

## **An Operational Analysis of 5 Top Airports for 2013 and 2014**

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**Abstract:** *This paper seeks to identify areas that a few major and advanced airports have been progressing in the development of their operations and it compares these initiatives and their effectiveness. The paper will use objective reports from I.C.A.O., and third parties, individual airport reports and statistical data from these reports. Ultimately, recommendations will be given for continuation of initiatives and for improvement, if gaps have been observed, in order to increase efficiency in general areas of safety, productivity, security and any legal concepts, policies or procedures, efficiency, sustainability and management of limited resources such as: labor, energy, water, waste, land and capital or simply known as the contribution to 'People, Planet and Profit.'*

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### **Statement of the Proposal**

The purpose of this paper is to compare the type of airport operations inclusive of their effectiveness, safety, productivity, sustainability and legality to the application that they are being used for. This is an individual project done for the completion of a Bachelor's in Aeronautics with minors in Airport Management and Aviation and Aerospace Safety.

### **1. Introduction**

Operations are a critical area within the daily activities of an airport aerodrome. Large commercial service airports with passenger flows above 10,000 annual enplanements require many supporting processes to facilitate efficient operations. Within recent years, airport shareholders and the community have questioned the accountability of airport management. Efforts at simply achieving a safe and financially lucrative operation aren't enough to convince shareholders and community members that all is being done to be efficient. The understanding and application of Industry Best Practice (I.B.P.), advances in technology, sustainable practices in operations, adherence to I.C.A.O. audits for alignment to I.C.A.O. Standards and Recommended Practices (I.C.A.O. Rio +20 2016) are major factors that prudent, modern airport management should seek to urgently accept and incorporate into their operations. This paper will seek to identify the areas that these airports should invest close attention toward and the ways that each has developed the concepts within their operations. A concept termed (E.O.N.S.) or Economic viability, Operational efficiency, Natural Resource Conservation and Social responsibility of the airport (A.C.I.-N.A. Sustainability Working Group 2010) and S.A.G.A. (S.A.G.A. 2008). Also taken into consideration, was availability of reported information regarding specific operations at the airports. The airports evaluated, were within the top (5) five recipients, selected by Skytrax for the "2016 World Airport Awards" or "Passenger Choice Awards." These are Singapore Changi Airport, Incheon International Airport, Munich International Airport, Tokyo International Airport and Hong Kong International Airport. These awards are the most prestigious accolades that are awarded within the airport industry and customers and passengers play the deciding factor in identifying their airports of choice (Skytrax 2016).

### **2. Background**

'Airport operations' can be defined as 'the daily activities that must exist concurrently within an airport in order for the safe transport of international and domestic passengers. These activities begin before an aircraft even departs and involved the planning, preparation, safety, training, facilitation, commerce involving matters for the airport, airline and passenger.' While 'Excellence in Airport Operations' can also be defined as the efficient management of the required daily activities, within an airport in a sustainable manner to achieve safety, security, economic viability and efficiency.' For the purpose of this analysis, (6) general areas have been identified and subdivided into 52 separate functionalities that the airport should have competence in. These areas have been identified in all of the I.C.A.O. Standards and Recommended Practices for airport operations and outlined for airport improvement." (I.C.A.O., Vreedenburgh). The I.C.A.O.'s and A.C.I.'s intent is that all airport management authorities, systematically improve their respective operations to achieve this standard of excellence. These (2) two organizations have collaborated in establishing several programs to address competence building in airports. These programs will be discussed in the recommendations of this paper. The

I.C.A.O. itself has launched its own program in January 1999, I.C.A.O. U.S.O.A.P. called the the Universal Safety Oversight Audit Program (U.S.O.A.P. 2016) to continuously monitor world airports for their implementation of safety aspects recommended by the I.C.A.O., that permeate into all aspects of airport operations and is founded upon (8) eight Critical Elements (CE) stated below. In order to assess an airport, a Comprehensive System Audit (C.S.A.) needs to be done, Ref: I.C.A.O. Assembly Resolution A-36/20, (I.C.A.O. Assembly Session 2007).

1. Primary Legislation
2. Operating Regulations
3. Organization and Safety Oversight Functions
4. Technical Expert Training
5. Guidance, Procedures and Information
6. Licensing and Certification Obligations
7. Surveillance and Inspection Obligations
8. Resolution of Safety Concerns

### **How Airport Operations Management has changed**

The skill of Airport Management previously entailed the management of an aerodrome facility for military purposes, as most airfields were constructed during World War I and II and were owned and operated by the federal government. These facilities were created to provide a military service to the public and not to be run as a viable business entity. But with after these major wars the burden of management of these assets was either fully privatized, partially privatized with part federal ownership of remained federally owned but managed by a private organization (Wells, T. A. and Young, S. B, 2004). Within recent times, these airport management organizations have acknowledged the rising importance of aviation safety, business strategy and decision-making, the necessity of technological integration, evolving concepts of human resource and financial management, airport master planning considerations and sustainability in airport operational concepts. This has all been brought to the forefront because of the gradual increase in the volume and frequency of global air travel and visionary efforts of organizations such as the International Civil Aviation Authority (I.C.A.O.), Airports Council International (A.C.I.), International Air Transport Association (I.A.T.A.), Federal Aviation Administration (F.A.A.) and the European Aviation Safety Agency (E.A.S.A.).

### **Limitations to this Study**

The assessment of the individual airports is being conducted with limitations. Acknowledging these limitations to the study is important in understanding the scope to which the assessment can be done. These limitations are:

The financial year of several of these airports end on 2015, March 31. The data provided is up until this period and used for assessment from 2014, March 31 to 2015, March 31. Some airports have different periods for the completion of their financial year. For this reason, the author has used data from the most recent report, which could be compared with the most recent reports along a similar timeline with the other airports.

The nature of an audit is generally done on-site, to allow the auditor the opportunity of observing, questioning, reading evidence of actual systems and documentation to support it. This analysis is basically an audit that has been done away from the airports. The evidence that the author relied upon was evidence noted in the Annual Reports of the airport and third-party reports to corroborate the evidence.

### **The Criteria for Operational Excellence**

I.C.A.O. Signatory nation status – The basis that these airports are within member countries of I.C.A.O. signatory nations, is very important. This would mean that the airports would have been subjected to an I.C.A.O. audit at some point and areas of non-compliance would have been identified. This presumption is most important in having the knowledge of what must be rectified. After the acknowledgment of a problem, an airport authority can now address it to become compliant. This takes time and by the least, the must provide a course of remedial action to be undertaken and at least initiated, by the next following audit.

