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Investigation of Finance Investments in Deoghar Airport Infrastructure

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Abstract: This paper presents a cost-benefit investigation approach devised to conduct Deoghar Airport Project (DAP) evaluation in conditions of limited analyst time, research budget and data availability. The emphasis is on discarding economically viable from unviable Deoghar Airport Projects (DAP) rather than on arriving at a precise return figure. The paper starts by setting out the theoretical background regarding the identification and measurement of Deoghar Airport Project (DAP) benefits. It then presents a practical approach to measure such benefits in Deoghar Airport projects involving the expansion of passenger capacity and, subsequently, those aimed at expanding aircraft capacity. Deoghar Airport Projects (DAP) for the freight market and the estimation of airport costs are both treated separately.

1. INTRODUCTION

The main issues in the economic evaluation of Deoghar Airport Project (DAP) are common to all cost-benefit analysis of major transport investments. The basic comparison of social benefits and costs and the criteria and procedures to avoid errors and biases are not significantly different: the definition of the base case; the identification and measurement of relevant effects; the use of appropriate parameter values; and the prevention of double or triple counting [see for example: Adler, 2017; Mackie and Preston, 2018; Boardman *et al*, 2016; and Gramlich, 1990].

Deoghar Airport Project (DAP) investments are centers of thriving retailing activity, and Deoghar Airport Project (DAP) with a sound financial performance might not be considered as good from a broader economic perspective. This paper is concerned with the cost-benefit analysis of

Deoghar Airport Project (DAP) infrastructure. The principle underlying the paper is that airport investments are to be assessed as transport infrastructure improvements aimed at addressing a demand for transportation. The analysis should therefore focus on the impact of the investment on the generalized cost of travel for the users and on the costs of supplying the transportation service, including both Deoghar Airport and airline costs.

The methodology proposed in this paper is aimed to help the practical application of cost-benefit analysis for a Deoghar Airport Project (DAP) analyst facing limited availability of data and a short period of time for issuing an opinion, a situation faced by many analysts in government and international agencies. Also, the political context within which project appraisal is carried out in practice and the uncertainties it is subject to [see Turró, 1999] can make a quick, low cost assessment valuable. The emphasis is placed in the consistency of decision criteria across Deoghar Airport Project (DAP) as to whether a given project is a "good" or "bad" investment, rather than on the detailed accuracy of the estimates of Deoghar Airport Project (DAP) returns.

The approach must be workable, meaning both that it must be pragmatic about data availability, and that it must be consistent with the limited resources usually available for Deoghar Airport Project (DAP) appraisal. When the full appraisal option is not possible (a full cost-benefit analysis with surveys of local conditions) the approach to be followed has to rely on data readily available from the majority of Deoghar Airport operators. There are significant differences in data availability across promoters of Deoghar Airport Project (DAP), and the methodology should be sufficiently flexible to allow application across Deoghar Airport Project (DAP) in order to ensure consistency of decision making.

This paper does not deal with safety, security or environmental impacts, and it is conceived for "incremental Deoghar Airport Project (DAP)". Strategic projects with broader objectives like "social and economic cohesion" or "national competitiveness" with controversial indirect effects are not suitable for conventional cost-benefit analysis and are prone to overestimating net social benefits [see for example Phang, 2012; van Exel *et al.*, 2016].

The paper does not pretend to measure strategic investments based on the presumed impact of the investment on the regional economy. Evaluating Deoghar Airport Project (DAP) investments in terms of maximizing regional development would require a comparison of the regional impact of Deoghar Airport Project (DAP) investment with investment in other sectors, such as manufacturing, education or health. In any case, it should be noted that the economic return of the Deoghar Airport Project (DAP) provides, in most cases, a good indication of the project's impact on the regional economy. This is because the willingness to pay for travel reflects the gross economic benefit generated by the trip. Such gross benefits include indirect effects. The only exception would be where a relevant distortion can be identified in which the Deoghar Airport Project (DAP) could have a significant impact. This could then be evaluated using standard cost-benefit analysis methods. Revenues from non-aviation activities - mainly retailing, but also land rental for other industrial activities, should not be counted as economic benefits resulting from the airport investment. This implies that construction and operating costs corresponding to non-aviation activities should be excluded from the economic evaluation. In many cases non-aviation revenues are transfers, but even when they add value, it is advisable to calculate the Deoghar Airport Project (DAP) NPV without the secondary activities. A positive global NPV could hide a bad transport project.

However, estimating such revenues is necessary in the appraisal process to estimate the financial return of the Deoghar Airport Project (DAP) and to gauge the necessary adjustments to aeronautical charges in the airport following project implementation.

Sections 2 and 3 provide the theoretical basis for the appraisal framework subsequently proposed. Section 2 is concerned with the theory of economic evaluation of Deoghar Airport Project (DAP), and section 3 with the theory for the measurement of the various benefits. Sections 4 to 7 are concerned with the practical application of the framework. Section 4 and 5 address appraisal of landside and airside investments, respectively. Section 6 deals with the special case of freight transport. Section 7 addresses the estimation of airport operating costs. Finally, section 8 draws some concluding remarks about the approach presented.

2. THE ECONOMIC EVALUATION OF DEOGHAR AIRPORT PROJECT

Deoghar Airport (ICAO: IN-0090) is located in Deoghar, in the state of Jharkhand, India. The airport is spread over 654 acres. The airport is being upgraded to handle Airbus A320 type of aircraft . Prime Minister Narendra Modi laid the foundation stone of development of the airport in Jharkhand on 25 May 2018. The Jharkhand government had signed a Memorandum of Understanding (MoU) with the Airports Authority of India (AAI) in 2013, to develop the airport, to promote religious tourism in the state. The government later signed a tripartite MoU with the AAI and DRDO in March 2017, to develop the airport for non-military use of Airbus A-320 category aircraft. AAI proposed to upgrade the airport at a cost of INR 350 Crore. The upgrade includes extension of existing runway to 2,700 metres, construction of a 5,400 square metre terminal building to handle 200 passengers per hour, a mobile air traffic control, apron for two A320 aircraft, taxiways and an isolation bay. A DVOR/DME navigational facility is also planned. Construction commenced in January 2018.

The economic rationale of public investment decisions concerning whether a Deoghar Airport Project (DAP) should be implemented, or which Deoghar Airport Project (DAP) should be selected subject to a given budget constraint, requires identifying and measuring the benefits and costs during the life of the Deoghar Airport Project (DAP) and calculating the net present value of this flow of net benefits.

An essential element in evaluating the economic benefits of a Deoghar Airport Project (DAP) is the definition of the alternative to the Deoghar Airport Project (DAP), the "without project" scenario. There are two elements in this respect. Firstly, what would happen to existing infrastructure. In the case of repair projects, which involve bringing existing infrastructure back into normal operative conditions, the "without project" scenario would be that no further investments are made and that the airport will progressively degrade into inoperability. If the Deoghar Airport Project (DAP) consists of capacity expansion, then the "without project" scenario should include all necessary investments to maintain operative the existing level of capacity.

The second element is the institutional constraints present in the market. These may involve government, airport or airline policies which would place additional conditions on the definition of the "with project" and "without project" scenarios. For example, faced with runway constraints, an airline dominating an airport may not want to increase aircraft size and may prefer to let yields rise instead. There may also be environmental constraints, as when there is a cap on aircraft movements below the notional capacity of a runway. These constraints are very much project-specific, and the project analyst must incorporate them into the evaluation exercise accordingly, by making ad hoc adjustments to the scenarios.

