Research paper on airport management and improving efficiency

Engineering, Aviation

A Research

Airport Management and Improving Efficiency

Airports are like gateways of the modern world. The aviation industry has contributed in bringing the world together and enabling globalization to be effective in a major way. It is through the airplanes that people could travel long distances between countries quickly and with improved safety. Airports are where the airplane reaches and the passengers get down to get going to each of their works- either business or pleasure.

With the extent to which the air travel has expanded, it has resulted in the airports to become large and have to handle huge volumes of traffic, both of aircrafts and the passengers on a daily basis. The congestion in the airports has thus increased, owing to the great volumes they have to handle. U. S Department of Transportation (2005) reported that in 2005, the industry annually operated 63. 1 million flights on 7, 836 aircraft; transported 739 million passengers and 74, 300 tons of cargo between 3, 500 domestic airports and 300 international destinations. There were as many as 5, 000 aircraft in the U. S. airspace on the busiest of the days. This congestion then translates to flight delays and cancellations and the subsequent revenue loss of the airports and the airlines. Thus the congestion at the airports affects the airline companies as much as it hurts the operational efficiency and profitability of the airports.

In terms of financial losses, the delays due to congestion and spending amounts to a lot of airline fuel wastage. The Indian carriers reported wastage

in Aviation Turbine Fuel (ATF) of the order of Rs 500 Crore (~$ 1 Billion) (Mansuri, 2010). This is about 3% of the total ATF consumed by the Airlines in India. With the increase in the number of flights and the growth in the industry, such numbers were expected to rise to 5%. Wastage in fuel was principally due to the incremental flying necessitated by congestion in airports which delays the landing and getting a parking space. Bad weather also contributes towards the flights circling the skies and wasting precious fuel.

The losses due to congestion are not limited to being financial in nature. The congestion also increases the risk of mishaps and thus puts the life of the commuters at risk. Tatge and Schmall (2007) reported that as many as 108 travelers had died in ground collision involving commercial airlines since 2001 in a few of the busiest American Airports. As many as 63 runway collisions were recorded since 2001 till 2007 in Northtown, Las Vegas and resulted in 6 fatalities (Tatge & Schmall, 2007).

The airports today are full-fledged and self sustained entities. An airport can be considered as a bottom-up-migrated heterogeneous system-of-systems with differing groups of stakeholders, each group operating within different fields with different goals (Eurocontrol, 2007). They are excellent examples of very large, dynamic and complex systems with many interacting traffic modes and numerous services (Eurocontrol, 2007). The airport management is a vast and extensive field and involves a lot of intricate and essential elements. Due to the importance of easing the congestion at the airports, which causes losses in revenue to the aviation industry as a whole and adds

to a negative experience of the commuters, several studies and measures have been undertaken ever since flying became the preferred way of travelling longer distances around the world. The studies and research have suggested many methods that aim to ease the congestion of the airports and improve its overall efficiency through smoother operations. These methods range from the airport expansion to using new technologies and also the use of scientific methods to design new methods of landing and handling of aircraft parking. The report shall look into the few of the methods in each of the fields and try and come up with a solution that is practical, viable and affordable. The methods can be broadly classified as being:

1. Runway and Airport Expansion
2. Improvement in technology
3. Demand Management (Le, 2006)

Runway and Airport Expansion

One of the simpler ways to increase capacity of the airports is through its expansion and development. Newer runways in existing airports and building new airports altogether seems to be a natural and obvious way to increase the capacity of airports in handling the airplane and passenger traffic. They also provide for the most significant capacity increase. However, the infrastructure expansion would need the land to be readily available and also extensive investment of capital funds. The Federal, state and local funds for US airports in 1999 stood at a whopping $20 billion (Cohen & Coughlin, 2003).

In addition to the economic costs that are associated with the airport expansion, there are other costs associated with it too. The expansion of airports and addition of runways is often protested by the local residents and businesses vehemently due to the need of large area of land to be acquired by the airport authorities and the relocation of the affected homeowners and businesses (Cohen & Coughlin, 2003). The moving of homeowners from their place near the airports to new locations requires the payment of compensation to them by the city authorities. The compensation is driven by the forces in the market. For the people living close to the airports, the value o their houses is generally lower than other places, due to the noise levels that are associated with aircrafts flying by. Thus the price offered to them might not be enough for them to buy homes in new locations in the city.