Airspace and Airfield systems - Runway safety, Runway incursion programs and improvement, airfield navigation aids, airport and airspace procedures, airfield expansion an development are critical aspects for the effective management, maintenance of safety and consistency in reliable airfield operations.

Passenger Terminal Facilitation for Visitors, Customer and Employee Experience - The improvement in Check-In times and experiences for visitors improves the appreciation levels at an airport. The services rendered don a daily basis by ground handling and service providers facilitate the true concepts of operations within the

airport and increase passenger flows. The proper utilization of land space enables this and keeps the dexterity of the operation flexible to adjust to changes that occur seasonally and circumstantially.

Sufficient support systems and Emergency services – systems relating to the operational safety, servicing and accommodation of commercial and private aircraft, emergency response capabilities can all affect the outcome of an operation. The aircraft turn around time for commercial operators, evidence of an Airport Emergency Plan, a plan to remove disabled aircraft, dangerous goods handling capabilities and certification, standby power provisions with maximum switch over times, provisions for anti-icing and de-icing holdover times, snow clearing capacity for airports affected by cold climates and surface water clearing abilities, wildlife control management, a preventative maintenance program for the aerodrome structures, equipment and systems and an Airside ground movement control program. Airports are also required to have (Rescue Fire Fighting) R.F.F. vehicles with response times of 2 minutes and up to a maximum of 3 minutes. These items must be planned properly and executed as separate functions that contribute to the entire working system.

Employee training and improvement program–This is an airport’s commitment to continuous learning, improvement by its employees in the face of constantly changing technology, standards and threats. It confirms procedures and maintains a high level of proficiency among the airport employees.

Cargo Terminals – I.C.A.O. specifies that cargo management should be well documented, time efficient regarding the processing of cargo and that the handling of dangerous goods should be safe and done securely.

Terminal Landside Ground Access –Road access, public transport access and terminals enable passengers, visitors and employees to arrive and depart easily. It facilitates the continuous movement from external areas and departing airport users.

Efficient management of airport operational procedures that affect the environment - Based upon the I.C.A.O.’s (3) three pillars of sustainability and their application within airport operations for sustainability. The I.C.A.O. Assembly requested that the Council pursue measure to reduce the operational emissions generated during aircraft operations in 2001 (I.C.A.O. Operational Measures 2001). Interpretation of this as it relates to airports, means that operational measure must be adjusted to facilitate a reduction in aircraft emissions or better yet, all similar emissions around an airport. This can range from waste management and recycling, aircraft and vehicle emissions, noise management, energy efficiency, water management, human resource management practices and financial management. The integration of sustainable practices into daily operational tasks plays a large part to efficiency and longevity of the airport operation. We will examine how the efforts of these airports have helped, if they helped and recommend steps that they could take.

**Airports To Be Compared**

**Figure 1.** List of Skytrax Top 10 Airport of 2016

	<b>Airport and I.C.A.O. Designation</b>	<b>Country</b>	<b>Region</b>
1	Changi International Airport(WSSS)	Singapore	Asia
2	Incheon International Airport (RKSI)	South Korea	Asia
3	Munich International Airport (EDDM)	Munich, Germany	Europe
4	Tokyo (Haneda) International Airport (RJTT)	Tokyo, Japan	Asia
5	Hong Kong International Airport (VHHH)	Hong Kong, China	Asia

Source: Skytrax

**Criteria for Weighing Excellence**

The ‘Operations Excellence Grading Table’ seen below was used to assess evidence of ‘Operational Excellence Criteria,’ at the specified airports. Evidence of the categories were researched online using verified sources such as the airport websites, reports from I.C.A.O., A.C.I. and online documentaries regarding the airport operations. The ‘Airport Performance Tables 1.0 and 2.0’ for the specified airports was tabled to show the outcome of airport operations firstly, over the period (2014, March 31 - 2015, March 31). This was the most recent and available data for all the airports, as the most recent financial year (2015, March 31 - 2016, March 31) was not available or was available only for some airports. However, the financial year (2013, March 31 – 2014, March 31) was presented as a starting benchmark (Guide To A.C.I. Airport Performance Measures, 2012) in order to assess if an airport’s performance from 2014 – 2015 increased or decreased. Below is a Legend, itemizing how the points were allotted.

**Figure 2.** Legend for Points Allocation

<b>POINTS</b>	<b>JUSTIFICATION</b>
1 point	If no data based upon the theme was available
2 points	If the data was reported in a qualitative or quantitative manner
3 points	If the data was reported in both a qualitative and quantitative manner

Figure 3. – Quality of Operational Performance by Top Listed Airports.

