivity, we also assume lower productivity growth as part of this scenario.

Again the impacts on the rest of the world from our downside scenario are largely focussed on the near-term, given the nature of the shocks simulated, and the limited "feedback" from slower trend growth in Ireland to the rest of the world (given that Ireland accounts for a relatively share of global GDP). GDP is lower than baseline by around 4 percent in both China and the US by the mid-2020s, with these differences persisting into the long run. The loss of GDP is around half as much in France and Germany, given that these economies are assumed to be less direct targets of US protectionism, which seems increasingly focused on the bilateral US-China visible trade deficit. GDP in the UK is 2.4 percent lower in the long-run, with the bulk of this impact coming in the period between now and 2030, as the UK adjusts to a "no-deal" Brexit.

Finally, we simulated a supply-driven shock to oil prices. Higher oil prices reflect the loss of oil production from Middle East economies because of security concerns undermining investment.

[11] The CSO M2 scenario assumes net migration returns to positive by 2018 and rises slowly to plus 10,000 by 2021, and remains at this level thereafter.

Fig. 5. Summary of macroeconomic growth rates for Ireland, by scenario[12]

	Average annual percentage change			Difference from base 2050
	2017-26	2027-2050	2017-2050	
GDP				
Upside	3.0	2.3	2.5	21%
Baseline	2.5	1.7	1.9	
Downside	2.0	1.2	1.5	-13%
Employment				
Upside	1.7	0.9	1.1	10%
Baseline	1.4	0.6	0.8	
Downside	1.3	0.2	0.5	-11%
Labour Productivity				
Upside	1.3	1.4	1.4	10%
Baseline	1.0	1.1	1.1	
Downside	0.7	1.1	1.0	-3%
Population of working age				
Upside	1.3	0.9	1.0	10%
Baseline	1.0	0.5	0.7	
Downside	0.8	0.2	0.4	-11%
Trade				
Upside	2.8	4.2	3.8	34%
Baseline	2.3	3.1	2.9	
Downside	1.8	2.8	2.5	-11%
Investment				
Upside	-0.2	2.2	1.5	16%
Baseline	-0.4	1.7	1.1	
Downside	-0.7	1.2	0.7	-13%

Source: Oxford Economics

[12] Growth rates for GDP, productivity, trade and investment expressed in real terms.

2.3 NATIONAL AIR PASSENGER FORECASTS

2.3.1 Modelling approach

To generate air passenger forecasts for Ireland we used the Tourism Economics[13] / IATA Air Passenger Model. The model is based on historical data from IATA and Oxford Economics' global macroeconomic forecasts. It produces annual forecasts of the origin and destination of passengers for 4,000 country-pair flows, including Ireland.[14] The forecasts take no account of airport infrastructure capacity constraints and so effectively represent an 'unconstrained' view of future passenger demand.

THE TOURISM ECONOMICS / IATA AIR PASSENGER MODEL

The Tourism Economics Air Passenger Model was developed in partnership with IATA to analyse the drivers of air travel demand and facilitate analysis of alternative scenarios. Air passenger flows are included and modelled for almost 4,000 country-pair flows, with total flows modelled for 191 countries. Domestic and international air passenger flows are separately identified and modelled for all countries in the model.[15]

Short term forecasts over the first three to five years are driven by demand-side factors such as GDP, unemployment rates, exchange rates and airfares. In the long run the forecasts are driven by changes in demographics, average wealth levels, trade intensity and the effect of technology and liberalisation on airfares. Other macroeconomic indicators, such as exchange rates and unemployment, are also included in the equations but these tend to be more stable in the long-run. The impact of exchange rates depends on how they influence the net flows of travellers between pairs of countries: decreased travel in a market due to a weaker currency is at least partly offset by increased travel from a partner country due to its corresponding stronger currency.

Volumes of air passengers using Irelands airports are affected by changes in GDP (and the other macroeconomic drivers) in Ireland itself as well as in countries which provide travellers to Ireland, and those countries which provide passengers who transfer through Ireland's airports, notably Dublin.

To develop passenger forecasts under alternative macroeconomic scenarios, we inputted alternative assumptions for key macroeconomic variables for Ireland and other major economies, such as levels of GDP per capita, population, exchange rates, trade intensity (imports and exports relative to GDP), and demographic factors such as age and the relative propensity to travel. Investment also features as a driver since it is a component of GDP.

As part of this project we incorporated updated macroeconomic assumptions and refined the model for country pairs which include Ireland. The passenger forecasts were also extended out from 2036 to 2050.

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[13] Tourism Economics is an Oxford Economics company

[14] The country-pair forecasts are based on a 'true' origin and destination of the passenger. In effect, we model demand between the point of origin of the passenger and their final destination so as to align with identified economic drivers. This means that a passenger flying from France to the US, via Dublin, will be defined as a France to US country-pair passenger.

[15] Further details are available at http://www.iata.org/publications/store/Pages/20-year-passenger-forecast.aspx

The base year for our model is 2016—the most recent full year of passenger data available at the time the modelling was undertaken in late 2017. Projections for 2017 were informed by information available for the first half of that year.

2.3.2 Results

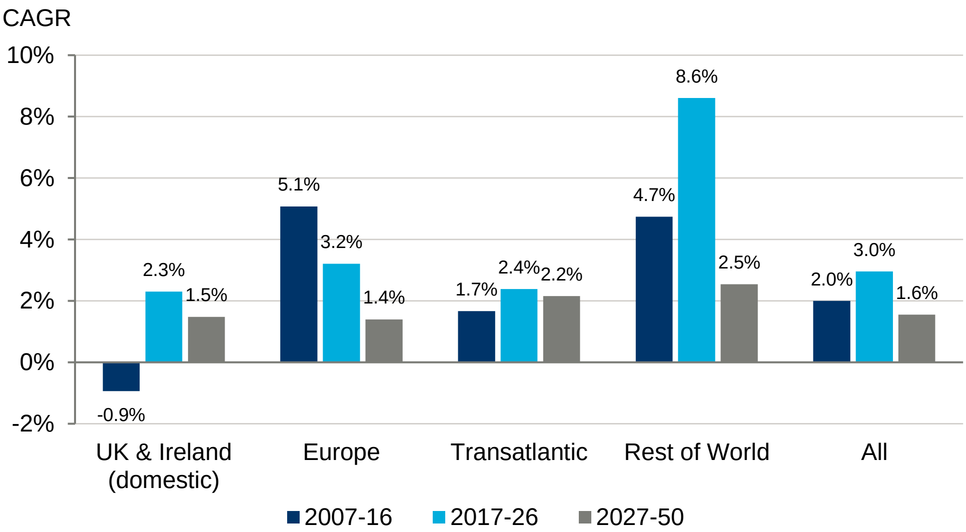
Fig. 6 provides a summary of recent and forecast growth rates in passenger traffic between Ireland and regional markets in our baseline scenario.[16] The key features of the forecast are as follows:

- **UK & Ireland (domestic):** passenger demand fell sharply between 2009 and 2011 due to the global financial crisis, before rebounding in 2014, as economic growth picked-up and APD in Ireland was removed. Since 2014, growth has continued but the level of passenger demand is still below the pre-crisis peak of 14 million passengers.

- **Europe and Rest of World:** further growth in both markets on the back of a further recovery in Ireland's economy, across Europe and among other key world markets.

- **Transatlantic:** This market was hit particularly hard by the impact of global financial crisis with, transatlantic passenger traffic only recovering to its 2007 peak in 2016. Faster passenger growth is expected over the forecast period than in the decade to 2016.

Fig. 6. Average annual growth rates by market area, baseline scenario

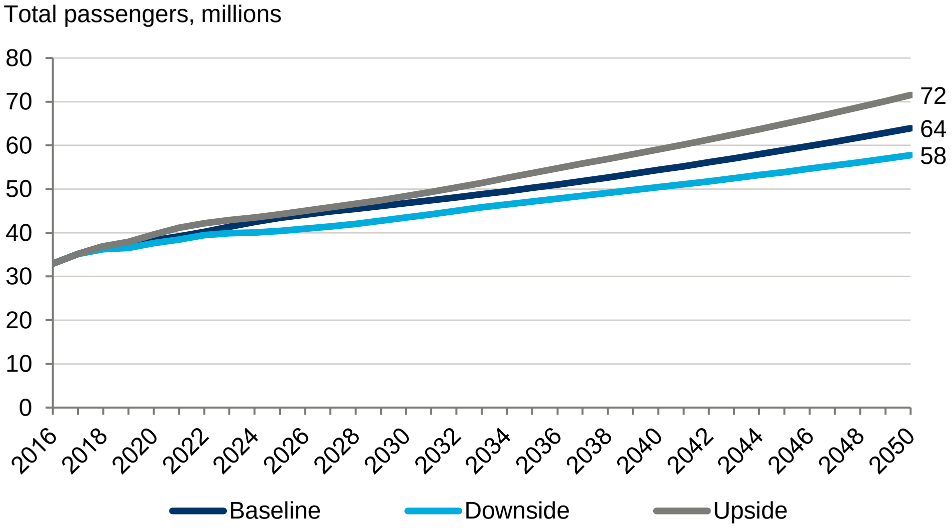


Source: Oxford Economics

[16] Transatlantic is defined as the United States and Canada, and Europe includes North African countries. These aggregations enable a comparison with daa's passenger market definitions.

Based on the regional growth rates for these market areas, our forecasts suggest that annual passenger growth in Ireland will average two percent per year for 2017 to 2050 under our baseline scenario. This compares to 2.3 percent annual growth in our upside scenario, and 1.7 percent growth in our downside scenario (Fig. 7).

Fig. 7. Passenger growth in Ireland under the three scenarios



Source: Oxford Economics

At this point we can observe that that the macroeconomic scenarios developed for this study do not provide symmetrical growth profiles over the entire forecast period. In the years to 2021, the upside scenario simulates a cyclical upswing in the global economy such that passenger numbers increase faster than in the baseline. There is then a period of weaker growth as global economies move back towards a stable longer term growth profile, before the effects of the fundamental supply-side improvements from faster demographic and productivity growth take effect. In contrast, the downside scenario broadly tracks the baseline scenario until the impacts of the cliff-edge Brexit and greater protectionism in the US take effect, notably from 2022 onwards.

2.3.3 Overseas visitors

Government tourism policy as set out in "People, Places and Policy: Growing tourism to 2025", targets ten million overseas visitors to Ireland by 2025. According to recent tourism estimates published by the CSO, there were 8.7 million overseas visitors in 2017, who stayed at least one night.[17] If international visitor numbers to Ireland increase by a further 15 percent between 2017 and 2025, this target will be hit. Our baseline passenger demand projections forecast growth at almost double that rate to 2025, suggesting that the forecasts used in this project incorporate sufficient growth for the government to meet its target for overseas visitors.

[17] CSO Ireland http://www.cso.ie/en/releasesandpublications/er/tt/tourismandtravelquarter42017/ [Accessed 9 April 2018]

2.4 DUBLIN

2.4.1 Passenger modelling approach

Passenger forecasts for individual airports were produced once the national level projections had been finalised. First, the forecasts for country-pair flows under each scenario were aggregated to four regions: UK & Ireland, Europe, Transatlantic and Rest of World. We then applied the annual forecast growth rate for each region to the 2016 passenger numbers at each airport (based on baseline data to 2016 from the CSO). Differences in forecast passenger growth rates across airports therefore reflect differences in the regional passenger mix in the base year. Two further factors are considered at this stage of our modelling: transfer passengers and transit passengers. These are discussed further in the box below.

TRANSFER PASSENGERS

The country-pair flow forecasts described above capture the flow of passengers based on the 'true' origin and destination of the passenger trip. However, at Dublin airport only, we also consider transfer passengers.[18] These are passengers who make a connecting flight at Dublin airport to reach their destination. A transfer passenger will be counted twice on each trip (e.g. a passenger flying from Paris to Boston via Dublin will be counted once as they arrive at Dublin from Paris, and counted again as they depart Dublin for Boston).

We estimated transfer passenger for each region using data supplied by daa. This shows that Dublin airport handled 1.2 million transfer passengers in 2016, of which about a half transferred to a transatlantic flight.

Transfer passenger are assumed to grow in line with the 'true' origin and destination of the passenger. So, for example, the number of passengers on a trip from the UK to US who transfer at Dublin grows in line with our country-pair forecast for UK-US passengers.

TRANSIT PASSENGERS

Transit passengers are those who fly in and out of an airport without changing aircraft. Typically, transit passengers stop at an intermediary airport for the purposes of refuelling the aircraft and do not disembark (e.g. Ethiopian Airlines transit flight from Addis to Toronto via Dublin, or London City Airport to JFK, stopping at Shannon). But in other cases, passengers may disembark the aircraft at the intermediary stop, before continuing the onward journey. [Redacted]

Transit passengers are not counted as a terminal passenger and therefore are not included in our subsequent terminal capacity assessment. However, while, airports only count transit passengers on departure, the aircraft movement is counted on arrival and departure and therefore does feed into our runway capacity assessment.

[18] Cork and Shannon airports do not report transfer passengers in their passenger statistics. While it is feasible that some passengers do transfer flights at these airports, the numbers are likely to very small, and therefore will not make a material difference to the overall passenger demand forecasts at these airports

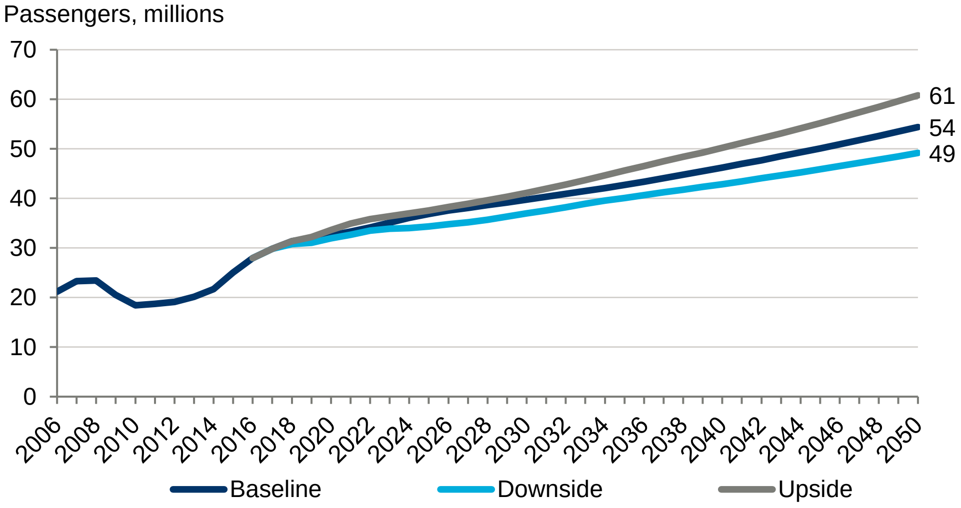
Transit passengers account for 0.6 percent of total passengers at Dublin, six percent of total passengers at Shannon, and 0.1 percent at Cork. Very limited information is available on transit passengers. To forecast this group, we looked at the difference in growth rates between origin-destination (OD) passenger growth and transit passenger growth in each airport's own forecasts.[19] We then applied this differential to our own passenger OD forecast. For example, if daa were to forecast transit passengers at Dublin to grow two percentage points slower than OD passengers, we would apply this differential to our own OD passenger forecasts under each scenario to obtain our own transit passenger growth forecast.

2.4.2 Passenger forecasts

Dublin is Ireland's largest airport, and handled 28 million passengers in 2016, equivalent to 85 percent of the country's total passenger traffic. By 2050, based on the methodology described above, passenger traffic at Dublin is forecast to increase to 54 million passengers in our baseline scenario. This implies an average annual growth rate of 2.0 percent per year for 2017 to 2050.

Under the upside scenario passenger numbers increase to 61 million in 2050 (an average annual growth rate of 2.3 percent), while under the downside scenario they reach 49 million (1.7 percent average annual growth). As such, passenger numbers at Dublin are expected to increase by between 21 million and 33 million in the period to 2050.

Fig. 8. Dublin passenger forecasts by scenario, millions



Source: Oxford Economics

[19] daa do not produce a forecast of transit passengers at Cork, so we used the growth differential from the daa centreline forecast for Dublin airport, and applied that to our forecast for Cork.

SENSITIVITY TEST: STRONGER GROWTH IN TRANSFER PASSENGERS

In addition to modelling the impact on passenger traffic at Dublin under alternative macroeconomic assumptions, we also considered how policy changes could lead to a change in passengers' demand to travel through Dublin Airport.

The 2015 National Aviation Policy highlights that Dublin will be promoted as a secondary hub airport to support services to global markets. If Dublin Airport can provide facilities to enable airlines to compete effectively with airlines operating at UK and other European hub airports, it may further increase the level of transfer business, which has already grown strongly in recent years. This could enable airlines operating at Dublin to run more frequent flights to existing destinations and offer direct flights to a larger number of destinations than would be possible if services at the airport were entirely reliant on travellers whose ultimate origin or destination was Ireland.

However, neither the study team nor the stakeholders consulted could identify any previous analysis of the extent to which overall passenger growth at Dublin might increase as a result of an increase in airline hub traffic. Indeed, estimating this is very challenging because transfer demand at Dublin is likely to depend not only on the demand to travel between pairs of countries (which is assessed within our model), but also on the operational and pricing decisions of airlines and airports, both in Ireland and in other countries. That is, Dublin Airport's growth as a secondary hub will rely on airlines' willingness to run additional connecting services from Dublin, as well as its own commercial offer and the offer of other airports. These factors are extremely difficult to predict, particularly over a long time horizon, and doing so would be a research study in its own right.

Nonetheless, we have undertaken a sensitivity test to explore the potential impact on passenger numbers of the introduction of new routes over the next few years. This uses transfer passenger growth forecasts from daa's 'Centreline' transfer projection, which is informed by insights into new routes planned by airlines, and so is a richer source of information on potential route developments than was available to the study team from other datasets. The daa forecasts suggests that, once new routes are taken into account, transfer passenger numbers could increase around three times as fast during the period to 2031 than in our own modelling, which is based on economic factors only.

For our sensitivity test we therefore tripled the annual rate of transfer passenger growth in the upside scenario for the period to 2031, before reverting to our original growth rate forecast in subsequent years. By assuming faster growth in hub activity at Dublin, passenger traffic increases by a further 1.7 million passengers over the period to 2050 compared to our main upside scenario. This implies total passenger numbers of 62.5 million by 2050, or an average annual growth rate of 2.4 percent for 2017 to 2050.

2.4.3 Passengers by purpose of travel

For each scenario, the passenger demand forecasts to 2050 at each airport are further segmented by reason for travel: business, leisure, and visiting friends and relatives (VFR) / Other.

APPROACH TO SEGMENTING THE AIRPORT LEVEL FORECASTS BY PURPOSE OF TRAVEL

Recent trends in purpose of travel by market region were drawn from passenger survey data supplied by daa for Dublin and Cork airports, and supplemented with information from Visit Britain, Tourism Ireland, and Tourism Economics' existing databases. The passenger survey data refer to non-transferring passengers only.[20]

The forecasts for each purpose of travel to each market area are based on historical growth profiles, combined with specific adjustment factors for each purpose of travel:

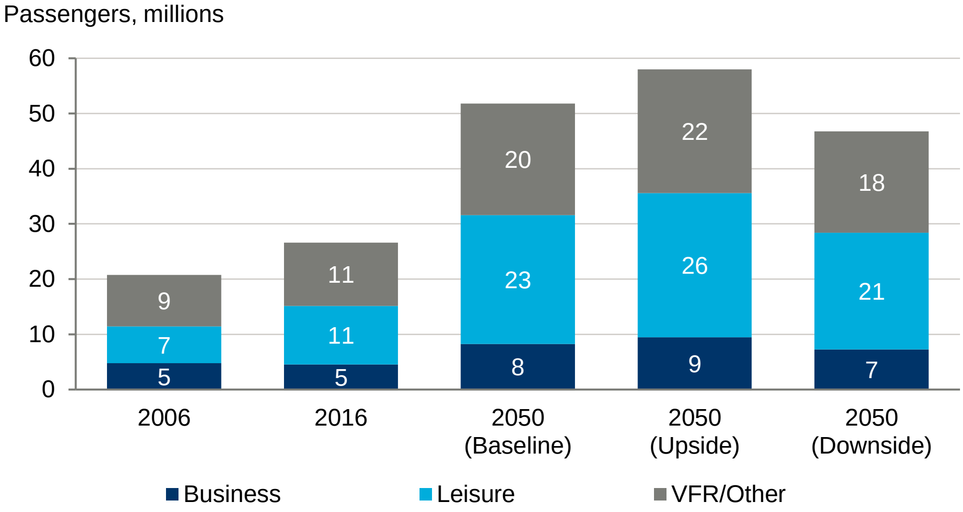
- For business travel, the adjustment factor is based on our forecasts of Ireland's investment to GDP ratio, relative to the long-run historical average. This is indicative of both the overall business environment in Ireland, and also incorporates the value of foreign investment in Ireland, which we would expect to be an important driver of international business travel.
- In the leisure and visiting friends and relatives (VFR) / other segments, adjustment factors are based on our GDP and unemployment rate forecasts for Ireland and each region of the world, relative to historical averages. The unemployment rate is used as a proxy for consumer confidence—higher unemployment rates can be shown to correlate with lower consumption, which in turn are likely to result in fewer overseas leisure trips, and to a lesser extent, VFR trips.

The modelling of all purposes for travel also considers the effect of exchange rate movements between Ireland and each market area. Some segments of travel are less sensitive to exchange rates movements than others. For example, the VFR / other segment has less sensitivity to exchange rates than the leisure segment, reflecting that leisure travellers might be more likely to choose an alternative destination or not travel at all than those wishing to visit family overseas.

According to recent surveys of non-transfer passengers at Dublin Airport, the proportion of passengers flying for business purposes declined from 23 percent to 17 percent in the decade to 2016, while the proportion of leisure passengers increased from 32 percent to 40 percent. In 2016, five million passengers used Dublin airport for business travel, 11 million for leisure travel, and the remaining 11 million for visiting friends and relatives or other reasons.

[20] While Shannon airport did provide survey data on the main purpose of travel for its passengers, they did not provide information on place of residence, which is needed to undertake this element of the modelling. As such we have only been able to forecast passengers by purpose of visit for Dublin and Cork.

Fig. 9. Dublin passengers by purpose of travel



Source: Oxford Economics based on data from daa, Visit Britain and Tourism Ireland

Growth is forecast across all the purpose of travel segments in terms of passenger numbers, as illustrated in Fig. 9. This outcome is also reflected across the upside and downside scenarios.

These findings suggest that leisure travel is likely to further increase its *share* of passengers, to 45 percent by 2050, supported by the anticipated strong growth in visitors to Ireland from the Rest of World and Transatlantic regions. The share of VFR/Other declines, continuing the trend observed at Dublin over the past decade. The share of business travel within total passenger numbers is expected to remain broadly unchanged.

2.4.4 Air transport movements

To assess runway and taxiway capacity at each airport, we need to understand the likely evolution of air transport movements (ATMs), as well as that of passengers.

APPROACH TO FORECASTING AIR TRANSPORT MOVEMENTS (ATMS)

To move from forecasts of passengers to ATMs, we developed a series of assumptions relating to the size of aircraft (number of seats per aircraft) and aircraft load factors (the proportion of seats which are occupied).

Aircraft size

Our projections make two assumptions about future aircraft size, based on the known aircraft orders of Ryanair and Aer Lingus:

- Ryanair currently only operates 737-800 aircraft with 189 seats. However, it has ordered 100 737-200 Max aircraft. We assume that Ryanair switches all its Dublin flights to the 197-seat 737-200 Max aircraft between 2019 and 2022, following delivery of the new aircraft in 2019-2020.
- We understand that Aer Lingus plans to replace B757 aircraft (177 seats) with A321neo LR aircraft (186 seats) for flights to the US in 2019-20. We assume this switch occurs for all Aer Lingus B757 flights at Dublin. The switch from one type of narrow-bodied aircraft to another, rather than a switch over to a wide-bodied aircraft, is consistent with views put forward by stakeholders during the consultations.

For Dublin, and based on the information above, we estimate that known Ryanair and Aer Lingus aircraft orders add three seats to the overall average seats per ATM by 2022, equivalent to an increase of 0.5 passengers per ATM each year for 2017 to 2022. Thereafter we assume that aircraft size for all aircraft increases by 0.1 seats per ATM per year as other airlines follow suit in up-gauging of their fleet.

For Cork and Shannon, we assume that aircraft size increases by 0.1 seats per ATM for the entire forecast period, in line with the longer term trend for Dublin.

Load factors

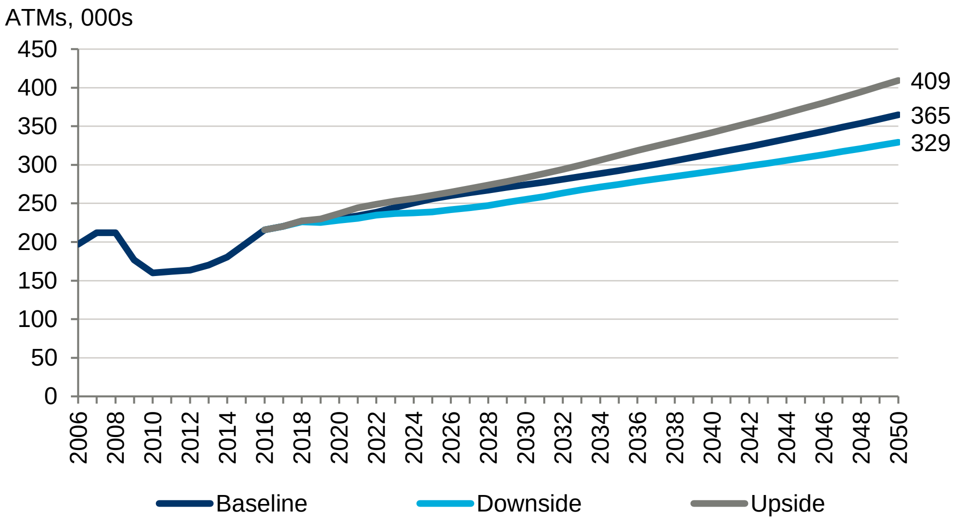
Current load factors were estimated using flight data from SRS Analyser[21] and passenger data from the CSO[22]. Both daa and CAR use an 85 percent load factor for capacity declaration. Our forecasts therefore assume that passenger growth on each route translates into higher load factors until the 85 percent load threshold is reached. From that point, the number of ATMs is assumed to grow in line with passenger numbers. Scheduled flights which are currently operating with load factors greater than 85 percent are assumed to maintain their current load factor. Non-scheduled flights (e.g. charter, cargo, general aviation, positioning) are assumed to grow at the same rate as scheduled ATMs).

[21] SRS Analyser accessed via Diio and available at <https://srsanalyser.diio.net/srs/pages/login.jsp>

[22] CSO Irish Airports Pairing Data accessed via <https://www.nisra.gov.uk/publications/northern-ireland-air-passenger-flow-publications> Table 5

The annual number of ATMs at Dublin is forecast to increase from 216,000 in 2016 to 365,000 by 2050 in our baseline scenario. The 2050 figure increases to 409,000 in the upside scenario, and falls to 329,000 in the downside scenario. Therefore, between 2016 and 2050, Dublin will need to handle an additional 113,000 to 193,000 flights.[23]

Fig. 10. Dublin ATM forecasts



Source: Oxford Economics

COMPARISON WITH DAA FORECASTS: DUBLIN

We have compared our results from those with airports' own modelling exercises to understand where differences may arise, and the reasons for those differences. In the case of Dublin airport, we compared our forecasts to figures provided to us by daa from its Annual Activity Forecasts, May 2017.

Passenger projections

At 54 million, our baseline forecast of passenger traffic at Dublin Airport is four million (or eight percent) higher in 2050 than the daa 'Centreline' forecast.

While Oxford Economics forecasts higher growth rates than daa across all regional markets, the ranking of each market in terms of growth rates follows the same pattern. Slowest growth is anticipated in the UK/domestic market, while growth is expected to be fastest with the Rest of the World.

Having reviewed the information available from daa, we believe that differences in the two sets of forecasts can be explained by a combination of differences in the modelling approach and differences in the underlying macroeconomic assumptions (Fig. 11).

daa adopt a 'bottom-up' modelling approach. The short-term outlook is informed by airport and airline market intelligence (such as allocated slots and known new routes), while the Beontra forecasting tool is used to develop long-term forecasts.[24] This forecasting tool develops regression

[23] Under the passenger sensitivity scenario which modelled faster growth in transfer passenger traffic at Dublin, ATMs would increase to 421,000 in the upside scenario.

[24] Beontra is an independent company that provides integrated traffic, capacity and revenue planning for airports.

models for each country/country group based on relationships between historical passenger performance at Dublin and key economic variables such as GDP, population, and exchange rates. Oxford Economics, on the other hand, follow a 'top-down' modelling approach. We have produced passenger growth projections for Ireland (again based on economic variables), and then apply the growth rates for each region to the route profile of Dublin Airport.

Fig. 11. Comparison of passenger forecasting methodologies

	daa	OE
Input data	Data up to 2016	Includes partial data for 2017
Short term forecasts	Bottom-up forecast informed by airport and airline market intelligence on airline growth, service and capacity plans.	Top-down unconstrained forecast based on a global model. This includes a wide range of economic variables, including oil prices, air fares, and GDP elasticities which measure the relationship between relative country GDP growth and passenger demand
Longer term forecasts	Regression models based on historical performance and economic drivers (e.g. GDP, population). Also considers market maturity	

Source: Oxford Economics and daa

Turning to the differences in the underlying macroeconomic assumptions, over the period for 2017 to 2050, both Oxford Economics and daa assume average annual GDP growth of around two percent per year. Oxford Economics were also asked to compare their long-term growth forecasts to those produced by other forecasters. However, very few economic forecasters publish forecasts over such a long time horizon. For example, at the time of writing ESRI's long-term forecasts go out to 2025,[25] and the European Commission publishes forecasts to 2028.[26] ESRI are slightly more optimistic than Oxford Economics over the period to 2020, and much more optimistic in the first half of the 2020s: ESRI forecast average annual GDP growth for Ireland of 3.7 percent in 2016-20, slowing to 3.2 percent in 2021-25. This compares to 3.5 percent and 2.0 percent, respectively, for Oxford Economics. Our forecast is, nonetheless, similar to the European Commission's longer-term view, which suggests Irish GDP growth of 1.7-1.8 percent per year in 2026-28.

In contrast to the GDP forecasts, the population forecasts used in the Oxford Economics and daa passenger forecasts are very different. Oxford Economics assume average annual population growth of 0.8 percent for 2017-2050, which is around four times higher than the value used by daa. We understand that the population projections used by daa in its May 2017 forecast round were sourced from Eurostat and were the latest available at the time the work was undertaken. Since then, Eurostat has published updated population projections and these now show 0.5 percent average growth to 2050. Oxford Economics' baseline population projection is based on information from Eurostat, overlaid with a higher net migration assumption. This gives an average annual growth rate of 0.9 percent for 2017-2046, similar to the CSO's M2F1 scenario, which suggests growth of 0.8 percent per year over this period.[27]

[25] ESRI, *Ireland's Economic Outlook: Perspectives and Policy Challenges,* December 2016. Table 1.6. Available at <www.esri.ie/publications/irelands-economic-outlook-perspectives-and-policy-challenges/>

[26] European Commission, *Debt Sustainability Monitor 2017*, (Luxembourg, 2018)

[27] CSO Ireland publishes six sets of population projections, based on two sets of assumptions for fertility, one for mortality, and three for migration. These growth projections range between 1.2 percent growth a year for 2017-46

If daa were to use a higher population growth assumption in its modelling of Dublin Airport, then total passenger numbers at Dublin might be expected to be higher in 2050. However, we cannot say by how much the passenger growth projection might increase as that will be determined by the modelled sensitivity of the passenger forecasts to population growth.

ATM projections

The Oxford Economics baseline forecast of ATMs is seven percent (24,000 ATMs) higher than the daa Centreline forecast.

One difference in the approach to forecasting ATMs is that Oxford Economics have considered average plane sizes and load factors separately, while daa consider them jointly in a single "passengers per aircraft" metric. daa's forecast of this variable is based on historical trends, overlaid with information gathered from airline route plans, and aircraft used on those routes. In the Oxford Economics baseline scenario, passengers per aircraft increase to 149 by 2050, slightly higher than in the daa Centreline forecast. The difference between these values is influenced by differences in the regional composition of passenger growth (since different sized aircraft serve different destinations), as well as the underlying consideration of load factors and aircraft sizes.

(based on a high fertility rate and high positive net-migration assumption) and 0.2 percent growth a year (based on the low fertility rate and negative net-migration assumption). M2F1 refers to the mid-range positive net-migration assumption and high fertility rate.

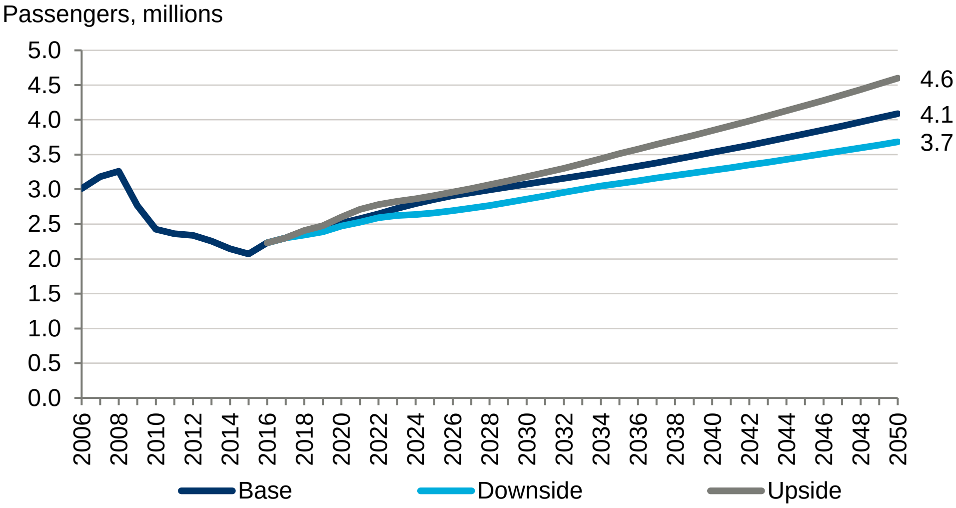
2.5 CORK

2.5.1 Passenger forecasts

Cork is Ireland's second busiest airport. It handled 2.2 million passengers in 2016, about seven percent of the country's total passenger traffic.

By 2050, passenger traffic at Cork is forecast to increase to 4.1 million passengers in our baseline scenario (an average growth rate of 1.8 percent per year). This increases to 4.6 million passengers in the upside scenario (2.2 percent average annual growth), or to 3.7 million passengers in the downside scenario (1.5 percent average annual growth). The total increase in passenger traffic between 2016 and 2050 is therefore between 1.5 million and 2.4 million.

Fig. 12. Cork passenger forecasts by scenario, millions

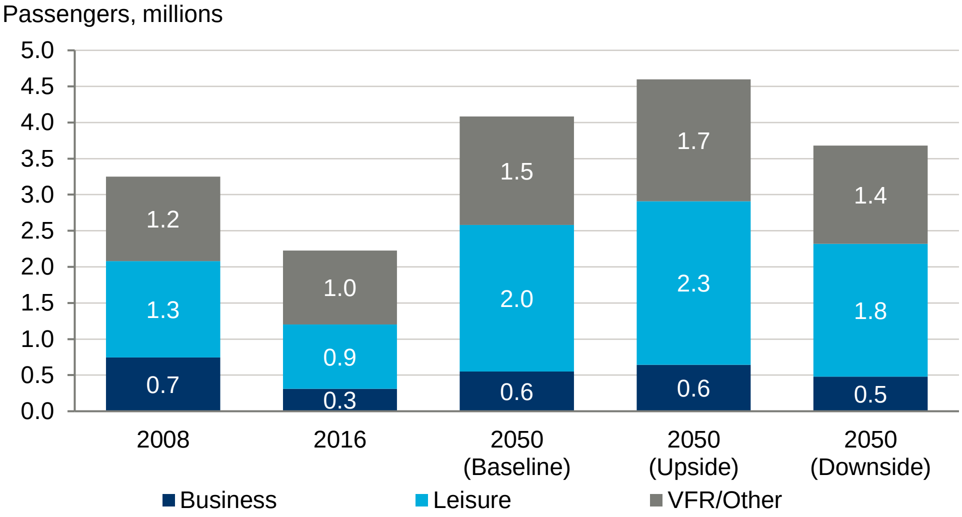


Source: Oxford Economics

2.5.2 Passengers by purpose of travel

The proportion of passengers using Cork Airport for business purposes declined from 23 percent in 2008 to 14 percent in 2016, while the proportion of leisure passengers remained constant at around 40 percent. Therefore, we estimate that in 2016, 300,000 passengers used Cork airport for business trips, 900,000 for leisure travel, and the remaining 1 million were visiting friends and relatives or making journeys for other reasons.

Fig. 13. Purpose of travel, Cork



Source: Oxford Economics based on data from daa, Visit Britain and Tourism Ireland

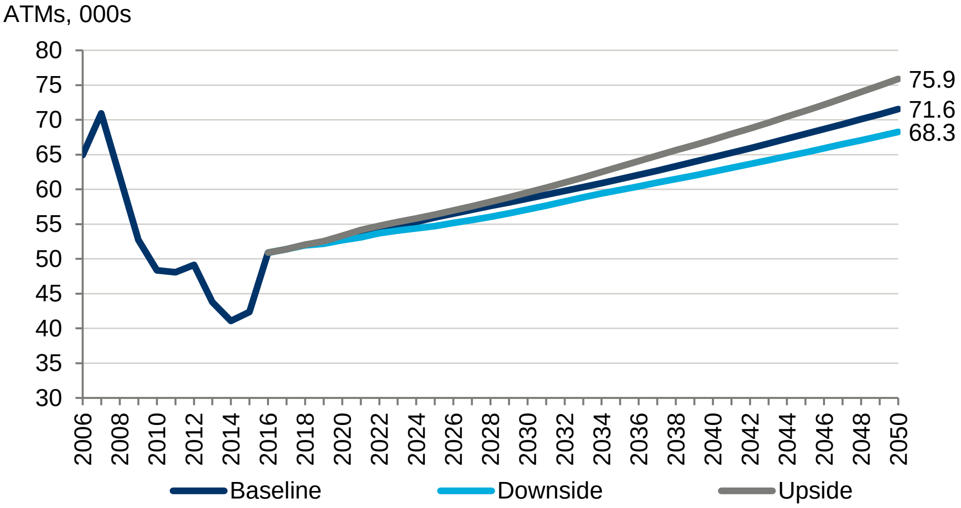
Similar to Dublin, the number of passengers in each purpose of travel segment is forecast to increase over the period to 2050. Leisure passengers to and from Cork will increase as a share of the total, led by growth in travel to and from Europe. By 2050, leisure travel will account for half of all journeys made at Cork.

The share of business travel will remain broadly unchanged, as relatively strong growth in business travel to and from mainland Europe counterbalances slower growth between the UK and Ireland. In level terms, the number of business trips from the airport is forecast to increase by between 53 percent (downside scenario) and 106 percent (upside scenario), demonstrating the continuing importance of Cork airport as a business gateway.

2.5.3 Air transport movements

Annual ATMs at Cork are forecast to increase from 50,900 in 2016 to 71,600 by 2050 in our baseline scenario, which equates to one percent growth per year, on average. The number of ATMs would increase to 75,900 in the upside scenario, or 68,300 in the downside scenario. The airport is therefore expected to handle an additional 17,000 and 25,000 flights per year by 2050.

Fig. 14. ATMs scenarios, Cork



Source: Oxford Economics

COMPARISON WITH DAA FORECASTS: CORK

Passenger projections

Oxford Economics' top-down' modelling approach produces a lower passenger growth outlook at Cork compared to figures provided to us by daa from its Annual Activity Centreline Forecast, produced in May 2017. In our baseline scenario, passenger growth averages 1.8 percent a year for 2017-2050, broadly in line with our projection for Dublin, but much lower than the 2.8 percent a year growth projected by daa. This lower growth forecast means that by 2050, Oxford Economics forecasts that passenger traffic at Cork to be 1.5 million (or 37 percent) lower than in daa's Centreline forecast.

The study team was not able to fully determine the reasons for the much stronger growth outlook in the daa projection. However, daa did highlight to us the challenges they faced in forecasting passenger growth at Cork Airport using a bottom-up approach. They noted that changes in just a few routes can have a significant impact on overall passenger numbers at Cork (e.g. the demise of domestic flights to Dublin, and the transfer of a small number of Polish and Eastern European routes to Shannon). As such, they felt that the relationships they used to forecast passenger numbers at Dublin may not be suitable for use at Cork. As such some degree of judgement and adjustment was necessary within the daa approach. daa suggested that their passenger forecast for Cork reflects an expectation that there will be a continuation of the strong recovery in growth observed since 2016. daa point out that their projected average annual growth rate of 2.8 percent in 2017-2050 is conservative in comparison to the 10 percent annual average growth experienced in the fifteen years leading up to the 2008 global crisis, or in the context of 6.3 percent average annual growth between 1987-2016.

ATM projections

The stronger passenger growth outlook in the daa forecast also translates into faster growth in ATMs. By 2050, ATMs are forecast to be around 30 percent (or 22,000 ATMs) higher in daa's Centreline Forecast than in Oxford's baseline scenario.

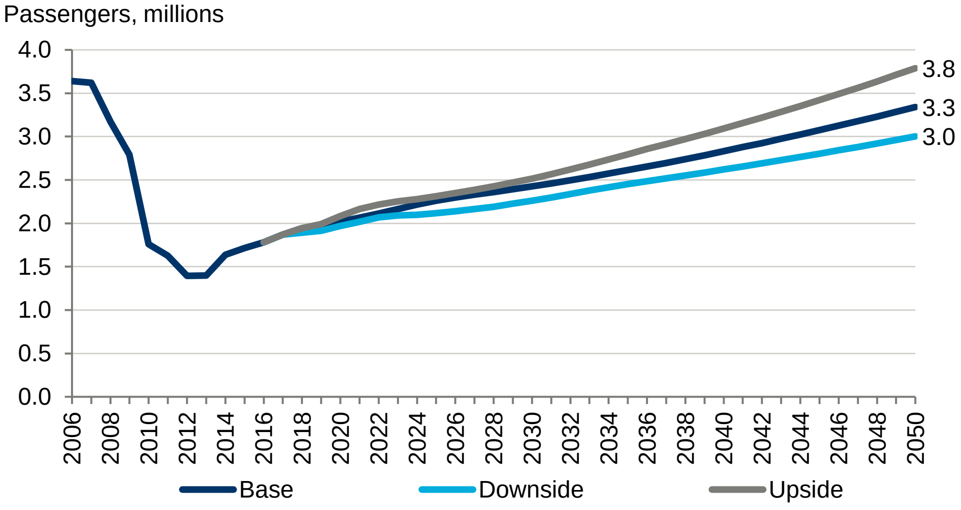
2.6 SHANNON

2.6.1 Passengers

Shannon handled 1.8 million passengers in 2016, about five percent of Ireland's total passenger traffic.

By 2050, passenger numbers at Shannon are forecast to increase to 3.3 million in our baseline scenario, reflecting average annual growth of 1.9 percent. Under the upside scenario passenger numbers would reach 3.8 million in 2050, or 3.0 million in the downside scenario. As such, our modelling suggests an increase in passenger traffic of between 1.2 million and 2.0 million passengers by 2050.

Fig. 15. Shannon passenger forecasts by scenario, millions

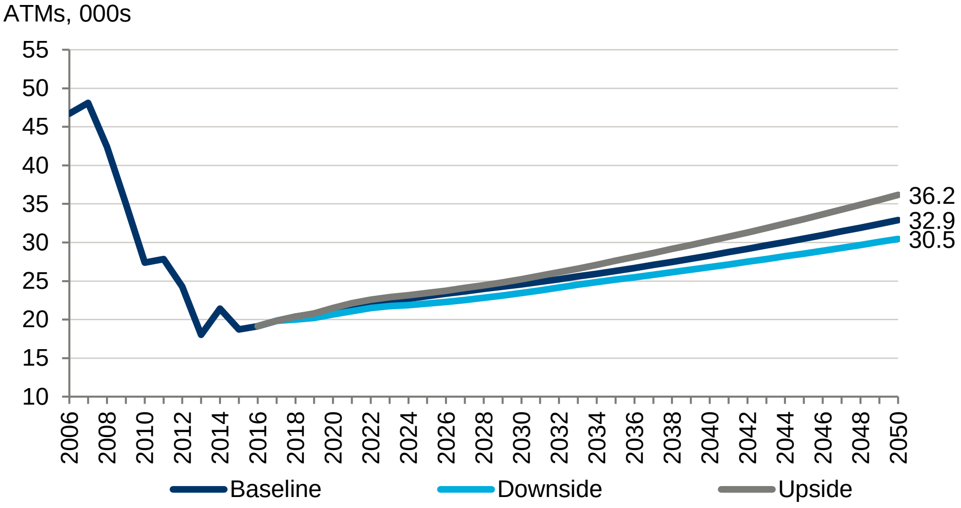


Source: Oxford Economics

2.6.2 Air transport movements

Annual ATMs at Shannon are forecast to increase from 19,100 in 2016 to 32,900 by 2050. Our upside and downside forecasts are 36,200 and 30,500, respectively, implying that annual ATMs at Shannon could increase by between 11,000 and 17,000 by 2050.

Fig. 16. ATMs by scenario, thousands



Source: Oxford Economics

COMPARISON WITH SHANNON AIRPORT'S FORECASTS

Passenger projections

Our baseline passenger projection for Shannon is very similar to the airport's own baseline ten-year passenger traffic forecast prepared in September 2016 by RDC Aviation Economics.[28] Both forecasts project passenger numbers to reach 2.3 million in 2026. RDC's approach produces short-term forecasts up to 2017 based on actual traffic to July 2016 and airline schedules for 2016-17. For the longer term, ten-year, forecasts, it uses an economic elasticity approach based on historical relationships between GDP growth in Ireland and destination markets, and passenger demand. The short- and long-term forecasts are supplemented with an assessment of potential new route development over the medium term, based on airport management discussions with airlines. No passenger projections beyond 2026, or any ATM projections were supplied to Oxford Economics as part of this study.[29]

[28] RDC Aviation Economics, Shannon Airport 10 year traffic forecast, 26 September 2016 v2.6

[29] Shannon Airport indicated that they consider 10-year forecasts to be adequate for their planning needs at the present time.