2.1. Economic Benefits of Deoghar Airport Project (DAP) Infrastructure

The economic benefits derived from investment in Deoghar Airport Project (DAP) infrastructure cannot be identified with the revenues obtained by the airport authority and retailing firms with commercial operations in the airports. Deoghar Airport Project (DAP) infrastructure devoted to meet transportation demand can be divided into landside and airside. Normally, airside involves infrastructure beyond security check points, where only passengers or authorised personnel can access. Landside involves infrastructure before that. For the purposes of this paper, airside is taken to mean infrastructure to process aircraft; whereas landside would involve infrastructure to process passengers or cargo. This latter division is more meaningful in the current context, as it draws the line by type of economic impact, as will be seen further down in the paper.

Airside projects are geared to increase the capacity of the Deoghar Airport to handle aircraft movements. Deoghar Airport Project (DAP) involve new runways or the widening or lengthening of existing ones; taxiways to increase the capacity of existing runways; apron space to expand aircraft parking capacity; or aircraft traffic control at the airport or in the airport's vicinity. Landside projects aim at expanding the airport's capacity to handle passenger and freight. Deoghar Airport Project (DAP) could involve expanding capacity of cargo or passenger terminals; improving access to terminals through parking facilities or rail stations; and enhancing product quality through increased use of jetways to access aircraft. Jetways are the mobile tube-like corridors which connect an aircraft with the passenger terminal and which enable indoor boarding and disembarking to passengers. Aircraft parking positions equipped with jetways are known as contact stands, and parking positions requiring walking or transport by bus are known as remote stands. Deoghar Airport Project (DAP) can involve any combination of these items or, ultimately, the construction of entirely new airports.

The sources of benefits of investing in landside capacity are threefold. Firstly, the avoidance of traffic being diverted to alternative travel arrangements that impose additional generalised cost of transportation to the passenger or freight customer. Secondly, by relieving congestion in terminals, passenger or freight process - or throughput - time is reduced, hence contributing further to a decrease in the generalised cost of travel. And thirdly, in the case of investing on contact stands (i.e. those equipped with jetways) in passenger terminals, comfort to passengers is increased by avoiding bus trips or walks to and from remote aircraft stands.

Investment on the airside will produce two potential benefits. First, enhanced airside capacity will enable an increase in the frequency of departure and range of routes from the airport. This will yield the benefit of reducing the frequency delay, as well as potentially the trip duration, both of which contributing to a reduction in the generalised cost of transport. The frequency delay is the difference in the average passengers' preferred departure time and the closest flight departure feasible for the passenger. Other things being equal, the greater the departure frequency, the lower the frequency delay, and hence the time cost of travel for the passenger. Second, airside investments may speed the processing time for aircraft, reducing operating costs to airlines.

The benefits derived from airside and landside projects can be summarized into four categories: first, reductions in travel, access and waiting time; secondly, improvements in service reliability and predictability; thirdly, reduction in operating costs; and finally, increases in traffic.

Regarding *reduction in travel, access and waiting time,* infrastructure investments may lead to faster or more frequent services, or to alleviate congestion, or to generate some network effects. The final effects translate into lower generalized cost of travel.

When capacity is not enough to match demand at a given level of prices, it may happen that investment in additional capacity would not alleviate congestion, but accommodate latent demand for that particular airport, which was previously served at a less convenient alternative. This is the concept of scarcity [Starkie, 2018] useful to account for the important fact of *ex ante* matching of supply and demand through administrative procedures.

Scarcity applies to transport infrastructure with non-random entry and where the different operators have access to the system through a coordinated scheme. Theoretically, demand cannot exceed capacity. Unattended demand at given prices is reflected in scarcity. Nevertheless, with tight schedules, system overloads due to flight delays generate congestion as the required rescheduling to accommodate the delayed flights impose changes in departing or arrival times for other flights. Scarcity is possible without congestion when the airport authority is not charging a market clearing price for the available slots and the number of slots give enough slack to accommodate timing problems without system overloads.

Investment in transport infrastructure can improve *service reliability and predictability* and this is converted in lower generalised costs for travellers or lower operating costs for firms using air transport services.

Other projects allow the introduction of more efficient technologies or facilitate a better use of those in use, resulting in a *reduction in operating costs* (lower cost per seat associated with more efficient aircrafts, handling equipment, etc.)

Finally, the reduction in costs for passengers and firms could lead to an increase in traffic. This is what it is known as *induced traffic*, with two basic types: *deviated* and *generated.*

The agents directly affected by these economic benefits are the following: airport users, airlines, firms operating at the airport or providing services to the airport, airport authority and taxpayers. Other agents can be affected indirectly through substitutive and complementary cross effects in secondary markets. The importance of these effects in terms of the economic evaluation of the project depends heavily on the existence of distortions in the economy and the magnitude of the cross effects.

2.2. Net Present Value (NPV) of the investment

The NPV of an investment in transport infrastructure can be expressed as

$$NPV = -I + \sum_{t=1}^{T} (\Delta CS_t + \Delta PS_t)(1+i)^{-t} \tag{1}$$

where:

I : investment costs

T : project life

ΔCS_t : change in consumer surplus in year t

ΔPS_t : change in producer surplus in year t

i : discount rate

The change in consumer surplus can be estimated with "the rule of a half":

$$\Delta CS_t = \frac{1}{2}(g_{t0} - g_{t1})(q_{t0} + q_{t1}) \tag{2}$$

$$g = p + \tau$$

where:

g_{t0} : generalized cost in year t without the investment

g_{t1} : generalized cost in year t with the investment

q_{t0} : airport users in year t without the investment

q_{t1} : airport users in year t with the investment

p : price per trip inclusive of airport charges, airline ticket, access and egress money costs

τ : value of total trip time (flying, access, egress and waiting)

The change in producer surplus (for any of the affected producers) is equal to:

$$\Delta PS_t = p_{t1}q_{t1} - p_{t0}q_{to} + C_{t0}(q_{t0}) - C_{t1}(q_{t1}) \tag{3}$$

where $C_{t0}(q_{t0})$ and C_{t1} (q_{t1}) denote total variable costs without the project and with the project.

Changes in producer surplus require estimating incremental revenues and costs for the airport authority, for airlines and other companies directly affected by the project. The degree of market power in the airline industry and other economic activities directly affected by the project will determine who is the final beneficiary of the cost saving or the increase in frequency or service reliability.

When markets are competitive, producer surplus remains unchanged. Passengers and consumers served by companies benefiting from the cost reduction will increase their surpluses through lower prices and higher levels of service. However, this is not always the case with the airport authority which enjoys some market power by being the only provider of aeronautical services within a given area. Such an operator, once the project has been implemented, has to set prices above avoidable costs to recover the investment.

There are two ways of approaching the economic appraisal exercise: the social surplus approach, and the resource use or resource cost approach. The social surplus approach consists of the direct calculation of changes in consumer and producer surpluses. This requires identifying changes in prices, costs and revenues with and without the new airport infrastructure. The alternative approach to estimating the economic benefit of the Deoghar Airport Project (DAP) consists in looking at the changes in real resources, ignoring transfers. Even in the case of positive airport authority surplus it is possible to concentrate in resource costs as shown below.

So, instead of looking at the changes in social surplus, we focus measurement in real resource costs changes ignoring revenues from existing traffic. In this approach one should take especial care when changes in quality occur, and with the treatment of taxes and incremental revenue in generated traffic.

