

2014 Iata Magsa

Service Improvement and Cost Reduction for Airlines Heng Chen

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annual u s air travel demand has been growing steadily by 4.5 over the last decade and it is estimated that the demand will nearly double in the next twenty years it has also been estimated by the international civil aviation organization that global demand for commercial aircraft will increase at an average annual rate of 4.1 by 2034 iata 2014 however airport expansions and aviation infrastructure upgrades have not kept pace with the increase in air traffic demand as only 3 of all the new airport projects around the world are planned in the u s capa 2015 thus the operation rates at existing airports are likely to increase significantly implying a greater need to increase the utilization of currently available runway capacity with steadily increasing demand in air traffic and limited airport capacity delay in air traffic is ubiquitous approximately 25 of flights experience delays of at least 15 minutes each year resulting in significant passenger service issues and costs to airlines and society in general delays constitute the top service complaint for airlines which has implications for the society as a whole both economically and environmentally flight delays also increase airline costs directly due to associated additional fuel crew and maintenance costs recent studies show that the estimated cost of air transportation delay to the american economy ranges from 32.9 billion to 41 billion a year of which 8 billion are direct costs to airlines ball et al 2010 ferguson et al 2013 noting that more than 60 of delay is due to airport operations balakrishna et al 2010 this thesis aims at helping reduce delay through better management of arrival and departure operations at airports which can create relevant and significant value for the airlines and for the society arrival and departure operations inherently involve significant uncertainty when an aircraft is approaching the runway many factors affect its trajectory such as weather wind conditions pilot behavior aircraft weight as well as the differences in types of aircraft and flight management systems when an aircraft arrives at the gate operating conditions such as unplanned security checks varied durations of deplaning and boarding as well as the maintenance and fueling involved could contribute to variations of actual departure time for the next flight all of these stochastic factors involve uncertainty and they need to be taken into account while making operational decisions on the other hand stochastic treatment of such operational problems has not been common in the literature due to difficulties associated with the characterization of uncertainty and the computational tractability i argue in this thesis that with recent advances in computing power and data analysis tools such stochastic treatments are more amenable for practical use to this end i study four novel operational problems related to flight arrivals and departures at airports under the uncertainty of operating conditions and demonstrate the potential value that can be generated through stochastic models within the context of airline and airport operations the problems i study involve both strategic and tactical decisions for airline service improvement and cost reduction the first two

problems consider managing arrival operations at airports while the last two problems focus on departure operations in the first and second problems i focus on arrival operations in the context of optimized profile descent opd which is a novel arrival procedure for the next generation air transportation system in the first problem i identify policies for managing arrival operations at the tactical level by developing a stochastic dynamic programming framework to manage the sequencing and separation of flights i find that simple calculation based measures can be used as optimal decision rules during such operations and that the expected annual savings can be around 29 million if such implementations are adapted by major airports in the u s of these savings 24 million are direct savings for airlines due to reduced fuel usage corresponding to a potential savings of 10 15 in fuel consumption over current practice i also find that optimal spacing of opd flights is much more important than optimal sequencing of these flights furthermore there is not much difference between the environmental costs of fuel optimal and sustainably optimal spacing policies hence an airline centric approach in improving opd operations is likely to be not in conflict with objectives that might be prioritized by other stakeholders in the second problem i study the optimal design of arrival traffic management systems at airports at the strategic level i claim that implementation of opd operations requires effective metering configurations at airports due to the increased role of uncertainty in aircraft trajectories during descent i develop stochastic models to further increase the value of opd operations over conventional arrival procedures by optimizing metering point configurations which include identification of the optimal number and locations of metering points to use i provide numerical results based on actual traffic information at major u s airports which indicate that the total potential savings in the top ten major airports could be up to 22 million per year if the proposed policies are implemented i also find that the optimal metering configurations are mostly robust under different operating conditions in addition my results suggest that early spacing adjustments near the top of descent tod are of more value for larger volumes of air traffic in the third and fourth problems i study optimal departure operations at airports under the context of departure metering which is an airport surface management procedure that limits the number of aircraft on the runway by holding aircraft at a predesigned metering area more specifically in the third problem i develop a stochastic dynamic programming framework for tactical management of pushback operations at gates and for determining the optimal number of aircraft to be directed to the runway from the metering areas i introduce four easy to implement practical departure metering policies and implement a comparative analysis between these practical policies and the optimal numerical solutions i also implement sensitivity analysis of the departure metering policies over state variable values in the fourth problem i study the optimal metering area capacity at the strategic level building on the dynamic programming framework mentioned in the third problem i identify the optimal metering area capacity using marginal analysis to minimize expected overall costs numerical simulations are implemented and potential savings are identified for sample u s airports based on varying capacity levels the optimal metering area capacity is then determined based on the numerical implementations to further improve overall efficiency and sustainability of departure operations i also analyze the benefits to airlines in terms of annual savings due to such policies and find that the annual savings could be 31 million if the optimal departure metering policies are implemented at the top ten major airports in the u s overall as one of the few studies on stochasticity in arrival and departure operations i derive both tactical and strategic policies to improve efficiency and

sustainability for airlines and the society which can enhance service quality and strengthen market position for the airlines involved

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