2.7 AIR CARGO

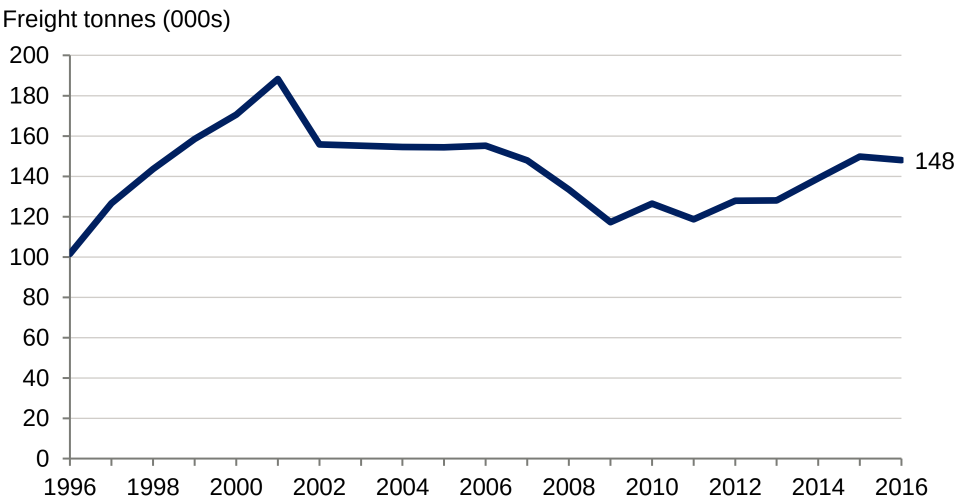
Air cargo operations support Ireland's economy by facilitating the movement of traded goods into and out of the country. These goods are often time sensitive or perishable, and therefore rely on a reliable and rapid means of transport. They can also be of high value (e.g. IT components and pharmaceuticals). ATAG have noted that, globally, while air transport accounts for around 0.5 percent of the volume of world trade shipments, it represents over 35 percent in value terms.[30]

The government's policy on air cargo services is outlined in chapter 3.3 of the National Aviation Policy 2015, which notes that *"Ireland's export competitiveness should be enhanced through improved air cargo provision to existing and emerging markets"*.[31] Amongst the actions identified to work towards this objective, the policy notes that *"the development of Shannon Airport as an air cargo hub will be supported"*.

2.7.1 Recent trends

Ireland's airports handled 148,000 tonnes of air cargo in 2016, about 20 percent lower than the historical peak of 188,000 tonnes in 2011. Around 40 percent of that cargo travels on dedicated air cargo flights, with the remaining 60 percent carried in passenger flights (known as "bellyhold" cargo).

Fig. 17. Air cargo volumes, Ireland, 1996-2016



Source: Oxford Economics, ACI, State airports

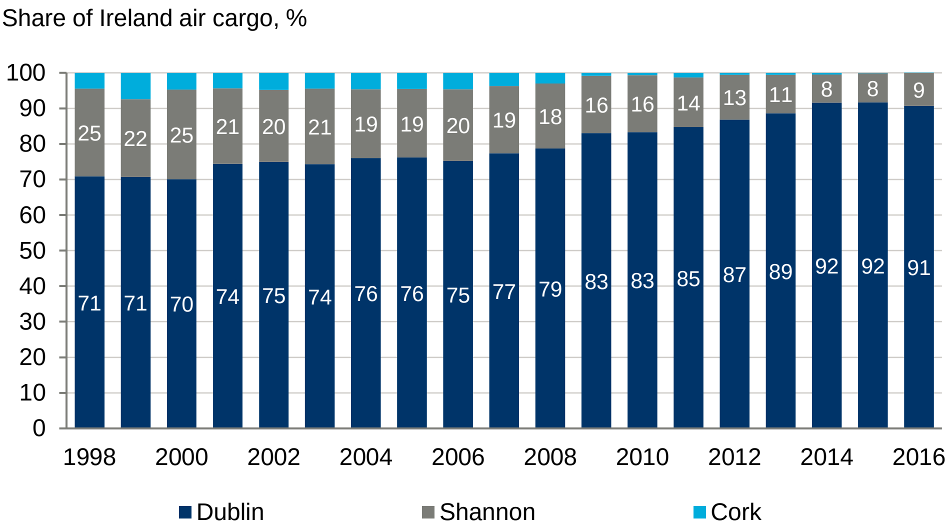
Dublin airport handled 134,000 tonnes of cargo in 2016, about 90 percent of all air cargo arriving and departing Ireland's airports. Cargo volumes at Shannon have declined in both level terms and as a share of Ireland's total since 1998, as the number of transatlantic passenger flights fell, which reduced long-haul bellyhold capacity at Shannon. At Cork, dedicated cargo ATMs have all but

[30] "ATAG" <https://www.atag.org/facts-figures.html> [accessed 26 June 2018]

[31] DTTAS, *A National Aviation Policy for Ireland*, (August 2015).

ceased: data from CSO suggest that Cork handled just 15 tonnes of air cargo, in 2016.[32] Around 70 percent of this cargo was moved on general aviation flights (i.e. corporate business flights), with the remainder on short-haul flights — very few long-haul passenger flights operate from Cork, so long-haul bellyhold capacity at Cork is negligible.

Fig. 18. Distribution of air cargo volumes, 1998-2016



Source: Oxford Economics, CSO, ACI, State airports

2.7.2 Cargo modelling approach

Historical estimates of airport level cargo volumes were sourced from CSO Ireland, ACI, and the three State airports, and aggregated to the national level. The national total excludes air cargo at Knock airport, due to a lack of a historical time series for that airport.[33] Econometric modelling was used to forecast air cargo volumes for Ireland, based on the same macroeconomic scenarios and assumptions used in the passenger forecasts. Details of the model specification are shown in the box below.

[32] "CSO" <https://www.cso.ie/en/releasesandpublications/er/as/aviationstatistics2016/> [accessed 26 June 2018]

[33] According to CSO data, Knock airport transported 16 tonnes of cargo by air in 2016. This amounts to 0.01 percent of the national total and so this exclusion has no material impact on our forecasts.

MODELLING AIR CARGO VOLUMES

Ireland level forecasts

We tested a range of model specifications and driver variables, such as imports, exports, GDP, consumer spending, and ATMs. Our preferred specification is a growth equation model using trade volumes (i.e. non-fuel imports plus exports) and ATMs as the explanatory variables. That is, air cargo is assumed to depend on both the demand for cargo (trade volumes) and the supply of available capacity (ATMs).

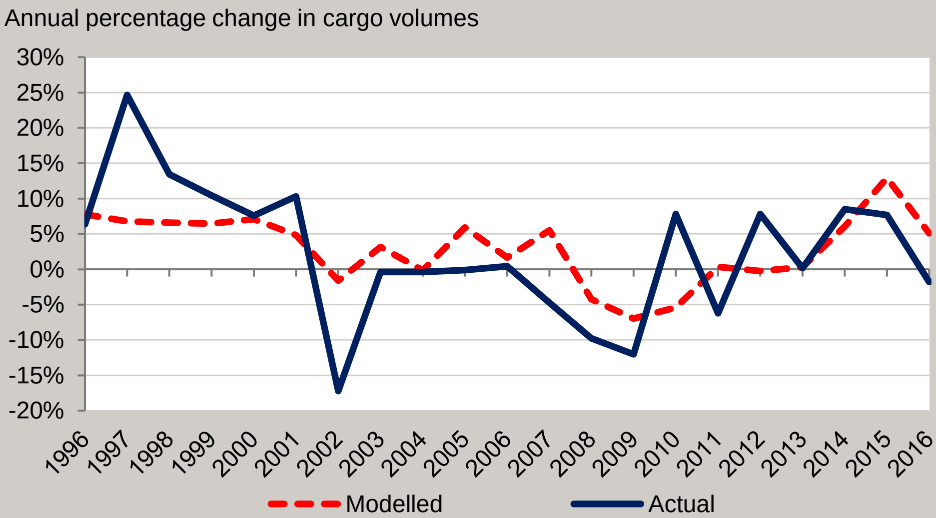
The inclusion of the ATM variable means that this forecast is not truly 'unconstrained' since it relies on the number of flights, which will be partially determined by airports' ATM capacity. However, after experimenting with a large number of model specifications we found that the ability of the model to explain past cargo volumes was substantively enhanced when ATMs were included, implying that the number of flights is an important determinant of cargo volumes (as might be expected given that more than half of cargo travels as bellyhold). This cargo forecast should therefore be regarded as indicative of future cargo volumes, *given the number of ATMs implied by our passenger forecasts*.

The estimated equation is as follows:

dlog cargo = 0.47*dlog(ATM) + 0.25*dlog (trade)

Both variables are statistically significant at the 5 percent level. The model has an R^2 value of 0.36.

Fig. 19. Actual versus predicted annual growth in air cargo volumes



Source: Oxford Economics

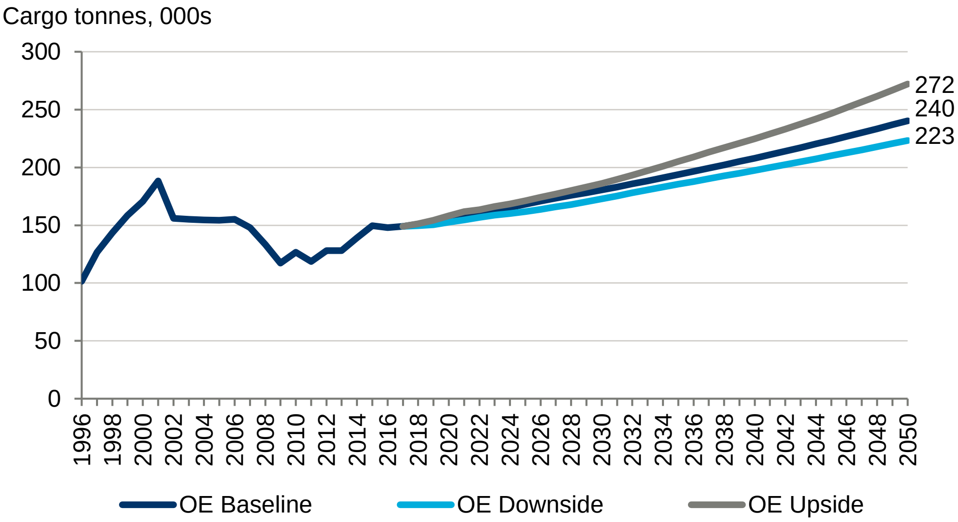
Airport level forecasts

As with the passenger forecasts, airport level air cargo forecasts were produced once the national level forecasts had been completed. We applied the annual forecast growth rate for air cargo volumes at the national level to the 2016 air cargo volumes at each airport. The same approach is used to produce the upside and downside cargo forecasts, based on alternative macroeconomic assumptions that drive the national level cargo volume scenario forecasts.

2.7.3 National cargo forecasts

Our model suggests that air cargo volumes (measured in tonnes) could grow by an average of 1.4 percent per year for 2017 to 2050. This compares to a historical average of 1.9 percent for 1997 to 2016, or -0.5 percent for 2007 to 2016. Our scenario modelling suggests average annual growth of 1.8 percent per year in the upside scenario, and 1.2 percent growth in the downside scenario.

Fig. 20. Ireland air cargo forecasts

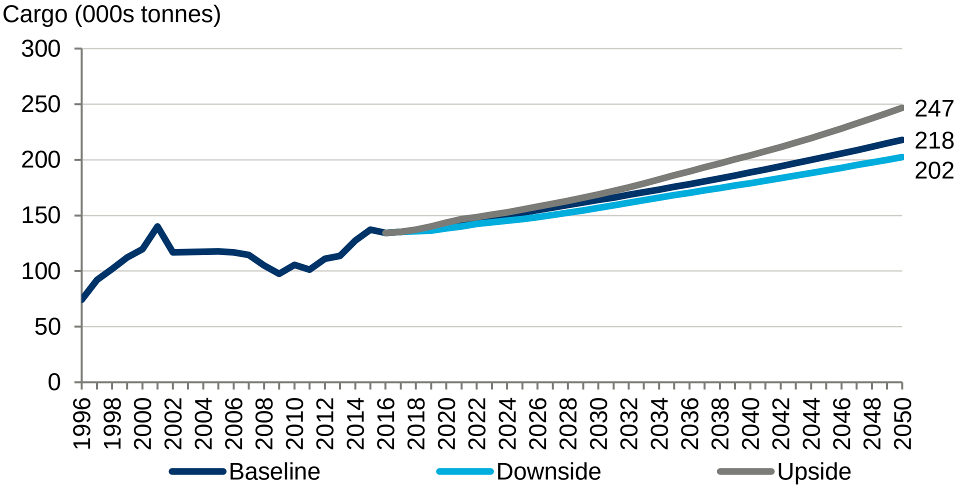


Source: Oxford Economics, CSO, ACI, daa and Shannon Airport

2.7.4 Dublin

Based on the modelling approach set out above, we forecast that air cargo at Dublin could increase from 134,000 tonnes to between 223,000 and 272,000.

Fig. 21. Cargo volume forecasts by scenario, Dublin



Source: Oxford Economics, CSO, ACI and daa

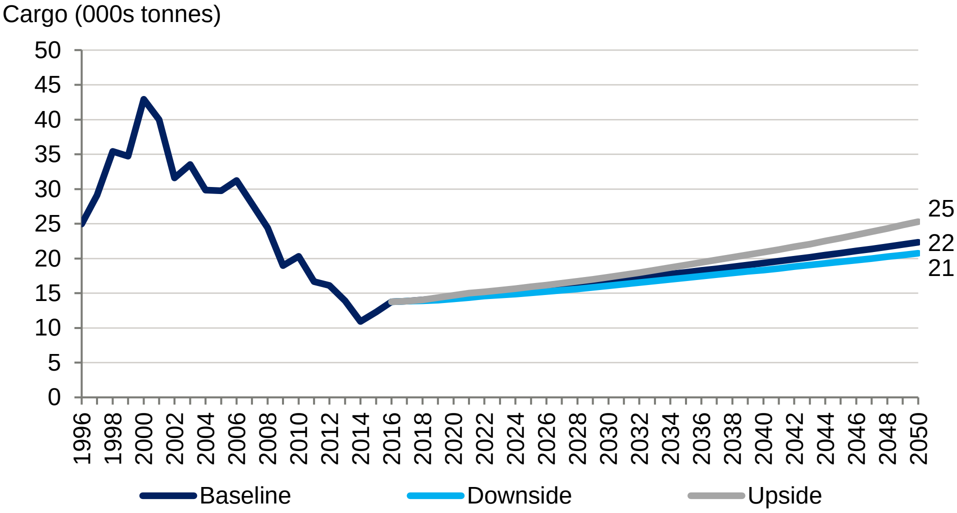
Cargo volume growth forecasts in all our scenarios are lower than forecast by daa in its Centreline projection. For Dublin airport, daa use three different methods to produce forecasts of 2.0 percent, 4.1 percent and 1.9 percent for the period 2015 to 2050.[34] Daa take 2.9 percent as the central scenario, based on the average result under the three approaches.

[34] Method 1 uses Ireland GDP/trade blended growth rate and yields 2.0 percent compound average growth rate (CAGR), Method 2 uses Ireland's share of world air cargo growth and yields 4.1 percent CAGR, and Method 3 uses seats on long-haul flights and trade and yields 1.9 percent CAGR.

2.7.5 Shannon

Based on our modelling approach, we forecast average annual growth in air cargo volumes of 1.4 percent in our baseline scenario, 1.2 percent in the downside scenario, and 1.8 percent in the upside scenario. This is equivalent to air cargo increasing from 13,800 tonnes in 2016 to between 21,000 and 25,000 tonnes by 2050. These forecasts implicitly assume that the policy environment is similar in future to in the past. However, to the extent that the government's policies to support Shannon's development as an air cargo hub are successful, there may be scope for it to secure a larger share of national air cargo growth than implied by the chart below.

Fig. 22. Cargo volume forecasts by scenario, Shannon

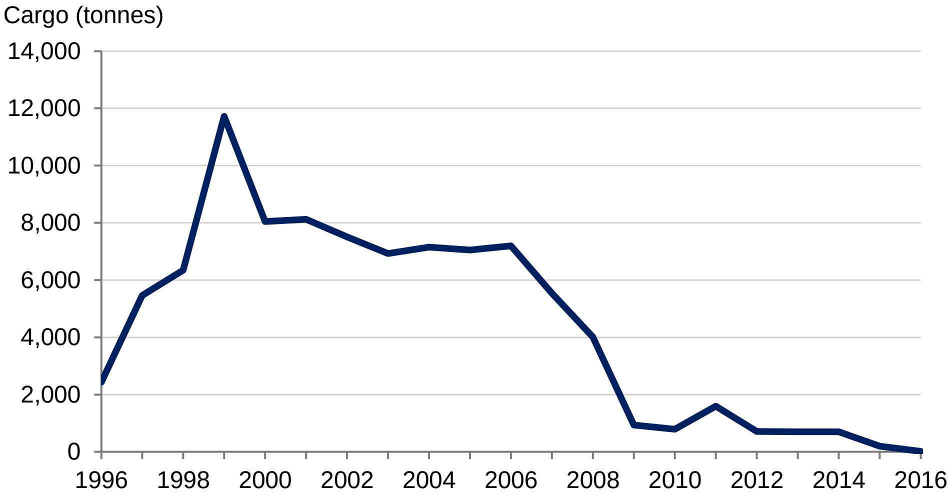


Source: Oxford Economics, CSO, ACI and Shannon Airport

2.7.6 Cork

Air cargo at Cork has declined sharply over the past 15 years, and by 2016 moved only 15 tonnes of cargo by air, equivalent to around 0.01 percent of national air cargo volumes.

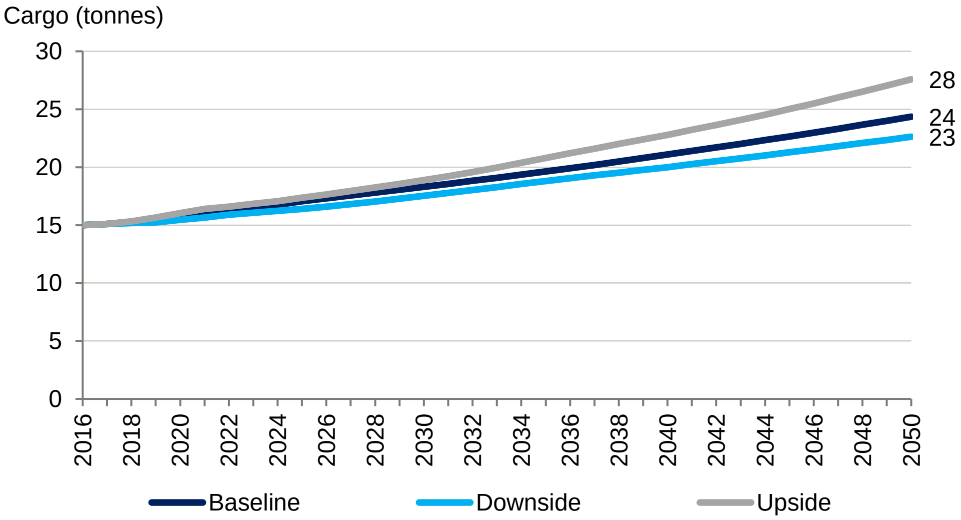
Fig. 23. Cargo volumes, 1996 to 2016, Cork



Source: CSO and ACI

For completeness, the forecasts of air cargo at Cork for each macroeconomic scenario are shown in Fig. 24.

Fig. 24. Cargo volume forecasts by scenario, Cork



Source: Oxford Economics, CSO, and ACI

3. AIRPORT CAPACITY AND PRIORITIES FOR DEVELOPMENT

AUTHOR: TAYLOR AIREY

KEY FINDINGS

This box identifies the main capacity constraints identified for each airport, and the years when such constraints are likely to take effect. We also suggest the volume of additional infrastructure needed to alleviate the expected capacity constraints. For some infrastructure components the range of future capacity requirements can be large (for example, the potential capacity need for stands at Dublin ranges from 39 to 89). This uncertainty is driven by a number of factors, including how near the infrastructure currently is to its capacity; the variation in demand between the lowest and highest passenger growth scenarios; the profile of demand growth over time; and the sensitivity of capacity to the variation in demand.[35]

The additional capacity needs shown should be interpreted as an indicator of the degree of shortfall in capacity compared to the current facility, and not a recommendation of what should be built. It may be preferential to address capacity issues by other means, e.g. process improvement or technology enhancement, rather than simply adding additional infrastructure of the type already used. Identifying the optimal means to addressing each constraint would require detailed airport design work.

Dublin

Fig. 25. Airport capacity requirements to 2050, Dublin

Infrastructure component	Year when capacity constraints start	Additional capacity needs to meet demand to 2050
Stands	2025-35	39 to 89
Terminal 1 baggage reclaim hall	2020-25	Up to 35 percent increase in reclaim carousel capacity, and up to 80 percent increase in space
Terminal 1 boarding gates (Pier 1)	2025-30 (driven by crowding, assuming it is not possible to spread demand to Pier 2)	Up to 10 gates
Terminal 1 boarding gates (Pier 3)	2025-30 (driven by gate availability, assuming it is not possible to spread demand to Pier 2)	Up to 8 gates
Terminal 1 immigration (queue times) [36]	2030-35	10 to 20 passport verification desks

[35] For example, if stands are already operating near to capacity, one additional flight would require one additional stand to be provided. However, the impact of an additional flight on security screening could be less stark, both because that part of the infrastructure has more spare capacity and because passengers arrive at the airport over an extended period, typically from between 30 minutes to four hours before their flight.

[36] The results of the analysis for the immigration area appear to contradict recent passenger experience of long queues and crowding because: (i) the analysis is based on the near future scenario where planned additional gates have been added; not on the actual situation in 2017 and early 2018; (ii) it is understood that there have been some technical issues with the introduction of e-gates that has reduced passenger flow; and (iii)

Terminal 1 immigration (crowding)	2030-2035	Approximately 300m^2 to 900m^2 of space
Terminal 1 passenger security screening (queue times)	2035-45	Up to 8 x-ray lanes
Terminal 2 TSA compliant screening (queue times)	2020-25	4-9 x-ray lanes
Terminal 2 bussing gates	2025-35	2 to 4 gates by 2050
Terminal 2, eastern check-in zone	2020	Up to 19 desks
Terminal 2 immigration (crowding)	2030-40	233m^2 to 649m^2 of space
Terminal 2 CBP pre-clearance border checks	2030	6 to 13 desks
Terminal 2, western check-in zone	2030-35	Up to 15 desks
Terminal 2 hold baggage screening	2035-40	Up to 4 HBS machines
Terminal 2 baggage reclaim (carousel capacity)	2040-45	20 percent increase
Terminal 2 passenger security screening (queue times)	2035-40	Up to 10 x-ray lanes (unless system can be upgraded to automatic tray return, similar to T1)
Terminal 2 baggage reclaim (area)	2035-45	Up to 40 percent increase in floor space

The findings for CBP pre-clearance are based on the process in place at the time of the research in late 2017 and early 2018. A new system based on biometric facial recognition was introduced on a trial basis in June 2018. It is expected that this will speed up passenger processing. We therefore recommend that the analysis of CBP pre-clearance capacity should be re-visited once the findings of the trial are known.

Dublin Airport's **runway** is operating at capacity in the early morning departure peak. Airspace restrictions that limit the spacing between successive departures are also contributing to this constraint. The addition of the new runway has the potential to alleviate the situation, but will require operation of both runways for departures in the morning peak, typically between 06:30 and 08:00. The planning restriction prohibiting the use of the new runway in the night period between 23:00 and 07:00 will reduce its benefits markedly. In addition, the planning restriction of the number night flights to 65 between 23:00 and 07:00 is below the level operated during summer 2017, and so will constrain growth and reduce the number of late night arrivals and early morning departures that are likely very valuable to Dublin-based carriers.

Given current forecasts and enabling the most efficient runway operations through, inter alia, ameliorating capacity constraints due to planning restrictions and allowing mixed mode operations, a two-runway Dublin airport could start to show the effects of runway capacity constraints by around 400,000 to 450,000 movements. This point could be reached around 2050 under our upside growth scenario. Effects are likely to include increasing and highly variable delays, as well as reduced resilience to disruption. Given that there are typically long lead times for runway and airspace changes, it could be prudent to start the planning process for additional runway capacity by around 2030. The planning process should not only consider additional infrastructure, such as a third runway and enhanced rapid access and exit taxiways to existing runways, but also include technology and process improvements, such as enhanced arrival and departure managers and time-based separations.

immigration staffing might not have been matched to the demand profile. Shortfalls in staffing levels will necessarily increase queues and crowding above those predicted from the infrastructure capacity alone.

Our analysis indicates that that **road system** around Dublin Airport is already under pressure in terms of traffic volumes and speeds, particularly the M1, R132 and R108, at peak times. Increased passenger numbers at Dublin Airport are likely to exacerbate this situation further, although the degree to which this is the case will depend on a range of factors, including changes in passengers' preferences for different modes of ground transport. A detailed study is needed to fully understand the impact from the network perspective and, also, on journey times to and from the airport.

Cork

Fig. 26. Airport capacity requirements to 2050, Cork

Infrastructure component	Year when capacity reached	Additional capacity needs to meet demand to 2050
Immigration area (queue times and crowding)	2020	5 lanes and 50 percent increase in space
Passenger security screening (queue times)	2020-25	3 to 5 x-ray lanes
Boarding gates	2030-35	Up to 3 gates
Stands	2030-35	4 to 6 stands
Departure lounge space (excluding space occupied by food and beverage outlets)	2030-35	60 percent increase in space
Passenger security screening at central search (crowding)	2035-45	50 percent increase in space

Shannon

Fig. 27. Airport capacity requirements to 2050, Shannon

Infrastructure component	Year when capacity reached	Additional capacity needs to meet demand to 2050
Baggage reclaim carousels	2020	2-3 carousels
Passenger security screening (queue times)	2020-25	5 x-ray lanes
Departure lounge space (excluding space occupied by food and beverage outlets)	2025-35	Up to a 75 percent increase in waiting space excl. food and beverage outlets to meet peak demand over relatively short periods of the day, principally in the summer months
Stands	2035	Up to 12 stands
CBP pre-clearance desks	2035-40	Up to 7 desks
Immigration area (queue times)	2040-45	2 desks

3.1 INTRODUCTION TO CAPACITY ANALYSIS

This section of the report summarises the approach to and results of the analysis of the capacity of Dublin, Cork and Shannon airports to meet projected demand to 2050 under the alternative passenger growth scenarios presented in Chapter 2.

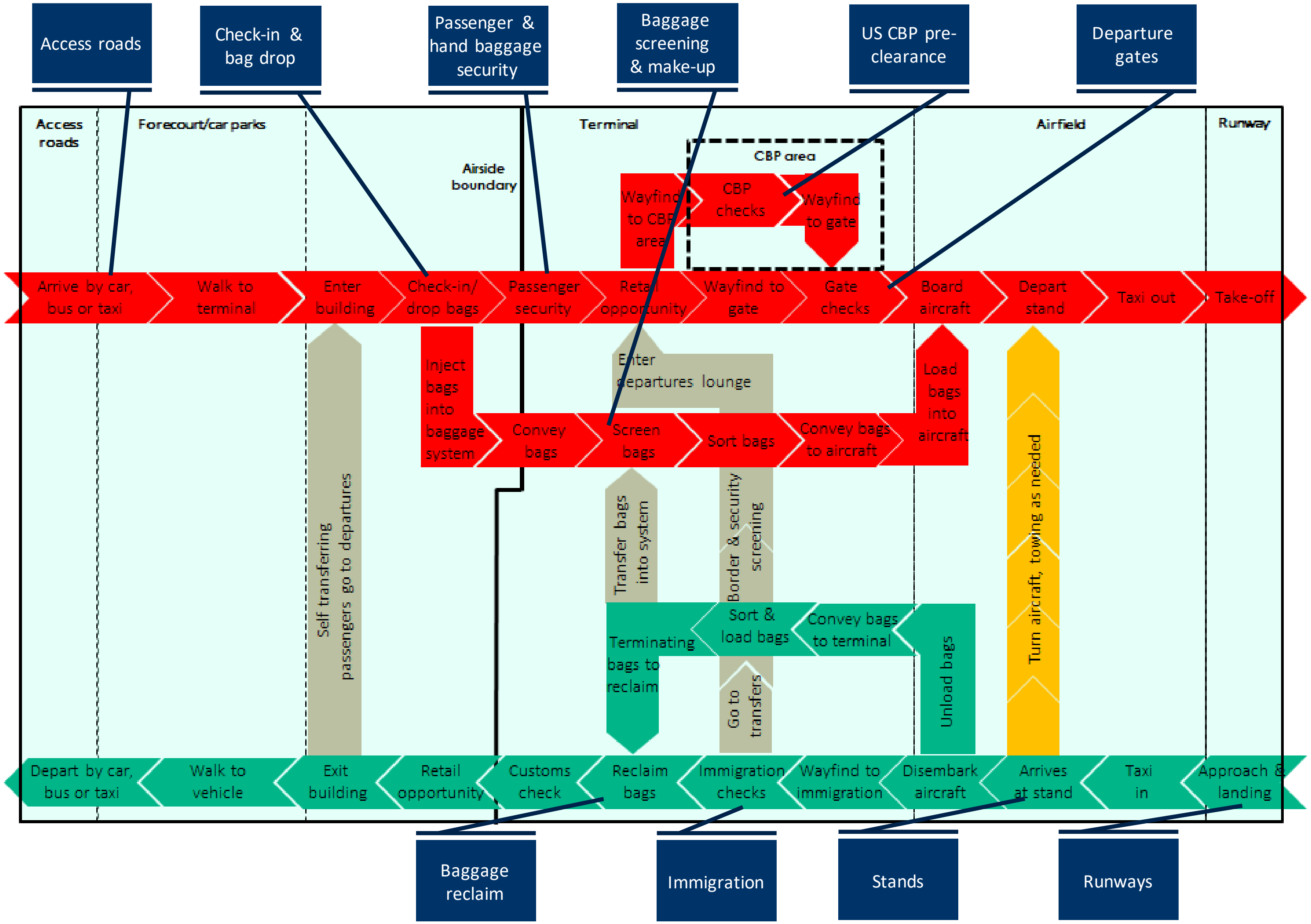
To ensure that the analysis reflects realistic traffic patterns, the actual traffic profile, in terms of passengers and air transport movements, from the 2017 summer season has been used as a baseline. Demand forecasts reflecting baseline, upside, downside and, at Dublin alone, enhanced transfer scenarios have been used to inflate the 2017 traffic on a half-hour resolution. This enables us to estimate the variation of demand across the day and from day-to-day.

Capacity figures have been derived from analysis of the processes along the passenger journey through the airport, based on published data wherever possible. Capacity is often not a hard metric and can vary according the level of queuing and crowding that are deemed acceptable. To provide an internationally comparable benchmark suitable for high quality airports, capacity has been defined against a 10-minute queue standard and the IATA optimum level of service for crowding. A more detailed description of the analysis and associated results is provided in the accompanying technical document.

3.1.1 Scope

The capacity assessment has focused on key elements of the passenger journey to and through the airport as shown in the figure below, using Dublin Airport as an example.

Fig. 28. Airport capacity elements for assessment



The analysis has focused on a number of potential capacity pinch-points as follows:

- Check-in and bag drop, where passengers who have not checked in online obtain their boarding cards and those passengers with hold baggage deposit their bags with the airline or handling agent.
- Baggage screening and make-up, where hold baggage is transferred from the check in hall through security screening machines to the facility where the baggage handlers combine individual bags to make-up the baggage load for individual flights.
- Passenger and hand baggage security screening, where passengers present their boarding cards for inspection and verification, have their hand baggage x-rayed and are themselves security scanned, principally using archway metal detectors and hand searches, augmented by security scanners where necessary and available
- US Customs and Border Protection (CBP) pre-clearance, at Dublin and Shannon Airports, where passengers travelling to the US are security screened to Transportation Security Administration (TSA) standards and undertake US immigration and customs checks so that they arrive in the US as domestic passengers.
- Departure gates, where passengers congregate to undertake final passport and boarding card checks and are quarantined prior to accessing the aircraft by jetty direct onto the aircraft, walking out and boarding using steps, or being bussed to a remote parking stand.
- Aircraft parking stands, where aircraft park to disembark and embark their passengers and undergo the servicing needed to turnaround the arriving flight to a departing flight (e.g. refuelling, catering and cleaning). Only those stands used to turnaround commercial flights are considered in this analysis
- The runways, including the impact of nearby airspace constraints.
- Immigration, where international passengers present their travel documentation for verification by immigration officials or, increasingly, pass through automated inspections at e-gates.
- Baggage reclaim where arriving passengers collect their hold baggage from reclaim carousels and all passengers pass through customs channels.
- Road access, for Dublin Airport only[37], where the current volume of traffic on the principal roads used to access the airport has been analysed. In addition, a tentative analysis has used demand data, projected forward to 2050, to compare to the available capacity This analysis is indicative only as it is based on a do-nothing scenario based on airport traffic drivers only and cannot take into account the various

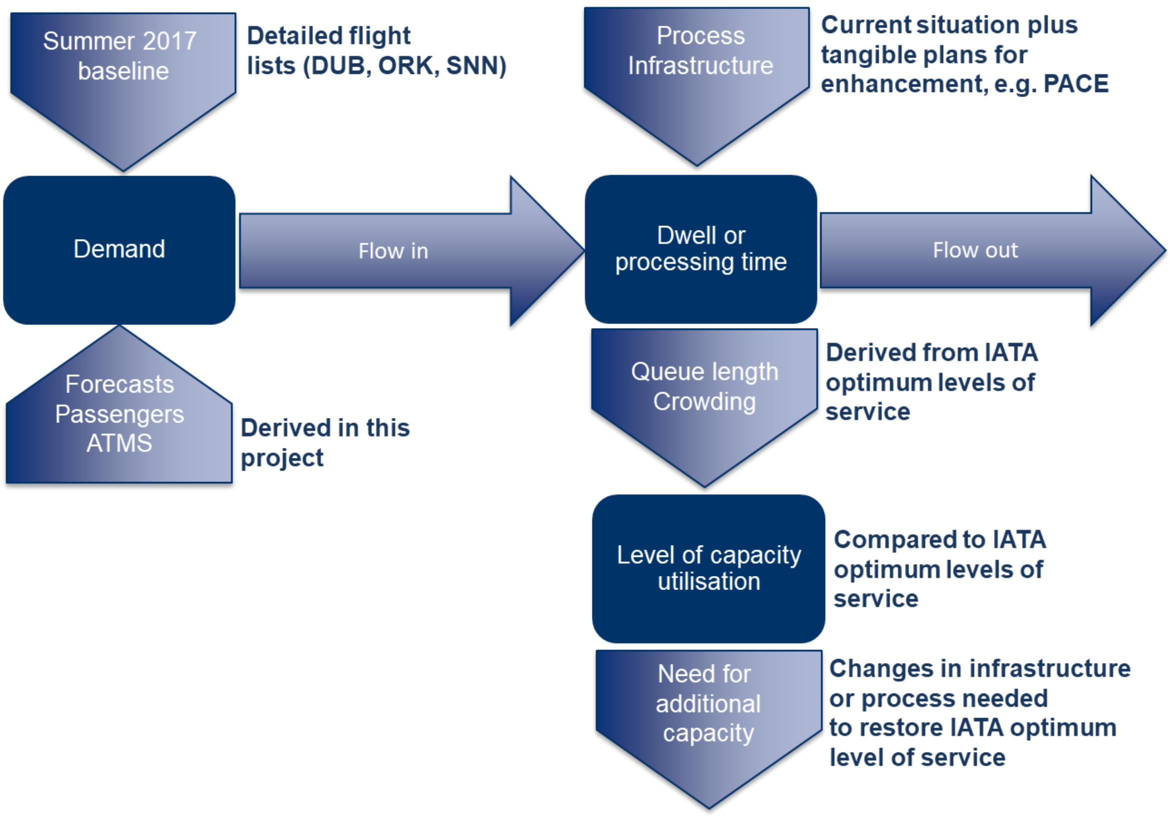
[37] Road traffic data is available from a series of road traffic monitoring sites around Dublin Airport. There is insufficient data from around Cork and Shannon Airports to enable meaningful analysis

strategies being considered for the development of the road system around Dublin.

3.1.2 Approach

The approach to airport capacity analysis is illustrated in the figure below and is based on flow/queue modelling and crowding calculations. The analysis is underpinned by detailed flight lists for the summer season 2017 which provide data on all aircraft movements and passenger numbers, ensuring that the analysis is grounded in reality as it reflects actual traffic patterns. These data have been inflated using the forecasts for future passenger volumes and air transport movements (ATMs) at five-year intervals, starting in 2020 and projecting forward to 2050. Traffic volumes have been derived at half-hourly intervals for each day across the summer season, which we regard as representative of the busy time for an airport. This generates an inward flow for each process or capacity element.

Fig. 29. Methodology for airport capacity analysis



Each capacity element is then defined in terms of available infrastructure, e.g. number of x-ray lanes available for passenger security screening, and processing time, e.g. the average or typical time to x-ray a passenger's hand baggage. This is underpinned by a series of assumptions when needed, e.g. the typical number of bags per passenger. These assumptions have been derived or sourced from previous capacity analysis undertaken mainly at Dublin Airport by daa and the Commission for Aviation Regulation (CAR). The baseline for the infrastructure available at each airport is based on observations from visits to the three airports during January and February 2018, as well as plans, descriptions and information provided by each of the airports. Therefore, developments at the airports after February 2018 will not have been captured in the analysis. However, where available, plans for future augmentation to infrastructure, e.g. through the Programme of Airport Campus Enhancement (PACE) in train at Dublin Airport, have been reflected in the analysis to account for planned capacity increases.

The analysis focuses on the physical infrastructure and associated processes under the assumption that staffing of the facilities is optimised to meet demand, i.e. sufficient staff are available and deployed to provide optimum capacity when it is required. In reality, this may not always be the case, so the analysis should be regarded as giving a best-case indication of the available capacity. This may not necessarily reflect actual passenger experience at times when insufficient staff are available.

The flow, be it passengers or aircraft, into the process at half-hourly resolution across the season is combined with infrastructure and process description to derive performance indicators, such as queue length and crowding (passengers per m^2), again at half hourly resolution. These performance indicators are compared to standards for queue length and crowding to determine the capacity for each process. The main benchmarks used to determine this capacity are:

- a queue length of 10 minutes, which is a reasonable benchmark applied at many airports internationally and is consistent with the upper end of the IATA optimum standard; and
- crowding at the level defined as IATA optimum standard, noting that this varies depending from process to process, but is typically of the order 1.0 to $1.7m^2$ per passenger.

IATA standards have been used because they represent international standards accepted by both airlines, through IATA, and airports, through the participation of the Airports Council International (ACI) in the definition process. The IATA levels of service standards are summarised in Appendix 5: IATA standards. Other standards are sometimes applied, however, for example by the Commission for Aviation Regulation (CAR) for quality of service compliance monitoring. The CAR standards represent the point at which the level of service becomes unacceptable and are therefore not suitable for design activities that are concerned with the optimum or appropriate level of service.

These standards and the level of demand are used to determine a level of utilisation or crowding for each process at half-hourly intervals across the summer season. Utilisation of 100 percent or higher indicates that capacity has been reached.

When demand exceeds capacity, the additional infrastructure needed to meet demand and restore the performance benchmark has been estimated from the 95^{th} percentile of the demand level, as this is more realistic than defining capacity to meet the absolute peak of demand. Three levels of capacity utilisation have been used:

(1) where the 95th percentile of demand exceeds capacity by 10 percent or less, which would represent up to moderate capacity constraints and may well be operable, if not ideal;
(2) where the 95th percentile of demand exceeds capacity by between 10 percent and 25 percent: this regime has been used to trigger the need for additional capacity; and
(3) where the 95th percentile of demand exceeds capacity by more than 25 percent, which would represent a severe capacity constraint.

The quantity of additional infrastructure needed should only be interpreted as an indicator of the degree of short-fall in capacity compared to the current facility. It may be preferential to address capacity issues by other means, e.g. process improvement or technology enhancement, rather than simply adding additional infrastructure description of the type already used.

3.2 DUBLIN AIRPORT

3.2.1 Airfield

Runway modes of operation

Dublin Airport's main runway is currently used for both arrivals (aircraft landing) and departures (aircraft taking-off). In the future two-runway configuration it is possible to operate the runways in different modes:

- mixed mode, where both runways are used for both take-off and landing contemporaneously
- segregated mode, where at any given time, one runway is used only for landing and the other runway is used only for take-off.

Current planning restrictions prohibit use of the new second runway between 23:00 and 07:00 hours. As such, the existing runway must be used for both take-off and landing during these hours and the airport will effectively continue to operate as a single runway airport during the night and early morning, even once the second runway is built.

Runway capacity is also influenced by the minimum safe separation between successive aircraft movements. For normal segregated mode operations two separations must be considered:

- arrival-arrival separations on the arrival runway, which are limited by the safe distance that the following aircraft must remain behind the leading aircraft to avoid interaction with the leading aircraft's wake vortex. This minimum separation varies depending on the relative size of the leading and following aircraft. International standards are applied by air traffic control to maintain safe separation.
- departure-departure separations on the departure runway, which also take into account wake vortex interactions, but are more often governed by the minimum separation that can be applied in nearby airspace along the airport's departure routes.

This latter constraint limits Dublin's departure runway capacity, as the minimum separation is currently set at 84 seconds between successive departures. At some other airports, depending on the departure routes used by successive departing aircraft, this separation can be as low as 60 seconds (e.g. at London Heathrow, Gatwick and Stansted airports). The study team understands that a reduction in this separation was recently trialled but was not sustainable with the current airspace structure. Reduction of the separation would require separate, diverging departure routes from the runway whereas at present only a single route is available.

In addition, there is a limit on the minimum separation between successive aircraft departing using the same runway because of the interaction of the wake vortex of the preceding aircraft with the following aircraft. This minimum separation depends on the relative size of the leading and following aircraft. There can also be restrictions in departure separation due to speed differential between successive departing aircraft to ensure that, if it flies faster, the following aircraft does not catch-up to the leading aircraft. These separations depend on the mix of the traffic using the airport and in Dublin's case the wide range in aircraft sizes and speeds using the airport may cause a capacity constraint for single runway operations.

In mixed mode operations, there are two further separation constraints:

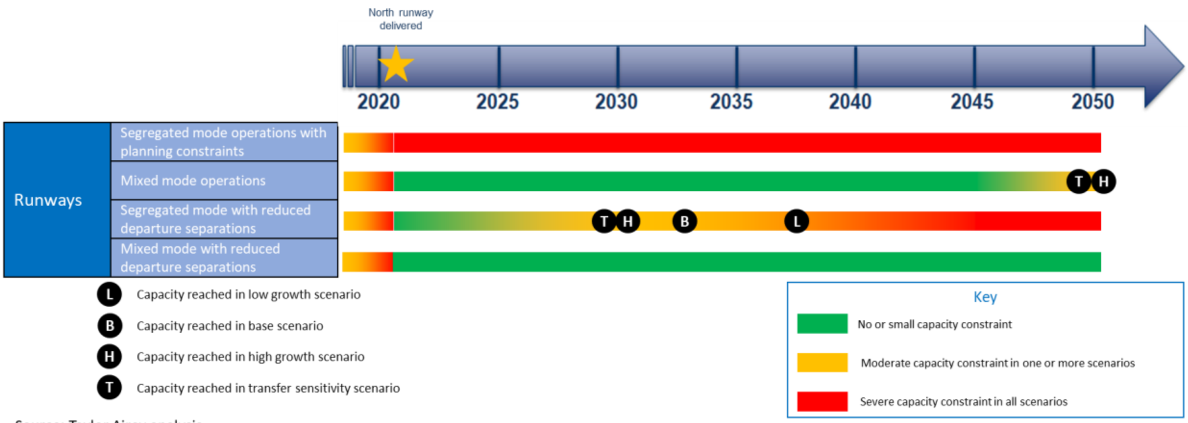
- arrival-departure separations, which is the space that must be left before a departure can take-off after a preceding arrival.
- departure-arrival separations, which is the time that must be left before an arriving aircraft can land after a preceding departure has taken off.

Runway capacity overview

In light of the considerations above, we have examined future runway capacity constraints at Dublin Airport under four scenarios, reflecting alternative modes of operation. In Fig. 30 we summarise the extent to which Dublin Airport is able to meet forecast demand to 2050 under each scenario. All of the scenarios assume that the new, northern runway enters into operation in 2021.

The graded scales from green through orange to red illustrate qualitatively the severity of capacity constraint. The figure also indicates the approximate time that capacity becomes constrained in each of the four growth scenarios, defined as the point in time which the 95th percentile of demand is 10 percent greater than the capacity.

Fig. 30. Runway capacity summary



Source: Taylor Airey analysis

Our analysis suggests that the main constraint on runway capacity is the early morning departure peak, between 06:30 and 07:30 hours, when demand is already at the limit of the capacity that can be provided by a single runway.

Under the operational restriction imposed by the planning consent process, the addition of a second runway does little to alleviate this principal runway capacity constraint because it will only be possible to operate using the existing runway at the time that the capacity pinch-point is deepest.

However, the study team understands that a new legal framework is being established to provide a means of reviewing the operating restrictions imposed within the planning consent for the new runway, in light of the ICAO Balanced Approach policy.[38] This development could potentially lead to a relaxation of the constraints imposed within the planning consent. Our analysis indicates that use of both runways for departures in the early morning would provide sufficient capacity to meet demand to around 2050.

If the planning restrictions cannot be lifted, it is possible that airspace optimisation to reduce minimum separations between successive departing aircraft could provide sufficient capacity to around 2030 in high growth scenarios, or longer under more moderate growth assumptions.

If both the planning constraint and the airspace restriction departure separations were alleviated, the two-runway Dublin Airport would not face any runway capacity constraints throughout the forecast horizon to 2050.