When markets are competitive and incremental revenues equal incremental costs for airlines and other firms, it is possible to measure the benefits of generated traffic by measuring the savings in resource costs. In the case of taxes, this shortcut is also feasible as long as there is a general indirect taxation in the rest of the economy. The net increase in tax paid to the government could be too insignificant to justify further effort [Adler, 2017].

The resource cost approach does not account for quality changes (e.g. comfort) and additional measurement should be made to avoid the understatement of user benefits when significant quality changes are part of the Deoghar Airport Project (DAP).

The measurement of benefits and costs requires estimating airport demand for the project life. Let us assume that the base demand level is known and equal to q_0 and the annual growth rate is γ. The annual airport demand for airport, assuming no changes in generalised costs is:

$$Q_t = q_0(1+\gamma)^t \tag{4}$$

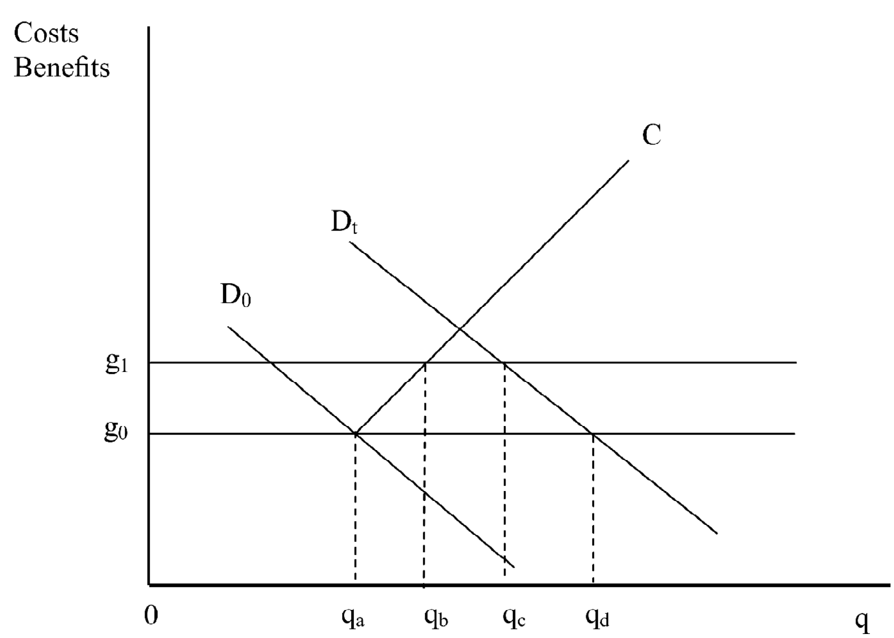
It is worth noting that Q_t is the number of users willing to pay, at the existing price, for the use of the airport in year t, and q_{t0} and q_{t1} in (2) and (3) are the equilibrium quantities in year t without and with the investment. This is assumed that the evaluating agency knows the annual demand growth and needs to work out the equilibrium quantities to estimate the change in social surplus (or resource cost).

3. IDENTIFICATION OF BENEFITS FROM DEOGHAR AIRPORT PROJECT (DAP) INFRASTRUCTURE INVESTMENT

3.1 Benefits without rationing

Assuming that the market is competitive and leaving aside the measurement of service reliability and predictability, the economic benefit

Figure 1: Users Benefits



of the investment can be determined through the reduction in resource costs. Let us consider a project in airport infrastructure which implies a reduction in total trip time (τ_1- τ_0), and assume that prices do not change.

Figure 1 represents the stylized case of this type of investment, in landside infrastructure, which eventually leads to higher capacity. Generalized costs and willingness to pay for airport services are measured in the vertical axis and the demand per unit of time (e.g. hour, peak period, day or year) in the horizontal axis. Initial capacity allows attending a maximum of q_a users per period of time at a constant generalized cost equal to g_0. The average generalized cost function *C* shows that once the critical level q_a is reached, a new increase in traffic is only possible, within existing capacity, at a higher average cost.

Initially the airport demand in a particular period of time has an imperfect substitute (another less convenient flight, airport or mode of transport) available at a generalized cost of g_1, higher than g_0) nevertheless, as demand is D_0, all the users willing to pay g_0 will be attended. Demand growth is expected to be equal to γ and according to (4) the level of demand in the following period is Q_t. Depending on which cost (g_o or g_1) applies, Q_t would be fully attended at the project airport ($Q_t = q_d$), or partially at this airport ($Q_t = q_b$) with some deviated traffic to second best alternatives (q_c-q_b) and some deterred traffic (q_d-q_c).

The situation with the Deoghar Airport Project (DAP) is characterized in the figure with the possibility of maintaining g_o as the generalized cost when demand has shifted to D_t, $Q_t = q_d$. The situation without the project is also with a level de demand equal to D_t, but with an equilibrium demand quantity of $q_b < q_d$.

Once the equilibrium level of demand with and without the project has been determined, we can proceed to evaluate the economic benefit of the investment Deoghar Airport Project (DAP).

Three categories of benefits can be identified in figure 1:

(i) Benefits to existing users (q_b)

(ii) Benefits from avoided diversion costs (q_c-q_b)

(iii) Benefits from generated traffic (q_d-q_c)

Benefits to current users are equal to (g_1-g_0)q_b, because the maximum number of the airport users (q_b) is now determined by the outside alternative with lower cost than the airport equilibrium with demand D_0.

Benefits from avoided diversion costs are equal to (g_1-g_0)(q_c-q_b). Passengers in the segment q_c-q_b will deviate to less preferred alternatives. The diversion could be in time, when passengers are forced to change to less convenient departure times, or in mode when the passenger has to use an alternative airport or mode of transport. The rule of a half applies equally to diverted as well as generated traffic. In Figure 1 the benefits of diverted traffic is represented by the difference $g_1–g_0$. This value should be interpreted as the average, equal to a half of the interval of time savings.

User benefits from generated traffic are equal to $0.5(g_1-g_0)(q_d-q_c)$. Contemplated from the perspective of forecasted future demand Q_t, this benefit can equivalently be interpreted as deterred traffic avoided thanks to the investment. It is important to notice that additional benefits (taxes and revenues above incremental costs) could be associated with deviated and generated traffic.

The previous analysis ignores two important facts: firstly, the existence of administrative rationing and different generalized cost for existing and deviated travelers; and secondly, the possibility of insufficient capacity to meet demand during the project lifetime.

3.2 Benefits with rationing

In Figure 1 it was assumed that the number of airport users in equilibrium was determined by the intersection of the average generalized cost function and the generalized cost (g_1) of an imperfect substitute (another less convenient flight, airport or mode of transport) and hence the generalized cost at the base case was identical for existing and deviated users. This is not usually the case when capacity rationing applies.

Figure 2 shows the standard case of different generalized costs for existing and diverted users. The situation with the Deoghar Airport Project (DAP) is identical to Figure 1, but the situation without the project is quite different: q_b is now determined through slot allocation and hence the generalized cost of existing traffic has to be lower (g') than the second best alternative.