EXCELLENCE CATEGORIES		Max Score	WSSS	RKSI	EDDM	RJTT	VHHH
I.C.A.O. Signatory Nation	Within an I.C.A.O. Member Country	1	1	1	1	1	1
	Airspace Flow & Delay Procedures	3	3	3	3	3	3
Airspace and Airfield Systems	Evidence of Operational Procedures	3	3	3	3	3	3
	Published Communications Information	3	3	3	3	3	3
	Aircraft Taxiing Procedures	3	1	3	3	3	3
	Aircraft Docking Procedures	3	3	3	3	3	3
	Aircraft Startup and Pushback Procedures	3	3	3	3	1	1
	Data Link Departure/ Arrival Procedures	3	1	1	3	3	1
	Minimum Climb Gradient Procedures	3	3	1	1	1	1
	Radio Failure Procedure on the Aerodrome	3	1	3	3	3	1
	Aircraft Stand Allocation Procedures	3	3	3	3	3	3
	Low Visibility Category II or III Procedures	3	1	3	3	1	3
	Special Operational Procedures to Large Aircraft	3	1	3	1	1	3
	Runway Configuration for aircraft Mix	3	1	1	3	1	1
	Additional Runway Development Plans	3	3	3	3	2	3
	Efficient Taxiway Configuration	3	2	3	1	1	1
	Sufficient Aircraft Stands	3	2	3	3	1	2
Proper Pavement Conditions	3	1	1	1	1	1	
Mitigation of Vehicle Taxiway Delays	3	3	3	3	3	3	
International Departure Pax Check-In to Departure max (60 min)	3	3	3	3	3	3	
International Pax Processing Max (45 min)	3	3	3	3	3	3	
Sufficient Guidance for In-Transit Pax	3	2	3	1	2	2	
Evidence of Assistance for Transfer Connections	3	3	2	1	2	2	
Efforts to Improve Pax Experience	3	2	3	2	2	2	
Assistance to Pax loading/ unloading	3	2	2	2	2	2	
Evidence of Terminal Signage	3	2	2	2	2	2	
Manageable Walking Distances	3	1	3	2	3	1	
A Public Address Systems	3	1	1	1	2	1	
Sufficient Terminal Landside Access	3	2	3	3	2	2	
Evidence of Baggage Handling Services	3	3	3	3	3	3	
Sufficient and/ or Upgrades to Security Equipment	3	3	3	2	2	2	
Compliance to I.C.A.O. A.V.S.E.C. S.A.R.P.s	3	3	3	3	1	3	
Aircraft Parking and Servicing	3	3	2	2	2	3	
Evidence of Additional Overall Standards	3	3	3	3	2	3	
I.C.A.O. S.A.R.P.: Remote Stands	3	1	1	1	1	1	
Split service to Contact & Remote Gates	3	1	3	3	1	2	
Sufficient Aircraft Turnaround time info	3	1	3	3	1	1	
R.F.F. Response time min 2 min/ max 3 min	3	3	3	3	1	3	
Emergency Plan	3	2	3	3	1	2	
Disabled aircraft Removal Plan/ Capacity	3	3	3	1	1	3	
Dangerous Goods Handling Standards	3	1	1	1	1	1	
Standby Power Switchover time max 3 mins	3	1	2	2	1	1	
Aircraft Anti-Icing/ de-Icing SOPs	3	2	1	3	1	2	
Runway Snow or Water clearance SOPs	3	2	2	2	1	2	
Bird Control Program	3	1	1	3	1	3	
Aspects of a Safety Management Program	3	3	2	3	1	3	
Preventative Maintenance Program	3	1	2	1	2	2	
Airside Ground Movement Control	3	3	3	3	2	2	
Employee Training And Improvement	Internal Airport or State Training Program	3	2	3	3	2	3
	A.C.I. Programs	3	1	3	3	1	1
	Waste Management	3	3	3	3	1	2
Efficient Operations Involving the Environment	Aircraft & Vehicle Emission	3	3	3	3	1	3
	Noise Abatement and Management	3	1	3	3	1	3
	Energy Efficiency	3	3	3	3	1	3
	Water Efficiency	3	1	1	3	1	1
	Continuous Descent & Approach Operations	3	1	3	3	3	3
Cargo Terminals	I.C.A.O. S.A.R.P.: Documentation & Processing S.O.P.s	3	2	1	2	2	2

	I.C.A.O. S.A.R.P. for Cargo Expedition SOPs	3	2	1	1	3	3
	I.C.A.O. S.A.R.P.: Max 4 hr Release of Import Cargo	3	2	1	1	3	2
	Secure D.G. Storage Facilities	3	3	1	1	1	2
	I.C.A.O. S.A.R.P.: Rapid, Reliable City Ground Transport availability	3	3	3	3	2	3
Terminal Landside Ground Access	3 or more modes of Ground Access to Landside Facilities	3	3	3	3	2	3
	Examples of any Operational Efficiency Measures for Ground Access Transport	3	2	3	3	1	3
	<b>TOTAL</b>	<b>187</b>	<b>132</b>	<b>151</b>	<b>150</b>	<b>112</b>	<b>139</b>
	<b>PERCENTAGE %</b>	<b>100</b>	<b>70.58</b>	<b>80.74</b>	<b>80.21</b>	<b>59.89</b>	<b>74.33</b>

Figure 4. Analysis of Airport Reporting out of 63 Individual Criteria

Score	EUROPE		ASIA		
	Munich International Airport (EDDM)	Changi International Airport (WSSS)	Incheon International Airport (RKSI)	Tokyo (Haneda) International Airport (RJTT)	Hong Kong International Airport (VHHH)
3s	39	27	40	16	29
2s	9	15	8	17	19
1s	15	21	14	30	16

Sources:

- C.A.G. Annual Report 2013/14.
- C.A.G. Annual Report 2014/15.
- C.A.G. Airside Safety, 2016.
- C.A.G. Airside Driving Centre, 2015.
- C.A.G. Airport Emergency Service, 2015.
- CAG. Behind Changi: Season 1 - Fire, Camera, Action, 2015.
- CAG Behind Changi: Season 1 – Follow That Bag, 2015.
- Hong Kong Civil Aviation Department, Topical Issues, 2016.
- Airport Facilities Co. Ltd. at Haneda Airport Annual Report 2014.
- Japan Airport Terminal (J.A.T.) Group 2015: Financial Report for the Year 2015, March 31.
- Youtube video: Singapore Changi Terminal 3 & Kinetic Rain art installation in Terminal 1, 2015.
- Youtube video: Hong Kong International Airport – Walking Inside Terminal 1 & 2, 2015.
- Youtube video: Tokyo International Airport/ Haneda Airport#1 International Passenger Terminal Guide, 2015.
- Youtube video: Tokyo Haneda Spotting 2015, 2015.
- Incheon International Airport Corporation Consolidated statements for Dec 31, 2104 and 2013.
- Munich-airport.de 2016.
- Munich AR 2014 and 2015.
- Hong Kong Safety Reduction Programme 2014 – 2017.
- Japan Airport Consolidated Financial Report 2015.

Figure 5. – Airport Performance 2014-2015.

PERFORMANCE CATEGORIES	AIRPORTS				
	WSSS	RKSI	EDDM	RJTT	VHHH
Gross Revenue inUSD	1,618,480,182	1,586,783	1,249,306,000	1,485,075	2,110,237
Gross Profit After Tax USD	577,296,137	6,561,466	308,548	188,109	937,339
Passenger Movements	53,969,875	44,910,000	41,000,000	72,826,000	64,700,000
Tonnes of Cargo Movement	1,8747,423	2,560,000	337,000	-	4,400,000
Passenger or Airport Accidents	3	0.35/ 1,000,000	0	1	4.85/ 1,000,000
No. of Concessions Increases	24	-	-	-	33
Additional Aircraft Parking Stands	-	-	-	-	28
Car Parking Capacity	6,030	10,000	36,000	3,000	3,000
Additional Aircraft Cargo Stands	-	-	-	-	9
Commercial Airline Operator Increases	-	6	6	-	4
Commercial Aircraft Movements	339, 191	265,000	380,000	-	396,000
No. Of Training Drills Performed	2	410	47	-	120
No. Of Airport Instrument Arrival Procedures	10	8	3	17	6
No. Of Airport Instrument Departure Procedures	16	10	57	13	29
No. Of New Flight City Destinations	-	22	2	-	1
G.H.G. Emission Savings	0	167,396	153,202	-	175,000