Given the long time horizon for planning, approval and construction of new runways, it is important to clarify the situation regarding the operation of Dublin Airport's two runways as early as possible. Currently the most binding limit on the runway capacity of the two-runway airport is regulatory rather than physical.

38 Further details of the ICAO Balanced Approach are available at the ICAO website. "ICAO" <https://www.icao.int/environmental-protection/Pages/noise.aspx> [accessed 26 June 2018]

Below we discuss in more detail the findings for each of the four runway operation scenarios.

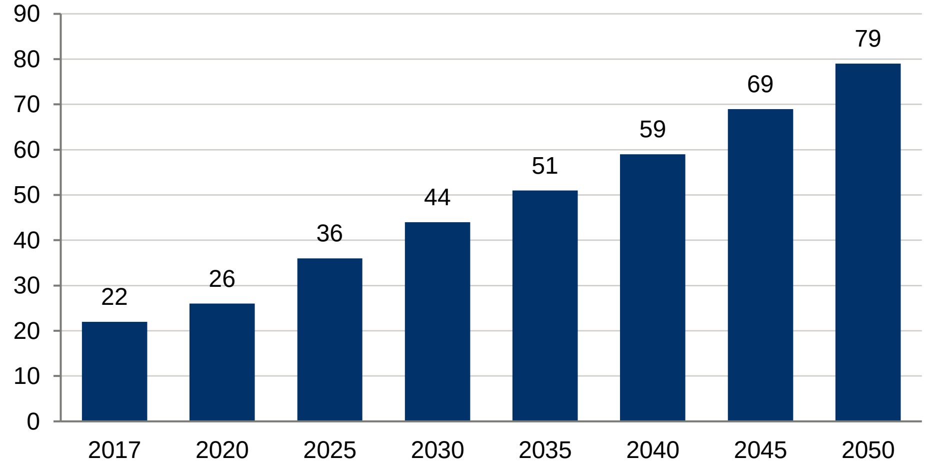
Runway scenario 1: segregated mode operations with planning constraints.

The current planning constraints applied to the new runway restrict the number of movements between 23:00 and 07:00 to 65 per night and prohibit the use of the new runway between 23:00 and 07:00 hours. Segregated mode operations mean that at any one time one runway is used for departures and the other for arrivals. As shown in the figure above, these restrictions severely impair the capability of the two-runway system to meet demand. Single runway operations are not sufficient to cope with demand in the period from 06:30 to 07:00. Segregated mode operations provide insufficient capacity to meet the early morning peak demand for departures between 07:00 and 08:00 hours.

The night time movement restriction would result in a constraint on demand, especially for late evening arrivals and early morning departures. The following figure shows the average daily number of flights that would not be able to operate under this restriction across the summer season to 2050. This restriction would have prevented, on average, 22 flights per day in the 2017 summer season and will prevent the scheduling of 79 flights per day by 2050.

Fig. 31. Night-time demand constraints due to restricting the number of movements between 23:00 and 07:00 to 65 per night

Oversubscription (average movements per night)



Source: Taylor Airey analysis based on daa data and forecasts from Oxford Economics

Runway scenario 2: mixed mode operations. Mixed mode operations, where both runways can be used for both arrivals and departures, would provide sufficient capacity for all growth scenarios until at least 2045. In the upside growth scenarios, mixed mode operations would be nearing capacity for the early morning peak, dominated by departures by 2050, with associated risks to performance and resilience. As the main pressure on capacity is during the early morning peak, mixed mode operations could potentially be restricted to these peak times rather than operating throughout the day.

Runway scenario 3: segregated mode operations with reduced departure separations. Currently the separation between successive departures is maintained at 84 seconds or greater due to restrictions on the use of airspace. It is this separation that results in the main constraint on runway capacity in segregated mode operations. Scenario 3 in Fig. 30 shows the impact of reducing this separation from 84 seconds to 60 seconds. This operational improvement would provide capacity to meet demand to around 2030 using segregated mode operations only. Thereafter, capacity would become constrained.

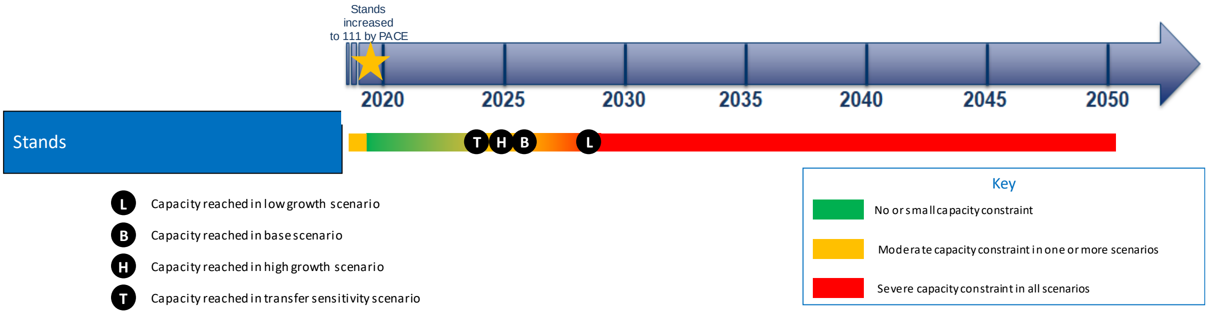
Runway scenario 4: mixed mode operations with reduced departure separations. Mixed mode runway operations with reduced departure separations provide sufficient capacity to meet all demand forecast scenarios to 2050 and beyond.

Stands

The figure below summarises the capacity of the aircraft parking stands to support turnarounds to meet forecast demand from the present to 2050, considering the key milestone in 2019 when the number of stands is planned to be increased from the present number of 90 to 111. The graded scales from green through orange to red illustrate qualitatively the severity of capacity constraint. The figure also indicates the approximate time that capacity becomes constrained in each of the growth scenarios defined as the point in time which the 95th percentile of demand is 10 percent greater than capacity.

As with runways the main capacity constraint affecting stands is for early morning departures, as well as providing sufficient capacity to cater for the large number of aircraft that over-night at Dublin.

Fig. 32. Stand capacity summary



Source: Taylor Airey analysis

Fig. 33 shows that the 111 stands to be delivered by PACE will likely provide sufficient capacity to between 2025 and around 2030 depending on the growth scenario. Thereafter, depending on the level of growth additional stands will be needed to support early morning departures and to avoid excessive levels of aircraft towing. By 2050, depending on the level of growth, between 150 and 190 stands are likely to be needed. The number of stands likely to be needed is summarised in the following table.

Fig. 33. Future requirements for stands

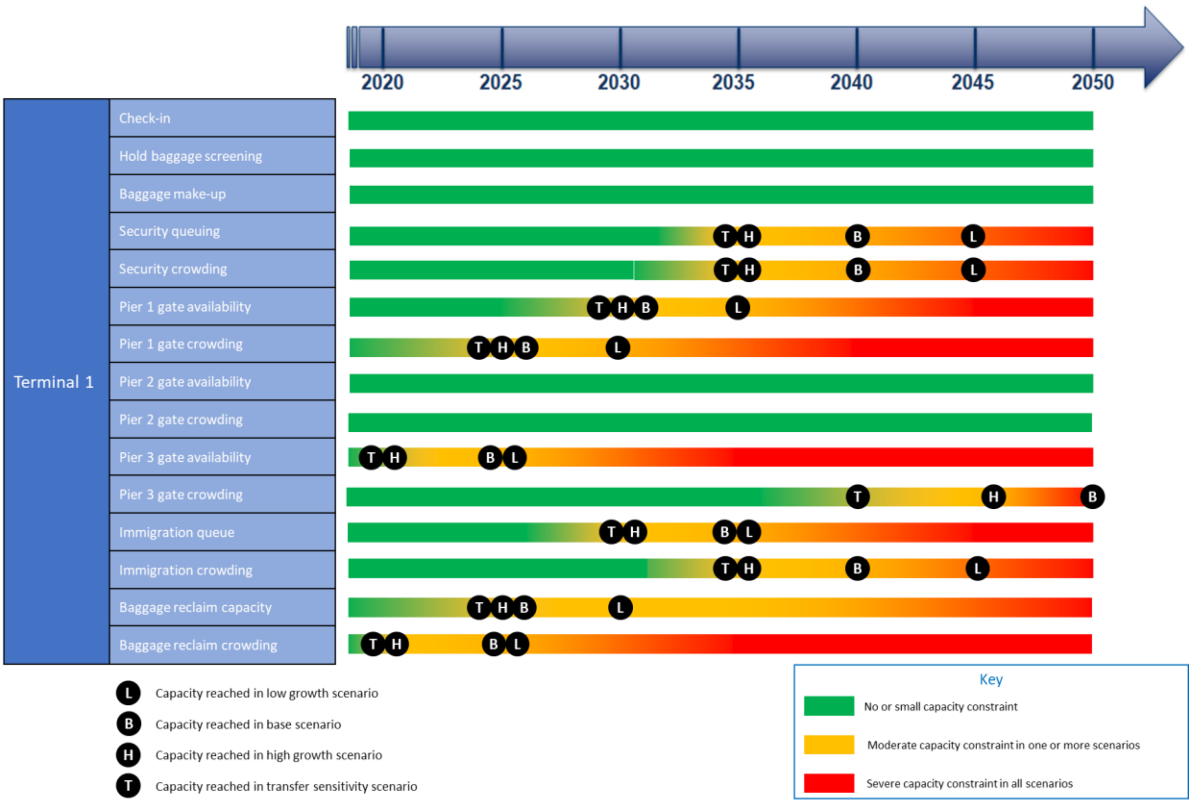
Year	Number of stands needed (depending on growth scenario)
2020	111
2025	111 to 122
2030	117 to 133
2035	126 to 147
2040	134 to 161
2045	142 to 176
2050	151 to 193

Source: Taylor Airey analysis

3.2.2 Terminal 1

The figure below summarises the capacity of the key passenger processing elements of Terminal 1 to meet projected demand to 2050. The graded scales from green through orange to red illustrate qualitatively the severity of capacity constraint. The figure also indicates the approximate time that capacity becomes constrained in each of the growth scenarios defined as the point in time which the 95th percentile of demand is 10 percent greater than capacity.

Fig. 34. Dublin Airport Terminal 1 capacity summary



Source: Taylor Airey analysis

Terminal 1 check-in

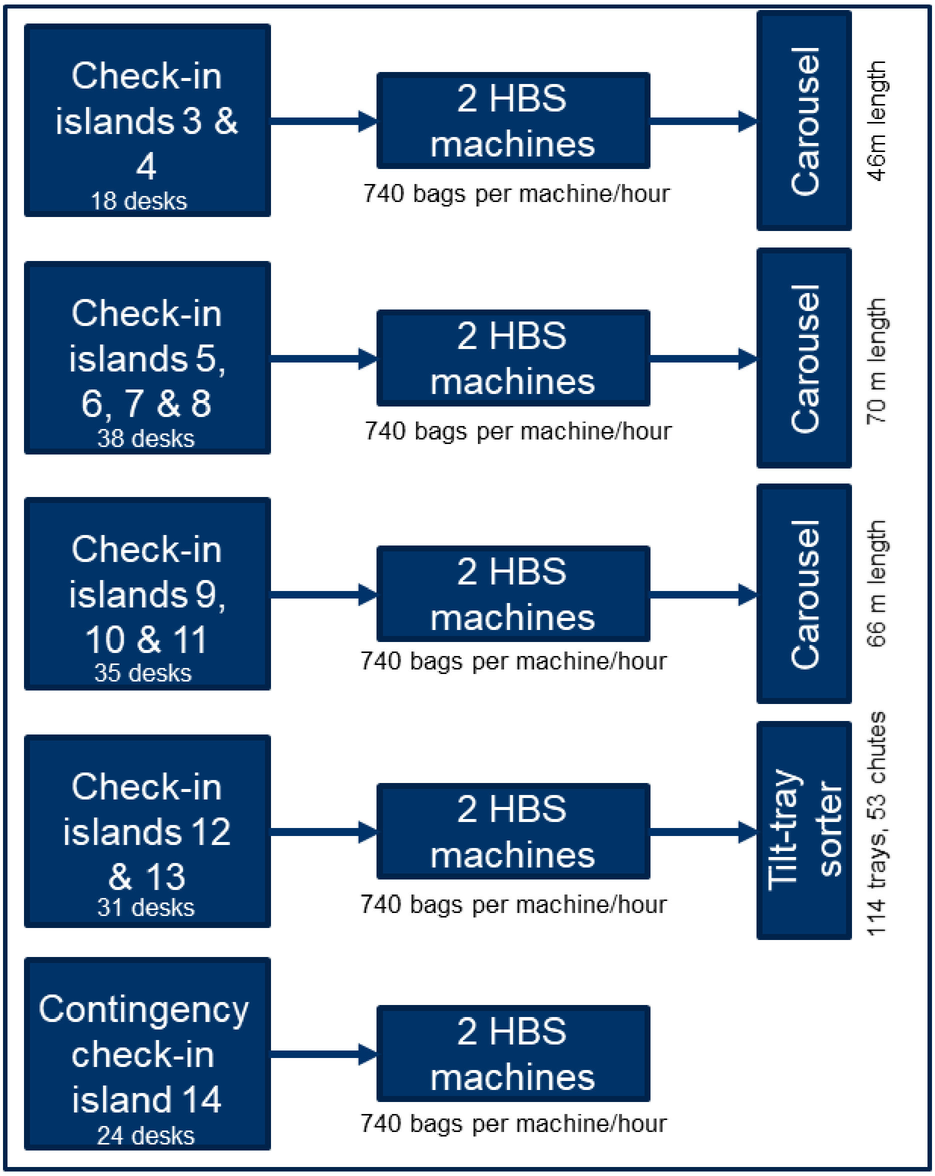
Terminal 1 check-in comprises 119 check-in/bag-drop desks and 23 self-service kiosks. The desks are arranged across 11 islands. In addition, there is a contingency check-in island with an additional 24 desks.

The current Terminal 1 check-in infrastructure provides sufficient capacity to meet forecast demand to 2050 for all growth scenarios. However, the allocation of check-in desks will require optimisation. For example, at present Ryanair is permanently allocated check-in islands 12 and 13 comprising 31 desks and 23 self-service kiosks. This part of the hall will soon reach saturation, potentially accelerated by Ryanair’s change of policy on cabin and hold baggage and will require expansion into other parts of the check-in hall, where there is spare capacity.

Terminal 1 outbound baggage system

The Terminal 1 baggage system currently connects groups of check-in islands to baggage make-up carousels, or a tilt-tray sorter for islands 12 and 13, via pairs of standard 2 hold baggage screening (HBS) machines. The figure below illustrates the configuration of check-in islands, hold baggage screening machines and make-up carousels.

Fig. 35. Schematic of Terminal 1 check-in and baggage system



The standard 2 HBS machines will need to be replaced by standard 3 machines in line with security regulations. For the purposes of this analysis the capacity of the Standard 3 machines has been assumed to be similar to that of the Standard 2 machines already in place.

Overall, following the introduction of the Standard 3 machines, the Terminal 1 hold baggage screening system has sufficient capacity to meet forecast demand out to 2050.

Similarly, the Terminal 1 baggage make-up facilities have sufficient capacity to meet forecast demand to 2050. However, like check-in some re-organisation of airlines to facilities will be required to use the capacity efficiently. Currently Ryanair is allocated check-in desks 12 and 13 and uses the tilt-tray sorter for baggage make-up. Although there is sufficient capacity in the sorter to handle the volume of bags, each flight requires the use of two chutes. The number of flights in the first departure wave means that that tilt-tray sorter is reaching saturation point and additional flights will need to be allocated to the other make-up carousels, with knock-on upstream effects on the allocation of check-in desks.

Terminal 1 passenger security screening

The infrastructure used for passenger security screening in Terminal 1 comprises 12 document check lanes, nine archway metal detectors and 15 x-ray lanes using an automatic tray return system (ATRS). It is the x-ray system that provides the capacity limit. The passenger queuing area is approximately 800m^2.

In terms of queue length, the Terminal 1 passenger security screening system has sufficient capacity to meet demand to around 2030 at a ten-minute queue standard. Thereafter, assuming the same security screening processes, additional infrastructure will be needed to meet demand depending on growth scenario. By 2050, three to eight additional processing lanes will be required to meet demand depending on the growth scenario.

Similarly, in terms of crowding, compared to the IATA optimum standard of 1.0 to 1.2 m^2 per passenger, the current space is sufficient to meet demand to around 2030. Thereafter by 2050 between approximately 140m^2 and 400m^2 of additional space will be needed to meet demand, depending on the growth scenario.

The following table illustrates the level of additional capacity that will be needed to accommodate evolving demand. The ranges in the requirements indicate the variation due to low and high growth scenarios.

Fig. 36. Future requirements for Terminal 1 passenger security screening

Year	Number of x-ray lanes needed (15 currently available)	Queuing area needed (m^2) (800m^2 currently available)
2020	15	800
2025	15	800
2030	15 to 16	800 to 805
2035	15 to 17	800 to 895
2040	16 to 19	818 to 985
2045	17 to 21	876 to 1083
2050	18 to 23	939 to 1195

Source: Taylor Airey analysis

Terminal 1 passenger boarding gates

Terminal 1 passengers board aircraft via gates arranged across the three piers:

- Pier 1 has 16 boarding gates with a combined, total passenger waiting area of 2405 m^2
- Pier 2 has 15 boarding gates with a combined, total passenger waiting area of 2140 m^2
- Pier 3 has eight boarding gates with a combined, total passenger waiting area of 1557 m^2.
- The capacity of the boarding gates is measured both by the availability of the number of gates to serve departing aircraft and by the crowding levels at the gates. Typically, a gate is required for around 40 minutes before the actual departure time of the flight that it is serving, extending to ten minutes after the departure time.

Assuming flights and stands continue to be assigned to boarding gates as at present and growth is not constrained by limited availability of aircraft stands:

- Pier 1 gate availability starts to be constrained to serve increased volumes of flights around 2025 for high growth scenarios. The shortage of gates at Pier 1 starts to become severe by about 2035. Pier 1 gates start to become more crowded than the IATA optimum standard by 2025 and will become severely crowded by 2035 for all growth scenarios
- Pier 2 has sufficient availability and passenger waiting area to accommodate projected growth to 2050
- Pier 3 gate availability starts to become constrained in 2020 with constraints becoming severe by 2030 for all growth scenarios. Pier 3 crowding does not start to degrade below IATA optimum level until around 2045. Combined, these observations indicate that the number of gates is insufficient to meet forecast demand, but the area occupied by the gates is proportionately larger.

If it is possible to combine the gates on Piers 1, 2 and 3 then the spare capacity in Pier 2 offsets the shortfall in capacity in Piers 1 and 3 to the extent that overall gate availability only starts to become constrained in 2045 for high growth scenarios and 2050 for all scenarios. This type of combination will require greater flexibility of allocation of flights/airlines to gates across the three piers in coordination with stand allocation, baggage handling and check-in desk allocation. The operational complexity and feasibility of combining capacity in this way is not known but could be studied in a future piece of research.

Fig. 37. Future requirements for Terminal 1 boarding gates

Year	Pier 1		Pier 2		Pier 3	
	Number of gates	Waiting area (m^2)	Number of gates	Waiting area (m^2)	Number of gates	Waiting area (m^2)
2018	16	2,405	15	2,140	8	1,557
2020	16	2446 to 2567	15	2,140	8	1,557
2025	16 to 17	2578 to 2808	15	2,140	9	1,557
2030	17 to 19	2726 to 3019	15	2,140	9 to 10	1,557
2035	17 to 20	2900 to 3281	15	2,140	10 to 11	1557 to 1620
2040	18 to 22	3057 to 3545	15	2,140	11 to 13	1557 to 1732
2045	19 to 24	3226 to 3835	15	2,140	12 to 15	1605 to 1862
2050	20 to 26	3410 to 4159	15	2,140	12 to 16	1670 to 2009

Source: Taylor Airey analysis

Terminal 1 immigration

Terminal 1 immigration infrastructure comprises a combined facility serving Piers 1 and 2 with a separate facility serving Pier 3. For the purposes of the capacity assessment it has been assumed that these facilities can be used flexibly with passengers being directed to the appropriate facility depending on queue length. This reflects a possible future optimised scenario and is different to the current mode of operation where the Pier 3 facilities cannot be used by Terminal 1 passengers when Aer Lingus Terminal 2 flights are using Pier 3 (these passengers are still directed to Terminal 2 immigration). The optimum use of Terminal 1 immigration facilities would require that the Aer Lingus flights that currently use Pier 3 are redirected to Terminal 2/Pier 4, which then impacts on Terminal 2 stand and gate capacity with the benefit of freeing-up Terminal 1 immigration capacity. The operational feasibility of more flexible use of Terminal 1 immigration facilities would require assessment by daa.

The analysis of immigration capacity focused on infrastructure—the number of immigration desks and gates, and the queuing space. To measure the infrastructure capacity, it was assumed that the facilities were adequately staffed to match the demand profile and that additional capacity available from e-gates and efficient use all immigration facilities, specifically combination of Pier 1 and 2 and Pier 3 in Dublin's Terminal 1.

The capacity assessment has used the summer 2018 combined Pier 1/2 and Pier 3 immigration facilities that will comprise 19 manual passport check lanes and 10 e-gates. The future facilities and process are substantially enhanced compared to those applied in 2017 and early 2018, where there were 12 manual and 4 e-gates and passenger experience was of long queues and crowding in the Pier 1 and 2 immigration hall especially during the late night arrival peak. The capacity assessment has used the summer 2018 combined Pier 1/2 and Pier 3 immigration facilities that will comprise 19 manual passport check lanes and 10 e-gates. The passenger queuing area for the Pier 1/2 immigration facility is 422 m^2 and the combined Pier 1/2 and Pier 3 queuing area is approximately 800m^2.

In terms of queue length, the Terminal 1 immigration system (Pier 1/2 and Pier 3 combined) has sufficient capacity to meet demand to 2025 at a 10-minute queue standard. Additional gates will be needed in 2030 for high growth scenarios and 2035 for all demand scenarios. Capacity constraints will be severe, in terms of immigration queueing, in all growth scenarios by 2040. Combining the immigration facilities across the piers means that IATA optimum crowding standards can be achieved at immigration queues to around 2035. Crowding starts to become severe in all growth scenarios by around 2045. The following table summarises the capacity requirements for Terminal 1 immigration facilities to 2050 with the lower end of the range applying to the lowest growth scenario and the upper end of the range to the highest growth scenario.

Fig. 38. Future requirements for Terminal 1 immigration

Year	Number of immigration desks needed (29 manual desks and e-gates currently available)	Queuing area needed (m^2) ($800m^2$ currently available)
2020	29	800
2025	29 to 30	800
2030	29 to 33	800
2035	32 to 37	800 to 971
2040	34 to 41	812 to 1182
2045	36 to 45	931 to 1424
2050	39 to 49	1069 to 1729

Source: Taylor Airey analysis

The results of the analysis appear to contradict recent passenger experience of long queues and crowding. This reflects that:

(1) it is often not possible to combine the Pier 1/2 and Pier 3 immigration facilities as at peak times the Pier 3 facilities are not available due to Terminal 2 Aer Lingus arrivals using Pier 3;
(2) the analysis is based on the near future scenario where planned additional gates have been added; not on the actual situation in 2017 and early 2018;
(3) it is understood that there have been some technical issues with the introduction of e-gates that has reduced passenger flow;
(4) immigration staffing might not have been matched to the demand profile. Shortfalls in staffing levels will necessarily increase queues and crowding above those predicted from the infrastructure capacity alone; and
(5) there has been a specific issue with late night arrivals at Dublin Airport's Terminal 1 where there is a peak around midnight. This peak can be exacerbated by late running flights where actual passenger demand is much higher than that planned for resulting in long queues and crowding in the immigration hall. The volume of inbound passengers during this late-night peak exceeded the capacity available from the infrastructure then available.

Terminal 1 baggage reclaim

The Terminal 1 baggage reclaim hall has an area of 1977 m^2 and is served by 10 reclaim carousels with total length of 422 m.

The capacity of the baggage reclaim belts is estimated to start becoming constrained by 2025 but only becomes severely constrained in high growth scenarios around 2045 and in all scenarios by 2050. Capacity is likely to be reached sooner if higher proportions of Ryanair passengers carry hold baggage in response to changes in baggage policy.

Crowding in the baggage reclaim hall beyond the IATA optimum level is likely to become a constraint by 2025 and become severe, except in the lowest growth scenario by 2030.

Fig. 39. Future requirements for Terminal 1 baggage reclaim

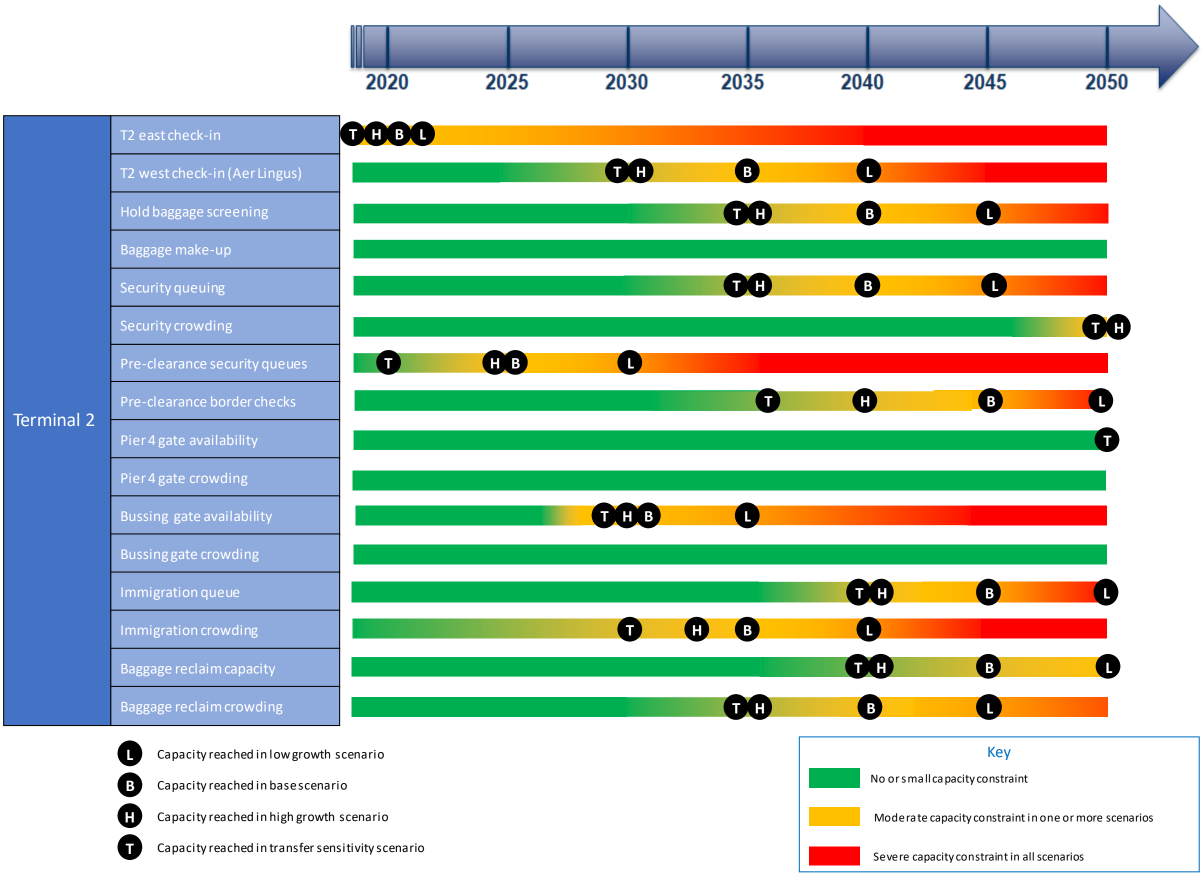
Year	Length of carousel needed (current frontage is 422m)	Hall area needed (m^2) ($1977m^2$ currently available)
2020	477 to 456	2121 to 2219
2025	457 to 473	2229 to 2416
2030	467 to 489	2349 to 2588
2035	480 to 508	2492 to 2802
2040	491 to 527	2619 to 3018
2045	504 to 548	2757 to 3254
2050	517 to 572	2907 to 3519

Source: Taylor Airey analysis

3.2.3 Terminal 2

The figure below summarises the capacity of the key passenger processing elements of Terminal 2 to meet projected demand to 2050. The graded scales from green through orange to red illustrate qualitatively the severity of capacity constraint. The figure also indicates the approximate time that capacity becomes constrained in each of the growth scenarios defined as the point in time which the 95th percentile of demand is 10 percent greater than the capacity.

Fig. 40. Dublin Airport Terminal 2 capacity summary



Source: Taylor Airey analysis

Terminal 2 check-in

The check-in facilities in Terminal 2 are split into two zones, east and west. The facilities in the west are dedicated to Aer Lingus and comprise 29 bag-drop desks, one of which is used for out-of-gauge bags, and 30 self-service kiosks. The facilities in the east are used by a range of airlines, including United Airlines, American Airlines, Delta Airlines, Norwegian, and Emirates, and comprise 29 bag-drop desks, one of which is used for out-of-gauge bags and six self-service kiosks.

The check-in facilities in the west zone have sufficient capacity to cope with forecast demand in terms of passenger queuing to around 2025 for high growth scenarios, and 2030 for low and base growth scenarios. By 2040 the facility will be reaching saturation for all growth scenarios.

In the east zone, queue lengths will start to be prejudiced by around 2030 and will reach saturation by around 2035. Future requirements for Terminal 2 check-in to support passenger volume are shown in the following figure.

Fig. 41. Future requirements for Terminal 2 check-in

Year	Desks needed in east zone (currently 28)	Desks needed in west zone (currently 28)
2020	28	28
2025	28 to 29	28
2030	28 to 32	28 to 29
2035	30 to 35	28 to 32
2040	32 to 39	30 to 37
2045	34 to 43	32 to 39
2050	37 to 47	34 to 43

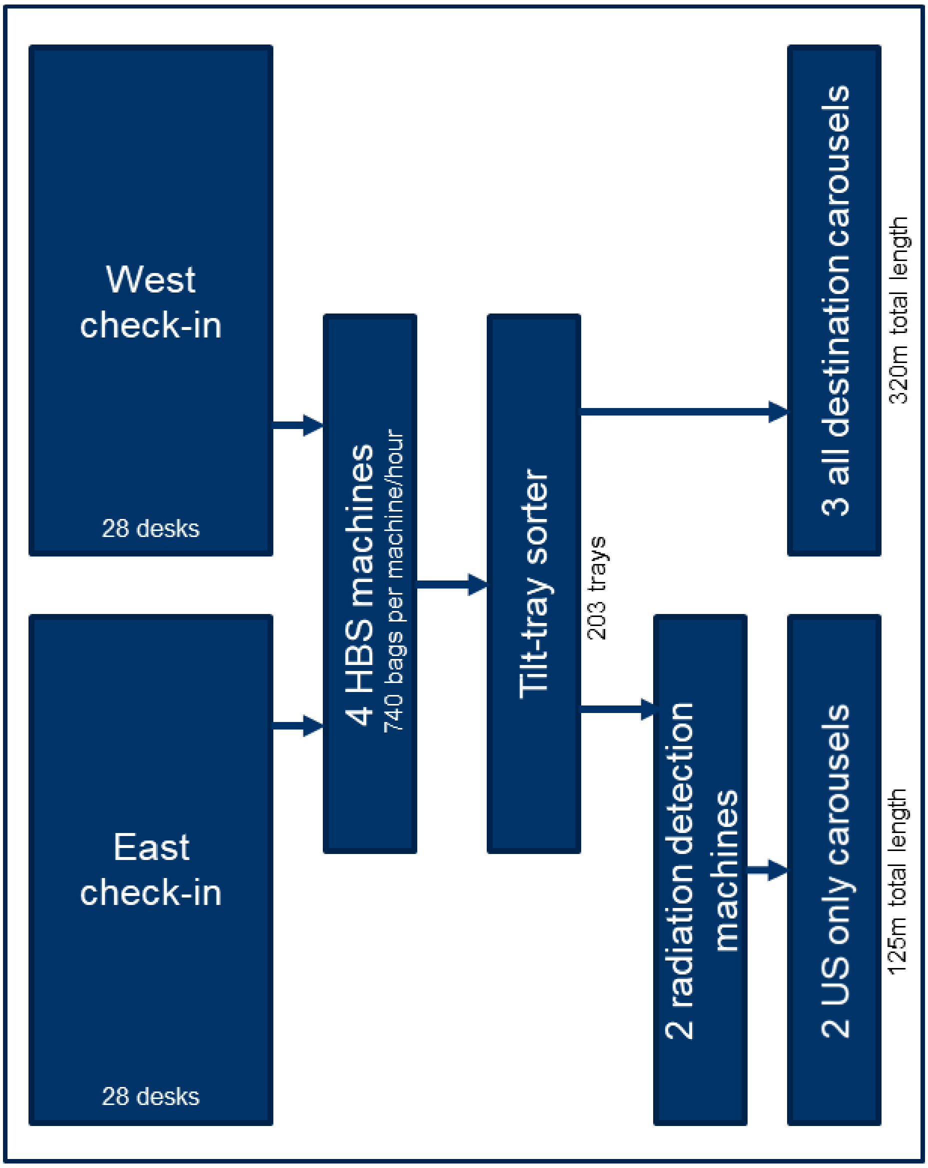
Source: Taylor Airey analysis

However, it is the number of available desks and not queue length that is the constraining factor for Terminal 2 east zone check-in. Several of the carriers operating from this zone offer multiple classes of travel and require different desks to check-in first, business, premium economy and economy class travellers, requiring up to five or six check-in desks per flight. With the current schedule, the limited number of desks available is already constraining the level of service available to the airlines operating in Terminal 2 east, with airlines having to accept fewer check-in desks than they would like. Prior to Etihad moving its operation to Terminal 1 the short-fall was approximately 10 desks. Currently this short-fall is estimated to be approximately five desks at around 09:00 hours, assuming full service carriers require five desks per flight. Demand and capacity are balanced if full service carriers can make do with only four desks per flight and Norwegian operates with two desks per flight.

Terminal 2 outbound baggage system

The Terminal 2 baggage system currently connects check-in desks to make-up carousels via HBS machines and a tilt-tray sorter as illustrated in the following figure. US bags are directed to US-only make-up carousels and are screened for radiation after conventional hold baggage screening. The radiation screening machines can only be used for US traffic meaning that that part of the baggage system is prohibited to non-US traffic.

Fig. 42. Schematic of Terminal 2 check-in and baggage system



There is sufficient capacity in the Terminal 2 HBS system to cope with forecast demand to 2030. Thereafter capacity starts to become constrained for high growth scenarios with additional screening capacity being needed for all growth scenarios by 2045. There is, however, sufficient make-up capacity for both US and non-US traffic to 2050.

The following table illustrates the HBS capacity needed to accommodate forecast Terminal 2 traffic to 2050, noting that the current standard 2 HBS machines will need to be replaced by standard 3 machines to comply with screening standards.

Fig. 43. Future requirements for Terminal 2 HBS

Year	Number of HBS machines needed (4 currently available)
2020	4
2025	4
2030	4
2035	4 to 5
2040	4 to 6
2045	5 to 7
2050	5 to 8

Source: Taylor Airey analysis

Terminal 2 passenger security screening

The infrastructure used for passenger security screening in Terminal 2 comprises 12 document check lanes, 10 archway metal detectors and 18 manual return (conventional) x-ray lanes. It is the x-ray system that provides the capacity limit. The passenger queuing area is approximately 730m^2.

In terms of queuing to a 10-minute standard, there is sufficient capacity to reach 2035 for all but the highest growth scenario. The system becomes capacity constrained for all but the lowest growth scenario by 2040 and for all growth scenarios by 2045.

There is sufficient queuing space to achieve the IATA optimum standard to 2050, except for the highest growth scenarios, where a small amount of additional space would be needed by 2050.

The following table illustrates the future requirements for the Terminal 2 passenger security screening system using the existing infrastructure.

Fig. 44. Future requirements for Terminal 2 passenger security screening

Year	Number of x-ray lanes needed (18 currently available)	Queuing area needed (m^2) (730m^2 currently available)
2020	18	730
2025	18	730
2030	18 to 19	730
2035	18 to 21	730
2040	19 to 23	730
2045	21 to 25	730
2050	22 to 28	730 to 793

Source: Taylor Airey analysis

However, if the Terminal 2 passenger screening system is upgraded to ATRS, as deployed in Terminal 1, there would be sufficient capacity to meet demand for all growth scenarios to 2050.

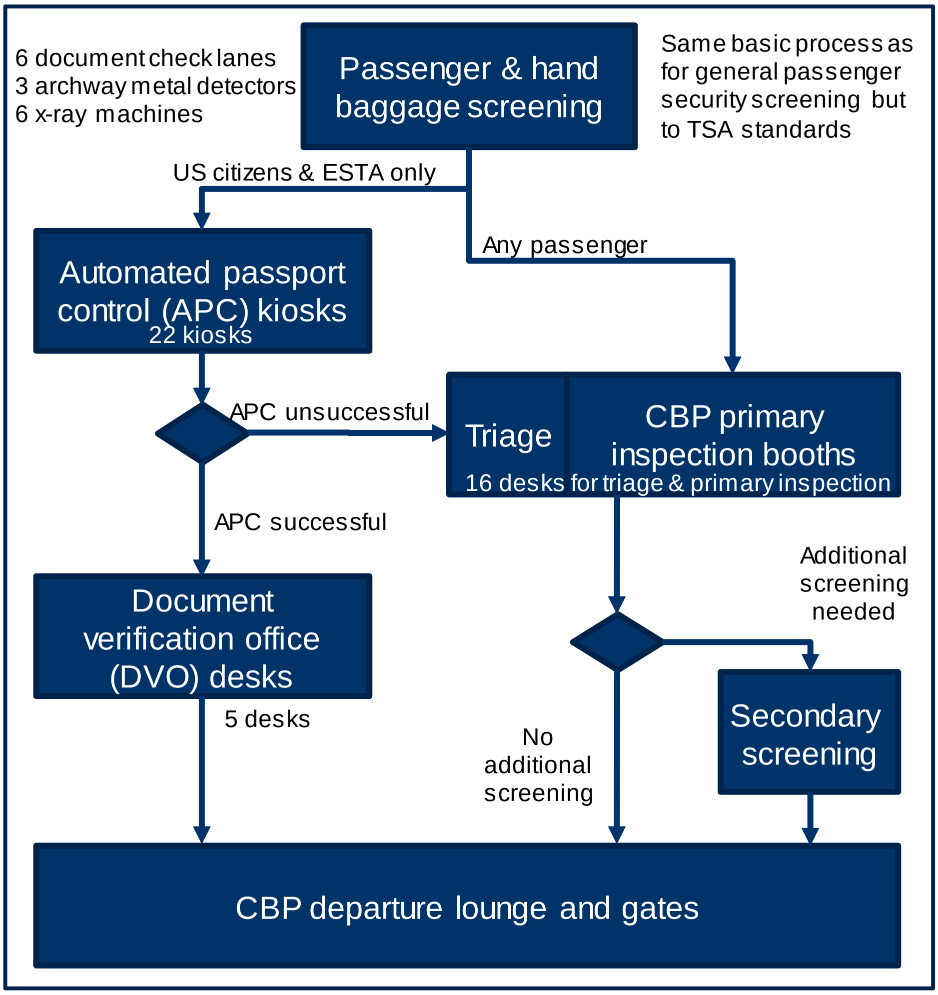
US Customs and Border Protection pre-clearance

Analysis of the capacity of US Customs and Border Protection (CBP) pre-clearance is based on the process in place at the time of the study, in late 2017 and early 2018. This process is illustrated in the figure below. Initially passengers pass through a security process very similar to that applied to all passengers but performed to Transportation Security Administration (TSA) rather than European Union (EU) standards. There are six document check lanes, three archway metal detectors and six x-ray machines in this part of the facility. The x-ray machines are the principal capacity constraint for this part of the process.

US citizens and other appropriately authorised passengers can scan their documentation at one of 22 automated passport control (APC) kiosks and, if granted a waiver, can proceed to a manual check by one of five document verification officer (DVO). If the automated check fails, the passenger must present at a triage desk.

Passengers not qualifying for the APC kiosks must proceed to a manual check at a CBP desk for primary inspection. There are 16 desks shared between primary checks and triage. If the passenger passes the primary inspection, he/she can proceed to the quarantined CBP departure lounges and gates. If the passenger fails primary checks he/she is referred to secondary screening, which is not considered in this capacity assessment.

Fig. 45. US CBP pre-clearance screening process



Because different passengers follow different processes for pre-clearance, capacity depends on the mix of passengers presenting and the choices that the passengers make on their path through the process. The capacity assessment has been made based on the assumptions that:

- the passenger mix comprises approximately 64 percent US citizens, 31 percent non-US electronic system for travel authorization (ESTA) passengers and three percent non-ESTA passengers.[39]
- 75 percent of US passengers and 75 percent of ESTA passengers follow the APC route.[40]

[39] daa, July 2018

[40] Helios Technologies Ltd, *Capacity assessment at Dublin Airport for the purpose of setting slot coordination parameters*, draft final report for the Commission for Aviation Regulation, October 2017

Based on these assumptions and the assumption that the facilities are staffed optimally:

- passenger security screening at the front-end of the process is the principal capacity constraint with additional capacity needed for high growth scenarios by 2020 and in all growth scenarios by 2030 at the latest; and
- with the current passenger mix, the capacity of the CBP/DVO process will become a constraint in high growth scenarios by 2040 and in all scenarios by 2050. The capacity is sensitive to the passenger mix so capacity constraints may begin to bite earlier if the proportion of US passengers decreases or later if the proportion of US passengers increases compared to the current mix.

The following table illustrates the infrastructure requirements for the US CBP pre-clearance process to 2050.

Fig. 46. Future requirements for US CBP pre-clearance

Year	Number of x-ray lanes needed (6 currently available)	DVO/CBP desks (21 currently available)
2020	6 to 7	21
2025	6 to 8	21
2030	7 to 9	21
2035	8 to 10	21
2040	8 to 11	21 to 25
2045	9 to 13	21 to 29
2050	10 to 15	23 to 35

Source: Taylor Airey analysis

Since the analysis reported in this document was performed, the process used for CBP pre-clearance has changed on a trial basis, starting in June 2018. The new process is based on biometric facial recognition at staffed verification points. The APC machines are not used. In the new process, if the automatic biometric verification is successful the passenger is processed without further checks. If the verification fails, the passenger is processed by the verification officer using the traditional methods, including fingerprints where necessary. It is expected that the new approach will speed up passenger processing and hence increase the capacity of Dublin's CBP facility. However, the trial is still ongoing and detailed analysis of transaction times and success rates and capacity impact is in its early stages. Therefore, it may be necessary to revisit the assessment of CBP pre-clearance capacity at a later date once the findings of the trial are known, particularly in relation to transaction times and verification success/failure rates.

Terminal 2 passenger boarding gates

Terminal 2 passengers board aircraft via one of two sets of gates:

- Pier 4, which has 19 boarding gates with a combined, total passenger waiting area of 4150 m^2; or
- by bus to remote stands from six bussing gates with a combined waiting area of 1034 m^2.

The capacity of the boarding gates is measured both by the availability of the number of gates to serve departing aircraft and by the crowding levels at the gates. Typically, a gate is required for around 40 minutes before the actual departure time of the flight that it is serving, extending to ten minutes after the departure time.

Assuming flights and stands continue to be assigned to boarding gates as at present and growth is not constrained by limited availability of aircraft stands:

- Given the current distribution of flights between Piers with some Aer Lingus flights using Pier 3, there are sufficient Pier 4 gates to meet future demand through to 2050 with adequate waiting space to provide the IATA optimum level of service. However, if all Aer Lingus flights were to be directed to Pier 4, then six to 13 additional Pier 4 gates would be needed by 2050.

- There will be a short-fall in the number of bussing gates by 2030 for higher growth scenarios and for all scenarios by 2035 although there is sufficient space in the bussing gate area to meet IATA optimum standard through to 2050. This is likely because the bussing gates serve a high number of flights using small aircraft.

The following table illustrates the requirement for bussing gates through to 2050.

Fig. 47. Future requirements for bussing gates

Year	Number of busing gates needed (6 currently available)
2020	4
2025	4
2030	6 to 7
2035	7 to 8
2040	7 to 9
2045	8 to 9
2050	8 to 10

Source: Taylor Airey analysis

Terminal 2 immigration

The Terminal 2 immigration facility comprises 16 manual passport check desks with a passenger queuing area of 430 m^2. There is sufficient capacity to maintain 10-minute queue standards to 2040 for the high growth scenarios and to 2050 for the low growth scenario. Crowding in the immigration hall will degrade to below the IATA optimum standard by 2030 for the high growth scenarios and 2035 for all scenarios. The table below illustrates the capacity requirements for Terminal 2 immigration.

Fig. 48. Future requirements for Terminal 2 immigration

Year	Number of immigration desks needed (16 manual desks currently available)	Queuing area needed (m²) (430m² currently available)
2020	16	430
2025	16	430
2030	16	430 to 488
2035	16 to 17	441 to 603
2040	16 to 19	504 to 739
2045	17 to 22	576 to 884
2050	18 to 24	663 to 1073

Source: Taylor Airey analysis

As with Terminal 1 immigration, the results of the analysis for the immigration area appear to contradict recent passenger experience of long queues and crowding because: (i) the analysis is based on the near future scenario where planned additional gates have been added; not on the actual situation in 2017 and early 2018; (ii) it is understood that there have been some technical issues with the introduction of e-gates that has reduced passenger flow; and (iii) immigration staffing might not have been matched to the demand profile. Shortfalls in staffing levels will necessarily increase queues and crowding above those predicted from the infrastructure capacity alone.

Terminal 2 baggage reclaim

The Terminal 2 baggage reclaim hall has an area of 2136 m² and is served by six reclaim carousels with total length of 858 m.

The capacity of the baggage reclaim belts is estimated to start becoming slightly constrained by 2025 but only becomes appreciably constrained by 2050.

Crowding in the baggage reclaim hall beyond the IATA optimum level is likely to become a constraint by 2025 and become severe, except in the lowest growth scenario by 2035.