Another cost of the airport expansion is the level of noise pollution surrounding the airport. Therefore, there is often opposition from local community groups when an airport in an urban area plans to expand. The homeowners are required to be suitably compensated for the increase in the noise generated in the airport too as the real estate prices are related to the noise levels in the surrounding region. One alternative to paying compensation is to help the property owners take defensive action against the noise through soundproofing the buildings (Cohen & Coughlin, 2003).

All these costs are added expenses to the already expensive expansion of the airports through adding new runways and terminals. This solution, is easy to carry out in principle and has the most direct effect in easing congestion, but has a lot of complex issues associated with it. First being the

very high cost of infrastructure involved in the expansion and the availability of land in the area that limits the ability of many cities to exercise the option. Following this, there is the opposition that the authorities have to often deal with. Thus the expansion of airports might be rarely feasible and a practical option.

Improvement in Technology

The technological enhancements is this field has seen the most efforts and focus by the aviation industry on the whole. A large number of research and programs have been initiated and implemented by the airports which aim at dealing the problem of congestion through scientific methods.

There are n number of methods and studies that are currently undergoing in the field of airport management. In this section we shall throw some light on the popular technologies used by the various airports and a few studies that have been found to of being particular help in easing the congestion at the airports.

Instrument Landing Systems

Instrument Landing systems are aids that assist the pilots in safely landing the airplane in the congested airspace. The system is of particular help in adverse weather conditions and low visibility and can help the airport management in clearing up the long queues that pile up during fogy and unclear skies. The weather conditions also contribute in a major way towards the flight schedules to go haywire and add to the congestion in the already busy airports. The use of ILS can help ease the congestion by precision

landing and minimizing or avoiding the need for aircraft to circle the skies and save precious airline fuel.

The ILS is a ground based radio system designed to provide an airplane pilot with precise guidance for the final approach in landing (Columbia Electronic Encyclopedia, 2011). The system consists of two parts -the Localizer for horizontal alignment of the aircraft and the Glide-slope that controls its angle of approach. The localizer is a horizontal beam and the Glide-slope a beam in the vertical plane. The aircraft is equipped with an indicator that has a two needles-one horizontal and the other vertical, each sensitive to the deviations in the respective planes. The pilot needs to keep these needles centered so as to land the aircraft safely and with even the extreme of absolutely no visibility of the runway from the cockpit. There are three categories of performance of ILS system- Cat I, II and III with the tightest limits being in Cat III systems. The ILS should be seen as an approach rather than a landing system. The US Air Force calls the similar system as instrument low approach system (ILAS). The ILS is often used in conjunction with DME (Distance Measuring Equipment) which provides a slant range measurement to the pilot and a more accurate and continuous monitoring of progress on the ILS Glide-slope.

The ILS does have a few drawbacks. The first is that it cannot be used in runways which are uneven on slope. Also since the radio frequencies are being used, it is possible to cause distortion in the signals leading to inaccurate readings at the indicator in airplane. The use of microwave frequencies in place of radio frequencies does eliminate many drawbacks.

The ILS system in the airport runways is now being fast replaced by a newer technology that aids the safe landing of an aircraft. The new technology is based on Global Positioning System/ Wide Area Augmentation System (WAAS). According to GPS World (2008), it was reported by Federal Aviation Administration (FAA) in 2008 that the GPS/WAAS-based approaches surpassed the number of traditional Category-I Instrument Landing System (ILS)-based approaches at U. S. WAAS signal is broadcast from space and eliminated the need of ground-based equipment as needed for an ILS (GPS World, 2008). Safety is improved as more aircraft are provided with vertically guided approaches and improved flight planning options (GPS World, 2008).

The GPS based navigation tool has also been successfully implemented by Southwest Airlines and resulted in allowing more flights in and out of the airport in Midway, Chicago(Hilkevitch, 2011). The tool is called Required Navigation Performance, or RNP and is used in as many as 11 airports in January 2011 (Hilkevitch, 2011). Routing planes using RNP provides unprecedented accuracy vertically and laterally to stay on a precisely defined path over the ground (Hilkevitch, 2011).

Hybrid Metaheuristics and Airport Management

The airport runway scheduling has a very important role to play in the operations of the airport. Hybrid Metaheuristics has been observed to aid the runway scheduling at London Heathrow Airport. London Heathrow happens to be one of the busiest airports in the world and relies on a single runway for use by departing aircraft at any time. Efficient scheduling of the aircraft for take-off can reduce the total separations and increase throughput (Atkin

et al, 2007). A human runway controller is responsible to monitor the take-off scheduling and a lot depends on his/her competitiveness. Hybrid Metaheuristics can include more aircraft than a human controller can handle, and so can aid the runway controller by recommending schedules that anticipate some future problems (Atkin et al, 2007). The hybrid system makes use of both the computerized system as well as the human controller and consists of a decision-support system could help at Heathrow because the increased search power could improve the holding-point delay and calculated time of take-off (CTOT) compliance (Atkin et al, 2007).