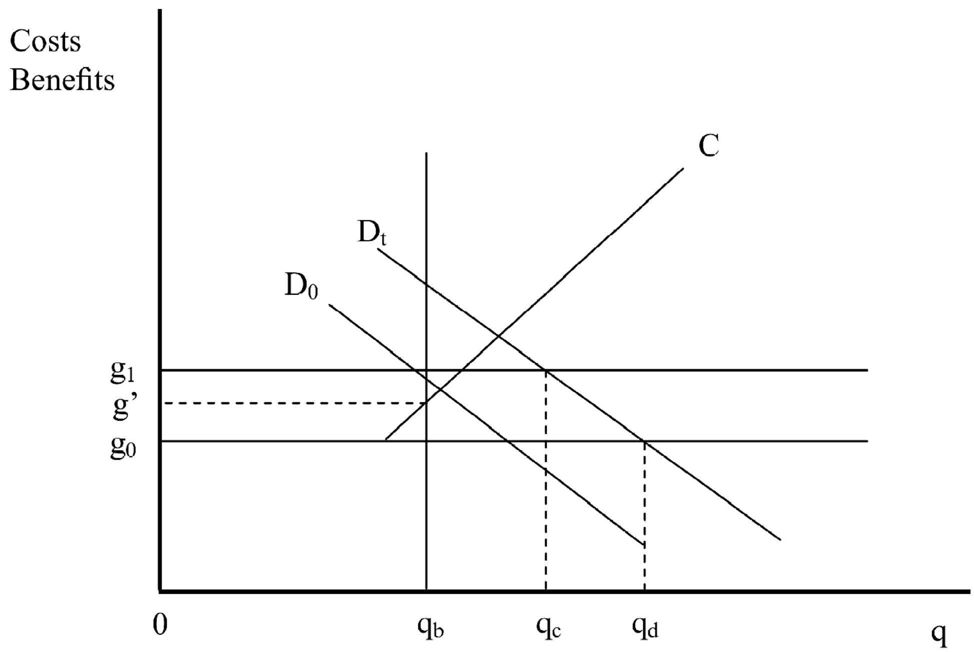
This way, the generalized cost of deviated traffic is higher (or equal in an extreme case) than the generalized cost of existing traffic. Scarcity without the project results in some deviated traffic to second best alternatives (q_c-q_b) and some deterred traffic (q_d-q_c).

The comparison with and without the project leads to the following benefits:

Benefits to current users are equal to $(g'- g_0)q_b$, strictly lower than without administrative rationing. Benefits from avoided diversion costs are equal to (q_c-q_b) (g_1-g_0), which are strictly higher than those reflected in Figure 1 as (q_c-q_b) is now strictly higher. User benefits from generated traffic are similar. This is ignoreed the trivial case where q_b is equal in both cases.

The comparison between the situations reflected in Figures 1 and 2 also shows the interesting possibility of improving the results without implementing the project when congestion is above the optimal level. A Pareto improvement results without the project through a rationing of capacity. Another insight from the comparison of Figures 1 and 2 is that the benefits of the airport infrastructure project appear to be substantially higher in Figure 1 than in Figure 2, highlighting the importance of a clear definition of the base case.

Figure 2: User benefits with administrative rationing of capacity

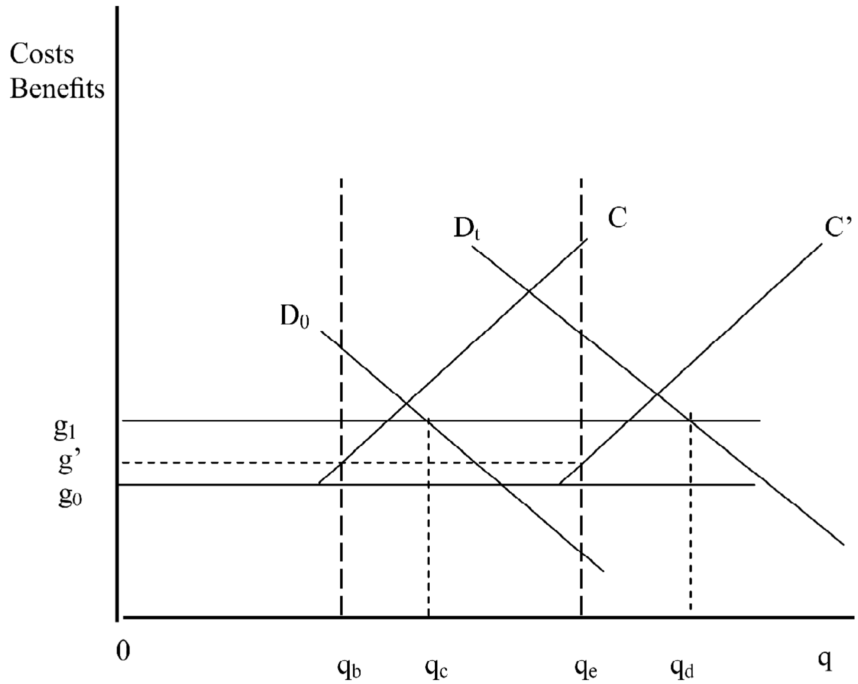


3.3 Capacity constraint

During the lifetime of the project it might occur that demand in some year *t* is above the baseline identified in Figure 1 with a generalized cost equal to g_0. This is a quite realistic case during a typical project life of 15 or 20 years.

Figure 3 illustrates a situation during the project life, in which demand Q_t cannot be met at a constant cost g_0 but at a higher cost, due to the presence of congestion. This could happen because of indivisibilities in airport investment. It may be optimal not to invest in additional capacity during some years, and hence the case represented in Figure 3 is compatible with the assumption of perfect information on demand.

Figure 3: User benefits with administrative rationing and congestion



In this case, benefits from capacity expansion are lower than those described in Figure 1. The reduction in the generalized cost of using the airport is now lower and so is the generated traffic. The generalized cost for existing traffic remains at g'. Benefits come from diversion costs avoided, equal to $(g_1\text{-}g')(q_e\text{-}q_b)$. No deterred traffic exists in this case. Project benefits are definitely lower when supply and demand conditions are similar to those represented in Figure 3: lower demand at equilibrium and smaller cost reduction.

The graphical analysis shows the user benefits we have to measure to work out whether the investment is socially profitable: time savings for existing passengers, diversion cost avoided and the consumer surplus of generated travel.

This is assumed that the economic effects of the investment were limited to user time savings and therefore leaving the producer surpluses of airport authority, airlines and other firms constant. Investment in airport infrastructure can change operating costs and revenue of airport authority, airlines and other firms, so we need to generalize the previous graphical analysis based in the resource cost approach to the case of a positive airport authority surplus. For simplicity, we keep the assumption that cost reduction accruing to airlines will finally benefit consumers through lower prices.

Without rationing, from (2) and (3), and disaggregating existing and generated traffic, the change in social surplus with the project in year t is equal to:

$$\Delta(CS_t + PS_t) = (g_{t0} - g_{t1})q_0 + (p_{t1} - p_{t0})q_0 + \frac{1}{2}(g_{t0} - g_{t1})(q_{t1} - q_{t0}) + p_{t1}(q_{t1} - q_{t0}) \tag{5}$$

Given that, and rearranging (5), social surplus can be expressed as:

$$(\tau_{t0} - \tau_{t1})q_0 + \frac{1}{2}[(\tau_{t0} - \tau_{t1}) + (p_{t1} + p_{t0})]\Delta q \tag{6}$$