Fig. 49. Future requirements for Terminal 2 baggage reclaim

Year	Length of carousel needed (current frontage is 858m)	Hall area needed (m²) (1977m² currently available)
2020	858	2174 to 2271
2025	858 to 885	2282 to 2469
2030	876 to 909	2402 to 2641
2035	896 to 938	2545 to 2855
2040	913 to 968	2672 to 3071
2045	932 to 1000	2810 to 3307
2050	953 to 1037	2960 to 3572

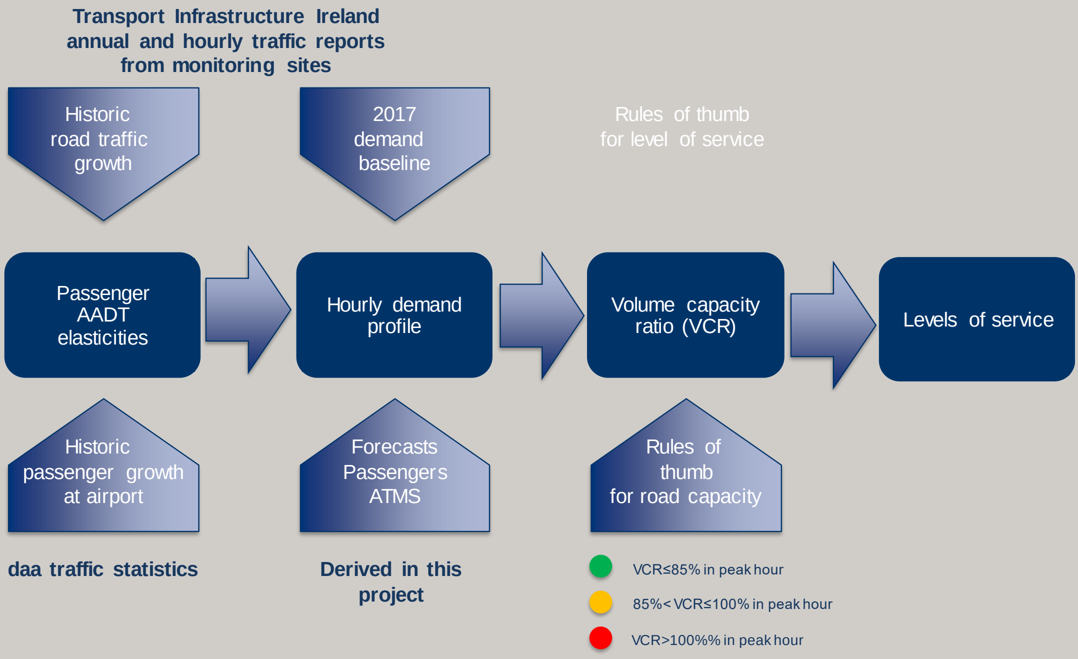
Source: Taylor Airey analysis

3.2.4 Road access

METHODOLOGY FOR ASSESSING CURRENT ROAD CAPACITY

To analyse the current capacity of the main roads used to access Dublin Airport we have used a process which is very similar to that for the potential airport capacity pinch-points (see Fig. 50).

Fig. 50. Methodology for road capacity analysis



We have derived a profile of current hourly demand using data collected at traffic monitoring sites around the Airport available from Transport Infrastructure Ireland. Strong correlations have been drawn between historical passenger growth at the airport and road traffic growth with a typical elasticity of 0.5, i.e. for every 1 percent growth in air traffic there is a corresponding growth of 0.5 percent in road traffic. However, these correlations do not imply a causal relationship; it is more likely that both growth rates are driven by the same underlying factors, principally economic growth.

This demand profile is combined with road capacity figures derived from:

- recent daa simulations[41] on road capacity around the airport; and
- standard capacities per lane by road type published by US, Australian and UK road authorities.

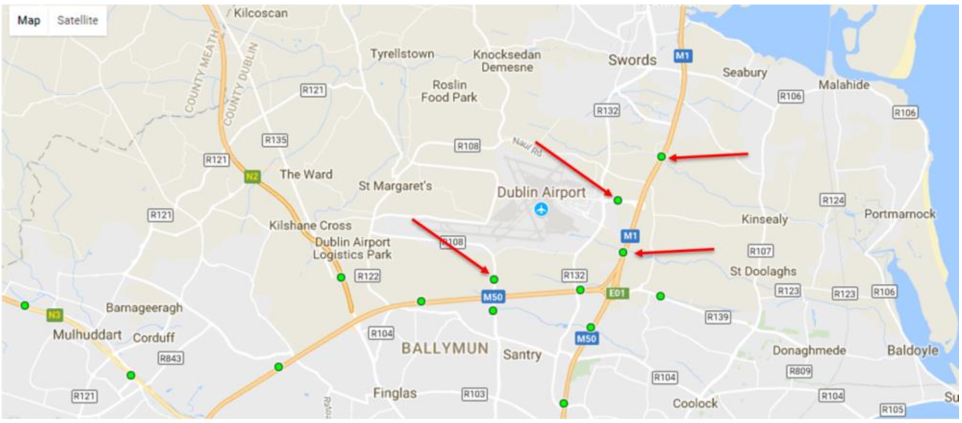
Demand and capacity figures are combined to give a volume capacity ratio (VCR). Simple rules of thumb have been applied to the VCR such that if the VCR is lower than 85 percent in the peak hour the road has ample capacity; if the VCR is between 85 percent and 100 percent in the peak hour the level of service is adequate and the infrastructure is being used efficiently as long as the traffic is flowing freely; and if the VCR is greater than 100 percent the road has reached capacity.

[41] Presentation by daa to Engineers Ireland Roads and Transportation Society, 21 September 2016

In addition to VCR, speed data are important to assess the level of service provided by the road. The availability of speed data is limited, and it has only been possible to undertake spot analysis on current speed performance using publicly available Google Traffic data.

The capacity of the road system around Dublin Airport has been assessed at the four monitoring points shown in the following figure.

Fig. 51. Road monitoring points for capacity assessment



Source: Transport Infrastructure Ireland

Measurement sites

Traffic flows investigated at these points

The figure below shows the summary of the VCR assessment at these four monitoring points for traffic travelling in both directions at peak times.

Fig. 52. Current road traffic volume summary

Road	Peak hour VCR	Assessment
Airport link road in eastbound direction, evening peak	0.63	Green
Airport link road in westbound direction, morning peak	0.69	Green
M1 north of Airport Link road, northbound direction, evening peak	1.19	Red
M1 north of Airport Link road, south bound direction, evening peak	1.09	Red
M1 south of Airport Link road, northbound direction, evening peak	0.93	Amber
M1 south of Airport Link road, south bound direction, evening peak	0.88	Amber
R108 north of M50 junction, northbound, morning peak	0.76	Green
R108 north of M50 junction, southbound, morning peak	0.74	Green

Source: Taylor Airey analysis

The figure shows that from a VCR perspective, the M1 has already reached saturation at peak times both north and south of the airport junction.

The following two figures use Google Traffic for Monday morning and Friday evening, as peak times, to illustrate the typical speed of traffic flows around the Airport.

Fig. 53. Typical road traffic speeds around Dublin airport, Monday morning, spring 2018

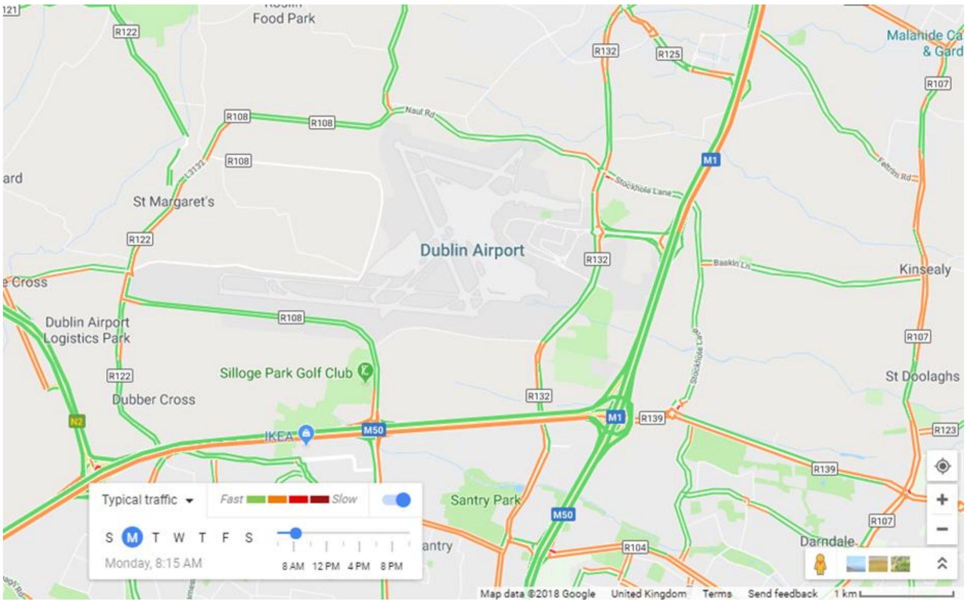
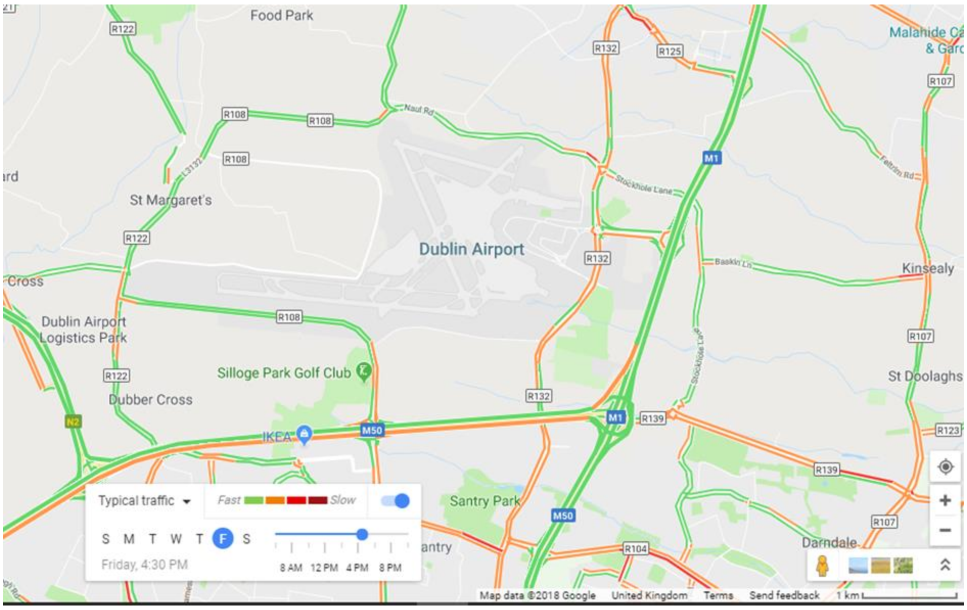


Fig. 54. Typical road traffic speeds around Dublin Airport, Friday evening, spring 2018



Combined with the VCR data, the figures indicate:

- In the morning peak, the Airport Link Road is flowing freely with low VCR but in the evening peak even through the VCR is low traffic is moving more slowly west towards the Airport even though the peak flow is in the other direction at this time. This implies that the cause of the slow-moving traffic is something other than the volume on the Airport Link Road.
- On the M1 north of the airport during the morning peak the southbound traffic is moving more slowly than free flow and the VCR is high, implying the road is becoming saturated. However, south of the Airport for the morning peak southbound traffic the traffic speed is higher, and the VCR is lower indicating that there is sufficient capacity at present.
- For northerly flows on the M1 in the evening peak, south of the Airport the VCR is 98 percent and the traffic is flowing freely (after slow movement at the M50-M1 junction) implying efficient use of the road. Further north, the VCR has increased to over 100 percent but the traffic appears free flowing indicating efficient use of the infrastructure.
- On the R108 traffic is slow northbound in the morning and southbound in the evening even though the VCR is relatively low. This implies that the road has reached saturation.
- Although there are no traffic monitoring data to assess volumes, the speed data indicates that traffic is slow on the R132 in both directions at peak times and all the way back to the Airport Roundabout in the evening peak.

This analysis indicates that the roads around the Airport can be very busy at peak times and that the M1 and R108 are reaching saturation. Traffic on the Airport Link Road can be slow moving at peak times, but this does not appear to be associated with volume on the road itself.

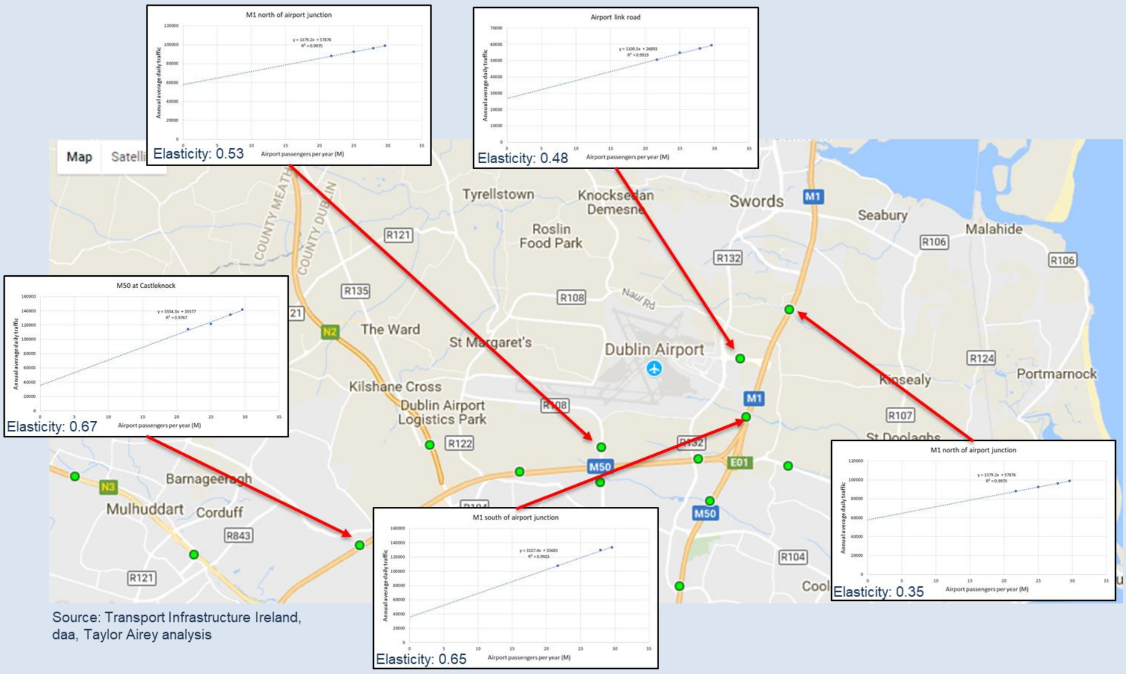
However, the analysis is focused on congestion impacts at spot points and speed analysis has been limited because of the lack of data. It is recommended that detailed simulation work is undertaken to understand fully the impact of traffic growth on the roads serving the airport, considering both traffic volume and speed as well as journey times to and from the Airport.

INDICATIVE ASSESSMENT OF FUTURE ROAD CAPACITY

A complication with assessing road capacity utilisation during the forecast period is that the forecasts produced for the project focus on the number of passengers and aircraft using the airport, and not on the number of vehicles using the surrounding roads. The latter will be influenced by a range of factors, over-and-above the number of airport users, particularly population and employment growth in surrounding areas, and people's travel preferences. There are also a range of demand and capacity management options available to address congestion, while changes in travellers' preferences for different modes of travel could also play a role. A detailed traffic forecasting study would be required to properly assess all of these factors, which is beyond the scope of the current exercise.

Nonetheless, Taylor Airey has been able to make an **indicative** assessment by looking at the relationship between passenger growth at the airport and traffic volumes at a series of monitoring points on nearby roads provided by Transport Infrastructure Ireland. This suggests there has been a strong positive association between growth in annual average daily traffic (AADT) and airport passengers during the last few years, although this does not imply any causal relationship. The relationship may be more likely observed because both airport traffic and road traffic have the same principal driver, for example economic growth. However, based on these tentative relationships it is possible to derive indicative estimates of how road traffic might grow in parallel to passenger growth in future, under the simplifying assumption that the relationship between passenger and road traffic growth in future is similar to that observed over the last few years.

Fig. 55. Correlations between road and airport traffic



Source: Transport Infrastructure Ireland, daa, Taylor Airey analysis

Taylor Airey used the observed relationships between passengers and traffic to project forward an hourly demand profile for road use around the airport. The findings are presented in Fig. 56, below. Although the elasticities are used to project road traffic in terms of vehicle volume, it should be noted that there will be corresponding increases in demand for bus transport not captured in this analysis. The potential impact of planned public transport enhancements, such as the Metrolink and BusConnects projects are also not factored into the analysis. Furthermore, the analysis cannot capture the impacts of the future road strategy that could, for example, involve the introduction of demand management measures. A detailed transport modelling exercise would be need to assess the impact of these factors.

Fig. 56. Indicative future road traffic volume summary

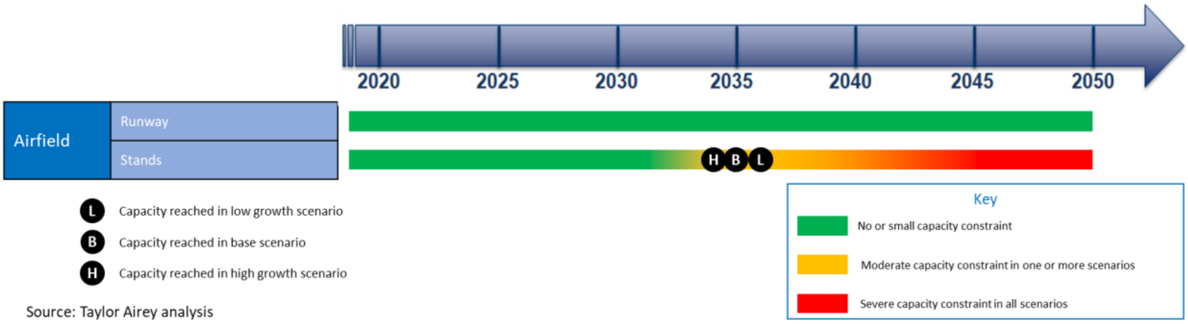
In light of the limitations highlighted above, the large number of factors which drive road traffic growth, and the range of potential policy responses to manage the impacts of growth, we recommend that a separate, comprehensive study should be undertaken to analyse future traffic levels on the roads surrounding Dublin Airport. This should be based on a sophisticated traffic modelling exercise which is able to capture the full range of influencing factors, not only the impact of the airport. In addition to the traffic volume to capacity ratio, such a study should also investigate other important indicators of performance, such as speed and end-to-end journey times.

3.3 CORK AIRPORT

3.3.1 Airfield

Fig. 57 below summarises the capacity of Cork Airport's main runway and 16 stands for use by commercial aircraft to meet forecast demand. The graded scales from green through orange to red illustrate qualitatively the severity of capacity constraint. The figure also indicates the approximate time that capacity becomes constrained in each of the growth scenarios defined as the point in time which the 95th percentile of demand is 10 percent greater than the capacity.

Fig. 57. Cork Airport airfield capacity summary



Source: Taylor Airey analysis

Cork Airport has sufficient runway capacity to meet demand up to 2050 and beyond. However, in terms of simple numbers of movements stands will start to become short by around 2030. Stand capacity constraints occur in the early morning for the first departure wave and in the late evening as overnighting aircraft return. Depending on the mix of traffic—regional, narrow body and wide-body aircraft—there may be pressure on stand capacity before this as not all stands are suitable for use by all aircraft. The following table illustrates the number of stands that will be required to meet demand on volume terms up to 2050.

Fig. 58. Future requirements for stands at Cork Airport

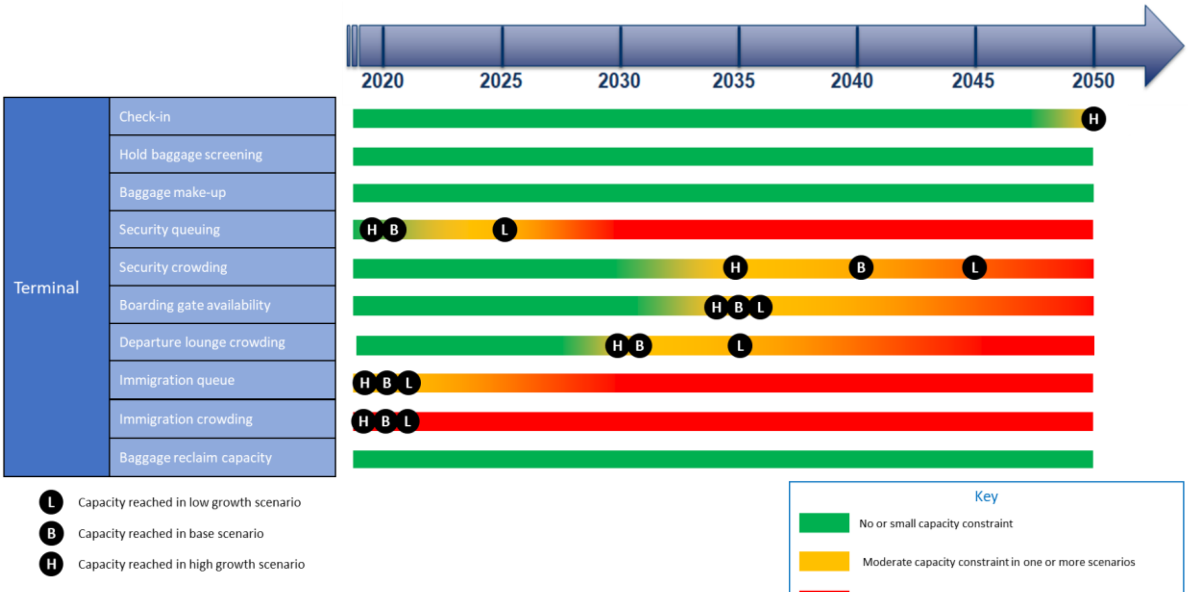
Year	Number of stands needed (16 currently available)
2020	16
2025	16 to 17
2030	17
2035	18 to 19
2040	18 to 20
2045	19 to 22
2050	20 to 22

Source: Taylor Airey analysis

3.3.2 Terminal

The figure below summarises the capacity of the key passenger processing elements of Cork Airport's terminal to meet projected demand to 2050. The graded scales from green through orange to red illustrate qualitatively the severity of capacity constraint. The figure also indicates the approximate year that capacity becomes constrained in each of the growth scenarios defined as the point in time which the 95th percentile of demand is 10 percent greater than the capacity.

Fig. 59. Cork Airport terminal capacity summary



Source: Taylor Airey analysis

Check-in

Cork Airport currently has 28 check-in desks for check-in and/or bag drop. This is sufficient to meet projected demand in all growth scenarios to 2050, except for the high (upside) growth scenario where check-in capacity will start to become tight in 2050.

Outbound baggage system

Cork Airport's outbound baggage system connects the check-in desks via two standard 2 hold baggage screening (HBS) machines to a make-up area with carousels of total length of 196m. There is a separate out-of-gauge facility. The standard 2 HBS machines will need upgrading to standard 3 capability by 2020. The standard 3 machines are larger and heavier than the standard 2 machines and will likely require some extension of the baggage hall to accommodate them.

However, in terms of throughput the capacity of the outbound baggage system is adequate to meet demand to 2050.

Passenger security screening

The principal capacity constraint on Cork Airport's passenger security screening infrastructure is the five-manual return (conventional) x-ray lanes. The passenger queuing area is approximately 297m².

In terms of queuing to a 10-minute standard, capacity is likely to become constrained in the high growth (upside) scenario by 2020 and in all growth scenarios by 2030. There is sufficient queuing space to achieve the IATA optimum standard to between 2030 and 2035.

The following table illustrates the future requirements for the Cork Airport passenger security screening system using the existing infrastructure.

Fig. 60. Future requirements for Cork Airport passenger security screening

Year	Number of x-ray lanes needed (5 currently available)	Queuing area needed (m²) (297m² currently available)
2020	5 to 6	297
2025	6	297
2030	6 to 7	297 to 311
2035	7 to 8	297 to 343
2040	7 to 9	320 to 376
2045	8 to 9	339 to 411
2050	8 to 10	360 to 450

Source: Taylor Airey analysis

Use of an automatic tray return system (ATRS) would increase the capacity of Cork Airport's passenger security screening facility. However, current space constraints prevent the implementation of this this type of system. These space constraints will need to be overcome to provide adequate queuing area around 2035. This will require structural alterations to the building, either through a cantilevered floor extension or a building extension.

Boarding gates

Cork Airport currently has eight boarding gates. There appears to sufficient boarding gates to meet demand up to between 2030 and 2035 when additional gates will be needed.

Passengers waiting to board aircraft wait in the lounge area, which excluding the space taken up by food and beverage outlets has an accessible area of 1690m². This space is adequate to the IATA optimum crowding level for passenger demand up to around 2030. The following table summarises the boarding gate requirements to 2050.

Fig. 61. Future requirements for Cork Airport boarding facilities

Year	No of boarding gates needed (8 currently available)	Waiting area needed (m^2) ($1690m^2$ currently available)
2020	8	1690
2025	8	1690 to 1782
2030	8	1753 to 1948
2035	9	1890 to 2151
2040	9 to 10	2004 to 2345
2045	9 to 10	2127 to 2575
2050	10 to 11	2256 to 2817

Source: Taylor Airey analysis

Immigration

Cork Airport current has four manual passport control desks occupying an immigration hall with $119m^2$ queuing space which can overspill into a corridor providing $515m^2$ queuing space. The immigration facility will be at capacity and require expansion from 2020 onwards. The following table highlights the future requirements for Cork Airport immigration facilities.

Fig. 62. Future requirements for Cork Airport immigration facilities

Year	No of passport desks needed (4 currently available)	Waiting area needed (m^2) (119m2 currently available)
2020	5	179 to 189
2025	5	193 to 211
2030	5 to 6	204 to 231
2035	6 to 7	244 to 255
2040	6 to 7	237 to 279
2045	6 to 8	254 to 305
2050	7 to 9	267 to 334

Source: Taylor Airey analysis

Baggage reclaim

The baggage reclaim facility at Cork Airport comprises three carousels with a combined length of 180m. There is sufficient capacity to meet demand through to 2050.

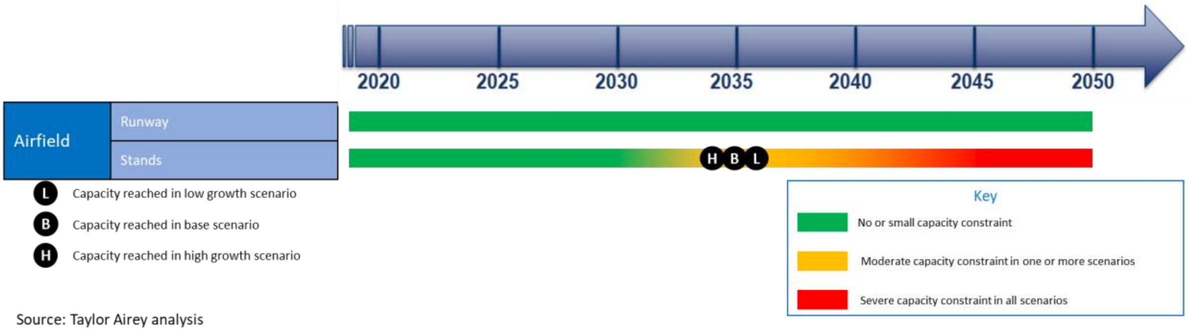
3.4 SHANNON AIRPORT

3.4.1 Airfield

The figure below summarises the capacity of Shannon Airport's runway to meet projected demand. The figure also illustrates the capability of the existing aircraft parking stands to meet demand. Shannon Airport has between 17 and 25 aircraft parking stands, depending on the mix of aircraft present. Of these, six are pier-served passengers stands, five are walk-on passenger stands and three are cargo stands. For this capacity analysis, 14 commercial stands are used as the baseline for the assessment.

The graded scales from green through orange to red illustrate qualitatively the severity of capacity constraint. The figure also indicates the approximate time that capacity becomes constrained in each of the growth scenarios defined as the point in time which the 95th percentile of demand is 10 percent greater than the capacity.

Fig. 63. Shannon Airport airfield capacity summary



Source: Taylor Airey analysis

Shannon Airport has sufficient runway capacity to meet demand up to 2050 and beyond.

Stand capacity is likely to become short between 2030 and 2035. Stand capacity constraints occur principally in the early and late morning. In the early morning, the capacity is used by the arrival of freighter aircraft between 05:00 and 06:30 combined with arrivals from the US. The late morning peak in stand utilisation is driven by the arrival of passenger aircraft from Europe between 10:30 and 11:30. The following table illustrates the future capacity requirements for commercial aircraft parking stands at Shannon Airport.

Fig. 64. Future requirements for stands at Shannon Airport

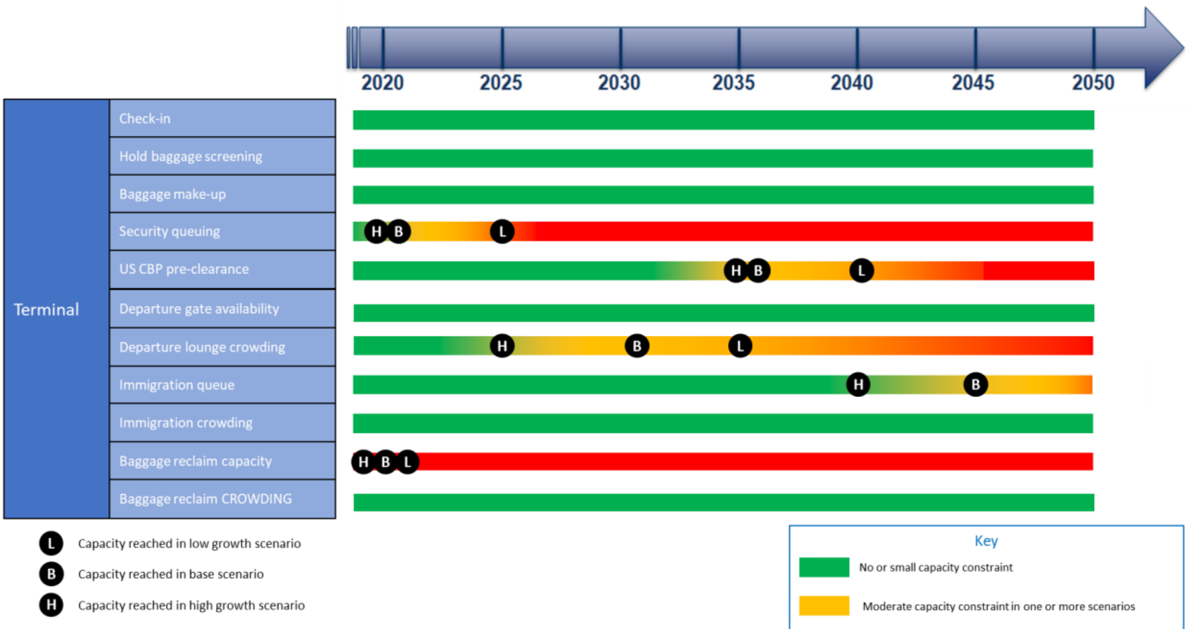
Year	Number of stands needed (14 currently available)
2020	15
2025	16
2030	16 to 18
2035	18 to 20
2040	19 to 22
2045	20 to 24
2050	22 to 26

Source: Taylor Airey analysis

3.4.2 Terminal

The figure below summarises the capacity of the key passenger processing elements of Shannon Airport's terminal to meet projected demand to 2050. The graded scales from green through orange to red illustrate qualitatively the severity of capacity constraint. The figure also indicates the approximate time that capacity becomes constrained in each of the growth scenarios defined as the point in time which the 95th percentile of demand is 10 percent greater than the capacity.

Fig. 65. Shannon Airport terminal capacity summary



Source: Taylor Airey analysis

Check-in

Shannon Airport's check-in hall has an area of 2885 m^2 and contains 41 manual check-in/bag drop desks and eight self-service kiosks. There is sufficient capacity to meet forecast demand to 2050.

Outbound baggage system

Shannon Airport's outbound baggage system connects the check-in desks to two make-up carousels, of combined length of 115m, via two standard 2 hold baggage screening (HBS) machines. There is also an out-of-gauge baggage belt that is served by an additional HBS machine that also serves for Level 3 screening. There are seven radiation scanners for US CBP pre-clearance scanning.

The capacity of the HBS machines and the baggage make-up carousels is sufficient to meet forecast demand to 2050.

Passenger security screening

At Shannon Airport the passenger security screening facility is compliant with both EU and US requirements so serves as the primary screening facility and also for US CBP pre-clearance. The facilities at central search comprise four archway metal detectors, five conventional manual return x-ray machines and four security scanners. The five x-ray lanes are the main constraint on queue throughput, with capacity constraints starting to become apparent by 2020. The following table illustrates the additional number of x-ray lanes that will be needed to meet demand to 2050.

Fig. 66. Future requirements for passenger security screening at Shannon Airport

Year	Number of x-ray lanes needed (5 currently available)
2020	5 to 6
2025	6
2030	6 to 7
2035	7 to 8
2040	7 to 9
2045	8 to 9
2050	8 to 10

Source: Taylor Airey analysis

Space in the hall used for passenger security screening is likely to be a constraint to adding additional x-ray lanes and may be already be causing capacity constraints from a crowding perspective.

US CBP pre-clearance

Shannon Airport provides a US pre-clearance service to commercial, technical transit and general aviation traffic. It is the only European airport to offer full pre-clearance services to private traffic. Commercial and general aviation passengers are subject to the same screening process.

The approach taken to passenger pre-clearance, be it commercial or general aviation, at Shannon Airport is slightly different to that applied at Dublin. At Shannon security screening is carried out at the same time as normal passenger security screening, so passengers do not have to queue twice for security screening. This requires specially designed and certified screening equipment to meet both EU and US regulations. A further difference is that there are no automated passport check machines at Shannon and all checks are performed manually at 12 CBP desks. Based on current processes (i.e. not making any assumption concerning the take-up of facial recognition software which is currently being trialled), capacity is dependent on the mix of passengers using the facility. Assuming 25 percent US and 75 percent non-US passengers, the pre-clearance facility has sufficient capacity to meet demand to around 2030. Subsequently additional lanes would need to be added as indicated in the table below. Alternatively, the process could make use of automation to increase the passenger flow.

Fig. 67. Future requirements for US CBP pre-clearance screening at Shannon Airport

Year	Number of CBP desks needed (12 currently available)
2020	12
2025	12
2030	12 to 13
2035	13 to 14
2040	13 to 15
2045	14 to 17
2050	15 to 19

Source: Taylor Airey analysis

Departure gates and lounge

The analysis is based on the situation at Shannon Airport in February 2018 when there were 14 departure gates used by passengers use to access aircraft, either directly through a jetty or by walking to the aircraft parking stand. This is a sufficient number of gates to serve the demand for passenger air transport movements through to 2050.

The gates are accessed via the departure lounge which has an area of 1620 m^2, excluding food and beverage areas, which contribute a further 650 m^2 area. The size of this departure lounge is sufficient to meet forecast demand to around 2025 to the IATA optimum level of service applicable to crowding. Thereafter additional floor space will be required to maintain the IATA optimum crowding level. The following table illustrates the floor space required to 2050 to provide this level of service. The requirement for extra space is driven by the relatively short, peak period at the airport in the middle of the day, from around 12:00 to 14:00, mainly in June, July and August.

Fig. 68. Future requirements for departure lounge floor space

Year	Area required (currently 1620 m^2 excluding F&B)
2020	1,620
2025	1620 to 1734
2030	1699 to 1889
2035	1838 to 2097
2040	1965 to 2321
2045	2083 to 2565
2050	2283 to 2842

Source: Taylor Airey analysis

Immigration

The Shannon Airport immigration hall has an area of 415 m^2 and contains six manual passport verification desks. Based on the assumption that the inbound passenger traffic is 25 percent US and 75 percent European, optimally staffed these desks will provide sufficient capacity to around 2040 or 2045. The queuing area is sufficient to support forecast demand to 2050. The following table illustrates the number of passport verification desks that will be needed to support forecast demand to 2050.

Fig. 69. Future requirements for passport verification desks at Shannon Airport

Year	Number of passport desks needed (6 currently available)
2020	6
2025	6
2030	6
2035	6
2040	6 to 7
2045	6 to 7
2050	6 to 8

Source: Taylor Airey analysis

Baggage reclaim

Shannon Airport's baggage reclaim hall occupies an area of 1950 m^2 and has four reclaim belts, each of length 17.5 m. From a crowding perspective, the hall is sufficiently large to support forecast passenger demand to 2050. However, the capacity of the reclaim belts will likely be exceeded by 2020. The following table illustrates the total carousel length needed to support forecast demand through to 2050.

Fig. 70. Future requirements for baggage reclaim carousels at Shannon Airport

Year	Total carousel length needed (current length 70m)	Number of 17.5m carousels (currently 4)
2020	88 to 90	6
2025	90 to 93	6
2030	93 to 96	6
2035	95 to 100	6
2040	97 to 104	6
2045	100 to 108	6 to 7
2050	103 to 114	6 to 7

Source: Taylor Airey analysis

VOLUME 2

DUBLIN AIRPORT DEVELOPMENT AND FINANCIAL AND REGULATORY FRAMEWORK

4. INTRODUCTION TO VOLUME 2

In Volume 1, we presented Oxford Economics' forecasts of the demand for air travel under alternative scenarios (Chapter 2). We also introduced findings in relation to the capacity of each airport and used the demand forecasts to identify the priorities for and timing of capacity enhancements (Chapter 3).

The forecasts in Volume 1 drive the analysis in Volume 2 and are taken as an input. Should actual demand vary significantly from the forecast—particularly in later years—the recommendations would need to be revisited.

In this Volume we focus on Dublin Airport, and address the third and fourth objectives in the project ToRs:

(3) In the case of Dublin Airport only, the study should set out a reasoned recommendation for (1) the timeframe for the development of new terminal capacity – Terminal 3; (2) the options in terms of appropriate size and design; and (3) the optimum location. The study should have regard to the need to promote effective use of the runways and ensure that the airport as a whole can respond to the needs of users—notably airlines.

(4) In the case of Dublin Airport only, the study should (1) assess the relative advantages and disadvantages of the funding and operation of Terminal 3 by the existing airport operator in comparison with being operated on an independent basis, (2) set out proposals for any transitional arrangements which might be necessary to avoid stranded assets/labour costs where a new terminal is operated independently, and (3) outline the implications of, and proposals for, an appropriate legislative and regulatory framework to ensure fair competition between the existing terminals and Terminal 3.

The remainder of this Volume is set out as follows:

- Chapter 5 sets out high-level options for developing Dublin Airport, based on both making the best use of existing infrastructure and potentially constructing a new terminal.
- Chapter 6 assess the potential financial and regulatory frameworks for a third terminal at Dublin Airport with detail on the financial model presented in Appendix 3: Financial model.

5. DUBLIN AIRPORT DEVELOPMENT

AUTHOR: CEPA

KEY FINDINGS

Timeframe for the development of Terminal 3

We consider the timeframe for development of a new terminal, and the case for either avoiding expansion or instead incrementally expanding the existing terminals. There are two distinct questions: **when, if at all, is a third terminal required**, and **when can it be afforded?**

Expansion can be avoided by accepting constraints on operations at the airport, managed through formal scheduling, i.e. offering airlines a different time from what they request. Whether airlines would accept the effect on charges of an increase in capacity that would relieve such constraints is a regulatory matter. The Commission for Aviation Regulation (CAR) recently made an interim decision to allow charges to rise to enable some relief of constraints.[42]

daa has presented options for expanding the existing terminals, first to 40 million and later to 55 million capacity, rather than building a third terminal. The 55 million capacity layout includes a large satellite building west of the crosswind runway.

Our findings on **when, if at all, a third terminal is required** are:

- Some incremental expansion is likely to be desirable in the short term, because a third terminal will not be available in time to relieve the short-term issues in the airport.
- Some material expansion of T1 and T2, certainly to 40 million, is very plausible, setting aside issues of surface access and choice[43] for airlines.
- The timing around a third terminal decision needs to take into account any measures to remodel T1 and T2 beyond approximately 40 mppa. Works at that level are likely to be very disruptive, so if a third terminal is to be built, a decision would be required at the latest in time to avoid the commencement of large scale remodelling of the existing terminals. On Oxford Economics' central forecast, that means by about 2031, which would require a decision on a third terminal early in the 2020s. But actual demand levels and prospects should be monitored to check if the timing might change.
- Surface access issues in the wider road network may make it overall a better solution for Ireland to pursue a third terminal in the western part of the airport rather than allowing much further expansion in the eastern campus. Developing the wider road system to handle traffic generated by different terminal strategies might have substantially different costs, and thus might justify spending more on a terminal layout that reduces wider costs. Detailed study outside of the scope of the present project is required to assess this.
- The government should make an early strategic decision on whether the crosswind runway should be retained. This substantially affects the available development options and their cost and relative advantages.

[42] Commission for Aviation Regulation, *Decision on the Second Interim Review of the 2014 Determination in relation to a Supplementary Capital Expenditure Allowance for Dublin Airport*, Commission Paper 9/2018, 13 June 2018

[43] When we refer to choice it means choice for airlines, as passengers inherit the airlines choice.

To assess **when a third terminal can be afforded**, we built an illustrative financial model to assess whether a third terminal should be phased, and on what timescale it can be afforded, assuming a third terminal is the chosen response to medium- to long-term capacity requirements. The assessment is based upon the traffic forecasts in Volume One (Chapter 2), and a base cost for the terminal similar to T2.

Our findings on when a third terminal can be afforded are:

- **The financial modelling suggests that the growing demand at the airport is sufficient to fund a new terminal, extended in stages, relatively shortly** (with some confirmation from the willingness of external investors to enter).
- On these assumptions, airport charges do not go above about five percent higher than 2016 charges to pay for such a terminal, including the new runway. If it can be developed at this cost, there appears to be no strong reason to delay development on grounds of affordability.
- Our main concerns would be the risk in the demand forecasts, and a materially more expensive terminal, which can disturb these conclusions. Phasing the terminal would appear to be a wise method of responding to such risk.

Design considerations of a new Terminal 3

The question as to whether DTTAS should direct the form of the terminal (e.g. low-cost vs. full service) requires careful consideration. Points it should note include:

- If the government has any specific requirements for its main "front door to the world", it will need to find a way of ensuring those requirements are observed.
- In our view, airline (not airport) strategy is the greater determinant of whether a country attracts the air traffic consistent with its connectivity aspirations—airports can act as impediments but have limited ability to encourage airlines to develop the links the country may desire.
- daa already actively manages its estate to offer the different airlines the style of service they require, so long as capacity permits.
- An independent terminal supplier would aim to maximise choice to airlines if it can select its own terminal style in response to market demand.
- The risk of an unbalanced overall airport offer seems low, because a new terminal expansion, of whatever kind, will lead to spare capacity, at least for a time, that will likely be modelled best to attract airlines, whoever owns it.

Thus we do not find that the government would obtain advantage in directing an independent terminal provider or DTTAS to specify a terminal to serve a specific market. But a terminal operator might choose to serve particular market, or a terminal concession may be configured to serve a particular market

Size and location of a new Terminal 3

We find that a new terminal which can be built in phases to ultimately serve 20 million passengers per year would be an appropriate response to the requirements of the airport, given that we expect some modest incremental expansion in T1 and T2 to tide the airport over to completion of a new terminal. Such a terminal could be specified at about 60,000 m2.

We consider three possible locations for such a terminal, and our findings on these options are as follows.

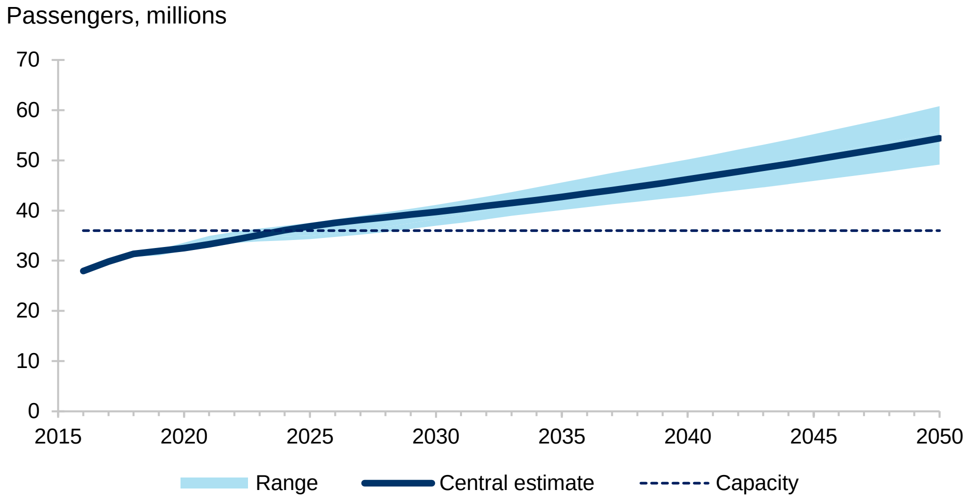
- **Location 1: North-East of T1, currently occupied by Maintenance, Repair and Overall (MRO) facilities**—a constrained site requiring a smartly designed terminal likely more suited to the requirements of low cost airlines. It would be straightforward to integrate with the rest of the airport but stand location becomes a complication as traffic grows. Surface access issues may present an overriding problem and require further detailed assessment.
- **Location 2: North-West of T1**—a site which is also straightforward to integrate with the rest of the airport but does not make an overall addition to stand capacity without the closure of the crosswind runway. Also, as in location 1, surface access issues may present an overriding problem and require further detailed assessment. Additionally, it has the complexity of taking account of the listed infrastructure in the area.
- **Location 3: West of the crosswind runway between the Northern and Southern runways**—an unconstrained site where it will be easier, cheaper and less complicated to develop the core terminal and stands, assuming land is made available. It will have material additional costs to develop a passenger transport solution to integrate with the airport, and to build roads for surface access. These additional costs would be reduced if the crosswind runway is closed. But there would be other, perhaps less obvious, costs in losing the crosswind runway.

