Edinburgh Airport Rail Link



Turnhouse Station Options STAG1 Report

Appendix A

Calculation of Generalised Journey Times

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Appendix A – Potential Impact of Turnhouse Options on EARL Revenue/Patronage

Method for Estimating Impacts

1.1.1 Given the largely qualitative nature of the scoping carried out for a STAG Part 1 appraisal, it is desirable to have some idea of the likely impact of each of the Turnhouse Options on travel patterns for EARL. Detailed demand modelling work for the Runway Tunnel alignment was still underway at the time this report was written, and in any case detailed modelling of demand for the Turnhouse Options is outwith the work generally associated with STAG Part 1.

1.1.2 It is therefore proposed to give a general outline of the magnitude of likely changes to patronage resulting from the options being considered. The comparison will take place using the methodology set out in the Passenger Demand Forecasting Handbook (PDFH)[1]. This is related to the concept of Generalised Journey Time (GJT) which it defines as follows:

GJT = J + S + I

Where **J** = Total station-to-station journey time
S = Service interval penalty
I = Sum of the Interchange Penalties

1.1.3 It will be seen that by expressing the different journey characteristics in this way allows all the factors that typify the options to be taken into account (journey time, frequency of service and ease of interchange). Each value is converted into *equivalent minutes*.

1.1.4 For the purposes of this exercise it is assumed, however, that the most "typical" journey will be one between Edinburgh Waverley and the air passenger terminal at Edinburgh Airport, and the effects of the various Turnhouse Options on this "typical" journey was initially used as a proxy for the anticipated overall impacts however in the main report some further allowance was made to include consideration of a wider catchment area. Table A1 in this Appendix relates only to the restricted catchment area analysis.

1.1.5 PDFH advises that where only journey time, service frequency and interchange are changing, then the formula for calculation is as shown below. This has been applied assuming that there is a direct change in revenues with respect to the change in the volume of demand estimated from the equation[2]:

$$I_j = \left(\frac{GJT^{new}}{GJT_{base}} \right)^g$$

Where I_j = Index for change in volume due to journey-related factors
g = GJT elasticity
GJT_{base} & GJT^{new} = Base and New GJT respectively

[1] Passenger Demand Forecasting Handbook, Version 4 (*Passenger Demand Forecasting Council,* August 2002), Chapter B3
[2] ibid, section B3.4

Application to Turnhouse Station options

1.1.6 The Runway Tunnel alignment, in its latest form, assumes the following with reference to the requirements for calculating GJT as set out in section 1.1.5.

- Waverley Station – Edinburgh Airport Station by EARL train = 14 minutes (average);
- Airport Station to passenger terminal = 2 minutes;
- Consequently total journey time from city centre to airport terminal = 16 minutes; and
- Timetable (and hence service frequency) is as per specimen timetable.

1.1.7 It is assumed that the journey time between Edinburgh Waverley and Turnhouse Station will be the same as that quoted in section 2.7.6 above, and that a similar pattern of service will be provided. However there will be a significant difference in the journey time to travel between Turnhouse Station and the passenger terminal. For a sub-surface travellator SWHJV estimated the journey time as 20-25 minutes. For the purposes of this work it has been taken as being 22 minutes, making a total city centre to passenger terminal journey time of 36 minutes.

1.1.8 It is assumed that the sub-surface travellator will be slower than the driverless vehicle (although there will be no need to wait for a shuttle vehicle). If half of the journey distance is by travellator (11 minutes) then the shuttle element would be around 4 minutes (an average speed of 10 kph), but it will be necessary to wait an average 2 minutes for a shuttle giving a total city centre to passenger terminal journey time for the driverless shuttle option of 31 minutes.

1.1.9 In addition there are effectively two "modes" involved in this interchange, the driverless shuttle section and the western travellator section (including a change of level between the two), and this will need to be reflected in the calculation of the interchange penalty.

1.1.10 In contrast to the other options the shuttle bus service provides a "door-to-door" service, although there will be some waiting time associated with its operation, and a walk of 2 minutes between the station and the bus stop is assumed. Assuming a 10-minute frequency (at worst), then waiting time could be expected to be 5 minutes, with a distance to travel of circa 4.2 miles. Average speed is likely to be low, given the need to negotiate congested junctions; the in-bus travel time is likely to be just 5 minutes, making a total interchange time of 12 minutes, and a total city centre to passenger journey time of 41 minutes.