Sources:

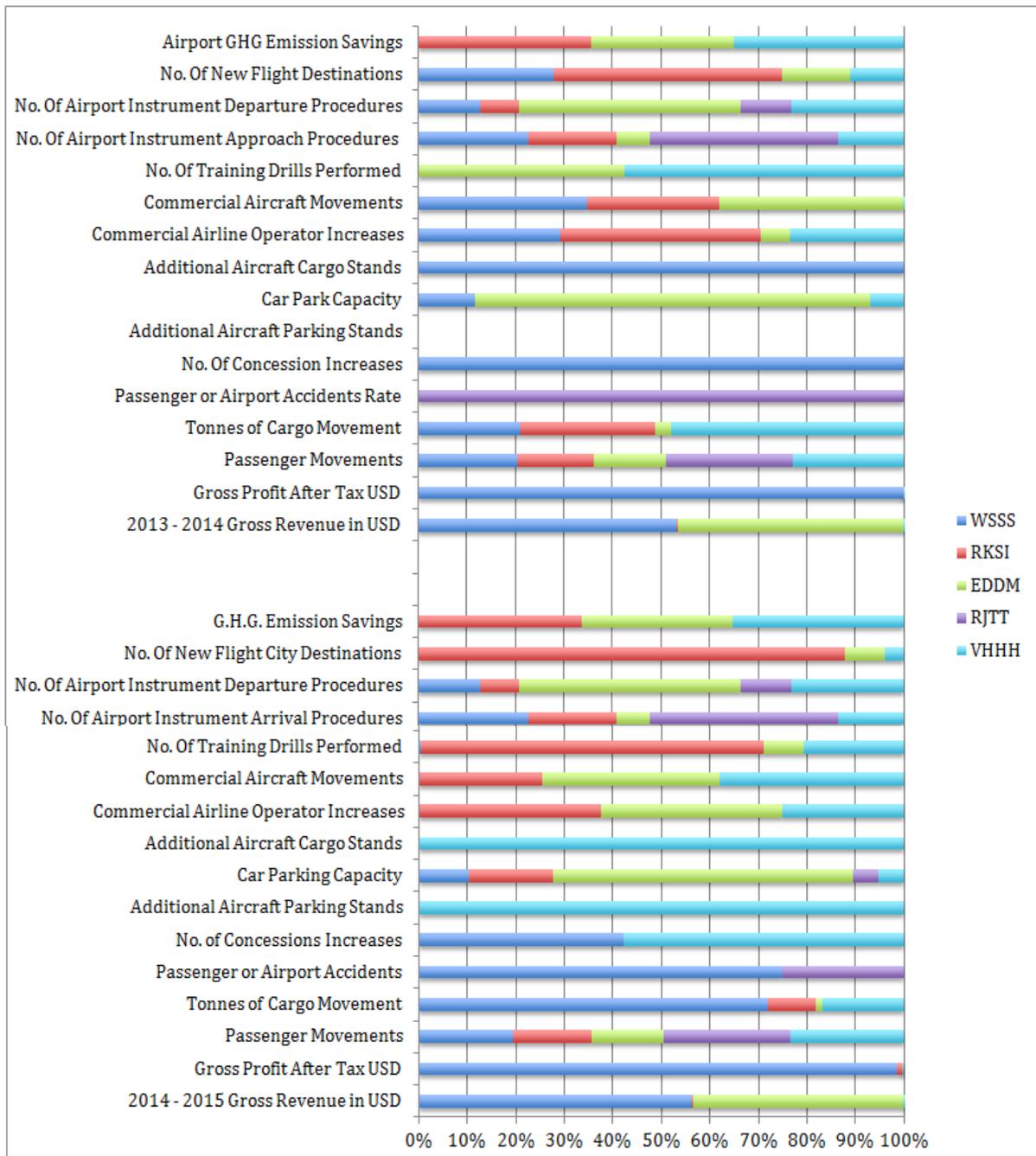
Changi Airport Group Annual Report 2014.  
 Incheon International Airport Corporation Consolidated statements for Dec 31, 2104 and 2013.  
 Incheon Social Responsibility Report 2014.  
 Incheon Green Report 2014.  
 Munich AR 2014.  
 Munich Annual Traffic Report 2014.  
 Japan Airport Consolidated Financial Report 2015  
 Hong Kong International Airport 3-Runway System, Atkins Group, 2016.  
 Hong Kong Safety Programme 2014 – 2017  
 Hong Kong Annual Report 2014/15  
 Fly-Sea.com 2016  
 Pdf-Tron.com 2016

**Figure 6. – Airport Performance 2013-2014.**

PERFORMANCE CATEGORIES	AIRPORTS				
	WSSS	RKSI	EDDM	RJTT	VHHH
Gross Revenue in USD	1,544,912,901	1,527,443	1,347,292,265	1,345,477	1,909,490
Gross Profit After Tax USD	577,503,156	427,700	112,265	175,238	831,356
Passenger Movements	53,874,049	41,480,000	39,700,000	68,906,000	60,700,000
Tonnes of Cargo Movement	1,837,580	2,460,000	291,475	-	4,200,000
Passenger or Airport Accidents Rate	0.45/ 1,000,000	0.39/ 1,000,000	0	1	5.32/ 1,000,000
No. Of Concession Increases	2	-	-	-	-
Additional Aircraft Parking Stands	-	-	-	-	-
Car Park Capacity	5,080	-	35,000	-	3,000
Additional Aircraft Cargo Stands	30	-	-	-	-
Commercial Airline Operator Increases	5	7	1	-	4
Commercial Aircraft Movements	347,458	271,224	376,678	-	377,476
No. Of Training Drills Performed	-	-	74	-	100
No. Of Airport Instrument Approach Procedures	10	8	3	17	6
No. Of Airport Instrument Departure Procedures	16	10	57	13	29
No. Of New Flight Destinations	10	17	5	-	4
Airport GHG Emission Savings	0	179,376	148,235	-	176,000

Sources:

Changi Airport Group Annual Report 2014.  
 Incheon International Airport Corporation Consolidated statements for Dec 31, 2104 and 2013.  
 Incheon Green Report 2014.  
 Incheon Social Responsibility Report 2014.  
 Munich AR 2014  
 Munich Annual Traffic Report 2014.  
 Japan Airport Consolidated Financial Report 2015  
 Hong Kong Annual Report 2013/14  
 Hong Kong AR 2014/15  
 Fly-Sea.com 2016  
 Pdf-Tron.com 2016  
 Figure 7.2013 – 2014 and 2014 - 2015 Airport Comparison.