This chapter focuses on options for developing Dublin Airport to address the practical consequences and implications of the future capacity requirements analysis as set out in Chapter 3. It is clear from Fig. 71 below, showing forecast demand against the capacity, that additional capacity will be required at Dublin Airport in the near future, therefore this section sets out:

- the timeframe for the development of new capacity, including a potential T3;
- the options in terms of appropriate design and size for any T3; and
- the optimum location for any T3.

The following sub-sections address these areas in turn.

Fig. 71. Passenger demand forecasts, and when T1/2 capacity is reached[44]



Source: Oxford Economics

5.1 TIMEFRAME FOR THE DEVELOPMENT OF NEW CAPACITY

This section discusses the timeframe for the development of new terminal capacity at Dublin Airport, to best enable the Airport to take advantage of the potential demand growth as set out in the forecasts in Volume 1. We consider the extent to which required additional capacity can be provided through changes to, or expansion of, the existing terminals. We also consider at which point a third terminal (T3) becomes a viable best option for providing required additional capacity, and how construction of any T3 could be phased.

Fig. 71 sets out the range of the forecasts for passenger demand in Dublin Airport developed in Volume 1 of this report. Because of the inevitable uncertainty in these types of calculations, Volume 1 of the report showed a range of forecasts. It should be understood that in practice the outcome may lie outside the range shown. For example, the development of demand at Dublin Airport lay well below the range of demand forecasts published in official documents prior to the financial crisis, and recently demand has been well above the range of demand forecasts published in official documents around five years ago.

Bearing in mind the difficulties of any such forecasts, in the above diagram we use the range of forecasts in Volume 1 to illustrate how much time it may take for demand to exceed the "nameplate" capacity limit of the airport of 36 million passengers per year. Taking that number as given, for now, new capacity would be required by 2023 (under the high demand forecast) or by as late as

[44] Capacity here refers to the "nameplate" stated 36m capacity for T1 and T2 (see further discussion below), which would require adjustments to the current planning permission. T2 planning permission includes a capacity restriction of 32m, due to surface access limits. It is reasonable to expect this restriction to be relaxed in certain circumstances – we therefore use a figure from the high end of the daa's capacity range. CAR and daa are currently investigating short-term options to release additional capacity.

2029 under the low demand forecast. This may require that planning and preliminary design work begins now.

We use 36 million, as this is the "nameplate" capacity of the airport from when the T2 expansion was designed.[45] Airport capacity is a conceptual idea, rather than a firm number, but we need some kind of a benchmark. As is usual practice, the terminals were not fully fitted out to deliver this nameplate capacity when T2 initially opened and T1 was remodelled to some degree at that time. In practice, fitting out the terminals to take advantage of the potential capacity is now bound up with the PACE programme, which takes into account, at least to some degree, the specific requirements of the airlines currently using the airport and the nature of their businesses. There is also some potential for expanding the capacity of the terminals beyond their original nameplate capacity. So, in practice matters may be less urgent than this 2023-2029 range suggest. PACE, assuming other issues are resolved, can increase capacity to 40 million, which under the central scenario above would not be exceeded until 2031.

A separate issue is the fact that there is a planning limit of 32 million which has been imposed on the airport because of concern about surface access conditions. [Redacted].[46] We have no power to predict what the planning authorities may decide, and what may be the result of traffic planning studies currently being carried out by local authorities which take into account both the airport and wider traffic issues. It seems plausible to expect some degree of relaxation of the current planning restriction on the airport, but what the strategy will be for the longer term and what implication that has for airport planning is not currently possible to say. It will be very important for decisions on the future planning of the airport to take account of these studies.

These forecasts are a crucial input to the decision over how to expand Dublin Airport in the coming years. With demand forecast to increase steadily over the next few decades, incremental increases to the capacity of existing terminals may be an inefficient choice given that a third terminal may be eventually required regardless, because, for example, of traffic considerations. Conversely, if there is less certainty over these forecasts, and if there is considerable concern that shocks may slow down—or reverse— predicted demand growth, then it may be harder to justify the capacity (and cost) of a new terminal.

Stakeholders have expressed reservations about introducing T3 in the near future, with concerns about a corresponding increase in airport charges. With a large percentage of Dublin's current traffic being low-cost carriers, if a new terminal were to lead to higher charges at T1/2, demand may be negatively affected. These concerns would be exacerbated by uncertainty surrounding the capacity forecasts.

Therefore, Section 5.1.1 discusses the following areas in turn:

[45] Source: DTTAS Review – Paper 2 – Dublin Airport – Existing Capacity (July 2017). Page 10. Mid-point of passenger departure kerb. Terminal 1 = 19.5 mppa and Terminal 2 = 16.5 mppa.
[46][Redacted]

- Options for making best use of the existing infrastructure, including changes that could enable higher capacity without physical expansion.
- Options for physical expansion of Dublin Airport that avoid a third terminal, such as expansion of T1 and/or T2.
- Options for phasing the introduction of any third terminal, to minimise forecast-related risks.

5.1.1 Options for making best use of existing infrastructure

We consider two ways in which the airport might proceed without material capacity expansion in the near future:

(1) Accept temporarily-binding capacity constraints, rather than increasing capacity.
(2) Make changes that would enable the terminal(s) to take more passengers without expansion, including peak-spreading and reorganisation of the terminal.

(1) Accepting temporarily binding capacity constraints. It is not unusual for airports to find themselves "full" on some relevant criterion. Every airport declared as "scheduled" has some period of time when a certain aspect of its operations— be it runway, terminal, or other bottleneck factor—is operating at its declared capacity. New requests for operations at those times cannot be accommodated. An airline may minimise the effect of this by moving their operation to another time of day, or another day in the week, or through a mutual rearrangement with another airline.

In some cases, capacity can be increased in relatively small increments and at relatively modest cost. But airports can ultimately exhaust this possibility and reach a point where only a larger investment can increase capacity. A new terminal, or terminal extension, are examples of that. At the point where smaller scale capacity enhancement is exhausted a trade-off exists between airlines' willingness to pay increased charges to fund investment, tolerating the inconvenience of "scheduling" the airport.

It may be practical, for either or both airport and customers, to delay making an investment, so that when it is made there is sufficient demand that the charges to airlines remain acceptable, and so that there is sufficient business at those charges to fund the investment. In the interim, airlines will have to accept some restrictions on their operation. The airport may make some interim arrangements to handle these restrictions but will wish to consider carefully the long-term value of such arrangements. If arrangements will only have a short period of value, they may not be justified, and again this is an issue to discuss with airlines.

Since there are in fact, as we see below, material opportunities for incremental expansion of the airport, the main argument for temporary constraints would be because a major expansion was taking place. This happened previously when T2 was being built, and for a number of years the conditions at the over-stretched airport were considered unacceptable. It is likely that the present airport would be better able to cope with such temporary pressure while a third terminal was in preparation, as relatively modest things can be done to relieve pressure, and not all of those reliefs would be insignificant following later expansion. However, if the present airport was extended, that may no longer be true.

(2) The existing airport could achieve a higher capacity through some logistical changes rather than a physical upgrade. Even in situations with apparently binding capacity constraints, some growth can be accommodated by a variety of techniques. For example:

- airlines can accept somewhat inferior schedules, and in effect spread the peak;
- airlines can do deals with other airlines to swap timings to try to reduce the impact of that on each other;
- the airport can provide increased capacity within existing facilities but at lower standards of service, such as longer queues or increased delays; and/or
- airlines can introduce larger aircraft, assuming the airport has sufficient processing capacity for the additional passengers.

There are also changes that can increase capacity by means other than replicating present capacity. For example:

- improvements to runway technology and airspace management can increase runway movements per hour;
- reducing the airside shopping areas, to create more space for passenger processing, thus reducing the impact of the increased number of passengers, but there would be a consequent loss of commercial revenue; and
- changes in terminal management methods and technology can increase terminal passenger throughput in a given space.

These are generally not costless changes and may affect the ambience of the airport or other aspects of customer service, but they can be cheaper than replicating elements of present capacity in the airport. So, especially when the constraints are for relatively short periods, there can be available workarounds that in practice mean capacity can be stretched to some degree. These help relieve the annoyance to airline customers while a more major capacity upgrade is considered or delivered. But as the airport fills up further, the situation can become more restrictive to airlines' business ambitions.

Ultimately it is for a debate between airlines, airport and regulator what such constraints would cost to relieve, and whether airlines collectively would be willing to pay. The airlines have already indicated to CAR their willingness to pay for a degree of expansion to the airport to relieve present constraints, and CAR has agreed to allow airport charges to be adjusted to pay for some expansion.

5.1.2 Physical expansion of Dublin Airport

If forecast demand growth is sufficiently high to require physical extension of Dublin Airport, there are two options:

(1) Extensions to existing capacity at T1/2.
(2) Introduction of a new terminal, T3.

While these options are not mutually exclusive, the decision to invest in one will affect the business case for investing in the other, and it is necessary to take a long-term view to consider which option should be pursued in the short/medium term.

In the following, we will set out the information and criteria relevant to a decision on the balance and timing of these two options. But the best outcome depends on a number of issues which are not yet knowable, including surface access issues which require detailed studies to assist, and which are currently being carried out by local authorities, and also how much disruption in practice would come from increasing capacity within the present terminals. Timing also depends upon the actual growth in demand, which in practice is subject to unknowable developments in the future. daa's PACE programme in principle gives some time to consider these issues, although it tends to assume that the present surface access planning limit will be relaxed to present no constraint on that.

More broadly, if demand is not expected to create enough additional capacity requirement to justify a new terminal, it may be prudent to instead expand T1 and/or T2 to cover expected additional capacity at a lower cost than a new terminal. Alternatively, this might be a way to provide additional capacity temporarily, while waiting to determine whether the strong growth will indeed continue for long enough to justify a new terminal. Expanding an existing terminal would likely result in a smaller capital cost (and therefore smaller increase in airport charges) as compared to building a new terminal. From many aspects, we find that this may be perfectly practical for medium term expansion.

It is important to consider whether short term costs for incremental expansion at T1/T2 would pose a long-term additional burden on customers and passengers should a T3 later become necessary. Assuming that the required expansion is large enough to justify considering a new terminal as an alternative to expanding existing terminals, there are then three key areas to consider in deciding whether capacity expansion is best delivered through T1/2 or a new terminal:

- Passenger processing capacity
- Number of stands, their location, and access to them
- Surface access

Passenger processing

In the short term, daa plans to make some extensions and adjustments to the present Terminals 1 and 2 to be able to process up to 40 million passengers per year. In materials provided to us, based on their master-planning process, they have indicated that achieving this requires an expansion to the total generalised floor area of T1 and T2 of around 80,000 m^2, which is in addition to the present 197,000 m^2, i.e. an increase of about 40 percent to the present generalised floor area. daa has made a distinction between the requirements of servicing low-cost airlines and full service airlines, indicating that the former have a more modest requirement. At the most simplistic level of analysis this seems to be a generously specified extension to achieve a 25 percent increase in capacity. It is not the place here to question this, and it is not necessarily the case that it is inappropriate– we can imagine a variety of reasons why this might be plausible, such are the potential complexities of making airport extensions.

The analysis in Chapter 3, looking at IATA's level C standards of service, indicated the nature of shortfalls of passenger processing capacity at 40 million passengers, but not in every service that we analysed, and the shortfalls are relatively modest. Without carrying out a full engineering/architectural analysis of the expansion proposal, on the face of this information and the analysis of the present level of service of the existing terminal, it seems plausible that this can be achieved and with relatively modest disruption.

In the longer term daa's plan is further to service 55 million passengers per year within Terminals 1 and 2. Their plan includes a large satellite building beyond the crosswind runway, where two extensive piers would service many gates and stands. A suitable passenger transfer system in a tunnel would be needed to connect the satellite to the terminals. It appears intended that the satellite is entirely airside: it lacks any external passenger entrance or exit, except via T1 and/or T2. In terms of providing all the passenger processing services, it is possible that some of that might be carried out in this satellite to relieve the pressure on T1 and T2. Some arrival processing, and pre-clearance, for example could be carried out here. daa indicate that the additional generalised floor area required for this extension is a further 40,000 m^2, beyond the previous mentioned extension.[47]

Overall daa prefer their two-terminal solution because they indicate it saves around 55,000 to 85,000 m^2 of generalised floor area, through avoiding duplication of services that would be required with a third terminal. The range in numbers is because they have two scenarios depending upon the disposition of full service to low cost[48] capacity.

It is not implausible that, in well-designed facilities, 55 million passengers per year can be processed within two terminals of approximately 315,000 m^2 generalised floor area, and to the required standards. So as a purely arithmetic exercise in floor area accounting, we cannot say this floor area is insufficient. For example, the present terminals are, due to their incremental evolution, oversized in several areas, and so their actual useful floor area is somewhat less than 197,000 m^2. So, in terms of useful floor area, the amount per passenger at 55 million within 315,000 m^2 is not obviously very different from

[47] There is a small inconsistency in the figures that daa gave us, such that the increment is not quite consistent with the total after adding the increment. In subsequent comments, we split the difference, give a rounded figure, and thus the numbers we quote may differ by up to 3,000 from the daa figures. This does not make any material difference to our judgment.

[48] We discuss what we mean by "low cost" later.

the present useful floor areas, if we imagine a reasonable deduction for the present inefficient layout.

But the plausibility of achieving the incremental evolution of air terminals cannot be reliably assessed simply by basic accounting of floor areas. Incrementally expanded terminals typically do not achieve the efficiency of a built-from-scratch purpose-designed facility. The present configuration of the airport with its inefficiently allocated space usage is perhaps an example of this.

The deeper issues are therefore:

- whether the available floor area can be sensibly arranged to obtain the desired levels of service and commercial opportunity required; and
- if they can be so rearranged, what would be the operational path to get there, how much disruption would that create, and would that be acceptable.

Another issue is around the crosswind runway. daa's preferred two-terminal solution retains the crosswind runway, but at the cost of excavating a tunnel under it containing a mass transport facility. If it was on balance acceptable to stakeholders to close the crosswind runway, this would offer much wider development opportunities for T1 and T2, and potentially therefore substantial cost savings in extending the airport. We would warn, however, that this may have consequences for the maintenance of the normal operation of the airport, both during and after construction. More detailed assessment would therefore be required to determine whether in practice it was a true saving or false economy.

Without detailed engineering and architectural studies, we are unable to assess these things. This therefore is a matter that we suggest should be subjected to some further study and public testing in a few years' time, if appropriate. It requires a proper engineering/architectural analysis of the changes that would need to be made to the existing buildings as well as an assessment of the operational impact of the works. Confirmation is needed that it does not compromise other aspects of the airport, such as sufficiently spacious departure lounges and retail experience to satisfy passengers and maximise income.

Stands and geographical access

The main requirements in expanding the airport is providing sufficient stand and gate capacity. For an airport of this size, there are few remaining economies of scale in stand usage. Stands are already insufficient. Thus, stands need to expand at least in proportion to the future level of operations of the airport, and to provide for the range of aircraft types likely to use the airport. Sufficient gates need to be provided to access the growing stand requirement. Some new stands can still be built east of the crosswind runway, and daa has a plan to do so. These can in principle be accessed with new or extended piers attached to the present terminals. In daa's plan, some of these stands will be remote stands, and in the short term a small remote satellite with bus connection is proposed. Further stands beyond this short-term plan, and piers to access them, can be built east of the crosswind runway if some other facilities were relocated.

At some point, as demand grows towards the 55 million point, capacity east of the crosswind runway becomes exhausted. To reach 55 million, a substantial number of stands must be built west of the crosswind runway and it will eventually be cheaper to do this than to continue trying to squeeze in every possible stand east of the crosswind runway. A substantial number of stands west of the crosswind runway will require substantial arrangements to provide access to those stands, as they will not be close to the present core of the airport. One option is a new terminal in that location. But daa's preferred solution, is a large satellite with suitable arrangements to move large numbers of passengers there. The appropriate nature of the transport link would be related to the character of the airlines using these stands, and any decision on keeping the crosswind runway, which most stakeholders favour.

We are unable to assess daa's satellite concept as part of this project. It is not inherently implausible but requires further demonstration. The concept of operations for the satellite need to be developed particularly the processing that is expected to take place in the satellite and access to it, not only for passengers and bags but also airport staff, aircrew, retail staff, goods in (duty free, food and beverage, etc) and waste away. Attention would need to be paid to meeting the requirements of US CBP pre-clearance, the operational process of building it, and any disruption to the present airport.

Surface access

A key issue as to whether in the medium term a third terminal is a better solution than incremental expansion is surface access. A western terminal presents options for genuinely additional surface access capacity, which might be cheaper for Ireland as a whole—noting that airports themselves tend not to fund expansion of the national road network—than expanding surface access at the eastern access. However, Heathrow Airport has said it has earmarked £1bn for works to the M25, which the third runway would cross, and a few minor roads.[49] It is beyond the scope of this study to assess this.

One might imagine a different solution with surface access to the west linking somehow to terminals in the east. One option would be an arrival area with minimal facilities to the west, and a passenger mass transit facility in a tunnel into eastern terminals. But any option with surface access to the west, assuming passengers leave their transport and enter the airport on the western side, is unlikely to be materially different from a western terminal, where more facilities are provided at that location, rather than in the more constrained areas to the east. So this option already addresses the main cost barrier of having a terminal in the west. It would likely be cheaper to develop it into a full terminal in the west, and so reduce the mass transit requirement.

Another option would be to have road tunnels built under the airport to allow road direct access from the west into the eastern campus. Whether this is a necessary or feasible solution to the surface access requirements of a growing airport on the eastern campus will have to be considered as one of the various

[49] The Guardian, October 2016. *Heathrow third runway: public bill up to £10bn hidden, says Tory MP*. https://www.theguardian.com/uk-news/2016/oct/26/heathrows-third-runway-public-bill-hidden-tory-mp-stephen-hammond-taxpayer-cost

road options for serving growth in the eastern campus in regional planning studies.

Currently there is a 32 million passengers planning limit on the airport. The road conditions within the Dublin Airport campus are more benign than previously anticipated at the present level of demand. But daa is constructing a business park in the campus that will increase road demand regardless of the airport throughput. Nevertheless the 32 million planning limit exists because it was anticipated that surface access would begin to become tight at this level of demand, not just on the airport, but more widely on the road system outside the airport. Conditions on the roads outside the airport are already challenging. If in fact it turns out that the present roads can cope with somewhat higher level of airport usage than previously anticipated, it does not alter the fact that access will become insufficient before very long if the airport, and other traffic generating developments in the vicinity continue to grow. The future Metrolink is not expected until 2027 at the earliest [Redacted]. DTTAS has informed us of the planned BusConnects scheme for improved bus services, with better services enabled by more bus priority measures. This may increase the convenience of accessing the airport by bus from a wider range of origins, and could therefore have some further impact on the use of cars to access the airport.

Fingal County Council is currently carrying out local area planning studies that include traffic planning for the Dublin Airport area. Without these studies, some judgment on the balance of advantage between expanding surface access into the eastern campus, or creating a new access to the west, and the additional costs of providing a second front door to the airport to the west, is not yet tested. It is possible that surface access considerations might ultimately drive a requirement for building a terminal to the West, but it is unclear at present.

Recommendation

We find that there are a number of dependencies on which the best decision in this area depend, especially in relation to surface access issues, and the potential disruption of carrying out any larger capacity expansions within the T1/2 buildings. Because of the potential to expand within the T1/T2 space to around 40 million with relatively minor disruption, there is time to carry out more detailed studies and make a fully informed decision. Our recommendation is therefore to wait for this to make such decisions. The surface access study will be crucial and could substantially affect the timing/demand levels at which one would aim for a third terminal and its location.

The key considerations in coming to this decision, we find, are the following:

- It is plausible, based on passenger processing and gate and stand requirements, that incremental expansion of T1 to T2 can achieve up to 40m passengers per year and with modest disruption to deliver that.
- daa have a plan to deliver up to 55 million passengers per year with incremental expansion of T1 and T2, together with a large satellite building beyond the crosswind runway. If the endpoint of this is feasible (which we have not assessed as it is not within our scope of work), it seems likely that achieving it must involve major rearrangement of the present use of space in T1 and T2 and thus may result in some major disruption and reduction in capacity for a period. The feasibility of the

concept, both for the terminal and the satellite, needs more detailed assessment, including the impact on operations during construction.

- Whether or not either of the above are feasible, we have serious concerns about the surface access implications of concentrating all or most surface access in the eastern campus. This has major transport implications for the road system outside the airport campus. Even if daa can achieve very local surface access requirements and it is a feasible and least cost option for the airport, it may prove not to be the least cost option for Ireland as a whole, given the consequential effect on the wider road network, other traffic-generating developments in the wider area, and the public transport system. We cannot say what is the best option. This is something that the councils are aware of and are currently studying.

Looking ahead to the following chapter, we can further note that incremental expansion of T1 and T2 is unlikely to lead to useful methods of offering further choice to airlines. This is more likely to happen if a third terminal is built. Thus a desire to offer that choice, if it can be practically arranged, could be a reason to promote or allow a third terminal to be built.

It could be argued that incremental expansion of T1 and T2 would compromise the business case for a third terminal, the more so the further that expansion proceeds. Against that, building a third terminal would take time, and the airport is already constrained. Thus there is a case for some incremental expansion in the short term, as in practice is already happening. The opening of a new terminal always results in an airport with excess capacity, and this is something airports need to be able to manage financially. So the possibility of a third terminal is not a reason to halt all incremental development, though at some point when a third terminal is being developed it is likely to stop. Competition between terminals is also facilitated by the presence of a degree of excess capacity.

Thus potential arguments for or against incremental expansion, versus a third terminal, putting aside the choice point, can be summarised as follows:

- Surface access issues, not on the airport site itself but in the wider road network, may make it overall a better solution for Ireland to pursue a third terminal in the western part of the airport rather than allowing much further expansion in the eastern campus. Which is better is far from obvious, nor is it even obvious if the difference is large or small. Detailed study outside of the scope of the present project is required.
- Some incremental expansion is likely desirable in the short term whether or not a third terminal is required, because a third terminal will not be available in time to relieve the short-term issues in the airport – it seems this is already happening.
- A substantial degree of incremental expansion in T1 and T2, certainly to 40 million is plausible, setting aside issues of surface access and issues of choice for airlines.
- We have not assessed whether daa's plans for further incremental expansion to 55 million are plausible (setting aside issues of surface access and choice), since achieving this would seem likely on the face of it to require a lot of rearrangement of space usage and considerable disruption to operations. If this is still potentially an option when

making a decision on expansion, as discussed in the next paragraph, it will require some further detailed study.

The appropriate timing of a decision on a third terminal is driven by demand levels, both current and prospective. Assuming that the expansion of Terminals 1 and 2 to 40 million goes ahead, then the key demand figure is 40 million. According to Oxford Economics' central forecast, a demand level of 40 million level is first achieved in 2031. This suggests that a timely decision on a third terminal and other planning and preparations should be in time to begin construction around about the middle of the 2020s. This suggests in turn that such a decision needs to be made sufficiently early in the 2020s to allow for the necessary planning and so forth. This timing should be kept under constant review. If demand as actually experienced varies from the forecast, or if the assessment of likely future growth changes, then this timing can change. It can also change according to how much one is willing to tolerate a period of crowding, or the risk of crowding, in the airport for a time prior to the opening of new capacity.

5.1.3 Phased construction of a new terminal

The single-phase construction of T2 of Dublin Airport led to there being substantial excess capacity for several years, due to the downwards shock to Dublin Airport's passenger demand on the foot of the global financial crisis, just before the terminal opened in late 2010.

T3 could be phased, to bring in part of the capacity increase at the start, delaying later parts of the capacity increase until demand has increased further. The initial phase of T3 would be a large proportion of the total T3 cost, as it would have to put in place the central and key infrastructure, but a substantial proportion could be delayed. Through these approaches, a meaningful proportion of the construction cost (e.g. 30 percent) of the terminal could be delayed to later phases. As there are economies of scale in operational costs, a terminal that has only 60 percent of the final expected terminal capacity would have more than 60 percent of the expected operating costs at that full capacity. The modelling recognises that there are some economies of scale and applies a non-linear relationship between capacity and operating costs.

There are several reasons to take a more cautious approach to implementing capacity at T3:

- While traffic growth has been steady recently, it is not guaranteed.
- It would allow some of the costs of construction (and of operating a larger terminal) to be delayed until there are more passengers using the terminal.
- It may help to avoid a large step-change in airport charges, to minimise risk of a negative price effect on demand.
- Issues such as Brexit may have uncertain effects on Dublin's traffic.
- The base cost for building a T3 is taken to be similar to the cost of building T2. T2 was a signature building, generously built in a somewhat constrained location, so this seems to be a relatively generous estimate of what a further terminal might cost. But it may be that there are large costs, for example in surface access, or providing for connection between the terminals, which substantially outweigh the generosity of this cost allowance.

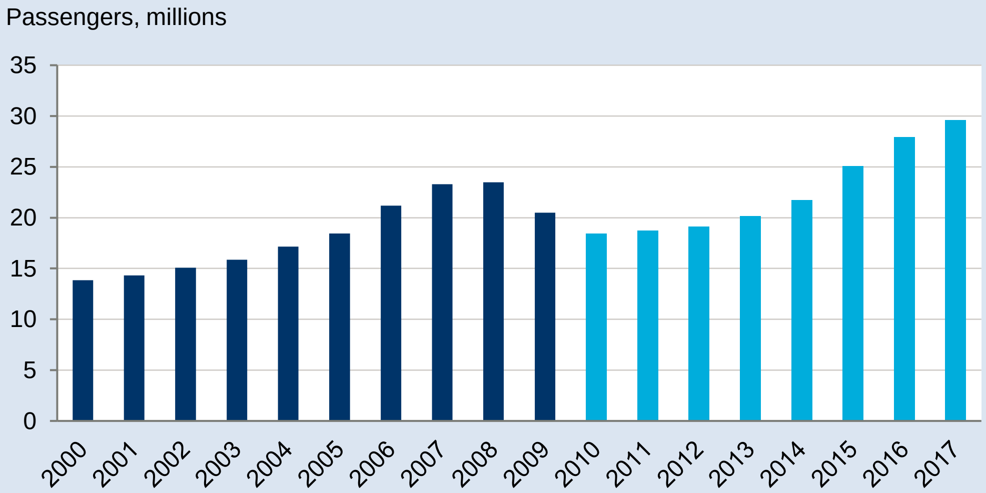
The phased approach would require passenger demand triggers before a new phase of construction begins. Given that construction periods for a phase are likely to be a minimum of two years (as assumed in the model—longer or shorter durations are possible), the trigger must be set at an appropriate level such that it triggers construction early enough that the new capacity is ready when needed. However, some constraints or a relaxation of quality standards may be acceptable to customers during construction, providing some flexibility over timing. It is also necessary to ensure that new capacity is not brought on too early, as this would result in an increase in costs without the passenger capacity/revenue to cover that.

CASE STUDY: SINGLE-PHASE CONSTRUCTION OF TERMINAL 2

In 2003, it was suggested that it might be prudent to start T2 with an initial phase of 10m passengers per year.[50] Indeed, CAR set daa's price cap such that a portion of the costs of construction would only be recoverable after passenger numbers exceeded 33 million.[51] But when construction of T2 began in 2007, T1 was approaching capacity and it was considered that the additional capacity that T2 would bring was required reasonably soon—daa's 2004 and 2006 forecasts estimated that 33m passengers would have been achieved in 2019. It is likely that daa therefore considered that the efficiency gains of constructing the whole terminal at once would outweigh the loss from bringing forward phase two by nine years. daa therefore constructed T2 in one phase, and its 16.5m capacity was made available in November 2010.

Due to the economic downturn, traffic fell between 2008 (23m) and 2010 (18m), only fully recovering in 2015 (25m). Airport charges increased to cover the T2 construction and running costs (the price cap increased by €2.33 per passenger[52]), but the additional capacity was no longer needed in the short run. Due to CAR phasing a portion of the construction costs (i.e. not adding it to the regulatory allowance yet), the impact on passenger charges has been limited. Had daa phased construction, it could have postponed some capacity (and therefore costs) until it was justified by sustained demand growth.

Fig. 72. Passenger numbers at Dublin Airport when T2 opened in 2010



Source: daa

We constructed a simple financial model to allow us to simulate the impact that phased construction could have on airport charges (in terms of the regulatory per-passenger cap). For this, we have run two main scenarios in the model.

[50] DTTAS (Feb 2003) "Dublin Airport: Review of expressions of interest for an independent terminal" online p.63.
[51] CAR (2009) "Final determination – Dublin airport charges 2010 – 14" available online, p.137.
[52] CAR (Dec 2009) "Final determination – Maximum level of Airport Charges at Dublin Airport 2010-2014."

- introducing all T3 capacity at once; and
- introducing T3 capacity in three phases.

These two scenarios are described in more detail in the table below. In addition to these two scenarios, we run three sensitivities for each scenario to allow us to understand and demonstrate how the impact of phasing changes if total construction costs are higher under the phasing scenario (Scenario B) or if demand is lower than forecast.

Fig. 73. Scenarios for the phasing of construction of T3

Scenario	Central	Sensitivity 1	Sensitivity 2	Sensitivity 3
Split of construction costs				
Scenario A	All-in-one costs, i.e. construction is completed in one phase when the airport reaches 33m pax per annum. It provides 16.5m pax capacity at €923m.[53]			
Scenario B	Construction costs are distributed across three phases, with more of the capacity coming in phase 1. Additionally, as there are economies of scale in constructing the terminal, and common areas would have to be constructed as part of phase 1, we allocate a higher proportion of costs to phase 1. • Phase 1 is triggered at 33m pax. It provides 60% of the 16.5m pax capacity at 70% of the assumed €923m construction cost of T3. • Phase 2 is triggered at 36m pax. It provides 20% of capacity, 15% of the cost. • Phase 3 is triggered at 39m pax. It provides 20% of capacity, 15% of the cost.			
Passenger forecast used as sensitivities				
Scenario A **Scenario B**	Baseline Passenger Numbers	Baseline Passenger Numbers	OE Baseline Passenger Numbers *minus 5%*	OE Baseline Passenger Numbers *minus 10%*

Source: CEPA

Fig. 75 shows how airport charges may change relative to 2016 charges over the period 2016 to 2050 if T3 is built as one or three phases (assuming T1/2 continue at their current capacities and with the central passenger demand growth forecasts). Before we discuss the impact that phasing has on airport charges it is important to explain the evolution that user charges follow under the baseline of T3 constructed in one phase (all-in-one).

Firstly, construction costs associated with the second runway are assumed to be incurred in 2020. Given T3 is the main focus of the analysis, the second runway is added to the regulated asset base (RAB)[54] within the financial model in 2021, which leads to a step change in capital costs in that year. Secondly, construction costs associated with Phases 1, 2 and 3 of T3 are incurred in 2021 under the assumption that all costs are incurred in one phase. As a result, T3 is added to the RAB in 2022, where it earns a rate of return but no other associated costs. Under the assumption that construction lasts for two years, in

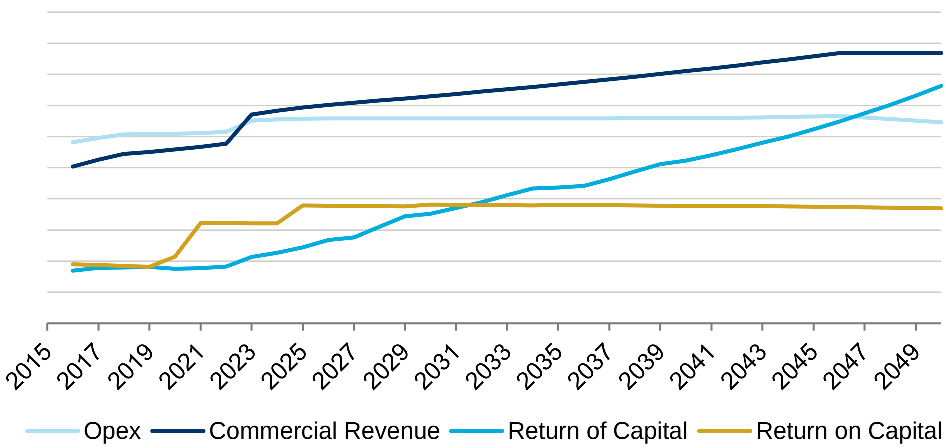
[53] This estimate of the cost of an additional terminal is based upon the cost of delivering T2. (Source: Commission for Aviation Regulation (CAR), 2013. Maximum Levels of Airport Charges at Dublin Airport. Issues Paper. Commission Paper 2/2013. 31 July 2013. Page 51.) This was the best estimate of the cost of a new and comparable terminal available at the time of conducting this analysis. The cost of maintaining the terminal over time is also taken into account within the financial model. It is possible that in practice delivering a further terminal at the airport might have a different cost and we consider sensitivities in our more detailed financial analysis in the next chapter, however it is not necessary for the narrow point being considered at this stage. See Appendix 3 for more information.

[54] A regulated infrastructure owner is typically allowed a certain level of return on their efficiently-incurred capital costs. The RAB sets out this efficiently-incurred amount, which may differ from the actual amount. It includes any previously-incurred capital costs that have not been depreciated yet alongside new capital costs.

2024 T3 begins to incur other costs associated with opex and depreciation, which is why there is a further step-change in required revenues per passenger in 2025.

Taking into account the model assumption that capital maintenance has an asset life of 10 years, alongside the CAR depreciation profile which increases in speed as the asset moves towards the end of its life, forecast total capital costs remain relatively constant between 2034 and 2036. During this period, passenger numbers and commercial revenues continue to increase and opex remains relatively flat based on the underlying assumptions of the model. As a result, required revenues per passenger fall between 2034 and 2036. However, for the same reasons listed above regarding the CAR depreciation profile and assumed asset life of capital maintenance, capital costs increase with a step change in 2039 and continue to increase at a similar rate until the end of the modelling period. In combination with increasing passenger numbers, increasing commercial revenue and relatively stable opex, this results in required revenues per passenger remaining relatively constant between 2039 and 2046. However, in 2047, Dublin Airport reaches its capacity and as a result required revenues per passenger increases at a steady rate from 2047 until 2050, perhaps indicating that further airport capacity is required at this point if the baseline passenger forecasts are realised. These movements in the building blocks of the price cap are presented in the figure below.

Fig. 74. Analysing the components and movements of required revenue[55]



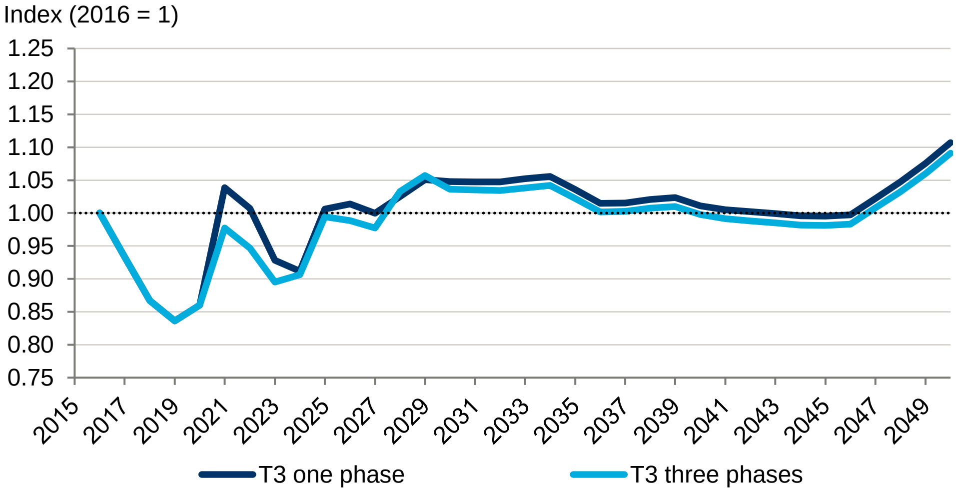
Source: CEPA modelling

Taking the above analysis into account we are able to comment on the overall evolution of Dublin Airport charges given the assumptions made. Overall, the results indicate that the combination of year-on-year passenger growth out to 2050 in combination with rising required revenue at a total level means that building a new terminal potentially may not take the charge much higher than the charge in 2016. This is until 2047 when the Dublin Airport reaches its

[55] Because this is an illustrative model we show results without units on the y-axis, rather to indicate the relativities of the various cash-flows over time

capacity and user charges begin to rise steadily as a result of increasing capital maintenance without a corresponding increase in passenger throughput.

Fig. 75. Analysing the effect of T3 timing on per-passenger Dublin Airport user charges, indexed to the baseline scenario charges



Source: CEPA modelling

We are also able to evaluate the impact of phased construction on user charges. Fig. 75 presents the case when T3 is constructed in one phase versus phased construction (three phases assumed) based on Oxford Economics' central passenger forecasts. The figure shows that for the majority of the modelled period (2020-2050), charges are lower when T3 is constructed over three phases than in one phase . The only point when this is not the case is following Phase 3 in the phased construction scenario, when user charges are momentarily higher than under the one phase scenario. Therefore, phasing construction of T3 has the potential to result in lower user charges.

However, based on relatively high passenger growth forecasts the difference in per-passenger charge is relatively small, which may explain why daa in 2007 chose to construct T2 in one phase—the sacrifice, in terms of making an investment which will not yet be added to their allowed revenues, could reasonably be offset by the efficiencies to be had by constructing the terminal in a single phase. This finding was reinforced by sensitivity scenario 1, which found that if total T3 construction costs are around 6 percent higher in the phasing scenario (scenario 2), as a result of lower efficiencies, user charges are approximately equal between scenario 1 and 2 after 2032.

We then used sensitivity scenarios 2 and 3 to assess the effect of timing on user charges when outturn passenger numbers are 5 percent and 10 percent lower than the baseline passenger forecasts. The results allow us to understand whether the potential benefit of phased construction changes when passenger numbers are lower than expected.

The analysis of the results indicates that the impact of phasing is enhanced the slower passenger growth is. The gap between user charges obtained under the one and three phase construction scenarios widen when actual passenger numbers are less than the passenger forecasts. This is logical as in low growth scenarios it takes longer to achieve the level of capacity required to justify the later phases of construction—so if the terminal is built all at once, there are capital costs to be recovered without the passenger numbers to justify it.

Therefore, given the uncertainty around passenger demand up to 2050, as discussed in Chapter 2, phased construction may be one approach to mitigating the risk of building a third terminal at Dublin Airport. It is therefore clear that the regulatory allowance for any future large capacity expansions at Dublin Airport should assume a phased construction. Whichever party is responsible for implementing the expansion (e.g. daa or an independent operator) would not necessarily be obliged to actually phase the construction, as it seems reasonable to allow the investor to make their own assessment of the risks, as long as customers' charges are not negatively impacted.

Another key question is whether the potential increase in charges that a new terminal might produce could be a reason to delay the development of a third terminal. According to the modelling, there are not, provided the development is phased. The model assumes building it in the short term, and yet charges do not become higher than 5 percent more than 2016 charges, which would appear generally acceptable. Some of that is due to the new runway rather than the new terminal. But this is plainly contingent on demand forecasts being met, and a terminal being practically capable of being built at a cost no more than T2. Indications of a slow-down, or cost estimates being much higher, might challenge this conclusion.

5.2 DESIGN CONSIDERATIONS FOR TERMINAL 3

The work above has shown that a *third terminal* at Dublin Airport is not yet needed as a particular, near-term, solution to passenger processing capacity constraints because a significant increase in passenger processing capacity can be accommodated within the existing two terminals. Therefore, at a strategic level, the need for a third terminal should be based on policy factors beyond the more immediate need for additional passenger processing facilities to accommodate the forecast growth in passengers. These policy areas include:

- **Efficiency of stand provision**—would it be more efficient to increase the number of stands through the provision of a new terminal?
- **Surface access**—is there an opportunity to make a step change in the provision of surface access infrastructure through the construction of a new terminal?
- **Optimal development of current terminals**—would the availability of a new terminal provide an opportunity in the medium term to accommodate traffic which currently uses T1 and T2? This could reduce the demand in these terminals, enabling capacity-enhancing and operational efficiency developments to be put in place more optimally and so further enhance their capacity and operational serviceability for the longer term.
- **Alternate terminal ownership**—are there passenger and economic benefits that are facilitated through the construction and ownership of a new terminal?

Therefore, rather than discussing the size and location of a third terminal at Dublin Airport to meet a specifically identified demand, the report considers the size and design factors associated with the provision of a third terminal capable of processing eventually about 20 million passengers. This is then followed by a review of possible locations for a third terminal.

Design parameters

The size and design of an airport terminal is typically based on widely accepted design parameters set out by the International Air Transport Association (IATA) working in partnership with the Airports Council International (ACI). These design parameters provide a high-level range of suggested sizes and infrastructure planning considerations that are likely to be required in order to provide airport terminals which are capable of providing facilities to process anticipated passenger demand. The size parameters are variable to provide developers an opportunity to adjust the size of facilities according to variable levels of service quality. Whilst these design parameters provide a high-level indication of size and anticipated levels of service quality, it should be noted that airport developers need to consider the specific operational and market circumstances as well as the service level aspirations of the terminal being developed.

IATA has developed a framework for considering space and service levels at both a strategic and a detailed level. At the strategic level airport facilities are classified into the four following levels:

Over-design	Optimum	Sub-optimum	Under-provided

Each of these broad categorisations has a range of detailed space and processing descriptions associated with it. These are given an alphabetical classification from A to E in order to provide a more detailed description of the performance levels that could be anticipated in terminals according to the design specification to which they are built. The descriptions of the IATA [56]A-E levels of facility performance are set out below:

Fig. 76. IATA service levels

IATA Service Level	Description
A	An excellent level of service. Conditions of free flow, no delays and excellent levels of overall comfort.
B	High levels of service. Conditions of stable flow, very few delays and high levels of comfort.
C	Good level of service. Conditions of stable flow, acceptable delays and good levels of comfort.
D	Adequate level of service. Conditions of unstable flow, acceptable delays for short periods of time and adequate levels of comfort.
E	Inadequate level of service. Conditions of unstable flow, unacceptable delays and inadequate levels of comfort.

[56] 9th Edition of the IATA ADRM 2004

Whilst noting the subjective interpretation of the broad classifications above, it is sometimes taken that the optimum level of performance equates to a range around the C level. In some instances, developers may prefer to provide a facility performance above the C level and consider this to be optimum; in other cases, developers may consider that a performance below the C level is still optimal in their circumstances. This could be the case for an airport terminal overall, or developers may choose a mix of above C and below C levels of performance for specific aspects of a terminal according to their policy objectives. For example, a B level security search may be preferred in order to increase the dwell time of passengers in the departure lounge exposed to retail and food and beverage (F&B) outlets. However, such a planning decision would need a careful consideration of the trade-off between the extra operating costs associated with a B level security search performance and the extra commercial income from passengers spending more time in a departure lounge.

Since there are a number of subjective, contextual and preference-based design variances capable of informing the development of airport terminals, it is important for service and design parameters to be discussed widely amongst all stakeholders with a view to achieving consensus.

A number of factors which should be taken into account in planning a new airport terminal are discussed in Appendix 2. Those factors which have a major impact on the size of terminal are analysed in further detail below in order to propose an overall physical size for a new terminal at Dublin Airport capable of processing 20 million passengers, being, to round approximation, a plausible future requirement.[57]

5.3 SIZING A TERMINAL 3

Estimating the overall size of an airport terminal is a subjective exercise. Guidelines are available such as those published by IATA.[58] Although IATA recognises, and it is accepted amongst airport planners, that the actual size of a terminal is usually based on many factors as well as many published guidelines. These include:

- the forecasted numbers and mix of passengers;
- demographic specifics of passengers;
- expected levels of direct and transfer passengers;
- service level aspirations;
- dynamic modelling of passenger flows;
- overall design aspirations e.g. a simple functional construction or a signature, national showcase development;
- resilience and contingency; and
- cost of construction.

[57] For clarity, this report is not recommending that this is the future required capacity of T3, as a number of considerations which are outside the scope of this study would be required to make that determination, and, as has been indicated, there are no precise relations between physical size and capacity.

[58] International Air Transport Association, Airport Development Reference Manual, 10th ed. (Montreal - Geneva: 2016).

Therefore, whilst the IATA guidelines are useful approximate indicators of likely size requirements, they are best used for conceptual planning in the early stages of a development. The actual size of terminal should then be determined after comprehensive consultation and discussion amongst stakeholders covering the areas above to more precisely define the actual space required.

In order to indicate the approximate size of a third terminal at Dublin airport we made a series of assumptions detailed in the table below. However, as indicated above, these are subjective assumptions to provide an overall estimate of the size of a new terminal. Changes to these assumptions would have an impact on both the interrelations of the operational elements and the overall size requirement.

Fig. 77. Assumptions for calculating an estimated size recommendation

Input	Description of assumption
Number of passengers	Since the development of a new terminal is an opportunity to provide a step change in the capacity of an airport we have made a practical assumption that the terminal should be able to process 20 million passengers. Since some incremental expansion of Terminals 1 and 2 might occur in the short run to tide the airport over as a third terminal is built, around about 20 million would approximately take the airport to its 55 million ambition. The third terminal need not be fully built out initially, and could be designed to facilitate straightforward incremental expansion.
Number of transfer passengers	Of these 20 million passengers we assumed that about 35 percent would be transfer passengers. This is in line with the European average of comparator airports.[59]
Typical peak hour passenger levels	The most accurate way to determine the peakiness and the level of any peaks is through an analysis of likely airline schedules, the mix of aircraft types, typical aircraft load factors and variations in the peakiness of different types of traffic e.g. departing business passengers tending to arrive at an airport closer to the time of departure than leisure passengers. Without this detail it is still possible to estimate the number of peak hour passengers using two peak estimation methodologies which have guidelines for their calculation. These are the Typical Peak Hour Passengers (TPHP) and the Standard Busy Rate (SBR). Based on using the annual passenger number above, the average of the TPHP and SBR peak estimation measures, and assuming that 35 percent of these passengers are transfer passengers results in the following estimated peak hour demand on airport facilities: ▪ Estimated typical peak demand for departing passengers: 2,400 passengers ▪ Estimated typical peak demand for arriving passengers: 2,400 passengers ▪ Estimated typical peak demand for transferring passengers: 2,500 passengers Transit passengers are assumed to be a de minimis amount and so are not factored into any calculations. These estimations of the typical peak hourly demand have been used in estimating the space requirements for specific functions as set out below.
Common use of facilities	The facilities are available for use by all passengers rather than specific facilities being used by particular airlines and their passengers only. This adds to the subjectivity of the space requirements. Knowledge of individual airline shares of passengers and their accompanying service expectations would be required for any more detailed analysis.