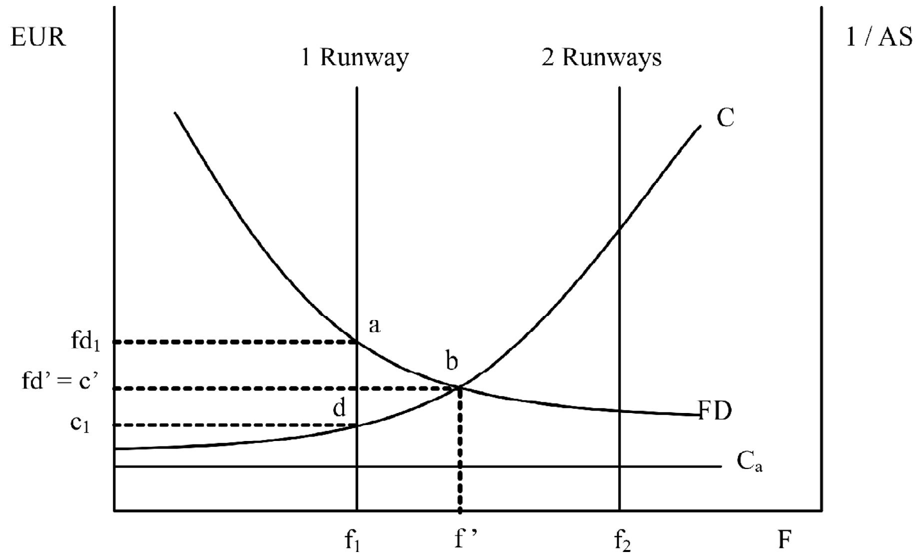
Following (6) the benefit of the project for current users is equal to total time cost savings. In the case of generated passengers, only half of that amount should be accounted for, plus the average of *ex ante* and *ex post* airport charge per trip. Time diversion cost savings are treated in (6) as existing traffic (conditions in Figure 1) and the full difference in trip time applies.

With rationing, condition (6) has to be modified to account for possible differences in time savings between existing and diverted traffic, as happens to be the case in Figures 2 and 3. The conditions prevailing in Figure 2 requires to calculate the first term of (6) twice, one for existing traffic and another for deviated traffic. With Figure (3) the calculus is straightforward as the same time saving apply for all traffic and no deterred traffic exists.

3.4 Additional considerations for airside investments

An increase in airport capacity in terms of the aircraft movements it can handle has three effects. Firstly, it enables an increase in the potential passenger and freight capacity. Secondly, it makes it possible to increase flight frequency, benefiting all passengers traveling through the airport. These benefits result from the greater choice of departure time, and consist of reductions in the "frequency delay", which is the difference between the passengers' preferred departure time and the nearest departure time available. Thirdly, for a given amount of traffic as frequency increases there can be a change in the average size of aircrafts using the airport. This has implications for airline operating costs because larger aircraft are, to a certain extent, cheaper to operate on a per seat basis than smaller aircraft. For an empirical analysis of the cost economies of aircraft size see Wei and Hasen (2018). They found that when pilot cost is treated as endogenous,

Figure 4: Benefits from airside investment



the cost minimizing aircraft size is smaller. Pilot cost increases with aircraft size and the optimal sizes are smaller than those resulting exclusively from technical efficiency criteria.

Indivisibilities in airport expansions imply that runway capacity cannot increase linearly with traffic. As a runway handles more passengers, it will eventually have to handle larger aircraft. When a new runway is built, two effects may bring about reductions in average aircraft size. Firstly, airlines would tend to compete for time sensitive business travelers by increasing flight frequency, which will tend to take place with smaller aircraft. Secondly, new airlines will enter the airport, developing new routes, also normally with smaller aircraft.

Should a new runway not be built, airlines will be forced to operate with bigger aircraft in order to accommodate growing traffic. Hence, the decision to invest in a new runway will have to consider the possible trade off between, on the one hand, reduced frequency delay at a higher cost per seat if the runway is built and, on the other hand, keeping frequency delay constant at a lower cost per seat if the runway is not built.

This trade-off is illustrated in Figure 4. The left-hand vertical axis measures currency units and the right hand-side vertical axis the inverse of average aircraft size (AS). The horizontal axis measures departure frequency. The marginal frequency delay schedule (FD) denotes the inverse relationship between departure frequency and generalized cost. An increase in the value of time would shift the schedule upwards.

The marginal airport costs schedule (*Ca*) denotes constant returns to scale. The marginal total cost schedule (*C)* includes both airport and aircraft costs. With respect to the right hand side vertical axis, *C* reflects the inverse relationship between departure frequency and aircraft size and, with respect to the left hand side vertical axis *C* reflects the direct relationship between departure frequency and unit cost per seat. When total traffic grows, for a given level of frequency, aircraft size will have to increase, reducing marginal cost per seat, rotating the *C* curve downwards, clockwise. It is worth to point out that traffic is not constant along the horizontal axis. Increases in departure frequency generate traffic in themselves because they constitute an improvement in service quality and a decrease in frequency delay. The cost curve *C* accounts for this effect. The shift in the C curve would be accounted for only by exogenous changes in traffic such as that caused by population or income growth.

In the example illustrated in Figure 4, runway 1 has a capacity for aircraft movements of f_1. Building a second runway would enable an increase in frequency to f_2. At f_1 the cost imposed on the passenger by the frequency delay is fd_1, higher than marginal operating costs of c_1. Airlines hence have an incentive to increase frequency at the expense of aircraft size, as passenger willingness to pay for en extra frequency is higher than the marginal cost associated with reducing aircraft size. Equilibrium would be reached at point *b*, where frequency is f' and where fd' is equal to c'.

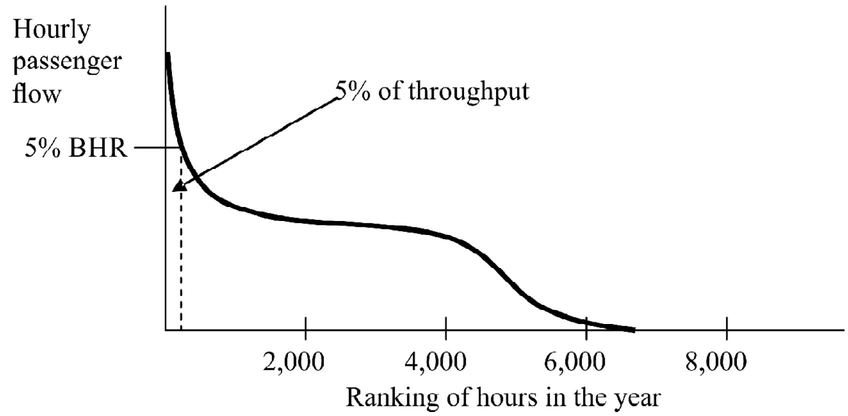
The benefits of building a new runway, enabling an increase in departure frequency, will be equal to the area *abd*. Moreover, the passing of time will bring about two effects: traffic grows, shifting the *C* schedule downwards; and the value of time increases with growing income, shifting the *FD* schedule upwards. These two effects would expand the area *abd* from all of its three corners, meaning that the benefit of building a new runway increases with time. The economic returns from investing on a new runway are determined by the present value of the future stream of benefits as determined by the area *abd* in each year, and by the present value of the capital investment required for the new runway. Until point *b* exceeds the capacity of runway 2, there will be no benefit from building a third runway.

4. APPLIED MEASUREMENT OF BENEFITS FROM INVESTMENT IN DEOGHAR AIRPORT LANDSIDE

4.1 Expansion of landside capacity

Deohahar Airport infrastructure usage experiences marked peaks and troughs, which follow time of day, day of the week and month of the year patterns. Figure 5 provides an indication of the degree of variability of

Figure 5: Flow Distribution Curve for a hypothetical airport



capacity requirements placed on airport infrastructure throughout the year. It displays the Flow Distribution Curve (FDC) for a hypothetical typical airport. The FDC ranks all 8,760 hours of the year by passenger throughput.