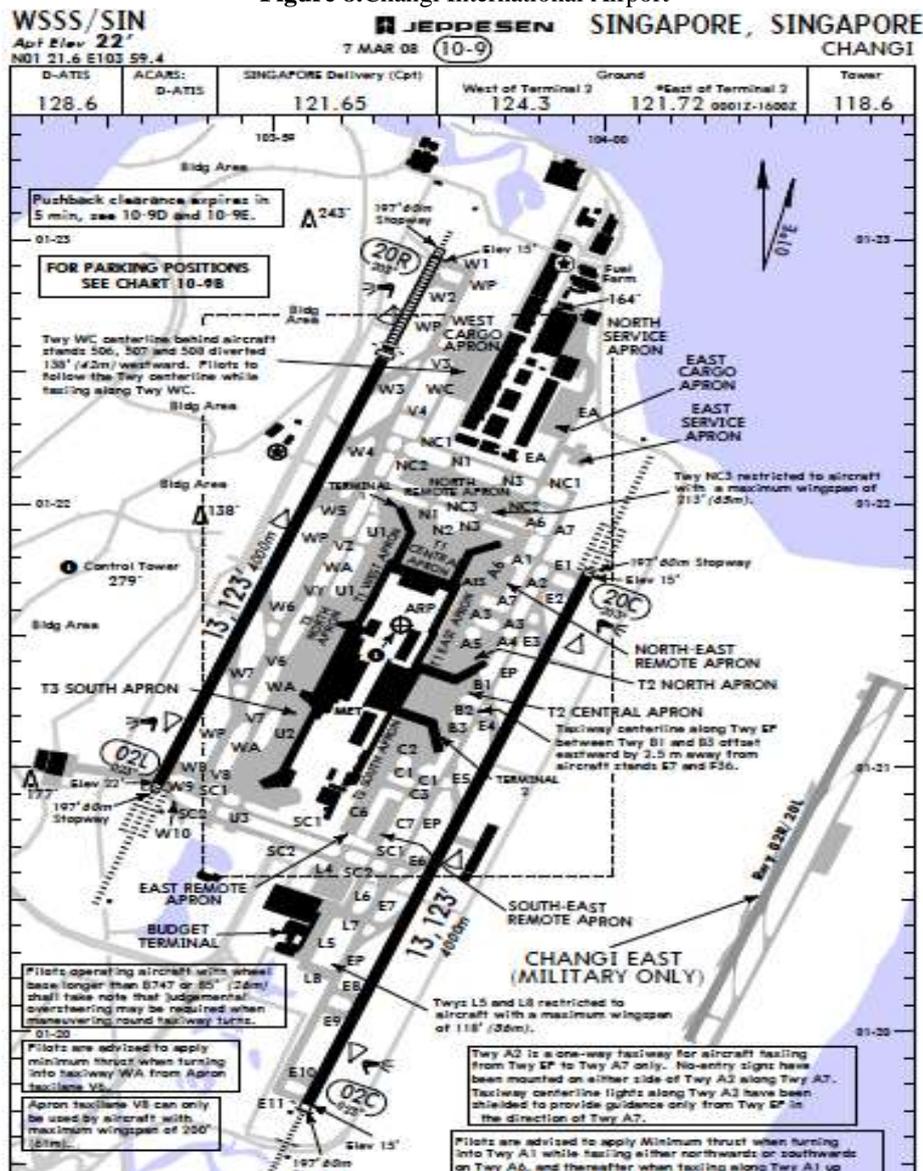


### 3. An Analysis of the Individual Airport’s Operations

#### Changi International Airport

**Background** – The Changi International Airport (I.C.A.O.: WSSS) is a public/ military type airport, which is owned by the Government of Singapore. The Changi Airport Group (C.A.G.) and the Republic of Singapore Air Force operate it. The airport serves as a hub for Singapore and is located in the Eastern Changi region. This airport caters for domestic and international passenger operations, as well as cargo operations. The airport utilizes two parallel runways for commercial aircraft and another for military aircraft. A third runway is being developed for commercial operations. The passenger terminals consist of Terminals One, Two, Three and development for a Forth Terminal is underway. JetQuay operates a Commercially Important Passenger (CIP) Terminal on the airport but this is for special VIP passengers. Future terminals in development are Terminals Four, Five and the Jewel Changi Airport. The airport also operates another terminal for Cargo operations (Airports-Worldwide.com, 2016).

Figure 8.Changi International Airport



Source: Jeppesen

From the data collected for the individual airports, (Figure 3. – Quality of Operational Performance by Top Listed Airports) with closer analysis Changi International Airport (WSSS) received a score of 70.58% out of 100%, had poor reporting for 25% of the operational criteria, 30% reporting for either quantitative or qualitative criteria and both quantitative and qualitative reporting for 46% of the operational criteria.

Airspace and Airfield systems –The Air Traffic Management (A.T.M.)is performed by the Singapore controllers are done by over 300 controllers on eight-hour work shift, using specific international commands and standards, all in English (Inside Changi’s Air Control Tower: ATC Pt. 1, 2013). Aircraft Traffic Management procedures are controlled using 10Arrival procedures, 16Departure procedures, Minimum Climb Gradient restrictions for each runway, Startup and Pushback procedures, assignment of flight level procedures, specific operational procedures for aircraft, Taxiing Guidance procedures, allocation of aircraft to stands at terminal, remote and cargo gate procedures, Instrument Approach procedures and Aerodrome Communication procedures (Fly-Sea.com, WSSS 2016)

The structure of the Changi Airport airfield terminals is one of the most efficient designs, using the Finger Piers indicated below:

**Figure 9.**Changi International Airport Aircraft Parking Stands.



Source: Eileen, P. Airport Planning and Terminal Design 2007.

**Passenger Terminal Facilitation for Visitors, Customer and Employee Experience** - The Changi Development Group (C.A.G.) experienced an increase of 95,826 in passenger growth between the 2013 – 2014 and 2014 – 2015 fiscal years. (CAG Annual Report 2014/15). This 0.17% growth in passenger flow can be attributed to several factors at passenger terminal facilitation. This was recorded as the highest increase in the 33 years of the airport's operation. It is reported that routes in South Asia rose 6.4% and North Asia by 2.5% but declined in the Southeastern Asian routes.