[59] Annual Analyses of the EU Air Transport Market 2016 – MOTT MACDONALD – March 2017

Service level aspirations	With respect to service level standards, CAR set out minimum levels— T2 was built to IATA standard C, with T1 then operating at standard C/D in different areas.[60] It will be necessary to understand the standard that airlines wish to offer their customers—and strike a balance between the differing preferences. We have assumed the mid-point of the 'C' level of service standards set out by IATA whilst noting that some stakeholders may prefer the upper level of C (or even into B) and some may prefer the lower level of C. It should also be noted that it is possible to plan for alternate service levels in various aspects of service performance. However, the range of any differences should not be too great otherwise overall system capacity and performance complexities could be introduced. In addition to this, the airport wide level of service and capacity is a function of the lowest level of service in any particular area. Therefore, any planned variation in the level of service should only be pursued after careful consideration of the impact of this variation on the overall service and capacity proposition.

Approximate terminal component sizes

The approximate sizes for the core passenger processing activities, general circulation and retail areas in a new terminal are set out below in square metres. Inevitably, there will be overlap between a number of areas so these figures are high-level indicators only.

- General entrance hall: 5,500
- Check-in: 3,500
- Direct security: 2,500
- Transfer security: 2,700
- Departure border control: 2,500
- Departure gate lounges: 8,000
- Arrival border control: 2,500
- Baggage reclaim: 3,800
- Customs area: 3,000
- General arrivals hall: 5,500
- General circulation: 6,000
- Retail: 9,000
- **Total: 56,500 square metres**

For estimation purposes we round the figure of 56,500 square metres to 60,000 square metres. This compares to the current T2 at Dublin which is classified as having 75,000 square metres. We would note the following points regarding this difference: firstly, for consistency we have used the IATA planning standards and considered only the main components of passenger processing areas. Second, we have not accounted for the space required for a baggage system as this is normally accommodated below the passenger processing levels of a terminal and does not necessarily make a material impact on the overall footprint of a terminal. And thirdly, the difference between the IATA standards and T2 highlights the subjective nature of determining the size of an airport terminal.

[60] The standards are set out in Table 3 of: CAR (Jun 2008) "Quality of service at Dublin Airport: consultation on the regulatory approach taken towards Quality of Service at Dublin Airport" available online.

We would emphasise again that the actual size of a terminal is contingent on numerous factors and the subjective views of stakeholders regarding those factors. The IATA guidelines can provide a broad view of the likely amount of space required but IATA themselves note that the need for wide stakeholder conversations to consider the actual amount of space required:[61]

As a consequence of these numerous variables, it is wholly misleading to surmise that the rigid application of the information contained within the ADRM will necessarily deliver the most appropriate solution.

5.4 LOCATION OPTIONS

5.4.1 Factors which impact location: Non-hierarchical

A number of factors should be analysed when considering the location of a new terminal at an airport which is already well established and has at least one other terminal. The selection of a location is based on a recognition of both trade-offs and compromises with an assessment of the impact of these trade-offs and compromises in the search for the 'optimal' location. The process of considering the trade-offs to be made and selecting the optimal location should be undertaken through a comprehensive consultation with all the stakeholders involved.

This report does not goes as far as recommending a location for T3 which would require extensive stakeholder consultations and further study; rather it is intended to contribute to it through highlighting a number of the factors which should be considered multilaterally by all stakeholders within the context of their particular policy objectives, business models, operational needs and customer service aspirations. A number of the factors which should be analysed in considering the optimal location of an airport terminal are discussed below.

Site geography and land availability

The geographical nature of a potential site for a new terminal and the availability of land are important considerations in site selection. Factors to consider when assessing the suitability of a site include:

- amount of land available;
- gradients;
- natural landscape features which need environmental protection such as rivers;
- possibility of developing redundant brownfield sites rather than greenfield sites;
- rights over land on which development can occur;
- regional land use plans;
- natural or constructed boundaries which can limit the extent of development;
- any existing facilities which would have to demolished and perhaps replaced;
- access for construction;

[61] 10th Edition of the IATA ADRM – 2017 Update

- complexity of construction; and
- site specific (rather than design specific) factors impacting the cost of construction.

Integration with facilities/ relocation of other facilities / infrastructure

The extent to which T3 can be integrated with T1 and T2 at Dublin Airport as well as the cost of achieving this are important factors. This integration should encompass an equal capability and performance with respect to passengers, bags, operational services and cargo (for bellyhold freight—often a key component in the profitability of routes for airlines). Without complete integration, the full overall airport capacity or hubbing benefits of providing a new terminal could be limited to some extent, risking the construction of a sub-optimal operationally stranded asset which is less attractive for airlines to occupy. Additionally, one of the benefits of complete integration is the inherent operational flexibility which comes from the interconnectedness of the whole airport.

Expandability

Building a terminal in a phased, or modular, approach enables supply to grow with demand by constructing the amount of infrastructure that reflects the expected numbers of passengers. One of the benefits of a phased approach is that charges can be more closely matched to the numbers of passengers. This reduces the risk of a large increase in charges to pay for a (often more than necessary) substantial element of infrastructure over a passenger base which has not yet grown to ameliorate the per passenger level of charges. A phased approach also provides some insulation from economic shocks reducing demand whilst still needing to pay for the expanded infrastructure as was the case for Tl 2 at Dublin just as it opened.

However, in order to realise the benefits of phasing, land availability must allow for the staged expansion of the original terminal.

Proximity to airside infrastructure

Where possible a new terminal development should occur at a location which is readily accessible from the full scope of the airfield without creating bottlenecks or particularly long taxi times for aircraft. Relatively easy access for aircraft to a terminal increases the operational efficiency and therefore capacity of the airport, reduces aircraft fuel burn, congestion on the apron, aircraft taxi times and overall journey times for passengers.

Surface access

Availability of already operational surface infrastructure in terms of roads, car parks, public transport and rail systems can reduce the overall cost of a terminal. However, a thorough capacity analysis is required to determine the ability of any extant surface access infrastructure to accommodate the increased demand placed on it by a new terminal. An important factor in considering the provision of surface access is the division of responsibility for funding it. It is often helpful to think of surface access infrastructure as that which is provided *to* the airport and that which is provided *at* the airport. The infrastructure to the airport is usually considered a national asset which is constructed as part of a wider programme of national transport infrastructure funded by the state. In contrast to this, surface access at the airport is required to access specific parts of the airport and is usually funded from the charges levied on airlines and passengers by the airport. The boundary line between these two dimensions of surface access is usually taken as the perimeter of the airport's property.

Complexity of construction

A number of factors contribute to making airports particularly complex environments for capital development. These include:

- the dynamic, time critical, operational environment;
- substantial amounts of airport related road traffic even before construction traffic; and
- maintaining the security of the airport whilst construction takes place between the landside/airside boundary.

Complexity adds cost. Therefore, the relative complexity of potential terminal locations is an important factor in the selection of an optimal site.

Resilience and contingency

Airports are characterised by operational complexity. The level of investment and cost of providing air transport services are such that even minor periods of disruption can result in substantial extra costs being incurred by all stakeholders. This includes to passengers in terms of both money and the personal cost/inconvenience of disrupted plans. Therefore, opportunities to enhance the resilience of all aspects of airport operations are important factors to be taken into account in assessing an optimal location for additional infrastructure.

Location of ancillary services

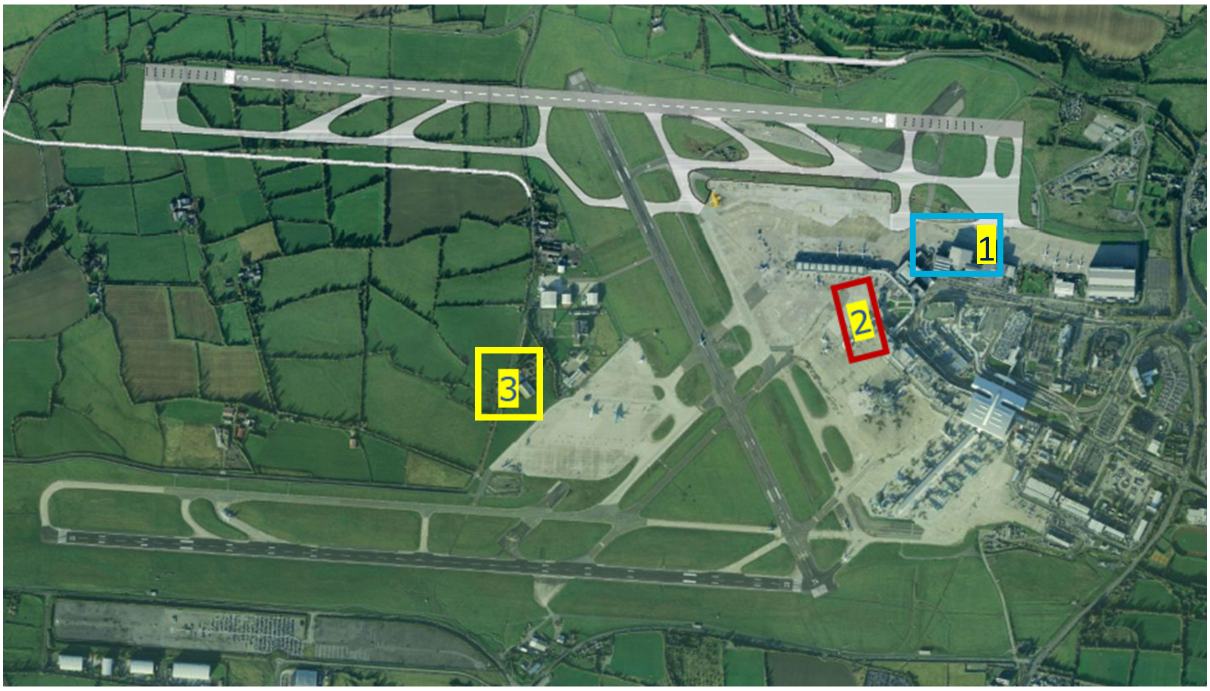
Although not a primary driver of the site selection for a new terminal the current location of airport fire and rescue facilities, fuel farms, and de-icing pads should be taken into consideration. Some re-positioning of these facilities may be required. Therefore, the complexity and cost of doing so should be factored into the overall site selection analysis.

5.4.2 Potential sites at Dublin Airport for Terminal 3

At the commencement of this project three possible locations were highlighted as possible locations for a third terminal at Dublin Airport. These locations are illustrated on Fig. 78 below.

- **Location 1**—North-East of Terminal 1 in the area currently occupied by Maintenance, Repair and Overall (MRO) facilities
- **Location 2**—North-West of Terminal 1
- **Location 3**—West of the crosswind runway between the Northern and Southern Runways

Fig. 78. Dublin Airport with possible Terminal 3 locations



Source: Image provided by daa. Locations added by CEPA

It became evident that the number of aircraft stands was the main capacity constraining factor at Dublin Airport. Whilst location 2 would add passenger processing capacity at the airport, this would be at the cost of reducing the overall number of stands; particularly while the crosswind runway (16/34) is still in operation.

The advantages and disadvantages of each potential location for a new terminal at Dublin Airport are set out below at a strategic level. It should be noted that the extent of the impact of the advantages and disadvantages set out below would have a subjective value to a range of stakeholders. Therefore, any specific site selection should only occur after a comprehensive utility analysis which takes into account the views of all stakeholders.

5.4.3 Location 1: North-East of Terminal 1 in the area currently occupied by MRO facilities

Advantages

Location 1 benefits from already being on the surface access loop of Dublin Airport. However, during peak times there is already significant demand on this surface access infrastructure and the completion of the Dublin Central Office complex will add to this demand. The land is already under the control of daa so would be accessible to them for development. It benefits from being able to be integrated contiguously with T1 and T2 for passengers and baggage at less cost than integrating a terminal in location 3. The integration of location 1 with T1 and T2 enhances the resilience of Dublin Airport although this would be contingent on the extent to which the nature of operations in location 1 were similar to the other terminals.

The location would enable one of the two anchor airlines at Dublin Airport to expand operations into an airport location which is already proximate to their current operations. The surface access roads already in place reduce the extent to which initial access to the site would need to be constructed before terminal development could occur. However, this would have to be balanced by the negative impact on the already busy airport road network. An additional surface access advantage is that there are already plans for the construction of a Metro North station on the east side of the airport which could be used to access a terminal in location 1. From an environmental perspective, it is preferable to develop a brownfield site such as location 1 than to develop on a greenfield site.

Disadvantages

Location 1 is bound by the apron to the north and the surface access roads to the south which could limit the size of a terminal able to be developed in that area. However, Bergamo Airport near Milan in Italy is an example of an airport which has successfully developed a terminal on a site which is constrained by a national highway. If a terminal was developed in location 1 it would be the third terminal to be accessed by the same surface access infrastructure, which has limited ability to have its capacity enhanced due to the infrastructure already in place. Also, if these roads were to be compromised for any reason it would negatively impact access to all the airport's terminals.

The MRO facilities at Dublin Airport are currently situated in location 1. The selection of location 1 for a terminal would require the re-location of these activities to another part of the airport. While location 1 would be proximate to the new northern runway at Dublin Airport it would be one of the furthest points from the southern runway adding time, distance for aircraft accessing location 1 from the southern runway and adding complexity to the flow and manoeuvring of aircraft from Terminals 1 and 2 to both the southern and northern runways.

Stand location eventually becomes a complication as demand grows, as ultimately there will not be sufficient space in the vicinity for all the stands required by both this new terminal and the present terminal and pier infrastructure in that area. We have come to a high- level conclusion that eventually stands will be required west of the crosswind runway, and a new terminal here does not obviously facilitate a solution to accessing those stands.

5.4.4 Location 2: North-West of Terminal 1

Advantages

The land at location 2 is already controlled by daa so wholly available to them for development. Location 2 also benefits from being on the surface access loop already in operation at Dublin Airport. Once the Metro North infrastructure is provided at Dublin Airport it would enable passengers to access a terminal in location 2 from a central Dublin Airport metro station. As with location 1, one of the advantages of location 2 is that its proximity to T1 and T2 would enable it to be integrated with these terminals with less complexity (and cost) than integrating a terminal in location 3. This, relatively straight forward, integration also provides enhanced resilience through the ability to process and transfer passengers and bags between these terminals in the event that one of the three terminals were not accessible – either from landside or airside. Although, the extent of this integration would be dependent on the degree to which the facilities and the nature of operations of a terminal in location 2 were similar to those in T1 and T2.

The proximity of this location to the crosswind runway would mean that a linear 'hammer head' type of terminal would need to be constructed rather than a pier extending from a terminal. Some of the benefits of such a terminal are: shorter walking distances for passengers from processing areas to (most) boarding gates; less complex way-finding; longer exposure of passengers to central commercial outlets for airport revenue; and passenger convenience.

The provision of 3 integrated terminals on the same surface access loop facilitates a latent flexibility of use for the accommodation of airlines in a way which could dynamically increase the capacity of the 3 terminals. However, as noted above this would be contingent on both the capacity of the surface access loop and the nature of the facilities in each terminal.

Disadvantages

Whilst location 2 is on the current surface access loop, there is significant demand, as in location 1, on this infrastructure. There are limited opportunities to develop this infrastructure for vehicles which reduces the extent to which being on the current surface access loop is an advantage.

The proximity of location 2 to the crosswind runway would require the construction of a linear terminal – rather than a pier. Therefore, although a terminal in location 2 would add to the passenger processing capacity of Dublin Airport, the requirement for terminal to be linear would not add stand capacity. This is because the size of a linear terminal in location 2 would be curtailed by its proximity to Pier 1 and T1. The results of the capacity analysis have shown that the amount of stand capacity is an airside constraint to the growth of Dublin Airport. Therefore, the inability to construct a pier at location 2 is a significant disadvantage. It should be noted that this disadvantage is contingent on the existence of the crosswind runway. If the crosswind runway was not operational there could be an option to construct a pier onto a terminal in location 2. Taking a view on the existence of the crosswind runway is beyond the scope of this study but a number factors which should be taken into account when considering its future are set out in Section 5.4.6, below.

It should also be noted that the original terminal at Dublin Airport is a listed building that is in the vicinity of location 2. This could add complexity to the design and construction of a terminal in location 2. Access to Pier 1 from T1 is already based on a circuitous route to by-pass the listed building. Whilst not ideal, it demonstrates it is possible to accommodate the building whilst developing the infrastructure in the area.

5.4.5 Location 3: Between the Southern and Northern Runway to the west of the crosswind runway

Advantages

The greenfield nature of this area is a key construction advantage, providing an opportunity to construct a new terminal with minimal disruption to operations on the rest of the airport. A new construction on a greenfield site also enables an optimal terminal design to be constructed with minimal adjustments needing to be made to accommodate design and build constraints from other buildings already in the area. Therefore, the amount of land available and the site geography provide an opportunity for the reasonably straightforward construction of a terminal. Placing the third terminal in this location provides a second 'front door' for the airport. This combined with the surface access infrastructure that would need to be provided would enable passengers to approach the terminal from the west, reducing the demand on the surface access roads used to enter the airport from the east. The existence of a second entrance and surface access system from the west would increase the overall resilience of the airport.

This site also enables a phased or modular approach to the construction of a terminal as there is land available to allow for phased development which can expand into the unoccupied land. The central location between the two runways would enable aircraft to access the terminal with reasonably equal convenience and operational efficiency. Under normal operating conditions, and as long as an efficient network of taxiways was in place, aircraft arriving and departing from a terminal in this location would have relatively little impact on aircraft manoeuvring at T1 and T2.

Disadvantages

The distance from the national road network on the west of Dublin Airport to location 3 could add significantly to the cost of developing a new terminal at this location. This surface access cost could be reduced by placing the main terminal closer to the road network. However, this would be offset by the cost of the greater amount of airside ramp and taxiway network required to integrate a further west location with the remainder of the airport.

For the optimal operational, hub and airport resilience benefits to be realised for the whole airport the connectivity between location 3 and the east of the airport would need to be robust and comprehensive. Although more expensive than providing surface connectivity, it is recommended that the integration between the east and west be achieved through a tunnel capable of moving passengers, baggage and service equipment. This is because this would not have an impact of the manoeuvring of aircraft on the airfield between the east and west campus areas; something which could, in time, impact the overall capacity/complexity of airside operations.

A possible disadvantage of location 3 is the mix of land ownership and development rights for the area. This is because the overall land area required for the optimal development of a terminal and the associate surface access infrastructure on this site may not be owned by one party.

5.4.6 Crosswind runway

As part of the engagement with stakeholders we noted that some felt the crosswind runway (16/34) should be retained for operational reasons whilst others considered it be no longer required. Making a recommendation on the future of the crosswind runway is beyond the scope of this work. Whether the crosswind runway is retained is a major factor affecting the shape of the future development of the airport, and there are strategic aspects to such a decision which means that it is not just a business decision for the airport. Nevertheless, we set out below some of the factors which should be taken into account in achieving a policy position on the future of this runway:

- The performance capabilities of modern aircraft have typically reduced the need for crosswind runways.
- In crosswind conditions pilots may prefer to approach a longer runway at increased speed (reducing the impact of the crosswind component) rather than approach a typically shorter crosswind runway at lower speed.
- The final decision on making an approach to a runway rests with the pilot. Where crosswind runways are already in place, pilots may prefer to retain the flexibility and choice this gives them.
- The consequences (and costs) of an aircraft being diverted due to weather conditions rest with the airlines and passengers rather than the airport. Passengers face the cost of inconvenience and personal/business disruption. The airlines face the costs of providing for passengers at an alternate location and then repatriating these passengers and their bags to the original destination. The airlines also incur the costs of complexities being introduced to the operational flow and resource scheduling of aircraft and crew.

We would recommend that any decision on the future of the crosswind runway at Dublin Airport be taken only after a comprehensive consultation with all stakeholders.

6. FINANCIAL AND REGULATORY FRAMEWORKS

AUTHOR: CEPA

KEY FINDINGS

DTTAS has asked us to focus on the possibility of delivering meaningful choice to airport users, and also to specifically focus on an independently operated third terminal. In practice, choice for users means choice for airlines, as passengers inherit their airline's choices. We consider a range of institutional structures for the operation of a third terminal and present alternatives that would allow choice, or a degree of choice, about how the options might be arranged and their broader effects. We use an illustrative financial model to assess what level of charges would allow such institutions to cover their costs.

The possible **institutional structures** for the operation of T3 that provide an alternative to the status quo are: an independently operated terminal; an airline alliance linked terminal; and a concession terminal. We explore the pros and cons of each in turn.

An **independently operated terminal** which set its own prices and competes for tenants is the option which offers the greatest choice to airlines. It also offers potential for additional competition by privatising other existing terminals, facilitated by a regulatory structure devised to accommodate it. However, it is an untested model and therefore presents risk. In looking at this model it is important to consider: whilst there appears to be investor appetite for such a development at Dublin currently, it is of higher commercial risk and would not in every case be a feasible commercial development; while it offers an effective choice for airlines it only does so at stages in the development cycle where there is sufficient spare capacity; it requires substantial new and complex regulatory arrangements; it might evolve into an airline/alliance-linked terminal and thus reduce choice later; it will become a commercial interest in the long term that can try to influence future development of the airport campus in its own interest; and it may lead to some loss of efficiency because of non-sharing of facilities and friction in allocation (but with the potential trade-off of competitive efficiencies).

An **airline/alliance-linked terminal** which is exclusive to selected partner airlines is the option which offers choice only to the partner airlines. It is a known and tested model, though used only in a small number of places. However, it offers no choice for other airlines; it requires some regulatory arrangements to demonstrate fairness between airlines (but can be simpler than a fully competing terminal); it leads to material loss of efficiency because of exclusive arrangements (but can be compensated by efficiency gain of terminal run to airlines' taste); and it requires arrangements for what happens when the airlines outgrow their terminal. [Redacted]

A **concession terminal** which defines a business opportunity for the concessionaire to operate, likely offering airline customers standard daa terms is the option mainly about efficiency not choice. It is a known and tested model, used in many places, more often for a whole airport, and it doesn't need material regulatory changes. However, it presents little practical choice to airlines; it offers the potential for a more cost-effective approach to operations and retail (but that needs to be a large enough problem to justify the costs of the institution); it means the financial terms, whatever they are, will inevitably have some unwanted behavioural effects; and it adds time to the procurement process.

It is worth noting that a **daa terminal**—same as today—could in principle offer some choice in the form of distinctive business terms by terminal if the overall business justified it.

Our key **conclusions on delivering choice** to airlines therefore are that fully commercial competing operation of terminals maximises choice. While airline operated terminals provide choice for those airlines, but not others, and requires an airline to pursue it. Independently operated terminals with a designated market, for example under concession, may have a more commercial attitude to users than present arrangements, but choice is limited because airlines cannot change terminals.

We also look at options where **the terminal operator may be daa, an airline (or grouping), a third-party investor, or an airline/investor consortium**. We find the following scenarios to be potentially feasible: a status quo with daa operating all terminals; a single airline/alliance operator running a terminal for themselves; a third-party investor competing with T1/T2, with or without an airline in consortium; a range of models where T3 serves a designated market, typically as build-operate-transfer (BOT) scheme.

We find that scenarios (within some of the above options) where the opening of T3 is used as an opportunity to close and redevelop T1 to be financially difficult, because daa will struggle to cover the inherited cost.

Finally, we set out a range of legal and regulatory issues specific to an **independently operated terminal model** and consider transitional arrangements. The introduction of a large amount of new capacity risks reducing the demand for an existing asset (and/or labour), which may then be considered "stranded". In the short-term this may leave daa in a situation of holding assets which it has relatively large operating costs to keep in operation, and unable to pay its full financing costs. Within a broad range, this can be consistent, within reasonable bounds, with a daa that is viable and successful in the longer term (and there can be compensating benefits in the form of investment made and competition).

Fair and transparent access arrangements to the airport's common user infrastructure are required—this could involve some level of institutional separation of common user infrastructure and other terminals. There is however no precedent for a such a regulatory/charging system for a fully competing independent terminal, so there is risk in attempting to make the first implementation.

Specific arrangements are required to preserving the long-term interests of the airport (e.g. an airport system controller/planner) to ensure the terminal's location and arrangements do not impede future efficient development of the airport.

A backstop provision for re-regulation if competition ceases to be effective is required, for example, a terminal may gain some market power if the airport becomes relatively full and hard to expand. In addition, a provision for competition powers if not covered by general law is also required, for example, if a terminal tries to put another out of business.

Fig. 79 below summarises the series of decisions required and recommendations around timing.

Fig. 79. Summary of decisions and timing

Time/ Decisions	**Decisions**			
Now:	Roads and traffic study Decision on future of crosswind runway			
After road and traffic study:	Eastern campus extension short term potential	Reform 32m planning limit accordingly	Check 2nd runway planning rules	**Compute time available for medium term decisions**
In time for a 3rd terminal decision:[62]	Determine how roads issues allow or militate against further eastern expansion			
	If further eastern expansion possible:	Investigate disruptive potential of T1/2 expansion	Investigate if expanded T1/2 delivers airline needs	Decide if choice requirement indicates a T3 instead
After deciding to have a T3 (E or W):	Series of decisions set out below			
Determine character requirements	Ireland gateway minimum standards	Since airlines deliver connectivity aspirations, focus on airport as enabler	Focus on allowing individual terminals to deliver airline requirements	Be aware that spare capacity is inevitable from time to time, and a useful enabler
Choose option based on these consideratio ns	**Competing independent terminals** Untested model presents risk Effective choice for users exists only when there is spare capacity Requires substantial complex regulatory arrangements (see below) Might evolve into an airline/alliance-linked terminal and thus reduce choice later In long term will become a commercial interest that can try to influence future	**Airline aligned terminal** Known and tested model, used only in a small number of places No choice for other users Requires some regulatory arrangements to demonstrate fairness between airlines, but can be simpler than a competing terminal Material loss of efficiency because of exclusive arrangements, but compensated by efficiency gain of terminal run to airlines' taste	**Concession terminal** Known and tested model, used in many places, more often for a whole airport Presents little practical choice to airlines Potential for more cost-effective approach to operations and retail – needs to be a large enough problem to justify the costs of the institution The financial terms, whatever they are, will inevitably have some unwanted	**daa runs all terminals** Status quo

	development of site in its own interest Some loss of efficiency because of non-sharing of facilities, friction in allocation (but trade-off with competitive efficiencies) Potential for further competition by privatising other existing terminals, facilitated by regulatory structure devised	Requires arrangements for what happens when the airlines outgrow their terminal	behavioural effects Adds time to the procurement process Doesn't need material regulatory changes	
In case of selecting independent terminal, decisions on these regulatory aspects	Fair/transparent access to common user infrastructure (simpler if airline aligned)	Consider institutional separation of terminals and common user infra	Arrangements to preserve the long-term interests of the airport	Backstop regulations Provision for re-regulation if competition lost Operator of last resort Competition rules (if not in general law)

This section considers potential institutional structures for the funding and operation of a new terminal at Dublin Airport. Below, we set out the objectives and the assessment criteria that we use to compare the available options. We then set out the different scenarios, before assessing these options against the criteria.

Appendix 3 sets out the financial model in detail.

[62] See section 5.1.2.

6.1 INSTITUTIONAL STRUCTURES

This section considers different institutional structures for a new terminal. We focus in particular on two issues, as specified to us in the brief for this study:

- Giving choice to airport users. The availability of choice to customers, and the presence of multiple suppliers who can devise and offer that choice, is the main driver of efficiency and innovation in much of the economy. Thus, it is likely that providing for choice for airport users on the airport itself would be of similar benefit in the development of airport services, given that Dublin does not have available choice through multiple airports. In practice, choice for the airport user means choice for the airline, since most meaningful aspects of service choice to the passenger are mediated by the airline, and inherited by the passenger when it chooses an airline. Thus we will refer in the rest of this report to choice for airlines.
- The possibility that T3 might be "independently operated". Since offering meaningful choice to airlines implies a separate provider of services, a likely institution to provide that is an independently operated terminal. Thus we focus on this option in particular.

Independent operation would involve T3 being operated by another party than daa, the regulated operator of T1 and T2. This independent party could also design, build, and finance the terminal, if DTTAS consider that adding such aspects of the project to the independent party's remit would be beneficial.[63]

DTTAS' main motivation for considering a different institutional structure is to explore the possibility of introducing a competitive choice for airlines (and, to some extent, their passengers). For sufficient meaningful competitive choice to exist the following four conditions need to be present:

(1) Competition for all services, not just for the incremental/additional demand to come. This would allow Ryanair and Aer Lingus, which account for most of the expected growth, to move some, or all, their existing operations from T1/2 to T3.
(2) Charges allowed to differ between terminals. This would enable competition and allow changes in service levels if desired.
(3) Service levels allowed to differ between terminals. This standard should be subject to an airport-wide minimum standard which should allow the possibility for a low-cost terminal. To enable competition, a clear differentiation between terminals needs to exist.
(4) Excess capacity in the short-term**.** Competition between terminals requires an excess of capacity, which can be facilitated in the medium- and long-term but is a short-term requirement.

DTTAS considered the option of an independent operation for T2, but the eventual decision was for T2 to be financed/operated by daa. This is discussed in the case study box below. Throughout our discussion of independent

[63] The GB energy regulator, Ofgem, has been considering the benefits of having its competitively-appointed transmission owners (CATOs) getting involved earlier or later in the process of introducing new infrastructure. For example, see Ofgem (Dec 2015) "Competition in electricity transmission", available online.

operation for T3 we will discuss, where relevant, the similarities and/or differences to the situation for T2.

CASE STUDY: CONSIDERATION OF INSTITUTIONAL STRUCTURES FOR T2[64]

In 2002 the Government received several expressions of interest for developing an independent terminal, and in 2003 decided not to pursue this option. A panel was appointed to assess the proposals, which included:

- **A terminal focused on full-carrier services.** The panel concluded that the new terminal should provide at least the same service level as T1, allowing full-carrier services.
- **A Low Cost Carrier (LCC) focused terminal** was considered not optimal given the desire that a new terminal would provide carriers with facilities that "match or exceed" standards available at T1. The proposal by Ryanair for an LCC-focused terminal was for a capacity of around 12 to 15 million, which may have been too small to allow sufficient economies of scale to be realised. It was considered that, given the common airport areas, an LCC-focused terminal could not reduce operating costs enough to enable meaningfully lower charges. Any LCC-focused terminal would therefore be infeasible while still having cost-reflective charges. Additionally, it was considered that allowing T2 to be an LCC-focused terminal might risk giving a negative first impression of Dublin to visitors.
- **An integrated hub and spoke traffic for full service airlines**. Hubs have very specific requirements, including a dominant airline "committed to a hubbing strategy", "abundant" runway capacity, and a local area that provides a significant amount of demand. The Panel considered that this does not represent a feasible strategy for Dublin Airport.

The panel identified several benefits of an independent terminal, namely:

- Stimulating effective competition through increased capacity and quality of terminal services, giving airlines a choice between terminal operators. With "appropriate regulatory structures", ensuring that airport charges are appropriately cost-reflective.
- Offering airlines a choice between terminal operators.

While the panel determined that it was a "viable strategic option", ultimately it was decided that daa would best operate T2. Some key considerations were:

- There was an unwillingness to have separate charges at T1 and T2, with the exception of a discount applied to T1 for a limited period, limiting the potential for competition.
- An independent terminal takes longer to develop due to the additional processes that need to be undertaken as compared to an expansion of the existing operator's assets – Dublin Airport was expected to reach capacity within several years.
- Concerns about operational and financial issues that might arise through having two separate terminal operators. "Unified airport control" is considered most effective for the strategic and operational side of the airport, while the reduction of daa revenues would result in a reduction in "available cross-subsidy".

[64] We consulted the following sources: DTTAS (Feb 2003) "Dublin Airport: Review of expressions of interest for an independent terminal" available online and Houses of the Oireachtas (Mar 2003) "Priority Questions – Dublin Airport" question 129, page 6.

6.2 OPTIONS FOR THE FUNDING AND OPERATION OF TERMINAL 3

In developing our different options for institutional structure, there are three aspects that we consider:

(1) How in principle choice can be given to airlines.
(2) Different business models, i.e. overall plans for the strategic purpose of the terminal.
(3) Different parties than daa building, financing, and operating the terminal.

We discuss these three areas in turn below, before bringing them together to discuss the various options for the combination of these two areas.

6.2.1 Giving choice to airport users

There is not a practical model of airport operation where the passenger can choose independently of his airline what core terminal services he makes use of and what price he pays for them. Passengers have available the commercial offer of the airport as regards retail services, where choice is extended to all passengers independent of their airline, but this does not extend into the core airport services. If an airline has a choice what terminal to use, the consequences of this choice pass through to the passenger in terms of the cost and quality of the core airport services that the passenger experiences. Thus the concept of giving users choice in practice amounts to giving airlines choice as to the terminal services they procure, and competition in terminal services occurs at the terminal/airline relationship.

Airlines have full choice when terminals are free to make different charges, and provide different levels of service to airlines, much as different airports might so compete. This then is the maximum level of choice that can exist. A specific terminal operator is unlikely to offer a service perfectly fitted to the requirements of all potential tenants. The operator may choose to target a particular sub-market, such as low cost or full service. So one might argue that such competition only operates at the margin, and with a small number of terminals there is a limited amount of competition. Nevertheless, it is the greatest competition that can be expected, and faced with the possibility of losing or gaining tenants, terminal operators may be persuaded to do their best to serve their requirements.

The main example we see of independently operated terminals, is where a **terminal is dedicated to a given airline, or airline alliance**. Then those airlines can choose their requirements. They have choice, but the other airlines on the airport excluded from such an arrangement do not. They might arguably have been said to have some choice at the point when the opportunity was available to secure such a terminal, but it may not have been a practical choice for them. There is some choice in this model, but it is less.

Another example we see of independently operated terminals is when **a terminal is offered as a concession for a defined class of users**. This could be closely defined, like international vs domestic, or European vs long-haul. In practice, in this case, there is no real competition as airlines have to use the terminal designated. One could imagine some designation that offers some degree of flexibility at the margin, such as low-cost vs full-service, as airlines chose which way to go, understanding the service they would obtain. However in general the purpose of such designations is to give terminal operators greater certainty of the business they are operating, and not to create a competitive offer for the potential tenants. We do not see these as offering very much choice to airlines. The point of them is more about increasing the financial feasibility of independent operation and trying to drive down the cost of delivering a given level of service through competition for the market, rather than competition in the market. Such commercial operators may also have a greater commercial desire to improve the attractiveness of their offer to airlines and thus attract in more business within their market segment than the traditional airport model. This could be said to be a kind of choice operating in the market.

In considering the advantages and disadvantages of various business models, we will import these considerations of choice.

6.2.2 Business models for Dublin Airport Terminal 3

A business model sets out the purpose for the terminal; the strategy that underpins the design and operation of the airport. T1 and T2 have a joint business model. The two terminals are in competition with each other as they have the same airport charge cap[65] (as set by daa), and each terminal has an anchor airline with a significant majority of its traffic (Ryanair at T1 and Aer Lingus at T2), and commercial revenues.

The government's policy in relation to airports and aviation is set out in the National Aviation Policy, 2015.[66] Chapter 4.3 of that document outlines the role of State airports, including the government's policy position that *"the three State airports will continue to provide essential strategic infrastructure and services that support the economic and social objectives of the State"*. The National Aviation Policy also committed the Department of Transport, Tourism and Sport (DTTAS) to commission a high-level strategic capacity review of State airports in Ireland (Dublin, Cork and Shannon). This review should take account of the policy objectives of *"developing Dublin Airport as a secondary hub supporting services to global markets without weight restrictions"*. It should also take account of *"wider government objectives and policies for enterprise, tourism and balanced regional development in Ireland and developments in the global aviation market".*[67]

Hub operation is an activity of airlines facilitated by suitable airport facilities that enables hub pattern flight scheduling—i.e. sufficient runway/terminal capacity for airlines to fly close enough to when they want to - and convenient transfer for passengers between flights. Our understanding is that Dublin is generally perceived within the aviation market as already being a secondary hub.

There is currently no pre-determined business model envisaged for T3, with DTTAS' objectives leaving the options fairly wide. The primary aim of DTTAS

[65] At the opening of T2, there was a temporary discount to the T1 charge.

[66] DTTAS, *A National Aviation Policy for Ireland*, (August 2015).

[67] DTTAS, *Request for Tenders dated 11 November 2016 for the provision of Consultancy Services to Review the Future Capacity Needs at Ireland's State Airports*

for its state airports is not to maximise profits, but to maximise the overall contribution to the Irish economy.[68] Although formally there is no longer a specific mandate to have regard to financial sustainability/viability, DTTAS explained to us it is nevertheless intrinsic to the broader elements of the policy remit that Dublin Airport be a successful and viable airport. It may be relevant to compare this with commercial companies that can be described as successful and viable and achieve this within a higher risk environment than the typical regulated infrastructure provider. They may experience greater variability of returns, and may from time to time have to make capital write-downs. We include in the following that, potentially at least, daa might have a risk profile more consistent with a commercial company.

This could be in line with a range of business model options, including:

- T3 could either replace T1 or compete with T1/2.
- T3 could become an airline hub.
- T3 could be for a designated group/type of traffic**.**

It might also be possible for T3 to be part of a wider plan to make Dublin Airport overall a primary hub airport, rather than its current secondary hub status.[69] This option could include BA moving some traffic over from Heathrow, which may be a consideration for the organisation post-Brexit.

The tables below provide a brief discussion of the options considered. These are then summarised and assessed in Fig. 80.

Fig. 80. Discussion of business model options considered

T3 could compete with T1/2

This could be treating T3 as a simple expansion of capacity (to meet anticipated demand) within the existing business model. All terminals could still have much the same quality standard and the same airport charges. Alternatively, T3 could be allowed to vary in quality and/or charges, providing different choices to airlines.

This option provides a good level of flexibility for users, and therefore efficient use of the infrastructure—if there are three terminals with reasonably similar service standards, airlines can easily switch between the three.

If T3 provides too much additional capacity to Dublin Airport, there could be problems with stranded assets and labour costs—at Dublin Airport or at Ireland's other airports. If there is too much capacity at Dublin Airport, and demand concentrates in two of the three terminals, then the lesser-used terminal has an asset that is still depreciating but without sufficient income. This works on an airport scale too—if there is "too much" capacity at Dublin Airport, it may reduce charges to encourage flights from Shannon/Cork to move to Dublin Airport, leaving potential stranded asset issues at these other airports.

[68] In 2017 government policy stated that it would "no longer be mandated to have specific regard to the financial sustainability/viability of the regulated entity in making a Determination." See: DTTAS *National Policy Statement on Airport Charges Regulation* (September 2017) available online. We understand that this statement is currently an aspiration: the legislation currently enacted explicitly requires CAR to have regard to daa's ability to finance itself.

[69] As we noted above, the 2015 National Aviation Policy has as specific objective that "Dublin Airport will be promoted as a secondary hub", although the 2017 National Policy Statement on Airport Charges Regulation did not make any explicit statements on Dublin Airport's hub status. Dublin Airport is now generally regarded as already being a secondary hub, which is why we refer here to a potential aspiration for being a primary hub. Given the nature of hub operation, described above, any of these options can be consistent with continuation as a secondary hub or development as a primary hub.

Terminals (and airports) have a minimum required amount of staffing, e.g. to meet legal security requirements, and so some "fixed" level of staffing cost would remain for as long as the terminal remains open, regardless of the number of passengers. These issues are discussed in further detail in Section 6.4, but represent real risks to existing or new terminals if demand is significantly lower than forecast.

A third terminal in competition with T1 and T2 could be a sensible option if there is confidence over the anticipated demand growth in the coming decades, However, due to the stranded assets/labour issue, if the forecasts are uncertain or particularly susceptible to shocks (economic or otherwise), incremental capacity improvements may be a more beneficial approach to addressing short and medium-term capacity constraints.

T1 could be retired when T3 is completed

T1 has a current estimated maximum capacity of about 19.5m passengers and was opened in 1972 with frequent upgrades since. There might, therefore, be a desire to remove and replace T1 with a new terminal, or at least make the kind of thorough renovation of T1 that temporary closure might allow.

T1 was not constructed in one phase, rather there have been incremental increases over time which were not planned in the original design. This incremental approach can result in a less efficient terminal overall, as compared to a terminal which has been planned from the outset, including potential future upgrades/expansions. If a T3 can be constructed to cover T1's current capacity plus any short-term growth, with a plan for well-integrated extensions for medium- and long-term passenger growth, there could be some efficiency gains.

In any decision to retire T1, DTTAS would have to consider how to deal with its residual asset value. Assuming no further T1 investment from 2028 onwards, the residual asset value is fully depreciated after eight years. daa and CAR may differ in their approach to the depreciation profile (e.g. choice of straight-line, annuity, or tilted annuity) but both assume an asset life for a terminal of up to 50 years, so it is clear that either approach would provide a significant residual asset value, while their values may differ.

There are two options that seem most likely for dealing with any such situation at Dublin Airport:

- The residual value could be recovered through T3, with the justification that if doing so makes T3 financially unviable, the case for retiring T1 is weakened.
- The residual value could be recovered through T2 and T3 jointly, with the justification that the decision to retire T1 is strategic (rather than purely a part of the T3 financial case) and should benefit both remaining terminals. This would be similar to the approach with Heathrow T2.

Because of this residual asset value, we would not consider retiring T1 as a feasible financial option. However, strategic reasons may also play a significant role in the decision-making process and may justify the retiring of T1 even if it does not seem feasible to do so on a purely financial basis at this moment in time.

T3 could become an airline hub

Ryanair and Aer Lingus, the current anchor tenants of T1 and T2, could opt to become anchor tenants of the new T3 instead, making it their hub.[70] This would mean that additional capacity would be predominantly available at the terminal that the anchor tenant is vacating—and T1/2 may be a less appealing option than T3 for encouraging new airlines/routes etc.

Alternatively, another airline such as BA might be interested in becoming an anchor tenant of T3 and making it its new hub, but they would have to have confidence that they could grow their number of flights from Dublin Airport—at present about 80 percent of seats on Dublin Airport's flights are with Ryanair and Aer Lingus.

Dublin Airport is a coordinated airport, and therefore as set out in the case study below, 50 percent of new slots on the second runway (due to open in 2021) would have to be first offered to 'new entrants'. While Aer Lingus and Ryanair clearly already have the justified traffic levels, other airlines would have to ensure they have confidence in their growth abilities. Airlines with modest numbers of flights, but which are too large to count as a new entrant, may therefore find it difficult to grow their business enough to justify a base. Given the secondary market for airport slots, it may be a case of buying slots over time—requiring that neither the cost nor the wait reduce the value of the investment to a significant extent.

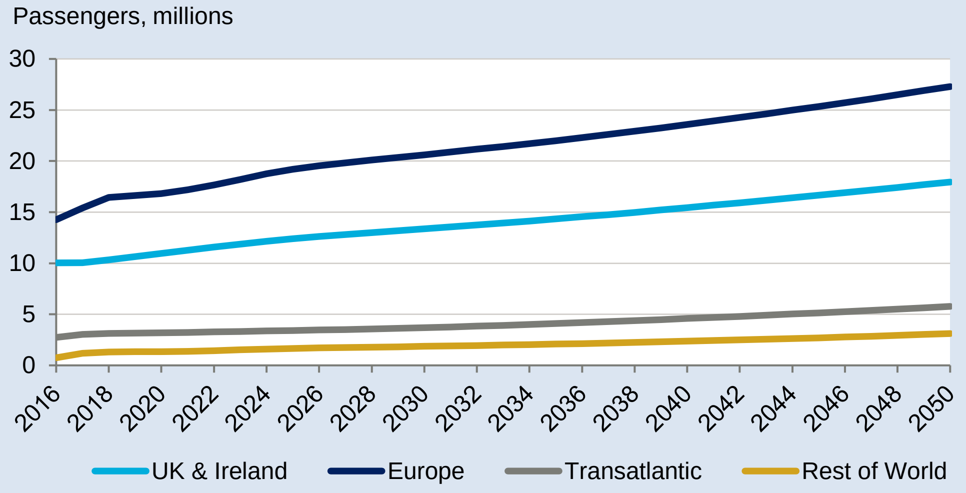
T3 could be for a designated group/type of traffic

[70] When IAG bought Aer Lingus, they made commitments about how they would operate – but these commitments were time-limited. As a result, when these commitments lapse, Aer Lingus may be able to operate in a different way, in line with IAG's interests.

The developer of an independent competing terminal may prefer to differentiate their product so as to specialise in a particular airline market sector and reduce direct competition with the other terminal(s).

Long-distance traffic has grown at Dublin Airport in recent years, and Dublin Airport is popular for US flights due to it having immigration clearance before boarding, rather than upon arrival in the US. There might be an opportunity to grow this traffic further at Dublin Airport, and a separate terminal focused on this type of traffic would allow the airlines and terminal operator to ensure that the terminal is best-placed to serve that market and make the most of the opportunities (e.g. premium commercial offerings, expanded U.S. pre-clearance). But is not clear that transatlantic (and Rest of World) traffic growth in coming years would support this—these two areas have a combined forecast 2050 demand of less than 10m pax (as shown in Fig. 81).

Fig. 81. Demand forecast, by region of flight's origination/destination



Source: Oxford Economics

Specialising in the low-cost sector is another possible option, as it could attract airlines that are looking specifically for lower charges. There are two distinct questions here: whether a terminal should be permitted that is deliberately set up for low cost customers only, and also whether there should be any explicit requirement from the state that new facilities should be designed for low cost service.

We need first to understood that "low cost" is an approximate categorisation. Airlines considered "low cost" typically have an operating model that requires different facilities within a terminal that are cheaper to provide. But one cannot say precisely what is a low-cost terminal, because the requirements of individual airlines are forever changing, as is the balance of the business of an airport. Airports typically try to meet the varying requirements of their airlines, to the extent it is practical to do so. In particular, Dublin Airport has been effective in purposing areas of its terminals to meet the needs of both low-cost airlines and full-service airlines. T2 was initially purposed for full service airlines, and accordingly when T2 was opened T1 was purposed for the needs of low cost airlines. However, daa is now repurposing part of T1 for full service airlines as it cannot provide all the requirements of the growing full-service business in T2. The repurposing of T1 to low cost has left some spare space in T1 to let it do this.