This pattern of demand means that the terminal is underused for a significant portion of time. In principle, terminal capacity could be increased - and a more economically efficient operation could be achieved - by flattening the FDC, for instance through pricing policy. Deoghar Airport charges should differ between peak and off-peak periods either through a differentiated pricing system or by a market-driven slot allocation. In practice, almost always a flat charge is applied, increasing the peaks in demand above efficient levels.

Terminals are designed to be able to process a target hourly throughput with a given level of service. The objective is to strike a balance between the need to address traffic peaks, and the need to minimize unused capacity during throughput troughs. This implies that the terminal needs to supply a level of service that is acceptable "most of the time".

There is not a single criterion to set the hourly throughput target for terminal design. Some alternatives include:

- the Standard Busy Rate, taken to be the thirtieth busiest hour;
- the fortieth busiest hour;
- the 5% Busy Hour Rate, defined as the throughput level which the 5% of passengers traveling during the busiest hours find as a minimum throughput level in the terminal (see Figure 1, where the area under the FDC and left of the doted line corresponds to 5% of total traffic); and
- measures of the type "busiest hour in the second busiest month".

At the target level of throughput, a standard of service is defined. The Airports Council International (ACI) and the International Air Transport Association (IATA) have defined a scale of service standards, in terms of space available per occupant at various locations in the terminal. These standards are shown on Table 1. Trespassing the minimum limits imposed by level E would take the terminal to level F, considered as "system breakdown". It is important to underline that the actual capacity of the terminal in terms of passenger throughput per hour is determined by the maximum capacity of the "weakest point" along the passenger processing chain. So, an otherwise A-level terminal with C-level hold room standards, can only be expected to be able to handle the amount of passenger throughput under C-level terminal standards, with a minimum C-level service quality standard.

Table 1: ACI / IATA Level of service space standard (m^2/pax)

	A	*B*	*C*	*D*	*E*
Check-in queue area	1.8	1.6	**1.4**	1.2	1.0
Wait/circulate area	2.7	2.3	**1.9**	1.5	1.0
Hold room	1.4	1.2	**1.0**	0.8	0.6
Bag claim area*	2.0	1.8	**1.6**	1.4	1.2
Gov. inspection services	1.4	1.2	**1.0**	0.8	0.6
Difference to C	**35%**	**18%**	**0%**	**-18%**	**-36%**

* Excluding luggage conveyor belt.
Source: ACI / IATA.

The extent to which passenger diversion takes each of its possible forms-diversion in time or in mode – is very much case dependent. It varies according to the shape of the FDC at the airport, passenger profile in terms of trip purpose, alternative transport means available, and the scheduling practices of airlines operating at the airport. Estimating diversion at an airport with precision can potentially be a complex process. In many cases the analyst does not have the required information readily available, and assembling it would require significant analysis costs.

A workable alternative would be for the analyst to use a set of generic rules that can be adjusted to each particular project. A general rule of thumb followed in the industry is that a C-level terminal will start experiencing significant traveller diversion when traffic exceeds design annual throughput capacity by about a third. As shown in Table 1, this roughly coincides with the average difference in space requirements between service level C and the lower limit of service level E. In view of this, it would be possible to take ACI/IATA service standard criterion as a proxy index of spare capacity before diversion takes place. It could be assumed that all forecasted potential throughput exceeding such a threshold would experience diversion. The percentage assumed for A-level terminals would be higher (some 50-60%) and for E-level designs lower (say, some 5%).

Diversion can be measured in equivalent time terms, and its cost calculated using published value of time estimates. One approach would be to take an average diversion time for all diverted passengers. It can be further assumed that all diversion would be equally resource consuming, and hence should be treated equally. The average time could be set at two hours for both diversion in time and in mode. Regarding diversion in time, peak periods in airport activity extend for 1 to 2 hours. It is reasonable to assume that in cases of scarcity, where rationing is necessary, flight schedules would have to be displaced by 1 to 3 hours, the average being around 2 hours. As for diversion in mode, two hours drive is deemed a reasonable additional access or egress time to an alternative airport, or longer travelling time if the trip is carried out on an alternative transport mode. If, for a particular project, circumstances dictate that such assumptions are unreasonable, the analyst can adjust them accordingly.

This diverted traffic is equal to q_c-q_b in Figure 2. The two hours worth of passenger time corresponds to g_1-g_0 in the vertical axis. This corresponds to the difference in generalised cost with respect to the best alternative available to diverted traffic, whether to an alternative transport mode or airport (diversion in mode) or to an alternative, less preferred, departure time from the same airport (diversion in time).

Only when for a specific project circumstances suggest that the overall cost of diversion would be significantly different for time or mode diversion, and when a reasonably accurate estimate could be formulated as to what proportions would each diversion take, would there be a case for treating them differently. The typical case would be when the alternative mode of transport poses a very large time penalty on the passenger, such as in islands. There the two-hour rule must be substituted by the time the passenger must invest in traveling on the alternative mode. If this is far too high, such as remote oceanic islands, then the assumed diversion in time per passenger could be increased.

In estimating future traffic, the analyst will start with existing traffic levels - the only hard evidence regarding demand available to the analyst - and, as mentioned in Section 3.2, it is very important to define very clearly what the situation of this existing traffic is regarding generalized cost. Throughput projections will normally have to be made for 20 to 25 years, and to do this the analyst must follow long-term air traffic projections, normally supplied in the form of average yearly growth rates. The critical issue when applying such growth rates to existing traffic is determining any possible changes in the generalized cost of travel to existing airport users after the Deoghar Airport Project (DAP) is implemented. If there are significant changes, then generated traffic might be significant and particular attention must be placed to its estimation.

Normally, new capacity will be opened before scarcity or congestion becomes serious. If so, existing traffic at the time of project appraisal will be experiencing a generalized cost of or close to g_0 in Figure 2. In this case, throughput on each subsequent year after project implementation can be estimated using long-term air traffic projections. These projections can be taken to include traffic that in the absence of the project would have been deviated or deterred. For ease of calculation, when estimating the welfare loss resulting from the "without project" scenario, both types of traffic can be treated equivalently and estimated jointly, as the resulting error will be small compared to the uncertainties regarding long-term traffic, anyway. It should be noted that this does not mean that the estimation excludes generated traffic, but only that both deviated and generated are taken to be included in the long-term traffic growth estimate.

However, if at the time of the appraisal the Deoghar airport is operating with significant rationing, then existing traffic would be experiencing a generalized cost akin to g' in Figure 2. If so, applying the long-term traffic growth to the years immediately following the opening of the additional capacity could result in a substantial underestimate, as the sudden decline in generalized cost of users will bring about significant generated traffic. The same applies to a situation without rationing but where the project still produces a lower generalized cost relative to that of existing traffic. An example is when the Deoghar Airport Project (DAP) attracts new services by no-frill airlines.

In these cases, generated and deviated should not be estimated jointly. The proposed method to calculate generated traffic would be to, firstly, estimate the difference in generalized cost between existing traffic and future traffic at the margin (that is, g_1-g_0 or g'-g_0, depending on conditions at the airport, in Figure 2), and then applying an elasticity of about –1, common in aviation.

4.2 Improvement of landside quality

Two key variables in determining the quality experienced by the passenger on a terminal are congestion in the terminal, and the quality of access facilities to aircraft, as defined primarily through the availability of jetways.