Stochastic Modeling

The Airline transportation is largely regarded as random system. The airline planning models should consider stochasticity in operations. Stochastic process, under the probability theory is a collection of random variable and is used to represent the evolution of a system over time. It is a branch of mathematics and can be very effectively integrated into airport management systems to have a relatively smoother airport operation. Many studies have been done in this field. Rosenberg et al (2002) were one of the earliest mathematicians to research this field. They developed a stochastic model called SimAir which was a modular simulation that simulates the daily operations of a domestic airline. Mukherjee and Hansen (2007) developed a model that used dynamic stochastic integer programming (IP) model for the single airport ground holding problem. They discussed a special case in which ground delays assigned to flights can be revised during different decision stages, based on weather forecasts (Mukherjee & Hansen 2007).

Another study in the field of stochastic and airline management was undertaken by Pavlyuk (2011). He proposed multi-tier modification of spatial models, which allow estimating of spatial influence varying with the distance. This model is used to use it for the estimation of competition and cooperation effects for European airport and airport's efficiency levels (Pavlyuk, 2011). Three tiers of spatial influence were identified on the basis of different completion-cooperation ratio in each. The study compared the two factors. It was found that in first tier, the one closest to airport, cooperation effects were significant. In the second the opposite was true and the third had no effect of distance.

Demand Management

Demand Management has been defined as set of administrative or economic measures - or combinations thereof - aimed at balancing demand in aircraft operations against airport capacities (Fan & Odoni, 2002). The Congestion Management by Demand management measures was first implemented in 1969 in J. F. K International in 1969 (Le, 2006). The HDR limits the number of Instrument Flight Rules (IFR) takeoffs/landings at High Density Traffic Airports (HDTA) by hour or half hour during certain hours of the day (Le, 2006). There is also a classification of the users as air carrier, commuter, and other operators. The HDR has been seen as an inefficient system and was discontinued in the 2007.

Other Measures

Apart from the three types of congestion releasing measures broadly outlined in the research paper, there are a few other measures that can be

undertaken and might result in the better operation of the airports. The most important among these is the argument to privatize the airports. N his research on the Airport Business, Doganis (1992) argued that it was important for the airports to be run as commercially oriented profit making bodies and should be privatized to achieve it. He argued that since the government lacks resources to cope with fast changing technologies and management skill and there is a huge economic potential of airport services, privatization would solve a lot of problems that are inherent in the current system of operations. The prime concerns of airports today are the lack of resources, outdated technology and failure of personnel management.

Sparks (2008) noted the United States airports are largely owned by the government. The privatization has been a common phenomenon in Australia, Canada and China. Sparks is of the view that the privatization experiments have not had an adverse effect on an air transportation system’s performance. He cites that airports in Australia and Canada remain high and the Chinese adopt an incremental approach to privatization and state still has a great influence on their operation and investment decisions (Sparks, 2008). He also says that the effort of UK at privatization failed as BAA was allowed to control only one airport.

Vogel (2005) found that a partial privatization over fully privatized airports were likely to be more profitable to stakeholders. However, in terms of efficiency, the fully privatized airports were noted to having the least flight delays and rescheduling problems.

Conclusion

A number of methods and techniques aimed at improving the efficiency of the airports were discussed. Beginning with the easiest to plain logic, expansion and setting up of new airports should ease congestion. However, this method is highly impractical as the cost associated with a new airport and expansion projects require mammoth investments in the infrastructure. The rise in other costs like noise levels is also a major concern and limits such expansion by the civic authorities.

The technological advancements and of innovative techniques to ease congestion are perhaps the best alternative. ILS, GPS and hybrid heuristic sciences can ease congestion in many ways. The ILS and GPS enable a smoother and accurate landing. Heuristics can be used to increase throughput and allow more number of aircrafts to take off by real time scheduling than the human controller can handle. Thus the times gap between each landing and take off can be reduced and overall efficiency of the airport operations can be raised.

Privatization has mixed views in the industry. A few analysts believe that the airports being run as commercial entities would result in freeing congestion and a better overall experience to the consumer. Others believe privatization would have no effect on the profitability or the operations of the airport. However, studies have shown that the privatization of airport does equate to smoother operations and fewer delays, irrespective of it being profitable or not.

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