Clearly a dedicated, purpose-built, low-cost facility is capable of being cheaper to construct and more economical of space than a full service or mixed-use terminal, as such purpose-built terminals elsewhere (eg, Bergamo, Luton) demonstrate. But provided within common use facilities, given the revenue/cost balance it is not necessarily materially cheaper to provide for low cost airlines. This is because the customers of low cost airlines also typically spend less money in the terminal, so the proportion of the revenue requirement that is needed from landing fees can be higher in the case of such facilities.

[Redacted] It is clear that in some regions of the world there is strong competition between airports to attract low-cost traffic, because discretionary travellers such as tourists can choose to go to another destination that is overall cheaper. But it does not appear that, in the specific location of Dublin, there is a strong requirement to provide the cheaper service facility the low-cost airlines might prefer. Ryanair has successfully grown its demand at the existing T1 without needing particularly low charges, although clearly it would prefer them to be lower. Additionally, the review of the T2 expressions of interest set out that lower charges are not considered to encourage large increases in tourism (as charges are small compared to the overall cost of a tourist's holiday), so it may be that the potential demand benefits of a low-cost terminal might be outweighed by deterring full service airlines from using that terminal also. Section 4.3 sets out that a LCC terminal would indeed be able to achieve lower charges than any of the other modelled scenarios, but whether this leads to an overall net benefit is more of a qualitative question.

Full service airlines would be unlikely to use a low-cost terminal that lacks the services that their higher fare-paying customers expect, regardless of the lower charges that may be allowed. This was one of the proposed options in 2002/03, but as highlighted in the earlier T2 case study, it was not considered a viable strategic option.

If a terminal was to be developed entrepreneurially, then any designation or restriction would reduce the ability of that business to maximise its business and compete effectively. A reasonable question is whether the ability of such a business to maximise its income would tend to "cream-skim" the best business in the airport—it seems plausible that it would try. If so could this potentially result in an unbalanced airport that can no longer service the requirements of the airlines that would deliver? We think not. Whilst clearly an entrepreneurial terminal will seek the best business it can get, we believe that airports do not service unprofitable business, and there are not strong business conditionalities that mean that selecting out the best traffic means that the rest of the traffic is financially not capable of being served.

In particular, if the other terminal is developed by daa, then daa has shown its ability to match the services to the traffic. The exception to this might be in a non-competing concession model, where the terminal concessionaire would reasonably require a designated exclusive traffic segment to keep risk low.

Overall, we consider that it may not be optimal for government to designate a third terminal to any single type of traffic. Whilst clearly parts of the airport may be specialised to particular operations, it does not require a policy steer to achieve this. An independent operator will wish to select their own business, this is the point of competition and independence; daa can also manage its own business. Nevertheless an airport will tend to specialise in different business in different parts. Thus in business models such as a concessioned terminal, where daa is acting as an overall planner of the airport, then daa may find it commercially appropriate to designate such a terminal for a particular market, and also as part of the risk management issues in relation to that concession.

Fig. 82 below summarises the advantages, disadvantages, and overall feasibility of these options.

Fig. 82. Summary of business model options for T3

	Advantages	Disadvantages	Overall feasibility
Common-user T3 options			
T3 competes with T1/2	Simple expansion of capacity without changing the business model of the airport. Provides choice if the independent operator has sufficient freedom to contract.	Risk of excess capacity resulting in stranded assets – requires careful planning.	Sensible if there is confidence in the growth forecasts for the coming decades. An investor is apparently interested in this option and is willing to risk its own money. But this is a commercially high risk model and in other situations there may not be investor interest.
T3 replaces T1	Replace T1 capacity with a more efficient terminal rather than further continued incremental changes. Choice possible if the closure of T1 is the voluntary choice of daa faced with competition from T3.	Residual asset value of T1 needs to be accounted for. Removal of excess capacity may result in lack of practical choice for airlines who have to fit into the remaining available capacity.	Difficult to justify without any clear business cases having been proposed by daa/ potential investors.
Specialised T3 options			
Airline hub – Ryanair or Aer Lingus	Provides a strong base for an airline and provides some confidence of expected traffic for the terminal. Gives choice to the airline at the point that it is given the option of selecting to move into such a terminal, if terms were negotiable.	Both airlines appear content in their existing terminal. Would leave a significant amount of unused capacity at T1/2, which may find it more difficult to attract new customers than T3.	[Redacted]
Airline hub – another airline or group of airlines	Provides a strong base for an airline and provides some confidence of expected traffic for the terminal. Gives choice to the airlines at the point that it is given the option of selecting to move into such a terminal if terms were negotiable.	Would require a significant confidence in growth, and no current proposals. EU Slot allocation rules may make the required growth slow or expensive. Other airlines have no practical choice after the decision is made.	[Redacted]
Designated low-cost	Would allow lower charges, encouraging growth and competition.	Would discourage full-service carriers (FSC) from using the terminal, making the terminal's capacity less flexible -if LCC falls and FSC grows, would need an upgrade. Limited choice as the terminals are largely allocated.	[Redacted]
Designated long-haul	Allows a terminal to focus on the requirements and opportunities related to long-haul traffic.	Only forecast ~10m pax by 2050; would be small, bringing potential inefficiencies. Limited choice as the terminals are largely allocated.	[Redacted]

Note: The implication of the redacted statements is that the overall feasibility of these options is unclear.

Source: CEPA

CASE STUDY: EU RUNWAY/TAKE-OFF SLOT-ALLOCATION RULES[71]

Airport slots refer to the full set of rights etc. required for an aeroplane to take off or land at an airport. The EU Airport Slot Regulation 1993 requires an "independent national coordinator" to allocate slots at any "coordinated" airport—those which have capacity constraints. They are allocated twice each year for the two seasons.

An airline is entitled to continue to use a slot from one scheduling period to the next, as long as it used that slot at least 80 percent of the previous time in the previous period (exceptional circumstances may be taken into account). These are called "grandfather slots" and are allocated first. The remaining slots are then allocated, with 'new entrants' (those with few slots per day) being allowed priority access to 50 percent of these slots. Secondary markets have emerged for reallocating the slots between airlines. New entrants may be able to theoretically buy slots to which they have free rights, and then sell them onto established airlines.

6.2.3 Financing and operation of Dublin Airport Terminal 3

There are three main alternative options for the introduction of T3:

- A single airline operator for T3, bringing an almost guaranteed revenue stream and some risk-sharing opportunities.
- A single independent owner (not an airline) for T3, which might be better than airline-operated for smaller airlines or those with less frequent flights.
- A consortium owner for T3, which may include both airlines and non-airlines, and may offer more risk-sharing opportunities.

To enable the independent operation of T3, it may be appropriate for daa (the operator of T1 and T2) to become an independent system operator which would operate all the non-terminal infrastructure but not the terminals. Instead, the three terminals would be operated by one or multiple separate entities; perhaps daa could set up an entity for T1/2 with an airline/third party for T3. We have not included this in our "conditions precedent" as it is not yet clear if it is necessary, however it should be kept in mind.

Independent operation itself brings several benefits, but also presents some challenges, regardless of the type of party that operates the terminal. These are summarised in the table below.

[71] House of Commons Library (Jun 2017) "Briefing Paper: Airport Slots."

Fig. 83. Key benefits and challenges of independent operation

Area	Discussion
Competition	An independently operated terminal, with charges allowed to vary between terminals, may provide choice to airlines – introducing competition between terminal operators. This is likely to encourage operators to take a more customer-orientated approach. This may lead to an offering more carefully tailored to the requirements of airport customers, as well as attempting to reduce the cost of delivering that as the airline would have a choice. It is nevertheless the case that style of terminal that the independent operator designs will have an effect on what kind of customers it can most effectively serve. A first new independent terminal operator may well choose to try and focus as what it sees as the most remunerative kind of traffic and seek to attract those operators into its terminal. Clearly it will still need to improve the offering to those airlines in comparison to what they can obtain elsewhere on the airport. The legacy airport will also try to avoid losing too much traffic and react in similar fashion. An issue in infrastructural industries, particularly where there is a "supplier of last resort" can be that competition/entry serves mainly to "cream off" the best business. This may unbalance the overall infrastructure offering given the requirement to serve all. It could perhaps result in inefficiently sized or located terminals for the long-term airport development. In the early stages of competition, when excess capacity is present, and given that airport users are in general expected to pay their way, these do not seem to be genuine concerns – there is not a class of airport user that is unprofitable to serve. Airports expect to have excess capacity at periods during the expansion process. As we have seen with a new T2 at Dublin Airport designed better to serve the specific needs of full service airlines, the original T1 was repurposed as a low-cost terminal. This did lead to excess capacity in T1, but this is inevitable in the airport development cycle. Thus we do not see this as a material issue, but rather that competition is more likely on balance to allow assets to become better matched to the requirements of users. The level of competition will tend to diminish as the airport becomes more full. A greater concern with competition is therefore the longer-term development of the airport, approaching the time when new capacity may be needed, which we discuss further below. A regulatory benefit of having different operators at different terminals would provide CAR with a ready comparator for daa, allowing benchmarking and enabling potential additional efficiency savings.
Additional work and risk involved in developing contracts etc.	Well-constructed contracts/letting procedures can drive beneficial efficiencies and attract capital but requires additional work and time to devise these in comparison to development in comparison to development as usual. Rather different kinds of contractual and regulatory structures are required for the different business models. The concession structure and airline-aligned terminal are well established structures internationally. There is an understanding of the kind of legal structures to enable them to proceed in a well-ordered fashion. The independently competing terminal is less well known and more of an exploration of the kind of regulatory structure that would enable it to function well. However, there are clear analogies with vertical unbundling in some other industries around the world – telecoms, energy – which present some kind of guidance. (In contrast, rail has typically not been as thoroughly unbundled as these, and thus offers a less useful parallel.) It is important to ensure that the rights are well-defined. One notable case where the failure to ensure this has caused an issue is with Murtala-Muhammed Airport in Lagos. Here, the economic case for the development of a privately financed and operated second terminal, specialising in domestic traffic, was based on the agreement that the government would stop operating another terminal – but it remained in use, among other non-compliances, resulting in legal disputes.[72]
Future development of the airport	Independent operation of T3 may result in later complications when adjustments are required for development of the airfield, as there would be more parties required to coordinate (and potentially contractual areas to deal with). As the capacity on the airport fills, an interesting question is therefore how does the next increment of capacity arise. This is affected by the kind of freedom to the various operators have to make extensions to their operations? To the extent that each operator has some, there can be beneficial competition to

[72] Department for International Development and CEPA (Aug 2015) "Mobilising finance for infrastructure: Nigeria country case study" p.29 available online

Area	Discussion
	provide that next increment. For example, if a terminal cannot accommodate an airline which would like to move in, it might develop additional capacity to take it, even though the airport is not quite full yet, thus intensifying rather than reducing competition. With only two operators on the airport, the level of competition might not be so great, however, a degree of implicit mutual understanding can arise in duopolies. Nevertheless two is much more than one in terms of the competition arising. It is also potentially possible, once the regulatory framework exists, to spin off an existing terminal and increase two to three (although there are some common facilities shared between T1 and T2). Another interesting question arises if in effect there is a requirement to expand a terminal, and neither operators is providing that voluntarily, or is unable to access land/consents to do so. Expansion in this case may require more negotiations and setting up than current expansions of T1/2 need, which may lead to delays. A further question would be the potential development of a fourth terminal. An independent operator on the airport would inevitably try to defend its business from competition and seek to maintain its market position. Who might develop that fourth terminal? If competition was a successful model, it might be desirable to introduce further operators. An independently operated third terminal would like to locate its business to make such a development difficult or give it some control over the process because of the need for cooperation. In our judgment, there would be a requirement for some overall supervision to protect the long-term development of the airport, for example in terms of the location of developments, cooperation required to make new developments, for example in relation to access issues.
Time delays	It takes time to procure a private party to deliver and operate infrastructure, with DTTAS in 2003 estimating that procurement of an independent party to operate T2 could take four and a half years.[73] This is in addition to the time spent considering the most appropriate approach for independent operation. If an airport requires additional capacity in the near future, such a delay could be problematic, and could result in inefficient short-term capacity expansions or constraints.
Operational efficiency	There may be some operational efficiencies from having a single operator for all terminals, which may be lost in introducing an independently operated terminal. Additionally, there may be efficiency gains from having the same operator for the terminals as for the common infrastructure, and if anti-competitive considerations require daa to become vertically separated (i.e. to separate the terminal operator and common infrastructure operator). This is a general issue in the monopoly vs competition debate: many parts of the economy can in principle be more efficient if operated as a monopoly. This argument is often used against the possibility of breaking up monopolies or introducing competition. In most of the economy, the gains of competition greatly outweigh the benefits of integration. Clearly the occasional difficulties that can arise on an airport from lack of cooperation will from time to time be apparent, but in general do not seem to be of sufficient magnitude to be taken seriously as an argument against independent operation.
Procurement or planning process	A relevant authority, whoever it is decided to be – be DTTAS, CAR, daa, or another specific body – may set out a specific requirement or approach for the third terminal. In the case of concession-like structures, bids would be focused on approaches to e.g. building the outlined terminal, providing the required service level, etc. The more specific the requirements, the less potential for variation between bidders, leading to more of a focus on price but less on 'innovation' or service delivery. In the case of more commercially free arrangements, authorities may set out some high-level constraints (e.g. IATA service standard, minimum/maximum capacity, locational constraints) and allow bidders to propose the detailed specification including the facilities. This may make it more difficult to assess the bids or plans but could bring meaningful benefits in terms of encouraging different approaches, and encouraging the bidders to think about how the terminal can best service its customers.

Source: CEPA

[73] DTTAS (Feb 2003) "Dublin Airport: Review of expressions of interest for an independent terminal" available online p.74

Below we discuss various areas which may differ depending on the type of party and/or arrangement.

An airline may wish to operate T3, allowing it to make T3 one of its regional bases. This could be one of Ryanair and Aer Lingus, which in 2016 together accounted for approximately 80 percent of the passenger seats available at Dublin. One might relocate their Dublin operations to T3, leaving the other as the majority user of T1/2. This might result in there being one terminal for Ryanair, one for Aer Lingus, and another for "all other operators".

Alternatively, a different airline might wish to become the T3 operator. For example, IAG/BA might choose to move its future growth out of Heathrow and into Dublin, which could contribute to Dublin's future growth.

While there is competition ***in*** the market at T1 and T2, at T3 this would be limited if airlines are able to compete ***for*** the market by applying to become the terminal operator (giving them some guaranteed capacity). However, EU rules on allocating slots (see earlier case study) mean that 50 percent of the slots on the new runway will have to be offered to new entrants first—meaning any airlines that already have a non-negligible presence at Dublin Airport could find it difficult or expensive to find a sufficient quantity of new slots to justify a regional base. New entrants, which get priority access to 50 percent of the slots, have not yet established their market at Dublin and so would be unlikely to perceive a strong business case for attempting a regional base.

A non-airline private party may become the terminal operator, as has been the case with Schiphol Group being the operator of JFK T4 since 2001. Much of the benefit of such a concession could also be gained by having an airline operator or a consortium which includes an airline. A key potential advantage to having a non-airline operator is that airlines which do not have enough demand at an airport to provide them with bargaining power, or which do not have their own designated terminal (as several airlines have at JFK), are able to deal with an independent service provider rather than with one of its own competitors.

CASE STUDY: JFK TERMINAL 4[74]

Terminals at JFK all compete with each other. All have some airline involvement, except T4 which is privately owned by a subsidiary of Schiphol Group (operators of Amsterdam Schiphol airport). Schiphol won a concession contract in 1997—to turn the International Arrivals Building into T4, which opened in 2001 and is contracted until 2043.

Here, the private developer took revenue risk. The lease encouraged on-time completion as the rates could only be increased once the terminal was completed—but then higher costs were incurred to ensure that it finished on time.

The lack of an "anchor tenant" proved important: there was no one to heavily influence the T4 operation (until an expansion in 2010 when Delta got a preferential lease status). Low frequency airlines preferred T4 over other JFK terminals, as it was less likely a "landlord airline" will bump their flights to help its own schedules, and because the airline-operated terminals are less flexible to negotiate with.

Without an airline being involved in operation of the terminal, it is possible for a substantial amount of the capacity to be open for competition between airlines on an ongoing basis—with airlines having full choice to move between terminals, subject to contracts and capacity. This would enable repeated/ongoing competition between terminals, although this may diminish over time, as airlines become established in specific terminals and fewer runway slots remain free. It is possible that an airline—an existing dominant airline or an emerging third dominant airline—might choose to become an anchor tenant. With either approach, ensuring that competition remains in the long-term would be a clear challenge for the regulator to consider when setting out new arrangements.

The terminal may be funded and operated by a consortium, which may or may not include an airline as part of that terminal. We would expect that a consortium would be most likely to operate the terminal in the situation of a BOT, where there exists a wider range of risks to be managed than in a pure operation and maintenance contract. Different parties might be better placed to manage different risks, for example there might be separate consortium members to focus on construction risk, performance risk, and revenue risk.

Whether or not an airline is involved in the consortium affects whether this model would bring more competition ***in*** the market or competition ***for*** the market. We have earlier discussed the benefits of competition in the market. Alternatively, if there is an airline as part of the consortium (competition for the market) may help an overall consortium to make a better offer, as the airline would bring important insight and likely take some demand risk. It would, however, result in an inflexible use of terminal capacity (as opposed to the regulated runway capacity). [Redacted]

In Fig. 84 below we tabulate some brief descriptions of independent terminal models that have been tried around the world. The purpose is to indicate that

[74] International Civil Aviation Authority (Sep 2015) "PPP – case study – United States"
JFK International Air Terminal LLC (Accessed March 2018) "Terminal 4 – the terminal of choice"

two models are well established and tested, namely the concession model, with a defined market, and the airline-aligned terminal. We also find independently operated common-user terminals where the other terminals are airline-aligned. What we do not see is independent common user terminals competing with other common user terminals. We believe that this is a potentially feasible model. It is most similar to vertical unbundling that has occurred in other regulatory sectors, facilitating competition in more parts of the value chain, such as in telecommunications and energy. Nevertheless, within airports this is innovation and there are risks involved in being the first to devise a working institutional structure and regulatory model for it.

Fig. 84. Case studies of independent finance or operation of airport terminals

Airport	Discussion
JFK T4	See extended case study above. JFK is an airport with a number of airline-aligned terminals, with the non-aligned T4 operating as a common user terminal. Airlines/alliances with a large enough presence at the airport may operate their own terminal, but others are generally use the non-aligned terminal. Thus the independent operator of T4 has a kind of defined concession, and not every airport user feels they have a choice. Many other US airports have a dichotomy between airline/alliance aligned terminals and common user terminals, so it is a well-understood model in that country, though most airports have only one major resident airline.
Toronto Pearson T3	Opened in 1991, Terminal 3 at Toronto Pearson is often described as the first separately privately financed and operated airport terminal within a wider airport. Terminal 1 is a Star Alliance terminal, and Terminal 2, since demolished, was a hurriedly converted cargo centre whose purpose was to provide some modest additional capacity in a hurry. In effect the privately built/operated T3 was a common user terminal serving non-aligned airlines, but we have been unable to discover how much commercial freedom it had. The immediately subsequent history of Pearson is confused by a botched privatisation in 1992 which was cancelled by the in-coming administration in 1993. Ultimately T3 was bought out for a substantial sum (>C$600m) in 1997 by the GTAA, a newly created public local transport authority, created to take over the airport following this difficult period, we have not been able to discover why they chose to buy it out. Difficult to learn lessons from this complex history.
Prague T2	Terminal 2 at Prague Airport was let as private finance arrangement. On opening, T2 was designated as the terminal for Schengen scheduled traffic, whereas T1 handled other scheduled traffic. Other terminals, on a separate site not integrated with the main airport, handle non-scheduled traffic. This is a common PPP model for airport expansion around the world and creates a seamless airport under standard terms to users. The airport has subsequently been refinanced for further expansion and is intending to make a reallocation of traffic between T1 and T2 on more typical airline division, so this may have extinguished the original arrangement.
Munich T2	Terminal 2 at Munich is developed, financed and operated by a separate company, which is a joint venture on a 60/40 basis between the airport and Lufthansa. The terminal is a dedicated Star Alliance terminal. Ryanair made a complaint to the European Commission, alleging state aid to Lufthansa. The Commission dismissed the case. Nevertheless, it indicates the importance of demonstrating fair arrangements when there is an airline/alliance aligned terminal.
Birmingham EuroHub	T2 (then the "EuroHub") opened in 1991 on an executive lease to BA. BA took over operations and made this its regional base – but did not take over security or maintenance. The local authority owners reduced their shareholding to a minority in 1993, to restructure it into a private sector company, as this was necessary to finance the £260m development, as new public sector borrowing restrictions were put in place. BA owned about 20% and were considered necessary partners as they helped to guarantee a revenue flow for the terminal. The airport was refinanced in 2010 to pay for combining the two terminals, so there is no longer any independent arrangement.
Budapest Airport /ADC	The Hungarian government entered into a public-private arrangement with Cyprus/Canadian company ADC, linked to Montreal Airport, to carry out some new build and refurbishment, and operate two of the several terminals at the airport. The refurbed/new facilities opened in 1997. In 2001 the Hungarian Government expropriated it for no clear reason. ADC were awarded most of the compensation they asked for by an international court. It seems that the arrangement with ADC was a typical concession

Airport	Discussion
	arrangement. Since the government entered into a much more valuable concession for the whole airport with Hochtief in 2005, the expropriation may simply have been to clear the way for that.

The table below summarises the advantages, disadvantages, and overall feasibility of the business models that we have set out in this sub-section.

Fig. 85. Summary of different funding/operation options for T3

	Advantages	Disadvantages	Overall feasibility
Daa operates T3	Operational efficiency. Efficient/fast future development of the airport. Known arrangement.	Reduction in competition as compared to independent operation – and potentially reduced efficiency and growth opportunities. Economic regulation is inevitably an imperfect substitute for competition in the market	Feasible solution for ensuring fast addition of capacity and a coordinated overall airport.
A single airline operator of T3	An airline may be able to design/procure a terminal to best fit its business model and customers. If the airline is not Aer Lingus or Ryanair, presents good demand growth opportunity.	Limits competition in the market. A single airline may struggle to find enough slots on the second runway given EC legislation. Time delays for procurement and developing/updating suitable contracts.	While this model has been seen elsewhere, [Redacted] .
Third-party operator of T3 – no airline tie	Equal treatment of airlines facilitates competition in the market.	Complex regulatory requirements to ensure equal access to common user facilities. Time delays for procurement and developing/updating suitable contracts – maybe require interim capacity increases until T3 is ready. Higher commercial risk.	Feasible solution for ensuring medium-term and, with sufficient safeguards, long-term competition, given that an investor is apparently willing to proceed with it (hard to know whether other investors would take a similar view), but have to carefully plan how to deal with any interim expansions to T1/2 as it may expose daa to stranded assets.
Consortium operator of T3 – including an airline	Ability to share risks effectively across the consortium partners.	Time delays for procurement and developing/updating suitable contracts. A single airline may struggle to find enough slots.	While this model has been seen elsewhere[Redacted]. The previous option may in practice evolve in this direction.

Note: The implication of the redacted statements is that the overall feasibility of these options is unclear.

Source: CEPA

6.2.4 Bringing together business models and funding/operation options

In Fig. 86 below we set out the high-level advantages and disadvantages of the matrix of options for combining business models and funding/operation options into scenarios. We also provide a comment as to the feasibility of each option. In relation to the specialised options, we recall that we concluded above that specifying a specialisation to an independent operator was likely not best. Within a centrally planned airport, it is likely that cost is minimised by the planner specialising various parts of the airport in accordance with the overall market needs.

Fig. 86. High-level initial summary of feasibility of various business model and funding/operation options

Columns: Funding/operation Rows: Business model		Daa operates T1-3	Single airline operator	Third-party operator	Consortium operator
Common-user T3	T3 operates alongside T1/2, competing in some scenarios	• Similar to the current operations, with daa taking the demand risk. Might lead to excess surplus capacity, depending on demand forecasts. • This option is considered feasible at this initial assessment, and so is further assessed through modelling in the next section.	• Viable for Aer Lingus (T2) or Ryanair (T1) but if either move into a T3, it is unclear if growth would be sufficient to keep both T1 and T2 open.	• A third-party may be tentative about taking on demand risk for T3, depending on the demand forecasts. Might have an interest in routes, e.g. Schiphol JFK T4. • This option is considered feasible at this initial assessment, and so is further assessed through modelling in the next section.	• An airline may wish to join with a consortium, e.g. an airline to take demand risk and the others taking construction/performance risk. • This option is considered feasible at this initial assessment, and so is further assessed in the modelling of scenarios in the next sub-section.
	T3 replaces T1	• This would be run similarly to the current operations, with daa taking the demand, construction, and performance risks. Due to the residual value of the terminal we consider it unlikely. We discuss this scenario further in Section 6.3	• Aer Lingus (T2) or Ryanair (T1) may choose to move their operations into a T3– but would the other may then request a T4.	• Given that traffic would move from T1, limiting demand risk, this could present a profitable opportunity to a third party, but given the stranded assets it would create, we consider it would not be politically acceptable.	• An airline may wish to join with a consortium, e.g. airline taking demand risk and the others taking construction/performance risk.
Specialised T3	Airline hub – Ryanair or Aer Lingus	• Not very likely that daa would operate a hub for a single airline.	• Aer Lingus or Ryanair may move their existing operations to T3, freeing up lots of capacity at T1/2.	• A third party may prefer using a contract to manage demand risk (rather than a consortium) e.g. if they want the cash flow rather than having the airline putting in equity as part of a consortium.	• Aer Lingus or Ryanair may move their existing operations, to T3 with a consortium for e.g. a BOT, freeing up lots of capacity at T1/2.
	Airline hub – another airline (e.g. BA)	• Not very likely that daa would operate a hub for a single airline	• Another airline, e.g. BA, may choose to move existing operations to T3.	• A third party may prefer using a contract to manage demand risk (rather than a consortium) e.g. if they want the cash flow rather than having the airline putting in equity as part of a consortium.	• Another airline (e.g. BA) may move some of their existing operations to T3 with a consortium for e.g. a BOT.
	Designated low-cost	• As LCC is the majority of T1/2 it might be unviable or suggest a smaller T3.	• Aer Lingus or Ryanair may choose to move their operations out of T1/2 into a T3– but the other may then request a T4, leaving T1/2 as stranded assets.	• There is unlikely to be a good enough business opportunity for a third party here – although less risky demand perhaps than with designated long haul?	• More likely for a BOT than pure operation contract, as there may be limited profitable opportunities otherwise.
	Designated long-haul	• May be unviable depending on percentage of traffic (actual and forecast) – but this would determine the size/ phasing of the terminal.	• It is unclear if it would be likely that any one airline would have enough traffic to make this viable – but could decide size of terminal.	• A third party may contract directly with airlines to manage demand risk (vs a consortium with an airline involved).	• A consortium of airlines, with or without third parties, may be well placed to identify opportunities and take revenue risk.

Note: green cells represent potentially feasible scenarios. Nine scenarios are marked as potentially feasible in this table

Source: CEPA

6.3 ASSESSING SCENARIOS FOR DUBLIN TERMINAL 3

Having considered the range of potential institutional structures for Dublin Airport T3, we selected six scenarios for investigation of their financial properties. These are not necessarily the six most feasible scenarios, rather they represent a variety of approaches for consideration, enabling conclusions on a range of possibilities. Each scenario is measured against a set of baseline assumptions, which includes the assumption that T3 is not constructed and the existing terminals retain their current capacity; 'the baseline scenario'.

The six alternative scenarios bring together the different options for business models for T3 and different structures for the funding and operation of the terminal and are summarised in the table below.

Fig. 87. High-level description of the modelled scenarios[75]

Scenario	Operator	Business Model	Comment
Baseline scenario	daa	T1/2 are operated by daa, no T3	T3 is not a certainty, and whether or not it happens will depend on whether it appears that T1/2 could cope with forecast demand. The status quo is therefore the chosen baseline.
Daa-operated T3 scenarios			
Scenario 1	daa	daa operates all three terminals	This provides a baseline scenario in which daa operates all three terminals. No competition.
Scenario 2	daa	T3 replaces T1	Although unlikely,[76] this is a useful scenario for demonstrating the impact of closing T1. T3 must be able to make up for T1's current demand in addition to any expected demand growth.
Independently-operated T3 scenarios			
Scenario 3	Single airline operator	T3 is an airline hub	This scenario expects that T3 would be set up as a terminal specifically for Ryanair or Aer Lingus. In turn we would expect a relatively low-cost terminal.
Scenario 4	Third-party operator	T3 competes with T1/2	A single operator takes on the contract, using further contracts (rather than a consortium agreement) to get other services e.g. construction, or to share demand risk with e.g. an airline.
Scenario 5	Consortium operator	T3 competes with T1/2	If multiple third parties are willing to put up equity, they may use a consortium agreement to share risk among the appropriate parties, e.g. include an airline taking demand risk.
Scenario 6	Consortium operator	T3 is a designated low-cost terminal	

Source: CEPA

[75] Given the relatively low traffic attributed to transatlantic and rest-of-world flights even in 2050, we have chosen not to develop a scenario for the "designated long-haul T3" business model.

[76] The possibility of closing a terminal after opening a new one, at least temporarily, is inspired by developments at Heathrow. There, T2 was closed for renovation after T5 opened. When T2 reopened, T1 was closed, with no current plan to reopen it. In practice some of the operational space (non-public areas) in T1 are still being used to providing operational capacity for T2.

6.3.1 Approach

To assess the potential impact that these scenarios may have on user charges, we have undertaken high level and illustrative financial modelling. In this model, we are able to change the underlying assumptions behind a range of calculations, presented in the table below. Further detail on the model is set out in Appendix 3: Financial model.

Fig. 88. Assumptions in the financial model

Input	Description
The cost of construction of T3	For the purposes of this illustrative model, and to have a firm data point based on Irish costs, we assume that the T3 is like T2, i.e. costs €931.3m. with the exception of scenario 6 where T3 is assumed to be a designated low-cost terminal, and as a result we assume construction costs are 25 percent lower.
Operating costs	Move in line with passenger demand whilst assuming a set of cost elasticities that are informed by our review of the relevant literature. Further supported by the literature review, we have assumed that T3 operating costs are 15 percent lower when it is a designated low-cost terminal (scenario 6).[77]
Constructed capacity	Again, basing our illustrative model on T2, for which we have a cost, we assume an illustrative base capacity of 16.5 mppa.[78] . An exception is Scenario 2 where T1 is closed on the completion of T3 and so T3 is larger to still allow demand growth (25 million versus 16.5 million), all other scenarios assume that T1 and T2 retain their current capacity. Furthermore, in all T3 scenarios, we assume a construction phasing: 60 percent of capacity is achieved following Phase 1, 75 percent of capacity is achieved following Phase 2, and 100 percent of capacity is achieved following Phase 3.
Cost of capital	For Scenarios 1 and 2 (the daa scenarios), we carry forward the weighted average cost of capital (WACC) from CAR's most recent regulatory determination, updating the value used in future determinations to reflect currently-forecasted risk-free rates. For Scenarios 3-6, with private operators, the WACC achieved at the start of each phase of construction is retained for the life of the asset.
Return on capital	In scenarios 3 to 6, with private operators, we assume no recovery of T3 costs during construction. However, for scenarios 1 to 2, we assume that a rate of return is earned during construction.
Passenger demand at each terminal	In the baseline scenario passenger numbers are split between T1 and T2 based on 2016 passenger numbers. T3 passenger numbers gradually increase as each phase of construction is complete, resulting in an equal split between T1, T2 and T3 at the end of Phase 3 in scenarios 1, 4 and 5. T1 closes at the end of Phase 3 in scenario 2, and its passenger numbers are split equally between T2 and T3, until T2 reaches capacity and then all additional passengers are allocated to T3. In scenarios 3 and 6 we assume that T3 has a greater proportion of passengers, resulting in a 30:30:40 split between T1, T2 and T3 at the end of Phase 3.

[77] Jacobs set out that low cost carrier focused terminals can have charges that are as low as 65-75 percent of the charges at other terminals in the airport. (Source: Jacobs (2007). Review of dedicated low-cost airport passenger facilities. A report for the Commission for Aviation Regulation, Dublin. We would observe it does not necessarily follow that providing for low-cost carriers within a mixed-use terminal is necessarily cheaper, even though they might for example use check-in space more efficiently, because the lower retail income typically arising from the customers of low-cost airlines acts as an off-setting effect.

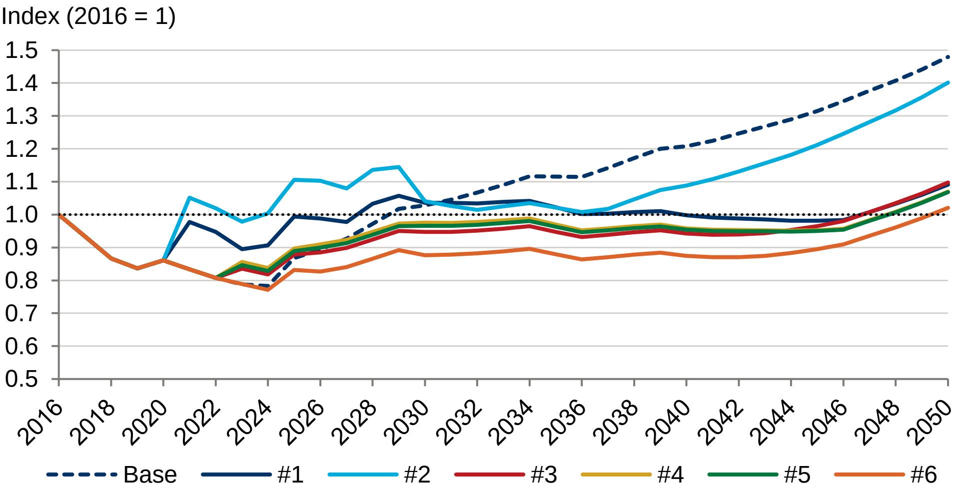
[78] This is a little different from the 20mppa illustrative figure mentioned above. In part this is a consequence of the fact that the modelling was carried out prior to that part of the report being researched. But it is also because we have a cost datapoint for a 16.5mppa terminal. Sensitivities are performed.

Commercial revenue elasticities	In scenarios 1 to 5, commercial revenue elasticities are based on CAR's most recent regulatory determination. In scenario 6, where T3 is a designated low-cost terminal, we assume that the commercial elasticities are 50 percent of the other scenarios.
Productivity gains	We have assumed an annual ongoing productivity rate of 0.75 percent, which is based on regulatory precedent.

6.3.2 Analysing the effect of Terminal 3 business models on Dublin Airport user charges

Fig. 89 below presents the effect of different T3 business models on per-passenger Dublin Airport user charges (relative to user charges in 2016). A separate solid line is shown for each scenario and the baseline scenario (no T3) is represented by the dotted line.

Fig. 89. Analysing the effect of T3 business models on per-passenger Dublin Airport user charges, indexed to user charges in 2016



Source: CEPA modelling

Fig. 89 above indicates that, under the assumption that the central passenger forecasts are achieved, the baseline scenario of no T3 leads to significantly higher user charges compared to scenarios where T3 is constructed. This is because of two factors. Firstly, this is because the cost of maintaining the current airport increases over time. Secondly, forecast passenger numbers exceed current Dublin Airport capacity of 36 million passengers in 2024.[79] As a result, passenger numbers are capped at 36 million from 2024 onwards under the baseline scenario, and hence costs are not spread across as many passengers. In turn, user charges in the baseline scenario are forecast to exceed user charges in all other scenarios from 2032 onwards.

If T3 is constructed, the modelling of Scenario 2, where T3 replaces T1, supports the earlier suggestion (see Section 0) that it is unlikely to be sensible to close T1. Even taking into account the larger capacity of T3 under scenario 2 (25 million versus 16.5 million), Dublin Airport is forecast to breach its capacity

[79] Source: DTTAS Review – Paper 2 – Dublin Airport – Existing Capacity (July 2017). Page 10. Mid-point of passenger departure kerb. Terminal 1 = 19.5 mppa and Terminal 2 = 16.5 mppa.

in 2032. This is compared to Dublin Airport not breaching its capacity until 2045 when T1 remains operational. As a result, by 2050 Dublin Airport user charges are forecast to be significantly higher under scenario 2 than in all other T3 scenarios.

Assuming that T1 remains operational when T3 is complete, overall the private construction of T3 may result in lower user charges compared with the scenario that T3 is constructed by daa (scenarios 3-5 versus scenario 1). However, under the assumptions adopted in the model, there appear to be only minimal differences in Dublin Airport user charges between scenarios 3 to 5. As a result, other evaluation methods are likely to be required to choose between scenarios 3 to 5 if these T3 business models are deemed the most appropriate.

Scenario 6, where T3 is a designated low-cost terminal, results in the lowest Dublin Airport User charges. This is because lower construction charges, lower opex and our central passenger demand forecasts outweigh the relatively lower commercial revenue that will be generated from the terminal.

6.3.3 Scenario financeability

We are also able to use the financial model to assess the financeability of different scenarios by evaluating the sum of discounted cash flows over the modelling period (2016 – 2050). Based on the assumptions used, the baseline scenario (i.e. no T3) has the lowest discounted cash flow. Scenario 6 follows, where T3 is a designated low-cost terminal. But even in this scenario, the sum of discounted cash flows is 15 percent higher than the baseline. Scenario 2, where T1 is retired, results in the highest sum of discounted cash flows, and is around 25 percent higher than the baseline.

However, it is important to note that the outcomes of each scenario are highly assumption driven, and actual user charges may differ significantly from those forecasts if market conditions differ from what has been assumed. This will need to be carefully considered when deciding on the most appropriate T3 business model to adopt.

In an attempt to assess the level of risk we have conducted sensitivity analysis around passenger demand (i.e. actual passenger demand is below forecast) and the cost of T3 (i.e. cost of T3 is higher than the assumed €923m).

6.3.4 Sensitivity testing

As in earlier parts of Section 6.3, we tested two sensitivities where our central passenger forecasts are not achieved by five and 10 percent respectively. Our analysis of these sensitivities indicate, as expected, that the positive impact of constructing T3 on user charges diminishes if the central passenger forecasts are not achieved in reality.

We have tested four sensitivities around scenario 1 where our T3 cost estimate is not achieved, which are described in the figure below. As mentioned above, the €923 million cost estimate for the construction of T3 was based on analysis conducted by CAR in 2013 and was the best available estimate of the cost of new terminal available at the time of conducting this study. Nevertheless, with any good estimate there is always the risk that actual costs exceed estimated costs. Therefore, the four sensitives described below aim to evaluate how DAA user charges are likely to evolve if the cost of T3 is higher than €923 million by 25, 50, 75 and 100 percent, respectively.

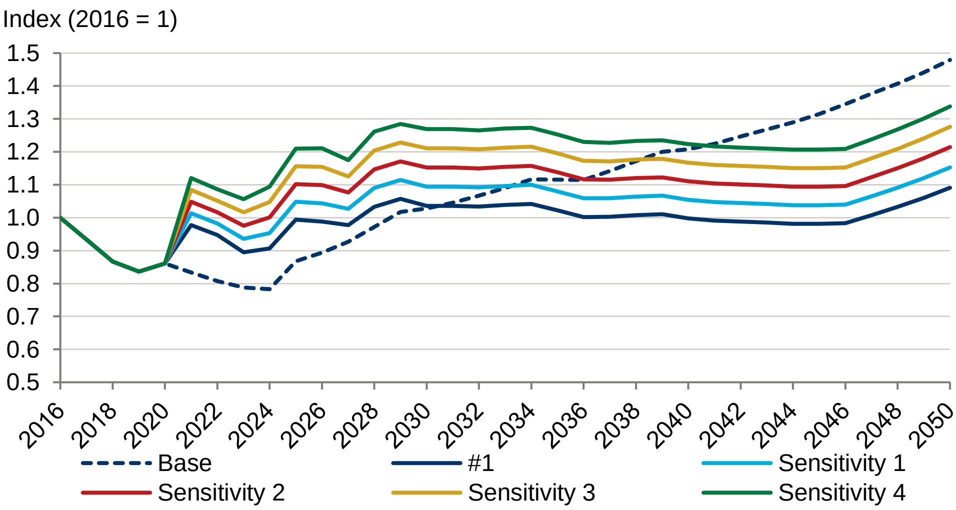
Fig. 90. Cost of T3 sensitivities

Scenario / Sensitivity	Operator	Business Model	Cost of T3
Baseline	daa	T1/2 compete with each other, no T3	N/A as T3 is not build under the baseline
Scenario 1	daa	T3 alongside with T1/2	€923 million
Sensitivity 1	daa	T3 replaces T1	€923 million + 25%
Sensitivity 2	daa	T3 replaces T1	€923 million + 50%
Sensitivity 3	daa	T3 replaces T1	€923 million + 75%
Sensitivity 4	daa	T3 replaces T1	€923 million + 100%

Source: CEPA

The figure below illustrates our analysis of these sensitivities. As expected, as the price of T3 rises above our central estimate of €923 million, the positive impact of constructing T3 on user charges diminishes. In fact, if the actual cost of T3 is twice what was expected (Sensitivity 4) user charges will remain above the baseline scenario (i.e. no T3) until 2041 (based on OE's baseline demand forecasts).

Fig. 91. Cost of T3 sensitivity analysis



Source: CEPA modelling

6.3.5 User charges for each terminal differ under T3 business model scenarios

It is also important to evaluate how user charges for each terminal react to different T3 business model scenarios. This is because in some scenarios T3 is allowed to directly compete with the other terminals and in other scenarios T3 is fulfilling a different purpose to the other terminals or replacing one of the other terminals entirely.

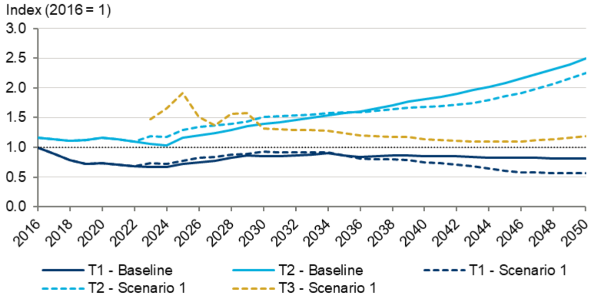
The model can calculate charges that operators need to meet their cost of capital. In practice the fact of competition may mean that operators cannot achieve these charges, and their returns may be lower than their target returns. If these are too low, it may be unable to meet its financing costs. So long as the business is at least covering its on-going costs, it can in principle be refinanced, rather than closing. It seems likely that a terminal once constructed and opened would therefore continue in some form, so long as demand conditions did not render it completely unnecessary. This therefore is an advantage of private finance models with competition, that investments that fail to achieve all their aims are not fully remunerated, whereas regulatory solutions find it harder to deny remuneration of investments made. The counterpart of this is that private investors take this risk because they expect to earn higher returns when business is good, whereas in a regulated solution charges would be lower in this scenario.

The diagrams below illustrate how terminal user charges vary across the six scenarios. In each diagram the scenario being examined is measured against the baseline scenario of no T3. In the short run, some of the options indicate high charges in order to break even, but it is unlikely that such high charges can actually be imposed. In practice, the operator will have to take a loss until it obtains sufficient demand. These losses may be capitalised and thus the longer-term income requirements may be somewhat higher than the illustrative model indicates.

By 2050, the charges faced by users of T1 and T2 are lower under all scenarios relative to the baseline. This is because according to the demand forecasts each terminal is still expected to reach capacity at some point before 2050, despite the share of total daa passengers the terminal receives being lower than the baseline. At this point each terminal is able to benefit from expenditure which is common to all terminals being allocated across a greater number of passengers, resulting in lower user charges.

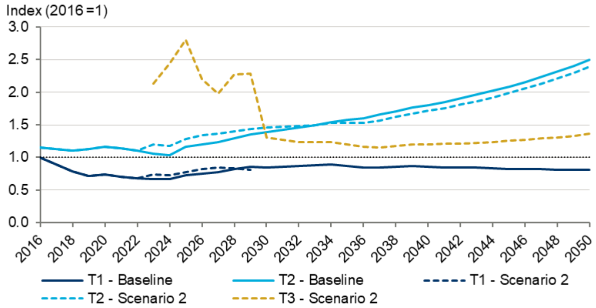
Fig. 92. Analysing the effect of different T3 business models on per-passenger Dublin Airport user charges across different terminals, indexed to T1 user charges in 2016

Scenario 1 vs. Baseline



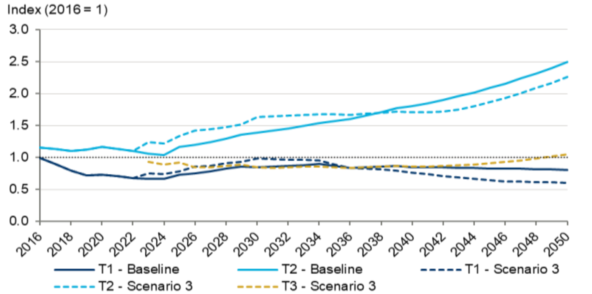
Source: CEPA modelling

Scenario 2 vs. Baseline



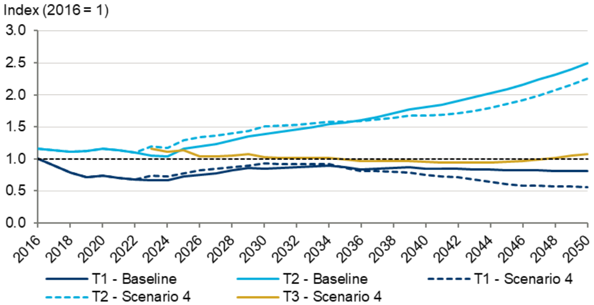
Source: CEPA modelling

Scenario 3 vs. Baseline



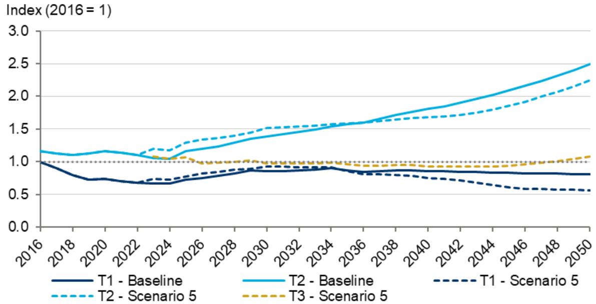
Source: CEPA modelling

Scenario 4 vs. Baseline



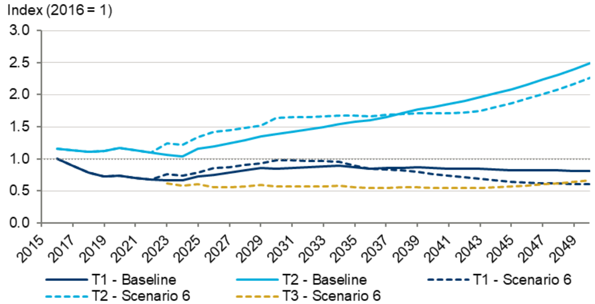
Source: CEPA modelling

Scenario 5 v s. Baseline



Source: CEPA modelling

Scenario 6 vs. Baseline



Source: CEPA modelling

Turning to T3 user charges, they are highest in scenario 2. This is the result of higher construction costs and capex that is common to all terminals not being distributed across as many passengers as a result of T1 being decommissioned. Conversely, T3 user charges are lowest in scenario 6, which is not surprising given that construction costs and opex are assumed to be significantly lower than in the other scenarios given that T3 is a designated low-cost terminal.