Congested terminals experience longer queues and more disruption to the flow of passengers within the building. Hence, whereas terminals can handle more traffic than they are designed for until they reach ACI/IATA level F, on the process, time delays are experienced. This corresponds to g'-g_0 in Figure 3, which is the additional passenger throughput time resulting from congestion, multiplied by average passenger value of time. In the absence of detailed congestion data, one approach for ensuring comparability across projects in project appraisal would be to set a single cost per passenger for all projects. A reasonable approximation to actual time penalty would be a cost per passenger of, say, 15 minutes worth of passenger time.

Some passenger terminal projects have as a central objective an improvement in the quality of service offered to the passenger via increasing the proportion of contact stands relative to remote stands. Such investments involve significant costs and do not increase terminal capacity. Benefits of the investment consist entirely of increased comfort to passengers.

There is no readily available evidence on the academic literature on passenger willingness to pay for contact stands. In the absence of studies, the analyst can make a judgmental estimate and apply it consistently across projects. A suggested approach is to take a value of Rs. 45-110 for tourist traffic, and double that for business traffic.

Contact and remote stands also differ in the type of operating costs involved. Contact stands require bus shuttling, while contact stands normally require aircraft towing vehicles, as well as maintenance, lighting and heating of jetways. These costs are similar in magnitude and any difference should have only a marginal impact on estimated project returns. Hence, for simplicity during appraisal, it could be assumed that the difference in costs between remote and contact stands consist only of infrastructure construction costs.

In order to keep the Deoghar Airport Project (DAP) appraisal as simple as possible, it is suggested that the comfort benefit provided by contact stands is only included explicitly on the appraisal exercise when the project at hand is highly geared towards increasing comfort. When projects involving new terminals do not significantly alter the proportion of contact stands in the airport, the Deoghar Airport Project (DAP) can be considered as a capacity expansion using the same production technology. If such proportion increases significantly, then there is also a quality enhancement element on the project, involving an upward shift on the airport's cost curve. The inclusion of comfort benefits in the appraisal exercise is a means to register the rationale behind such a shift.

5. APPLIED MEASUREMENT OF BENEFITS FROM INVESTMENT IN DEOGHAR AIRPORT AIRSIDE

Some projects may yield a disproportionate increase in airside (i.e. aircraft movement) capacity relative to the increase in landside (i.e. passenger or freight throughput) capacity. Airside capacity is determined by runways, taxiways and apron space. As with terminals, the actual hourly capacity of an airport's airside infrastructure is determined by the capacity of the weakest of these three levels. The exception being a possible partial substitutability between taxiways and apron space, in that the latter can handle "virtual queues" until taxiways are decongested. Investment aimed at alleviating an airside bottleneck could trigger large increases in the ability of the airport to handle aircraft movements. Improvements in departure frequency can be valued in terms of changes in frequency delay. Note that the additional runway capacity could also be used to open a new route. However, this can also be considered an increase in frequency starting from zero departures. The effect for the passenger could be considered the same as an increase in the frequency of an existing route: should the passenger wish to depart at the time of the new flight it saves him/her from either altering the departure time or from spending waiting time in an intermediate connecting airport.

Whereas studies explicitly using frequency delay are rare, the most widely quoted estimates of a delay function is that by Douglas (2014), as follows:

$$Fd = 92(F^{-.456}) \tag{7}$$

where:

Fd: frequency delay

F: departure frequency

Douglas (2015) acknowledge that the actual delay is affected by scheduling practices, not picked in the formula. However, they underline that the value of the formula does not reside in estimating absolute values of delay, but rather in estimating changes in delay, and that for this latter purpose chances of estimation bias are lower. Changes in delay are governed by the estimated elasticity of –0.456.

Changes in average frequency delay can be computed by referring to the average departure frequency per route in the airport, a figure that should be readily available for most airport operators, including those with poor data resources. The extent to which frequency delay changes over time will depend on how fast departure frequency increases. As a rule for a simplified type of project appraisal, it can be assumed that if movement capacity increases in line with passenger capacity, average aircraft size should remain the same. Frequency should then increase in line with traffic. In practice there could be more than proportionate increases in frequency during the first few years following project implementation, as airlines rush to secure runway slots. The rule reflects a long-run equilibrium.

If the increase in aircraft movement capacity were to be lesser than the increase in passenger capacity, then aircraft size would increase in the long run. Changes in aircraft size would bring about changes in operating costs, as larger aircraft are cheaper to operate on a per seat basis than smaller aircraft. The average cost per seat per trip for a mid-size aircraft, such as the Airbus A-320 is Rs. 51/-. The actual average cost per block hour in an airport will depend on the aircraft mix serving the airport, the average route length flown by such aircraft, as well as on the non-aircraft operating costs of an airline that can differ significantly by the airline's country of origin. The calculation can potentially become tedious and inefficient. The figure quoted was calculated from 2019 Indian data from The Airline Monitor.

Aircraft cost per seat is related to aircraft size by an elasticity in the region of –0.5. A constant elasticity is to be used as an approximation, in the absence of more detailed data.. The actual elasticity will vary somewhat with aircraft size itself, as well as with route length. New empirical evidence of this relationship can be found in Wei and Hasen (2018).

The impact of a change in average aircraft size on operating costs could be made by applying the –0.5 elasticity to cost per seat values based on the Rs. 51/- benchmark figure.

An additional element to take into account regarding investments on the airside is the impact that changes in aircraft operating procedures have on costs. To the extent that there is a significant change in airline operating costs as a result of the project, these should be included as a welfare change. Changes in aircraft operating costs could result from various sources, including changes in approach traffic patterns, ground taxiing requirements and turnaround times allowed by the new facilities. Each project will have different impacts on these factors. A common denominator for these factors can be to convert them into time savings and then translating them into a total cost figure through data on costs per aircraft block-hour. A workable way of including these factors into the project appraisal exercise would then be:

(i) considering only situations where the project will produce significant changes in aircraft operating costs; and

(ii) using an average figure for cost per block-hour which can be easily adjustable in situations where the aircraft operations differ significantly from the average.

The suggested approach is to use the A-320 benchmark mentioned above. The aircraft's cost per block-hour is estimated at Rs- 2,5300. Adjustments for airports with a significantly different aircraft profile – such as in projects on regional airports – would be made following the –0.5 elasticity of operating costs with respect to aircraft size already mentioned.

As in all other aspects of the practical framework here proposed, the analyst should be aware of institutional constraints facing the airport and its users which may condition the "with project" and "without project" scenarios. In the case of airside investments, one key concern is the extent to which it is realistic to expect an increase in aircraft size. In highly competitive markets, particularly in competition between hubs, airlines may demand more runways as a way to compete on frequency. To the extent that one airline is constrained in terms of number of runways and other competitors are not, forcing that one airline only to increase aircraft size may distort competition in the airline market. Moreover, the airline may go on to develop a second hub in another alternative airport instead of increasing aircraft size. So, in the case of a project consisting of building a new runway, the analyst may adjust its "without project" scenario by capping the extent to which the airline would increase the size of its aircraft below what would be technically feasible.

6. THE TREATMENT OF AIRFREIGHT

The Indian air freight market is very competitive. Operators compete on price and quality, normally with very narrow operating margins. Freight is less speed demanding and more flexible regarding traveling times than passengers. Also, aviation carries goods with a relatively high value to weight ratio, where transport costs are a relatively low proportion of the final price of the good. These characteristics encourage competition in two ways: First, it widens the catchment area of the various freight terminals relative to passenger catchment areas. Second, it enables more inter-modal competition than in the passenger sector.