Much of the passenger increase can be attributed to direct market share acquisition by seven new airlines at Changi, (Air New Zealand, Jetstar Pacific, Malindo Air, Oman Air, Tigerair Taiwan, Uzbekistan Airway and VietJet Air). These airlines all used their own market strategies that have assisted in the overall passenger transfer increase at Changi from the central, south and north Asian markets.

The C.A.G. also increased its worldwide city connections by seven cities, to include Lanzhou, Xi'an in China, Okinawa in Japan, LuangPrabang in Laos, Louisville in the U.S. and PhuQuoc in Vietnam (CAG Annual Report 2014/15).

Strategic management techniques such as the GAIN rebate program and the Gateway Incentive program, has influenced airlines to channel air transport business through the C.A.G. hub (C.A.G. Annual Report 2014/15). Other strategic measures have influenced a higher standard of performance from airlines and ground handlers to improve efficiency and productivity. These are key ideas to encourage group ownership of the airport operation.

More ingenious ideas such as a Memorandum of Understanding (M.O.U.) between the Okinawa Government in March 25, 2014 was intended to encourage collaboration involving tourism and air cargo, thus improving a mobile labor force for both parties, trade route access via the Changi hub and guaranteed reliability regarding flight schedules and performance (CAG Annual Report 2014/15).

In the fiscal year 2013 – 2014, the airport increased its commercial airline operations by five additional operators: Ethiopian Airlines, Golden Myanmar Airlines, Lucky Air, Regent Airways and Swiss Ethiopian Airlines. This increased the number of direct destinations by 10 cities overall eight in China, Kalibo in the Philippines and Mandalay in Myanmar (C.A.G. Annual Report 2014/15). It should be noted that the Haiyan Typhoon in the Philippines and volcanic eruptions affected passenger transport during the 2013 – 2014 period. The C.A.G. has also implemented a new time saving strategy called 'Fast and Seamless Travel (F.A.S.T.)' and this involves the automation of airport operational processes like: Self Boarding gates. Testing for this has already begun with Lufthansa. There is also the 'Straight To Gate' initiative that, allows passengers with no visa or baggage restrictions to by-pass counters and go directly to the gate.

To improve customer experience the C.A.G. has installed 880 universal charging stations across the airport, increased seating capacity at Terminal Three, a Social Tree at Terminal One and an Enchanted Garden at Terminal Two. Additional concession leases were completed for Liquor and Tobacco and Perfumes and Cosmetics, a launch of the airport's online shopping portal and an additional range of retail product brands were

introduced at existing concessions to give an increase of 7.9% growth in concession revenues(C.A.G. Annual Report 2014/15).

The C.A.G. continued to progress with infrastructural development works regarding Terminal Four, expansion to Terminal One should house will have full service for dining, retail and low cost carriers. An open-air car park is also said to be underway for Terminal One, with larger car and taxi bays (C.A.G. Annual Report 2014/15). This has since been completed and new spaces are available increasing the capacity by 950 in 2014 (Shi Wei, 2014). Presently, the airport has six car parks with a capacity for 5,080 spots (Singaporeairportguide.com 2016), and caters to private motorcars, vans, motorcycles and scooter, all allowing long term fees, short term fees, casual fees, weekend fees, public holiday fees, night fees and complimentary pickup and drop off. There are Car Parks located in Terminal One, Terminal Two and a Southern Open Air Car Park. Passengers can pay using cash, credit card or an auto-pass that can be topped up (Changiairport.com Airport Parking, 2016).

Further infrastructural works were entered in December 2013 with 'Project Jewel,' which is a mixed use complex to be built above the car park at Terminal One to be completed in 2018. A 2036 Steering Committee was created to oversee airport developments until the year 2036. The committee has already begun planning for the development of Terminal 5 (C.A.G. Annual Report 2014/15).

Sufficient support systems and Emergency services – The Changi Emergency Services main utility is the OshKosh Striker Foam Tender, which is capable of 10,000 liters of foam and 12,000 liters of water, an Air Stairs and a High Reach Extendable Torret. The response time to any location on the runway is two minutes and the department also houses the Sea Service, which is an underwater recovery diving team (CAG. Behind Changi: Season 1 - Fire, Camera, Action, 2015).

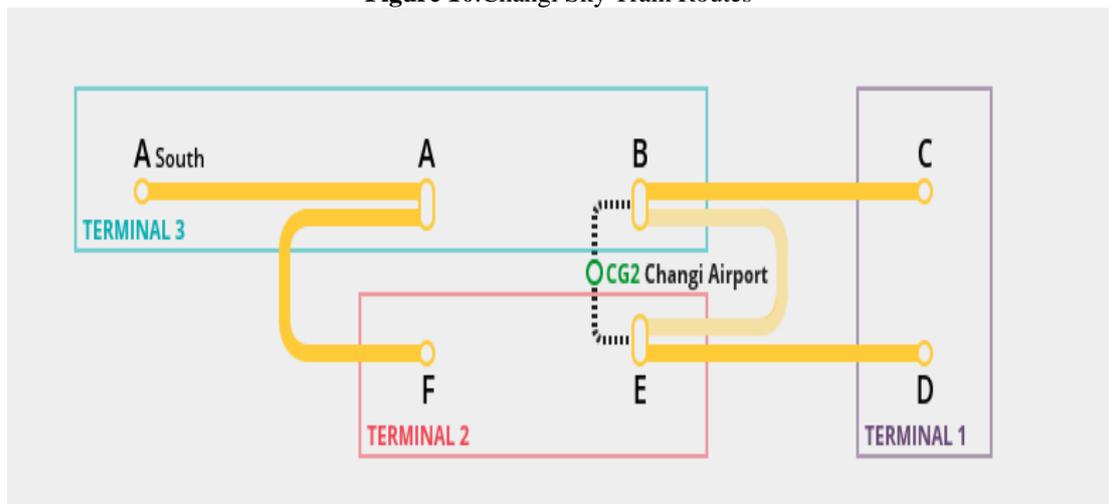
Employee training and improvement program–Two airport drills were held to train for emergency procedures during fires in 2014 (CAG Annual Report 2014/15) and the Changi Airport Crisis Seminar for airlines within the aerodrome was also held in 2014.

**Cargo Terminals** – The air cargo facilities at Changi Airport is quite robust and has three million tonnes of annual space on 70 hectares, in a Free Trade Zone. The warehouse and office space is reported to be over 100,000 sqm, with two runways measuring four km each. 14 dedicated freighter-parking bays, 30 remote bays capable of accepting cargo utility aircraft such as the A380 and B747-8, facilitate the operation. There are also 9 Air Freight Terminals (A.F.T.) which has two specific Express and Courier Centers (E.C.C.s) for time-definite shipments, all operated by contracted handling agents SATS, CIAS, D.H.L., T.N.T., FedEx and U.P.S. The operation is available for 24-hours and seven days of the week, inclusive of 24-hour customer service. All of this is protected within the airport security zone and monitored by the C.A.G. airport security.