It is perhaps important to note that given the initial cost of T2 and the associated costs attributed to T2 between now and 2050, the user charges of this terminal are forecast to be significantly higher than the other two terminals. The implications of this may need to be carefully considered if the three terminals are to compete with one another.

The table below provides a high-level summary of some of the modelling results. This is intended to supplement, not replace, the summary of the assessment in Section 6.2.

Fig. 93. High-level summary of our modelling results

Scenario	Comments
Daa-operated T3 scenarios	
Scenario 1 T3 competes with T1/2	• Mobilisation of phase 1 of T3 may be quicker, which could be important given the implication that T1/2 will reach capacity in the next few years. • Potentially higher cost than privately-operated options.
Scenario 2 T3 replaces T1	• Possibly bringing economies of scale through two not three terminals. • Creates significant costs and therefore higher charges. • Retiring T1 is unlikely to make a reasonable business case for development of T3.
Independently-operated T3 scenarios	
Scenario 3 Single airline operator: airline hub.	• Lower WACC than daa-operated T3 scenarios.[80] • Potentially greater number of passengers going through T3.
Scenario 4 Third-party operator: T3 competing with T1/2	• Lower WACC than daa-operated T3 scenarios. [81] • Risk premium associated with a third-party operator
Scenario 5 Consortium operator: T3 competing with T1/2	• Lower WACC than daa-operated T3 scenarios. [82] • Potentially less efficient decision making.

[80] This result was obtained under two assumptions. Firstly, that the risk free rate of 1.5 percent used by CAR at the last price determination appeared too high given new market information. Secondly, that competitive tendering can drive lower cost of finance, e.g. Ofgem's competitive tender process to appoint new offshore grid companies (OFTOs). Therefore, the results presented in this report need to be considered in the context of these assumptions. We consider these assumptions to be credible at this point in time but acknowledge that they may change under a different set of circumstances.

[81] See previous footnote.

[82] See previous footnote.

Scenario	Comments
Scenario 6 Consortium operator: T3 LCC	• Lower airport charges. • Lower WACC than daa-operated T3 scenarios.[83] • Lower cash flow (potentially weaker business case). • Lower quality of service.

Source: Oxford Economics and CEPA

An important policy question arises if an independently operated terminal would result in higher charges to users than a centrally planned airport, because the overall cost of operating the airport is higher even with competition. For example, some people initially criticised competition in telecommunications because there is a loss of economies of scale from having multiple operators. But in practice the benefits of competition outweighed whatever loss came from a reduction in economies of scale in that market.

This kind of unfortunate outcome has occurred with some forms of private finance where the financier mainly provides a capital asset, which has to substantially meet a public-sector specification, and is then operated by the public sector (e.g., hospitals, schools). The increase in cost occurs because the private financier has a higher cost of capital than the public-sector operator but has insufficient opportunity to reduce the capital investment or operating costs to outweigh the increased cost of capital. The modelling has not indicated such an outcome. In fact, we generally find that the private sector operator, in most scenarios, ultimately has a lower cost of capital than daa, provided it can come to some kind of commercial arrangement with airlines, rather than following the regulated pricing model.

6.4 LEGAL AND REGULATORY CONSIDERATIONS FOR AN INDEPENDENT MODEL

As the State airports and their operators are established and mandated by statute, a significant amount of primary and secondary legislation would be required to establish a new governance and operational model. We do not consider that further here, beyond noting that this is a time consuming legally technical activity.

We focus here on a range of specific legal and regulatory issues in broad outline of particular importance to an independently operated terminal.

6.4.1 Stranded assets and/or labour costs

The introduction of a large amount of new capacity risks reducing the demand for an existing asset, which may then be considered "stranded". This may leave daa in a situation of holding assets which it has relatively large operating costs to keep in operation, and unable to pay its full financing costs. This is not an unusual situation in competitive markets. We cannot find an example precisely similar to what may occur at Dublin, the closest available parallel might be competition between two airports, one of which has greater financial risks because of the structure as an operating concession. For example, the Luton Airport concession (a long-term BOT concession ultimately reverting to Luton

[83] See footnote 31.

Borough Council and paying a demand-related concession fee) was refinanced more than once as it suffered competition from the large quantity of capacity brought into the market by Stansted Airport. Nevertheless, Luton remained financially feasible, could be refinanced, and has ultimately thrived. We can also draw attention to the situation at Heathrow where development of new capacity has left (most of) Terminal 1 unused, although not fully depreciated in the RAB so, in effect, airport users are still paying for some of the capital costs of that unused space.

As mentioned previously, the latest regulatory policy statement suggests that CAR should not necessarily take full account of daa's financial requirements. We discussed this above, and suggest that a sensible interpretation of this, given the broader policy requiring Dublin Airport to be a successful and viable airport, is to consider the business in a more commercial way, with greater variability of return. The advantage of the present legal arrangement is that it reduces the cost of capital for the airport, as the providers of capital see the risk of the airport being unable to meet its financial obligations as low. However, it would probably have to be removed – as the new policy suggests – if daa were put into a situation of competition with an independent terminal.

The difficulty of a strict application of the present rule in a competitive situation is that when demand is reduced for daa facilities, in principle regulated charges should go up, as there is less demand over which to recover the costs. Thus competition would apparently be to the cost of those airlines remaining in daa's terminals. The higher charges may also encourage even more airlines to change to using another terminal (or to operate fewer flights), further increasing the difference between the two terminals. It seems likely in this situation that the public interest demands that daa not increase its charges in response to losing demand, and if necessary suffer some capital write-offs, consistent with changing the law in line with this.

There is a constant tension between the higher cost of capital that applies in competitive industries as opposed to public sector monopolies, and the potential benefits that may come from lively competition. It depends how much the private sector can influence the situation whether they can overcome the higher cost of capital and produce a net benefit. For example, in the case of PFI hospitals and schools in the UK, the public sector was substantially specifying the buildings, the manner of their operation, and actually carrying out their operation. Thus there was relatively little space in which the private sector could apply its skills and thus overcome the higher cost of capital. In the case of an airport terminal, where the private supplier can design the building to its own requirements, specify the manner of operation, and actually operate the building, the gains of private sector input are potentially large and may well overcome the higher cost of capital, at least in the case of their own building, as we have seen for example in telecommunications. However, achieving this in telecommunications required access to the monopoly component of the network.

The shorter-term consequences of allowing competition between terminals may be that daa has to achieve lower returns for a while, or even write down some of its capital. In the longer term, because if a more commercial risk profile, it may experience a higher cost of capital. If the experience of competition helps daa reform its own methods to improve its own cost-effectiveness, there may be gains to counteract that loss. In general, in competitive markets the cost of capital is higher, but the benefits of cost consciousness, innovation and customer focus result in better value.

6.4.2 Airfield access regulation

Currently commercial airlines using Dublin Airport pay a bundled charge for use of the whole airport. A key question is whether these arrangements can continue in some of the alternative structures, and if not, then what else should happen. In some structures, set out below, we judge that extensive regulatory reform would be required. Reforming the regulatory system to cater for an independent terminal competing in a fair structure, and a sufficiently transparent structure to demonstrate fairness, is likely to be a complex exercise for which an exact parallel does not yet exist elsewhere in the world. We would nevertheless judge it, in principle, to be feasible. Although in the short term the regulatory burden would increase, in the longer term it may be possible to narrow the focus of regulatory attention, as has happened in other infrastructure markets where unbundling has facilitated competition over more of the value chain. In those cases (energy, telecommunications) the benefit has clearly been worth the cost of regulatory reform. An airport is a narrower part of the economy, and it is less clear whether it is worth the effort.

In principle the present arrangements can continue when a terminal is independently operated, but it would place strong restrictions on the kind of commercial models that would be used. In this case, the airline would retain a strong relationship with daa in relation to services for the whole airport, including terminal services. In principle the terminal operator might be able to offer some airlines a rebate for moving into their terminal, or even, if it was permitted, charge a premium. At the same time, any airline would expect to use any terminal without favouritism or discrimination, so such a premium or discount would have to be carefully justified. It would also require the terminal to have a commercial relationship with daa, since the terminal would collect a substantial part of its income from daa as daa was collecting the full charge for using the airport. The airfield charge might remain non-transparent, as the commercial arrangements between daa and the terminal operator might be formed on other grounds.

But in most such situations where an airline has a more commercial arrangement with a terminal, or operates its own terminal, a more transparent airfield charge would likely be required. This could be specified in two ways:

- As a defined airfield charge to the individual airlines accessing the airfield from the independent terminal.
- A wholesale charge to the terminal operator, having regard to the totality of the business that comes onto the airfield from that terminal – such a contract might have both fixed and variable elements, and a reflection of peak and off-peak. It might reflect the extent to which airlines or their passengers used different airfield services and other common services on the airport campus. The terminal operator would then recover the cost of that from its customers as it considers best.

An issue in setting that charge would be defining the scope of the services provided. For example, an independent terminal might or might not include the provision of apron for use by the terminal's users – and whether an airline uses the terminal's apron or a common all-airport apron might vary from flight to flight. Thus such an airfield charge might have to be disaggregated and itemised according to which services were used. Then there are other costs of running the airport campus which are neither terminal nor airfield and would require some kind of allocation. For example, a material part of the cost of daa lies in surface access provision, but at the same time it obtains substantial income from activities such as car parking which might be considered as strictly related to surface access, or else they might be considered related to passenger demand. These common areas of the airport would need to be reflected in charges to an independent terminal, introducing the complex task of separating out the infrastructure from T1/2.

Setting out an explicit airfield charge subject to the oversight of a regulator has two potentially opposing purposes:

- Ensuring that the clients of the independent terminal pay a fair charge
- Ensuring that other users of the airport are content that they are not being discriminated against

Achieving this may require disaggregating the airfield charge for all users, not just those of the independent terminal, in order fully to demonstrate non-discrimination. One way of demonstrating this may be to require, at the least, some kind of accounting separation between terminal and airfield within daa, which is a common regulatory situation where an infrastructure service is provided to third parties and also self-provided. Ultimately it could potentially lead to other terminals being independently operated, for example under concession, to demonstrate no favouritism. Such issues exist in other regulated industries, such as telecommunications.

As well as basic access to the airfield, there are likely detailed issues of access which may require some monitoring or intervention by the regulator:

- **Access to runways and other airfield services when there are capacity constraints**: under international slot allocation arrangements, runway access should be based solely on the identity of the airline and its requirements, thus it should be blind as to whether an airline is a customer of one terminal or another. If there is any suspicion that airfield operations show any discrimination, there may be an oversight role for CAR. There might be concerns if daa was thought to be impeding expansion of taxiway capacity to an independent terminal.
- **The numerous airport shared services that add up to the full-service proposition for airlines**. There are numerous services which might be either essential or inefficient to duplicate. There would be concerns over whether these are available without discrimination. It is common in many access situations, for example in telecommunications, for issues of access eventually to extend to numerous ancillary services that are necessary for a truly non-discriminatory service provision.

Thus access regulation in an airport with independent service operation is likely to become complex. It becomes less complex if there is no vertically integrated supplier, rather a supplier of common airfield services dealing equally with several suppliers of terminal services. Regulation of energy networks in the UK has tended in this direction better to demonstrate non-discriminatory access.

6.4.3 Market power regulation

An independently operated terminal might, in principle, obtain some market power in some circumstances; we cannot reasonably expect a situation of perfect competition with two operators on site. A key consideration is whether the increased level of competition suffices to improve the situation for customers in comparison to a regulated public-sector monopolist. It would be wise to have some provision for re-regulation of charges if competition ceases, for whatever reason, to become effective, and there are difficulties in competition becoming re-established through further expansion of the airport.

The main issue is the long-term situation. As the airport fills up, it is possible that the new terminal may have a larger hold over potential tenants. As long as each independent operation has potential for incremental expansion, it seems unlikely that there can be much market power. Therefore, this possibility seems relatively remote at present, but may become more important later.

The nature of the long-term situation will depend upon the geographical layout. For example, with some layouts both competitors will be able, in principle, to expand, and thus continue competing at the margin. But if one competitor succeeds, through layout, ultimately to constrain the other, and become the only supplier who can expand at reasonable cost, then competitive possibilities are reduced. This may ultimately reduce to stand layout, and some intervention in the provision of stand capacity may relieve the problem.

The first point at which some market power may be a concern is when the operator is designing the layout of its terminal. Although it would not expect to have much commercial leverage early in the operation of the terminal, the layout it selects might, either by chance or design, later place it in a situation of advantage. It might for example occupy land in such a way that it is difficult for the present operator to expand very much, whereas it would be in a better position to make substantial expansions, simply because of the geographical arrangement. Thus from a planning perspective there might be an argument to facilitate a development that offers greater flexibility for competition to continue in the longer run.

Another point of market strength could arise when it is known and expected that an independent operator will construct a terminal, but that operator has not yet committed a great deal of capital. In this situation, alternative methods of expanding capacity might have been put to one side and, in effect, it might arise that a reliance is being placed upon the independent operator to complete its project. At this point the independent operator may seek to use this situation of reliance to obtain some commercial arrangements to its advantage. This has certainly been a point of concern in the UK that once the government selected one particular project over another to increase airport capacity for London, that project would be advantaged and could exercise some hold-up power. The situation is less concerning in Ireland. Daa still has substantial opportunities to expand capacity at relatively modest cost and relatively quickly, so that it seems relatively unlikely that an independent operator would have any strength in an early hold-up.

We might also consider whether some market strength could arise shortly prior to opening of a new terminal. At this point, the existing airport, in anticipation of the forthcoming opening, might be tight in capacity, and one might imagine that there is a hold-up game that could be played to obtain some advantage. In practice it seems likely that the new terminal has committed commercial arrangements with future tenants, and there would be a considerable downside to it to any delay in opening.

6.4.4 Possibility for a strategic airport manager

One solution to some of the above problems might be to have a designated strategic airport manager, who would have powers to make some high-level decisions as to the operation of the airport. This does not impede independent terminal operation with full commercial competition between terminals. But it probably sits less well with the complete free enterprise model of terminal construction and operation but sits better when a high-level terminal opportunity – e.g. a designated geographic space, some minimum requirements and obligations – is packaged.

There may be some advantage in the strategic manager also being the operator of the airfield and common airport services, but not of terminals, because then it would have an incentive to cooperate with whatever terminal operators were present to the general benefit of the airport. However, there are other possibilities. For example, in energy networks, there is a movement to construct independent system operators which are relatively small organisations and separated from the owners and maintainers of transmission and distribution networks.

6.4.5 Operator of last resort

A new terminal operator may get into financial difficulties, given that costs of capital might be so high that covering payments to the financier could be a large portion of the costs/revenue requirement. When a terminal operator is unable to fully cover these payments, a refinancing could reduce the capital costs by an amount sufficient to bring the terminal operator out of financial difficulties. An owner may also choose to mothball the facility with the intention of reopening it when conditions improve.

The difficulty arises when it is not the cost of capital, but the remaining cost categories, that makes a terminal financially unviable – even if that terminal is seen as essential to the operation of the airport (whether at the time, or in the future).

There may thus be value in an operator-of-last resort arrangement, so that useful and working facilities can be taken over, retained, and operated in the public interest. Such arrangements are common in other capital intensive public transport situations. Typically responsibility lies with the government department to designate an operator of last resort. In the UK energy sector, there is competition among other suppliers to be a supplier of last resort when an energy supplier fails, with the main criterion being the least loss to consumers.

6.4.6 Competition issues

With substantial excess capacity, competition between two terminal operators may become strong. Potentially one operator may undercut the other to the point of putting it out of business. It would be reasonable for daa to take over a terminal from a failed operator if it failed in its own terms for natural business reasons; it would be less reasonable for daa to take it over if it had played a substantial role in putting it out of business through "predatory" actions.[84]

As we noted earlier, a capital-intensive service has substantial financial resilience, as it can continue feasibly provided it makes a primary surplus. Thus in practice predatory behaviour in such an industry is difficult. For example (although not an exact comparison), after Stansted's present terminal opened, Luton Airport several times complained about Stansted's low prices, since Stansted made a loss for an extended period. The UK authorities were not persuaded to take any action. Luton Airport was refinanced more than once in this period, but ultimately both airports have been successful.

Thus our judgment would be that this is an unlikely problem, but one that it may be worth bearing in mind while setting up and monitoring an independent operator, if existing general competition law does not cover the issue.

[84] The notion of predation is an arcane and controversial area of competition economics and law, and detailed advice on it is beyond the scope of this study.

APPENDIX 1: ECONOMIC SCENARIO MODELLING

MACROECONOMIC SCENARIOS

Overview

Our best in class Global Economic Model is 1) Keynesian in the short run, 2) Classical in the long run. In other words, in the short to medium term, household and business confidence and demand are key. But in the long term (a typical business cycle might last 5-10 years) we expect economies to get back to equilibrium—the output gap closes, and unemployment is at its natural rate. Therefore, in the longer term, growth is driven by supply potential, i.e. the availability of labour, human capital, capital stock, total factor productivity growth.

Economic scenarios therefore typically to follow a similar modelling approach

Most scenario analysis tends to focus on event-driven demand shocks, with a short-to-medium term (i.e. 1-5 years) time horizon. For example, a faster-than-expected rate hike cycle in the US, a messy UK departure from the European Union, a financial crisis in China.

But the difficulty of predicting such events in 2025-2030 (for example with regard to government policies) means longer term scenarios must be based on more fundamental supply-side drivers of growth. This typically means 1) demographics, 2) capital accumulation, and 3) total factor productivity growth. For example, the long-term impacts of our downside Brexit economic scenarios incorporate the judgement that a UK less open to competition from European producers, or with less access to the EU market, would likely have slower productivity growth in the medium to long-run.

Our economic scenarios combine short-medium term upside/downside risks to global growth and confidence, with more optimistic/pessimistic views on Irish growth potential to drive the longer-run.

Developing the scenarios

In addition to the temporal aspects to macroeconomic forecast or scenario analysis, it is worth understanding some other high-level principles of our approach to scenario modelling for this type of infrastructure planning project.

- **Plausibility**. Scenarios should diverge from the base case sufficiently to generate forecasts that test current infrastructure plans. But at the same time they need to reflect plausible states of the world and the policy environment. It would not be optimal to simulate the extreme best or worst possible combinations of all variables if this is a scenario that has negligible probability. This approach makes sense for "stress-testing" banks, but it would be undesirable to build airport capacity that has negligible chance of being utilised.
- **Operability.** It needs to be possible to simulate the shocks identified within the Oxford Economics Global Economic Model.
- **Durability.** The scenarios should have a reasonable "shelf life", allowing them to remain relevant for the duration of a project that will have several analytical phases, and need to be referred to in future policy discussions. As such, they should avoid

being motivated too much by policy issues one way or another that will be decided in the coming months.

- **Relevance**. Scenarios should be relevant to Irish airports and the scenario levers should be the key drivers of passenger demand, reflecting the composition of the passenger base, e.g. business versus leisure versus transit passengers, key origin markets etc, and the key determinants of past trends.

Where appropriate we have incorporated key insights from our Global Scenarios Service (GSS). The GSS is a quarterly service provided to OE clients, drawing on feedback from over 200 clients. The GSS simulates the impact of major known global risk scenarios on 80 of the world's largest economies, across the full range of economic and financial variables.

Because the GSS forecasts only run to 2022, we layer on assumptions about the longer run. In some cases, in the GSS, economies have returned to trend by 2022 (after a period of bust-recovery), but typically the level of GDP and trade is permanently affected. In other cases, we need to calibrate assumptions using academic estimates or economic theory. Where we discuss demographics, we have drawn on CSO scenarios.

APPENDIX 2: TERMINAL DESIGN FACTORS

PASSENGER NUMBERS AND MIX

This considers the expected overall number of passengers and the nature of the expected traffic. For example, the expected proportions of origin/destination, transfer and transit passengers. Different types of passenger traffic place a heavier demand on specific aspects of airport infrastructure. For example, a larger proportion of point to point traffic would put a heavier demand on:

- Surface access infrastructure
- Car parking
- Kerbside facilities
- Check-in facilities (all kinds)
- Check-in to aircraft baggage systems
- Security search facilities
- Walking distances to gates
- Arrivals baggage systems
- Meeting and greeting areas

In contrast to this, a larger proportion of transfer passengers would place a greater emphasis on:

- Walking distances between airside boarding gates
- Integration of a terminal with any other terminals
- Integration of baggage systems
- Complexity of baggage systems (processing direct and transfer bags)
- Departure lounge space and facilities for possibly longer dwell times
- Passenger segregation
- Possible particular security requirements

TRAFFIC PEAKS

A critical factor in terminal designs is the extent of peaking in traffic flows. Facilities need to be provided in order to efficiently process peaks without resulting in facilities which are substantially bigger than necessary at other times. Since the size of any peaks is an important factor in terminal design, the basis of most terminal facility sizing and processing capacity guidelines are based around the size of peak demands. A number of classifications exist which seek to quantify the size of likely peaks. For example:

Typical Peak Hour Passengers—the level of peak demand which is expected to be typical of annual operations.

Busy Hour Rates—a measure of the percentage of time when demand will be above the design specification of a terminal e.g. passenger numbers may exceed the capacity of the infrastructure to process them within a particular level of service for 5 percent of the time but the terminal service performance is within the design parameters for 95 percent of the time.

Standard Busy Rate—the expected level of demand during a 'busy hour'. This is often expressed in terms of designing facilities to perform within the planned for levels of service that are at, or less than, the level demand in the 20th, 30th or 40th busiest hour over an annual cycle.

IATA Representative Busy Hour—the level of demand in the busiest hour of the second busiest day of an average week in the peak month.

All these methodologies seek to establish a demand level which is typical of a sustained busy period which can be designed for without incurring the cost of uneconomically providing facilities to meet the absolute peak of demand. There are guidelines for estimating forecasted numbers of peak passengers for all these typical peak assessment methodologies. However, the most accurate estimate of a typical peak period requires knowledge of likely airline schedules; the size and mix of aircraft; load factors; the mix of business and leisure passengers; the mix of premium and economy passengers (not necessarily the same split as business and leisure passengers); and any particular characteristics of the anticipated passenger demand.

Terminals designed for hub operations need to make provision for processing a series of peaks. The numbers of passengers in these peaks may be substantially greater than at other periods of time requiring the facilities and processes to efficiently handle this demand for particular periods of time. Terminals designed for hub operations also need to make provision for a range of aircraft sizes and boarding gates within an operational proximity to enable optimal hub operations. Hub operations also provide opportunities for generating commercial revenue from food and beverage (F&B) and retail concessions to passengers who may have substantial dwell times. In a single till environment, where aeronautical charges are offset by commercial revenue, the cost of any extra terminal space required for additional concessions could be offset by the commercial revenue generated through the increased revenue.

In all of these methodologies it is important to also factor in the impact of the likely numbers of meeters and greeters and the staff required by all stakeholders for processing passengers.

BAGGAGE

The baggage systems of modern airport terminals are substantial, complex and costly components of infrastructure. Although unseen, it would be a mistake to consider the design of a baggage system as secondary to the overall visible design and functionality of a terminal. An efficient baggage system capable of processing the anticipated demand can 'make or break' the operational performance of a terminal. In terminals with a substantial amount of transfer traffic the baggage system is often the critical component in the determining the minimum connecting time (MCT) for passengers transferring between flights. Any failures in the operation of a baggage system can rapidly become exponentially detrimental to terminal operations, very disruptive to the overall journey experience of passengers and result in airlines incurring the substantial costs associated with the repatriation of baggage to passengers. In airports with more than one terminal, the integration of the baggage systems across the airport campus is an early and important design and functionality consideration.

CHECK-IN AND BAGGAGE DROP

The activity of passengers 'checking in' for flights remains a fundamental part of each air transport journey. Relatively recent innovations such as online check-in and the introduction of facilities for passengers who have previously checked-in to drop bags have reduced the number of check-in desks required. Whilst the trend towards further automation and self-service facilities is likely to continue there is always likely to be a need for the ongoing provision of physical check-in infrastructure for the following reasons:

at least for the near-term future airports and airlines will not be able to assume that all passengers will have been able to (or are willing to) undertake online check-in;

it will always be necessary to have facilities which enable passengers to check-in baggage even if they have already checked-in themselves online;

airlines may wish to provide a personal check-in service to commercially important passengers as part of their overall service proposition to those passengers.

SECURITY

The security function at the landside/airside boundary is key component of terminal infrastructure. This is both in terms of protecting the terminal and airfield from a security threat and the experience of passengers as they are processed. Therefore, it is important for careful consideration to be given to the capacity required to undertake an internationally compliant security function which does not unduly delay passenger and does not detract from their overall experience. In hub airports the capacity of transfer search facilities is an important factor in promoting efficient movement of passengers between aircraft. The IATA recommendation is for passengers to have to queue for no more than 5-10 minutes. The UK CAA has set a service standard for Heathrow Airport of 99 percent of passengers queuing for less than 10 minutes for both the central and transfer search functions provided by the airport.[85] Since all personnel accessing the secure airside areas of a terminal must be security screened it is also important for ample provision to be made for processing the staff of all stakeholders. It is recommended that a similar (if not better, for operational reasons) security queue performance be provided for the staff security search function.

AVOIDANCE OF A LIMITING FACTOR

The complex, multi-functional and interrelated operational nature of terminal activities requires a comprehensive, holistic and integrated approach to be taken from the outset in the design of a terminal. If such an approach is not taken there is a risk of the unintentional introduction of a limiting service or component performance which ultimately limits the operational performance of the terminal as whole. Therefore, it is important to avoid the intended consequence of an operational limiting factor through thorough consultation and consensus amongst stakeholders regarding the nature of the passenger demand and the associated infrastructure requirements to meet that demand at the anticipated levels of service.

CENTRALISED/DECENTRALISED PROCESSING

Complex and expensive infrastructure and activities are required to enable passengers and bags to arrive and be processed through an airport. There are economies of scale in the provision of these services within a main centralised facility after which, if necessary, passengers move boarding gates in piers which are contiguous with the main processing facility or be transferred to boarding gates in remote, or satellite, piers.

[85] This is subject to the introduction of technology enabling a per passenger performance metric to be measured. Until then the performance standard remains based on queues being less than 10 minutes in 95 percent of 15 minutes periods.

INTEGRATION

Where a new terminal is being constructed at an existing airport it is important to consider the extent and nature of integration required with any terminal infrastructure already in place. This integration is likely to be required for passengers, baggage and service vehicles/equipment. It will be dependent on the expected amounts of transfer traffic but it could be substantially more expensive in the long-run to facilitate integration than if it was enabled at the terminal construction phase.

SURFACE ACCESS

Complex analysis of the modes of transport and the forecasted use of these modes by passengers is a critical design criterion for a terminal. Where there are already surface access facilities at an airport these can often be augmented and proactively factored into enabling at least some of the dimensions of integration set out above.

PHASING / MODULAR CONSTRUCTION

There are advantages to constructing a terminal in a phased manner. Such an approach enables the costs of new facilities to be more aligned to the level and trajectory of passenger demand. This is because if a terminal is built to accommodate its final expected level of demand this has to be reflected in the associated charges being levied on airlines and passengers; often in circumstances where the level of traffic at construction completion is lower than is expected in the future. Such a scenario is exaggerated if economic conditions cause a decrease in traffic even from that which was expected at the opening of a terminal—as occurred with Terminal 2 at Dublin Airport.

In addition to the lower cost of initial construction the adoption of a phased approach from the design outset should enable further modular expansion more efficiently than would be the case if additional capacity was not considered from the commencement of the project. This is because space, surface access integration and expandability of the terminal design can all be safeguarded to avoid the expense of future integration complexities if, and when, a terminal may be expanded in the future.

However, it should be noted that the construction of the original terminal is often a substantial amount of the overall final expanded cost as the base terminal infrastructure e.g. substantial parts of the baggage system and surface access facilities need to be provided at that point.

PERSONS WITH REDUCED MOBILITY

European Union (EU) regulations set out that passengers with reduced mobility (PRM)[86] who are travelling on an EU airline to or from anywhere in the world or who are travelling within the EU are entitled to special assistance. This special assistance is designed to enable passengers with reduced mobility to move through an airport with dignity and as conveniently as possible with access to appropriate hygiene and comfort facilities. The construction of a new terminal provides an opportunity to ensure the design promotes the convenience and comfort of passengers with reduced mobility in a way which reduces any differentiation between them and other passengers who do not have reduced mobility.

LEVEL CHANGES

Where possible level changes should be kept to the minimum amount necessary that are commensurate with the process and security segregation necessary for the secure and efficient processing of passengers. The extent of level changes is often a trade-off between available land areas, forecasts of passenger demand, operational space and the space for commercial activities which can contribute to the financial viability of the airport assets. Where level changes are necessary it is important to ensure that substantial provision is made for the level changes at multiple locations in the terminal and which are accessible to all passengers and especially passengers with reduced mobility.

BOARDING GATES

Open plan boarding gates enable wider circulation areas, flexibility in the layout of terminals and opportunities for passengers to choose where they spend available time at an airport; improving the overall airport experience of passengers. Therefore, boarding gates should be provided on an open plan basis unless there are specific security or border control reasons not to do so e.g. holding areas for transit passengers who leave an aircraft for comfort reasons and therefore some closed gate areas are needed.

ENVIRONMENTAL SUSTAINABILITY

Where possible construction materials should be sourced from renewable sources and careful consideration given to maintaining the terminal ambient environment in ways that are environmentally sustainable.

SERVICE LEVEL ASPIRATIONS AND TERMINAL FABRIC

As set out above, the level of service aspired to in a new terminal is a key design factor. This can take two forms, firstly, to design in a higher level of service when it is most efficient to do so or secondly, to specifically avoid the construction and fit out costs of a higher level of service from the outset. Both are valid approaches. But is important for all stakeholders to understand and agree with the approach taken from the beginning so costly adjustments are not required after construction and so that the operational impact on the whole airport of a specialised terminal is recognised and factored into overall operations. For example, the existence of a low frills, or full service, terminal may limit the overall flexibility of the airport infrastructure in times of disruption or the extent of integration for passenger and baggage movement provided at an airport.

WAYFINDING

The amount of retail and F&B outlets at an airport and commercial revenue opportunities from advertising can result in a crowded environment for conveying information to passengers. Therefore, it is important that terminal designs promote intuitive way finding for passengers, operational signage that is readily recognisable as distinct from commercial signage and opportunities for passengers to orient themselves through provision of natural light and outside views.

WALKING DISTANCES

IATA recommends that passengers should not be expected to walk more than 300 metres without the provision of moving walkways. Airport designers need to consider trade-offs between the availability of moving walkways for the convenience of all passengers, the cost of

[86] "person with reduced mobility" means any person whose mobility is reduced when using transport because of any physical disability (sensory or locomotory, permanent or temporary), intellectual impairment, age or any other cause of disability, and whose situation needs special attention and adaptation to the person's needs of the services made available to all passengers. (defined in Regulation (EC) No 261/2004 of the European Parliament and the Council)

moving walkways and the impact these may have on commercial revenue if passengers have less exposure to retail outlets because they are carried past them.

MINIMUM CONNECT TIMES

The minimum connect time (MCT) for passengers between flights is a critical dimension of terminal and overall airport planning. It is a key performance metric which is driven by the level of integration within a terminal and between terminals at an airport and is key determinant of the capacity of a terminal to facilitate the volume and pace of passenger and baggage transfers required to sustainably and predictably operate as a hub. Whilst it refers to the minimum time required for passengers to transfer between flights the actual amount of time is often driven by the time required for bags to be transferred between flights, any specific identity verification and security requirements. The IATA suggested MCTs for passengers transferring between domestic and international flights are set out below.

Fig. 94. IATA suggested minimum connect times

Type of Connection	Time in Minutes
Domestic to Domestic	35 - 45
Domestic to International	35 - 45
International to Domestic	45 – 60
International to International	45 - 60

COMMERCIAL REVENUE

The level of commercial revenue achievable at an airport is important dimension of airport planning for the following reasons:

the provision of F&B and basic needs retail facilities for the comfort and convenience of passengers;

enabling passengers to purchase specific items at lower prices which are often not subject to the application of local taxes given their location within 'international' areas after exit passport processing; and

the use of commercial revenue to off-set the overall costs of the development and operation of the airport and so reduce the charges levied on airlines and passengers by the airport.

RESILIENCE

The construction of a new terminal provides an opportunity to proactively build in resilience. This could be in the form of the amount of space provided so the airport is resilient to accommodate future growth and occasional extra pressure which may be put on terminal facilities in times of disruption. It could also be in the level of flexibility planned into the building e.g. enabling the overall design to facilitate internal spaces being re-arranged with minimal effort like a 'theatre set' to accommodate changing traffic patterns or levels of service. An example of designed resilience is Pier 1 at Dublin Airport which has made provision for airbridges to be added should it be felt these are necessary at some point in the future to facilitate alternate levels of service to passenger on that pier. Although a trade-off with cost, resilience can also be built into passenger moving equipment e.g. the provision of lifts and escalators for level changes. An important dimension of resilience when constructing a new terminal is the opportunity to include unobtrusive 'designed in' physical barriers on surface access roads to prevent vehicles from approaching the terminal for deliberate acts of sabotage. Inside a terminal, and particularly before security, there is also an opportunity to consider blast suppression design features to increase the resilience of a terminal and through this the security of those in it.

AUTOMATION

The increasing trend towards automation of passenger and baggage processing activities is key consideration in the construction of a terminal. Advances in technology are enabling processes to be automated which were once thought not possible to automate e.g. the passengers being able to deposit bags at airport without the intervention of a customer service agent. Automation of passenger processing activities has enabled staff cost efficiencies, reliability and objectivity (e.g. bag drop facilities simply rejecting overweight bags). This, combined with the reliability of biometric based passenger identification technologies for security and identity verification means the quest for increased automation is likely to continue unabated. The construction of a new terminal enables these technologies and the efficiencies gained from them to be factored into the design and construction from the outset.

APPENDIX 3: FINANCIAL MODEL

INTRODUCTION TO THE FINANCIAL MODEL

We have developed an illustrative financial model to assess how airport charges at Dublin Airport might change if a T3 is introduced under different scenarios. These are:

(1) Options for phasing the introduction of Dublin Airport T3.
(2) Options for the independent finance and/or operation of Dublin Airport T3.

The model covers the period 2015-2050. This long-time horizon reflects the long asset life of a new terminal, which we have assumed to be 50 years for modelling purposes.

The financial model has been built based on the well-known building block approach to economic regulation, which involves:

- Establishing demand projections.
- Establishing forward looking cost forecasts for Dublin Airport for operating expenditure (opex), commercial revenue, capital expenditure (capex) and weighted average cost of capital (WACC).
- Establishing an amount for depreciation.
- Applying efficiency assumptions to aforementioned costs. Efficiency assumptions can be in the form of catch-up efficiency (efficiency relative to a benchmark) or ongoing productivity (improvements in efficiency over time by the frontier (most-efficient) company). For the purpose this model we have only applied an ongoing efficiency assumption of 0.75 percent.

Based on the above, required revenue for Dublin Airport can be calculated as:

The price cap is then set at required revenues divided by the number of passengers, where passenger projections have been developed in Volume I.

The model allows each terminal to compete with one another. As a result, required revenues and, in turn, price caps have been calculated for each terminal separately and for Dublin Airport as a whole in each year of the modelling period. Required revenues for the proportion of the airport that is common to all terminals has been allocated across terminals based on passenger number forecasts in that given year.

MODEL INPUTS AND ASSUMPTIONS

The table below sets out the key inputs and assumptions to the model.

<table>
<tr><th>Area</th><th>Comments</th></tr>
<tr><td>Capacity</td><td>We have assumed that T3 will have a maximum capacity equal to T2, hence:

Terminal 1 capacity – 19.5 million pax
Terminal 2 capacity– 16.5 million pax
Terminal 3 capacity – 16.5 million pax

Phase 1 – 9.9 million pax;
Phase 2 – 13.2 million pax; and
Phase 3 – 16.5 million pax

</td></tr>
<tr><td>Passenger demand forecasts</td><td>The pax forecasts up to 2050 are an input to the financial model. We have used the baseline forecasts within all scenarios.

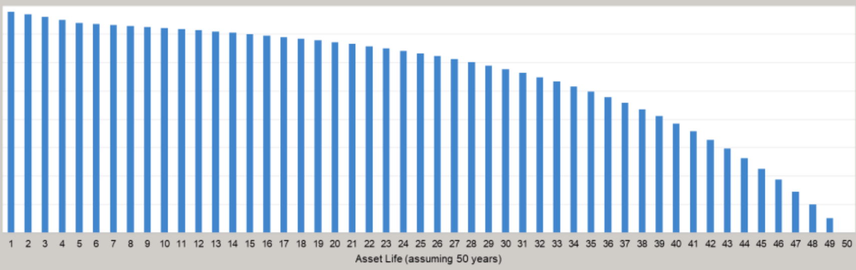
We then analyse two sensitivities where actual pax are 5 percent and 10 percent lower than the baseline pax demand forecasts. The aim of these two scenarios is to take into account the potential impact of demand downturns when assessing the effect of different scenarios on user charges.</td></tr>
<tr><td>Distribution of passengers between terminals</td><td>The table below demonstrates how the distribution of passengers between the three terminals evolves over the modelling period. The proportion of passengers going through T3 increases after each phase of construction. For illustration purposes, by the end of phase 3 we assume that each terminal caters for a third of total passengers unless otherwise specified. If capacity is exceeded at one terminal, the excess passengers are allocated across the other terminals.

Fig. 95. Share of passenger numbers going through each terminal across the modelling period
<table>
<tr><th>Terminal</th><th>Pax share before Phase 1</th><th>Pax share before Phase 2</th><th>Pax share before Phase 3</th><th>Pax share after Phase 3</th></tr>
<tr><td>T1</td><td>57%</td><td>43%</td><td>38%</td><td>33%</td></tr>
<tr><td>T2</td><td>43%</td><td>37%</td><td>35%</td><td>33%</td></tr>
<tr><td>T3</td><td>0%</td><td>20%</td><td>27%</td><td>33%</td></tr>
</table></td></tr>
<tr><td>Construction triggers</td><td>Each phase of construction is triggered based on passenger demand. The following triggers have been applied:

Phase 1: 33 million passenger numbers
Phase 2: 36 million passenger numbers
Phase 3: 39 million passenger numbers

Combining this with the demand forecasts, we find that:

Phase 1 of construction commences in 2021
Phase 2 of construction commences in 2024
Phase 3 of construction commences in 2028
</td></tr>
</table>

	For each phase, construction duration is assumed to be two years. Whether a rate of return is earned during construction differs across scenarios and is specified in the main report. During the construction period we assume that no other costs are incurred (i.e. operating expenditure or depreciation).
T3 cost assumptions	We assume that the total construction cost of T3 is equal to £931.3 million, based on data on the cost of T2. Total T3 construction cost is allocated across the three phases. However, the allocation is not even across the terminals, as we consider that the central and key infrastructure will need to be put in place during Phase 1 to ensure the terminal can operate effectively. Therefore, 70 percent total construction costs are assumed to be incurred in Phase 1. Therefore, we assume that 15 percent of total construction costs will be incurred in each of Phases 2 and 3, respectively.
Capital maintenance	Capital maintenance has been set equal to depreciation in the previous year in order to approximately maintain the value of the RAB over time.
Depreciation (return of capital)	We have assumed an asset life of 50 years for T3 and an asset life of 10 years for capital maintenance based on the CAR financial model used in the previous price control review. We have adopted a tilted depreciation profile, as used by CAR. Hence, the rate of depreciation increases as the asset life progresses and customer demand increases, and changes in line with the WACC. An illustrative depreciation profile is presented below, which assumes an asset life of 50 years. **Fig. 96. Illustrative depreciation profile**  Source: CEPA

Weighted Average Cost of Capital (WACC)	Between 2015 and 2019, we have applied the same WACC that was applied by the CAR for all capex determined at the last price determination. The WACC is updated every 5-years by adjusting the risk-free rate using the EUR Ireland sovereign forward curve. This adjustment reflects the high probability that the WACC is updated at each price determination to reflect new market information. The WACC is assumed to be fixed at the time of construction for each phase of T3. Whether a rate of return is earned during construction differs across scenarios and is discussed in the main report.
Operating expenditure (Opex)	Moves in line with passenger number forecasts, a set of cost elasticity assumptions, and an annual ongoing productivity assumption of 0.75 percent. The cost elasticities assumed are based on a review of literature: • Cost of sales = 1 • Payroll and related costs = 0.4 • Material and services = 0.3 Unit costs are used to determine T3 opex, and for simplicity we assume cost elasticities for T3 are equal to one until Phase 3 is complete.
Commercial revenue	Calculated using passenger number forecasts and a set of commercial revenue elasticities based on those assumed by the CAR. • Property = 0.09 • Retail = 0.67 • Car parking = 0.9 • Advertising = 1.14 • Other = 1.00 2016 unit commercial revenues are used to determine T3 commercial revenues. For simplicity we assume that commercial revenue elasticities for T3 are all equal to 1 until T3 is complete.
Timing scenarios (Chapter 5)	We consider two different timing scenarios: (1) T3 is constructed in one phase (all-in-one cost); and (2) T3 is constructed in three phases.
T3 business model scenarios (Chapter 6)	We consider six different scenarios in addition to a baseline scenario (T3 is not constructed) to assess the effect of different T3 business model options on Dublin Airport user charges. These six scenarios are summarised below, and more details can be found in the main report: (1) T3 is operated by daa; T3 competes with T1/2. (2) T3 is operated by daa; T3 replaces T1. (3) T3 is operated by a single airline; T3 is an airline hub. (4) T3 is operated by a third-party; T3 competes with T1/2. (5) T3 is operated by a consortium; T3 competes with T1/2. (6) T3 is operated by a consortium; T3 is a designated low-cost terminal

APPENDIX 4: FURTHER EVIDENCE FROM STAKEHOLDER CONSULTATIONS

STAKEHOLDER CONSULATIONS

Views and information were gathered from stakeholders during various points of our study. While undertaking a formal consultation exercise was beyond the scope of the study, the team did feel there would be value in gathering information and insights from a limited number of organisations with detailed knowledge of the issues discussed in this paper.

Stakeholder views in relation to the future outlook are summarised in the box in Chapter 2. Insights provided in relation to current capacity are summarised below, and these have informed the study team's analysis in the respective aspects of the project.

Fig. 97. Stakeholder's perspectives on current capacity

Facility	Dublin	Cork	Shannon
Overview	At capacity, leading to operational difficulties for airlines.	No overall capacity constraints	No overall capacity constraints
Runway	Limited slot availability	Slots not an issue	Slots not an issue
Taxiway	Congested leading to increases in time to taxi aircraft	OK	OK
Parking stands	Limited aircraft stands, particularly for overnight parking	Congested during first wave and for overnight parking	Congested during transatlantic operations
	Remote stands and bussing is primitive, with lengthy delays reported during peak operating hours.		
Check-in	OK	OK	OK
Security	Immigration halls poorly designed and of inadequate size for peak demand periods.	OK	OK
	CBP processing delays during peak hours		
Baggage	Lacks a process for transferring bags from T1 to T2	OK	OK
Boarding gates	Congested during peak hours	Congested at first wave	Transatlantic congestion
Parking	Insufficient car parking	OK	OK
Surface access	Existing transport infrastructure already a major constraint	OK	OK
	Surface access near capacity, notably the M50		

APPENDIX 5: IATA STANDARDS

IATA STANDARDS

The Level of Service (LoS) concept was introduced into passenger terminal capacity guidelines by the International Air Transport Association (IATA). IATA originally used a Level of Service A to F. More recently, as published in the 2014 Airport Development Reference Manual (ADRM) 10th edition, IATA introduced three more generic classifications, superseding the notation of previous editions:

- Over design
- Optimum
- Sub optimum

The standards cover both crowding and queue length. The economy class maximum wait times optimum standards for queue lengths for check-in, security and immigration have been applied in this work and are illustrated in the figure below. The bottom figure shows the IATA optimum level of service crowing standards: the minimum area per passenger has been applied in the analysis.

Fig. 98. Optimum level of service queue length

Main process	Sub-process	Economy class		Business class	
		Min wait time (mins)	Max wait time (mins)	Min wait time (mins)	Max wait time (mins)
Check-in	Self-service	1	2	1	2
	Bag drop desk	1	5	1	3
	Check-in desk	10	20	3	5
Security	Screening	5	10	1	3
Immigration	Passport control	5	10	1	5

Source: IATA Airport Development Reference Manual 10th edition, March 2014

Fig. 99. IATA optimum level of service crowding standards

Main process	Optimum standard	
	Min area (m2/passenger)	Max area (m2/passenger)
Security	1.0	1.2
Boarding gate lounge (seating)	1.5	1.7
Immigration	1.0	1.2
Baggage reclaim	1.5	1.7

Source: IATA Airport Development Reference Manual 10th edition, March 2014

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