Hence, demand is little dependent on a single project, as capacity constraints in one network node can be overcome relatively easily by channeling freight flows through other nodes. Under these circumstances, the benefits of the project would stem from the lower operating costs resulting from it. Given that an independent operator can take the price as given, such benefits would be the gain in producer surplus resulting from the project, that is, the financial internal rate of return.

In cases where demand is largely dependent on the project, as in a remote island, then the project could bring about significant savings in diversion costs. An estimate of such costs should then be made, and treated in an analogous manner to diversion costs for passengers.

These considerations apply to both landside and airside projects. In the case of landside projects, issues are the same as for the passenger sector: terminal capacity determines potential throughput. However, regarding airside projects, the aircraft size versus frequency of departure trade-off does not normally apply. Freighter flights can normally operate at off-peak times, so that runway slot availability is normally a non-issue, and hence there are no benefits of increasing the number of runways. Instead, the critical issue is the technical characteristics of the runway, as this determines whether large freighter aircraft can operate from the airport. When there is no sufficient belly-hold space on passenger aircraft and alternative means of transport are very expensive, large freighter aircraft reduce significantly the costs of carrying freight. In such cases, investments to upgrade a runway to accommodate such aircraft could be justified economically.

7. AIRPORT OPERATING COSTS

Airport costs can be grouped into landside costs and airside costs. Landside costs are those incurred by processing passengers and cargo through terminals. Airside costs are those attributable to processing aircraft through aprons, taxiways and runways. Both airside and landside operations are infrastructure-intensive, creating significant fixed costs that give rise to cost economies.

However, conceptually, the relationship between throughput and unit cost could be disaggregated into three potential sources of cost economies:

- Economies of density: arising from increasing throughput through the existing infrastructure;
- Economies of scale: arising from increasing throughput by increasing infrastructure capacity, while keeping throughput density constant.
- Economies of scope: arising from combining different types of output through the existing infrastructure, while keeping density constant. As in airlines, output segmentation could consist of passenger and freight.

A priori, economies of density should be expected in airports, taking place both on the airside and on the landside. This is because both types of infrastructure have large fixed cost components.

It is not clear whether there can be economies of scale as defined above. On the one hand, there should be economies through more intensive use of centralized functions such as administration. On the other, it is reasonable to assume that airports will expand by exploiting the next best available location, so that the cost of each successive piece of infrastructure is higher than the preceding one.

Unilateral expansion of either the landside or airside capacity while keeping the other constant can be expected to have distinctive impacts on unit costs. A landside expansion while keeping airside constant can create cost economies by increasing density on the airside. Such a project might have to be accompanied by an increase in the average size of the aircraft operating from the airport. However, a unilateral expansion on the airside can create cost diseconomies by reducing airside throughput density. The rationale for such a project would be to enable an increase in the flight frequency for a given amount of passenger throughput.

The main source for scope economies would be an increase in airside throughput density. It is not possible to judge a priori the impact on unit costs of a unilateral expansion of, say, a freight terminal, requiring significant airside expansion.

Hence, in principle there should be two types of projects that could result in cost economies, both of them relying on density increases. Firstly, an expansion on the landside (through expanded passenger or freight terminal capacity) leading to a higher density on the airside; secondly, an expansion on the airside (through expanded apron, or new or extended runways) leading to higher density on the landside.

It is not possible to say whether a proportional increase in airside and landside capacity would generate cost economies. As for a unilateral increase in airside capacity, not resulting in increased density on the landside, it will invariably result in higher costs.

Degghar Airport cost studies have so far centred on producing benchmarks for cost efficiency. There is no parallel to the research effort found in the airline literature modelling production functions and identifying sources of cost economies. Airport benchmarking studies normally relate unit cost to throughput via an all-embracing concept of "economies of scale", sufficient for comparing efficiency across airports. Their definition of scale does not correspond to the definition adopted in this paper, and says little about airport production functions.

However, a number of studies produce some evidence as to the shape of the production function. Doganis et al. (2015) finds strong economies of scale until about 3m WLU, constant or slightly declining thereafter. Salazar

(2019) sheds further light for larger airports, finding constant average costs in the range 3.5-12.5m passengers/year, but increasing thereafter. Findings by Murillo-Melchor (2019) are compatible the preceding two studies. It finds decreasing average costs for small airports, constant or increasing average costs for larger airports.

The project analyst will have cost information of two sorts: capital investment costs and operating costs. When calculating project returns these costs must be accounted at the time they are incurred. Normally data on current and projected costs is available from the project promoter. However, sometimes future operating cost estimates may not be available or may be unreliable. When this is the case, the analyst must make its own estimates of operating costs.

One way of proceeding is to use data on similar projects and to estimate a relationship between unit operating costs, that is operating cost per unit of throughput (i.e. per WLU), and airport capacity utilization. WLU, or work-load unit, is a standard measure of airport throughput and corresponds to one passenger or 100 kilos of freight. Costs can then be calculated as a function of throughput.

When estimating such a relationship, it must be borne in mind that unit costs will increase when a new piece of infrastructure is opened, and then decrease progressively towards long-term unit operating costs when the infrastructure is fully utilized. This pattern reflects the density economies that characterize infrastructure operations. As a rule of thumb, it is proposed that, after a new terminal is opened, unit costs increase in relative terms by half the relative increase in capacity. So, for example, a new terminal that expands airport throughput capacity by 50% would result in an initial increase in unit costs of some 25%. Subsequently, as throughput increases, unit costs would tend towards broadly the same level as before the expansion.

Such a rule will imply constant long-run returns to scale. In practice, future operating costs will depend on the following two additional factors, both of which are airport-specific:

- the degree of spare capacity with which the airport operator tends to operate on average; and
- the extent to which each additional investment is made more expensive by the circumstances surrounding the airport, including physical, institutional and traffic realities.

The analyst can adjust the constant returns to scale assumption according to project circumstances. Should additional infrastructure capacity come at a significantly increasing marginal cost, an appropriate cost surcharge could be included in the appraisal exercise.

8. CONCLUSIONS

Conducting a thorough cost benefit analysis of Deoghar Airport Investment Projects can be a very resource consuming exercise. An accurate estimation of the returns from an investment can require carrying out surveys of local demand conditions and the formulation of detailed hypotheses about the future evolution of traffic and airline operations. Nonetheless, it should be noted, even a full appraisal exercise will render the evaluation subject to significant uncertainties.

Sometimes, project analysts do not need to have precise estimates of the expected returns of a project and instead need to find out simply whether the project is "good" or "bad", whether the project should go ahead or not, or indeed whether it is a borderline case that merits a closer look. For arriving at these types of conclusions, conducting a full economic evaluation might itself be not economically justified. Instead, the emphasis should be placed on comparability across projects with widely differing data availability, in order to ensure consistency in decision-making, rather than on the accuracy of the results.

This paper has proposed one possible way (indeed, not the only one) in which such a "back of an envelope" answer can be provided. This is done by drawing on rules of thumb generally accepted in the aviation industry, and applying them to the standard cost-benefit analysis framework.

The approach is itself flexible and requires judgment by the analyst, as assumptions can be altered for a specific project when there is a good case for doing so. It is believed that, whereas the approach makes a large degree of generalizations and would not substitute a full cost benefit analysis where necessary and feasible, it still has a role to play among applied economists. It is useful in conditions of very limited analyst time, research budget, available information, and where quick decisions must be made for a large number of projects, a condition which many professionals face in practice.

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