The cargo operation has specific departments that deal with unique cargo based upon their details and requirements. The Dnata Cool Chain Facility helps cool the SATS Cool Port (Behind Changi: Fresh From The Runways, 2015), which processes perishable goods that require 28 to +18 degrees Celsius for storage. The Singapore Freeport facility has robust security measure and protection in order to house fine arts and equipment and the Ace Cargo Hub boasts direct airside access and special facilitation by Singapore Customs and Immigration departments (C.A.G. 2016).

**Terminal Landside Ground Access** –Interconnection between the landside terminals is done via the Changi Sky Train and it boasts of seven stations and is fully automated people mover and covers 6.4 km in track. The Sky Train services all of the terminals (SGTrains, 2016).

**Figure 10.**Changi Sky Train Routes



Source: SGTrains.com

Efficient management of airport operational procedures that affect the environment –CAG has indicated that existence of an Environmental Policy and a few initiatives are explained within the C.A.G. Annual Report 2013/14. ISO14001 recertification was given in 2013 for reduced energy consumption and waste management. Operational implementation was seen on 15 November 2013 at the Airport Recycling Day, where old newspapers, boxes, computer equipment etc were collected for recycling. Also, 34,000 bulbs were collected from the three terminals for recycling. Lastly, in 2014, to preserve energy, only critical lights were used within the terminals during its ‘Earth Hour’ (C.A.G. Annual Report 2013/14).

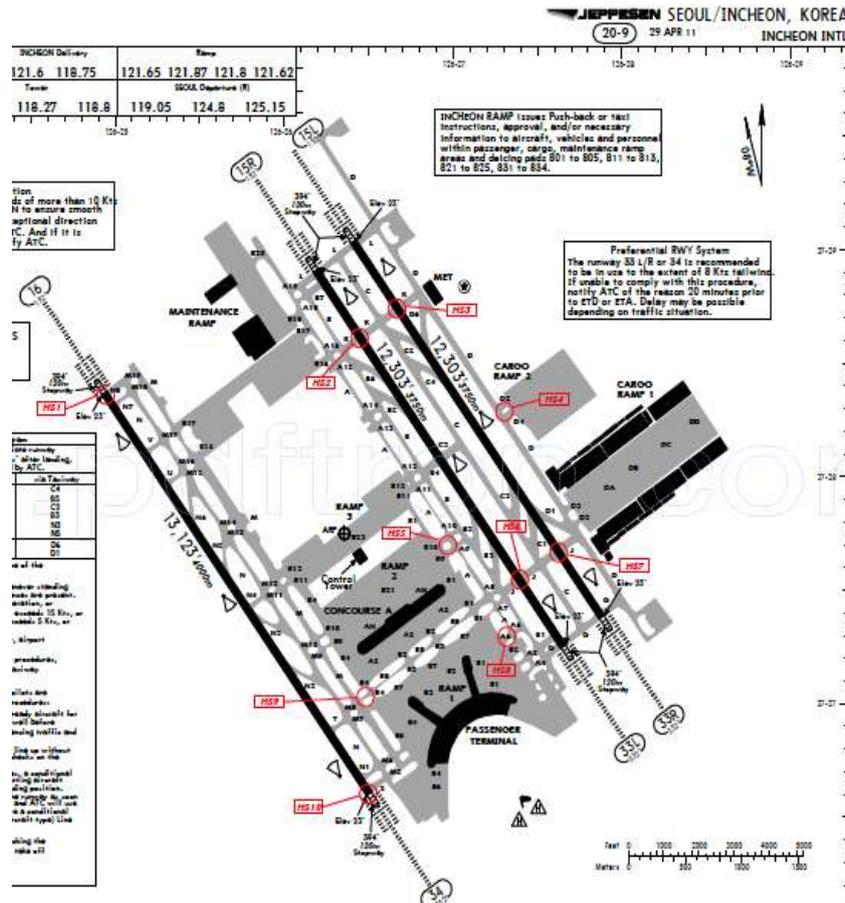
Further energy saving initiatives is seen in the airport’s design of Terminal Three. The terminal’s roof and double glazed glass window walls were designed to allow natural light in and keep heat out. During off-peak hours, the airport also shuts down escalators and travellers and they utilize eco-friendly lights. Water management initiatives encompass the harvesting of rainwater to irrigate landscaped areas, in the airport nursery, for fire-fighting and industrial cooling. The use of water flow regulators for washrooms has reduced water wastage by 66% and this is supplemented by educating passengers regarding efficient water usage. Ultimately noise mitigation attempts within the airport and aerodrome are encouraged among airlines, in support of I.C.A.O. S.A.R.P.s. Detailed information is given regarding flight procedures, noise abatement efforts that engage the community and consideration during land planning for runways that conclude in the direction of the sea (C.A.G. website 2016).

It was interesting to note that Changi International after having been a part of the A.C.I. Carbon Accreditation Program withdrew its membership in 2013 – 2014 (A.C.A. Annual Report 2013-2014) and the C.A.G. website mentions no data concerning G.H.G. emissions, possibly because they were above accepted levels during the period.

### **Incheon International Airport**

**Background** – The Incheon International Airport (I.C.A.O.: RKSI) is a public run international airport, owned by the Government of South Korea but managed by the Incheon International Airport Corporation (I.I.A.C.). It serves as a hub to Seoul, operating for domestic, international and cargo operations and is located on Yeongjong-Yongyu Island on the West Coast, serving Incheon, South Korea. The airport consists of Passenger Terminals One, a Concourse and Terminal Two. There are also Cargo Terminals A, B and C, a helipad and three runways (Airports-Worldwide.com, 2016).

**Figure 11.** Incheon International Airport.



Source: Jeppesen

From the data collected for the individual airports, (Figure 3. – Quality of Operational Performance by Top Listed Airports) at first glance we observe that with closer analysis Incheon International Airport (RKSI) though receiving a score of 80.74% out of 100%, had poor reporting for 22% of the operational criteria, 12% reporting for either quantitative or qualitative criteria and both quantitative and qualitative reporting for 63% of the operational criteria.