In-Vehicle Travel Time Weighting

1.1.11 PDFH advises that in-vehicle travel time by non-rail modes will require to be weighted compared to travel time by rail, reflecting the change in perceived "attractiveness" for different modes – generally car travel is perceived as more attractive than rail, whilst walking and travelling by bus are perceived as less attractive[3].

[3] ibid, Chapter B3.6

1.1.12 Appropriate weights are suggested by PDFH. For walks of 10 minutes within journeys of an overall length of 10 miles, a weighting of 1.77 is recommended[4]. However it also notes that using stairs or escalators should be weighted at higher amounts, up to 100% higher in the case of walking upstairs or escalators. For the purposes of this exercise it is proposed to weight these walking times by 1.77 + 62.5%, viz. 2.88.

1.1.13 It is considered that whilst this figure may be suitable when travellers have to use stairs or escalators, it is not suitable for representing the use of a travellator. PDFH has no recommendations for this situation, but based on the extrapolations a figure has been derived for travellator use:

- Walking on Travellator – 1.77;
- Riding on Travellator – 1.60*;
- Assumed split between walking/riding – 50/50; and therefore
- Average weighting for travellator = 1.68.

* - Based on 1.0 for rail, 2.0 for bus and an assumed 1.5 for the driverless shuttle – see below.

1.1.14 For travel by bus PDFH recommends a weighting of 2.0[5]. There are no recommended values for use of a mode equivalent to the "driverless shuttle". In the absence of a recommendation it has been assumed to be midway between bus and rail, viz. 1.5. However about half of the journey distance would still be travellator under this option, and this latter section would requiring weighting by 1.68 as per the travellator option.

1.1.15 There is also a need to weight "waiting" time. For a 2 minute wait within an overall journey length of 10 miles PDFH recommends a weighting of 2.24[6].

1.1.16 These journey time calculations and weightings are included in Table 1 below, which also includes the calculation of GJT using the formulae set out above. Given the provision of brand new rail stations, the interchange factors have been "moderated" as recommended by PDFH[7].

GJT Elasticity

1.1.17 It is also necessary to calculate a value for elasticity (g in section 1.1.5). PDFH generally recommends the use of an elasticity of –0.9 for short distance flows (under 30 miles)[8], however it notes that airport access flows "*might be expected to have relatively high GJT elasticities because of* ***a strong aversion to interchange*** *and the risk reducing benefits of high frequencies.*"[9] In this case it recommends the following[10]:

- -1.5 for outbound traffic; and
- -1.0 for inbound traffic.

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[4] ibid, Table B3.11
[5] ibid, Table B6.5
[6] ibid, Table B3.11
[7] ibid, Table B3.8
[8] ibid, section B3.5.1
[9] ibid, section B3.5.4, author's emphasis
[10] PDFH contains a range of elasticities some of which would produce lower estimates. We have used airport-related elasticities which are middle of the range

1.1.18 At the scale envisaged in this study no distinction is made between outbound and inbound traffic, and hence the arithmetic mean (-1.25) has been adopted for GJT elasticity.

Estimated Impact

1.1.19 Using the above assumptions, Table A1 sets out the estimated impact.

Table A1: Calculation of Change in Volume/Revenue (Initial Restricted Catchment Area)

	Weights	Runway Tunnel Alignment	Turnhouse Options		
			Bus Shuttle	Travellator	Driverless Shuttle
Rail Journey Time	*1.00*	14	14	14	14
Walk Interchange	*2.88*	2	2	2	2
Sub-surface Shuttle Interchange	*1.50*				4
Travellator Interchange	*1.68*			20	10
Bus Shuttle Interchange	*2.00*		20		
Waiting Time	*2.24*		5		2
Total Journey Time		16	41	36	32
Total Weighted Journey Time		**19.76**	**70.96**	**53.36**	**47.04**
Service Interval Penalty		7.5	7.5	7.5	7.5
Interchange Penalties		6	6	6	12
Total GJT		**33.26**	**84.46**	**66.86**	**66.54**
Volume/Revenue Changes (Runway Tunnel = Index 100)		**100**	**31**	**42**	**42**

Sources: PDFH Tables B3.5, B3.7 and B3.8

Conclusions

1.1.20 The simple analysis set out above suggests that each of the Turnhouse Options is likely to reduce the overall revenue/patronage for EARL compared to the current Runway Tunnel option. The "worst" Turnhouse Option would be the bus shuttle.

1.1.21 Whilst these figures are insufficiently defined to produce "absolute" estimates of revenue/patronage they are grounded in industry-standard methodology (i.e. PDFH) and are sufficient to inform the level of this STAG Part 1 appraisal.