**Airspace and Airfield systems** –The Incheon International airport in South Korea, manages its airspace and aerodrome operations using several procedures such as eight Arrival and 10 Departure procedures, Instrument Approach procedures, Continuous Approach and Descent procedures, Communication and Radio Failure procedures, recently approved Low Visibility Category II/ III procedures, Airspace Restriction procedures, De-Icing procedures, Noise Abatement procedures, Runway Construction Danger Alerting procedures, Operational Procedures for Aircraft Parking, Startup and Pushback procedures, Runway Safety Management procedures, Taxiing and Docking Procedures and Special procedures for heavy and large aircraft such as B747 (Pdf-Tron, 2011).

Figure 12. Incheon International Airport Airfield



Source: Goggle Images

In 2014 – 2015 the airport intended to increase aerodrome safety and has been in pioneer an effort to digitize the airport’s airfield environment, to increase spatial awareness among cockpit crews. The digital representation of the airfield is accurate up to 11 cm and represents obstructions, buildings, taxiways, roads, towers etc. This airport map is shared with airlines and is the first of its kind in the world of airport mapping. Aiding in this endeavour of aerodrome safety, the I.I.A.C. has instituted a method of precise obstacle surveying and mapping for flight path obstacles, using 3D/ GPS modeling and it has also served a dual purpose to consider noise abatement in the surrounding community (Incheon Sustainability Report 2014).

Redundancy in air navigation systems have been attained by an M.O.U. with the military in preparation for any abnormal failure of the Radar Facility, a G.P.S. warning and location system and information sharing for Seoul’s Approach and the A.T.C., using a mutual flight control system (Incheon Sustainability Report 2014).

**Figure 13. Incheon Terminal**



Source: Goggle Images

**Passenger Terminal Facilitation for Visitors, Customer and Employee Experience** - Passenger facilitation was met in 2014 – 2015 with much anticipation, as passenger enplanements grew giving a 10.1% increase with 4,491,000 enplanements from 41,480,000 enplanements in 2013 - 2014 (Incheon Sustainability Report 2014) and (Incheon Green Report 2014). Reasons for this can be attributed to the I.I.A.C.’s installation and promotion of the Fast Track Check Counters among passengers and airlines. Although installed in 2007, the rewards of its use improved. In the 2014 – 2015 year passenger check-in rose 26% with the system and check-in time were recorded at two minutes per passenger. In 2013, further budgetary allocations were made to advance to facilitation of disabled persons and three voice-reading systems along with two videophones were installed for the handicapped and visually impaired persons (Social Responsibility Report 2013).

Baggage delay statistics were forecasted baggage delay at the airport to be 1/ 1,000,000 (Social Responsibility Report 2014). A Self-Bag Drop Service that was also installed witnessed a seven minute reduced check-in time and a re-Simplification of the previously launched Web/Mobile Check-in facility in December 2014, which also assisted in prevented forged passports from entering the system (Incheon Sustainability Report 2014).

Parking at the airport includes 10,000 spots (Seoul-icn.airports-guides.com 2016), or short term and long term parking for compact and large size vehicles. These also involve hourly, daily, first 45 minutes free and first

time rates. This also caters for persons with limited mobility and disabilities. The airport has also secured additional parking spaces at the nearby Seoul Gimpo Airport.

The I.I.A.C. reported a reduction in departure time to 38 minutes and arrival processing time to 23 minutes in 2014. Though this was a decline in the 2013 standard of 19 minutes for departures and 10 minutes for arrival, it is still well below the I.C.A.O. limitations. This identified limitation to the infrastructure and in an effort to develop the airport based on projected enplanement increases, justifies the efforts for the Three-phase construction project for the airport, which began on September 2013 (Social Responsibility Report 2013). Its strategic management allowed it to attract six new airlines and add 22 new routes (Incheon Sustainability Report 2014) and it provided discounted fees to airlines for overtime fines and landing charges (Social Responsibility Report 2013). In 2013, it was able to increase its service by seven new airlines and 17 new routes (Social Responsibility Report 2013).

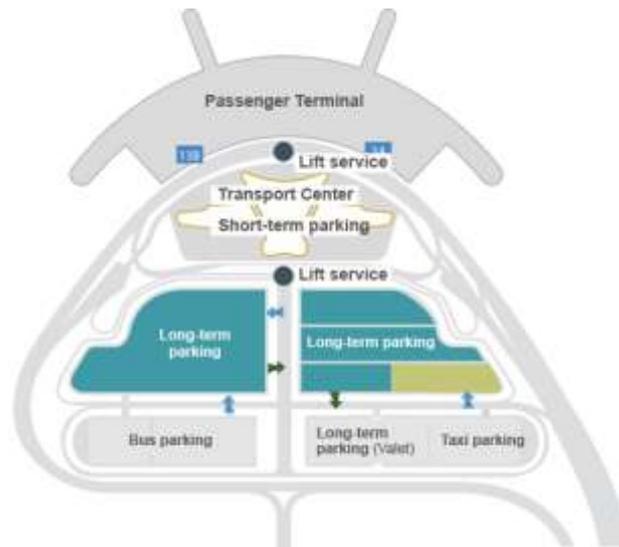
The I.I.A.C.'s development Master Plan involves an Air City Project consisting of leisure and business areas, a hotel, shopping mall and new in-flight facilities. The project is projected to serve the projected increase in travelling demand and provide over 3,000 new jobs (Social Responsibility Report 2013). Fast Track Launch facilities have been established to accommodate elderly, disabled, the infirm and sick specifically, within the terminal. Through efforts of the Departure/Arrival Procedure Simplification Committee, these passengers now experience a faster check-in process at dedicated security and immigration locations (Incheon Sustainability Report 2014).

Infrastructural improvements were made because of changing on/ off-season passenger requirements, many of the low cost carriers were required to change location at the terminal based upon accommodation figures and at check-in counters. The I.I.A.C. addressed this in 2014, after numerous complaints by passengers and created a dedicated Location for Low-cost Carriers (L.L.C.). All low-cost carriers now reside at that space and it is located close-by the Self-Drop-Off Baggage point and Flight Information Display Systems (F.I.D.S.). This has reduced check-in time and congestion immensely (Incheon Sustainability Report 2014).

The airport has developed an established Peak Time Sorting System for using a green; yellow and red 3-stage plan to task. Further to this, partnering with a S.M.E. has developed useful equipment concerning airport baggage operations, e.g. a unique conveyor belt (Incheon Sustainability Report 2014). Identification security developments regarding the I.I.A.C.'s database was improved considerably through internal policies for time limited storage of personal data, optional personal data field sharing for passengers, and transparency by disclosing the monthly disposal of the data. These efforts have been made to protect customer identity information (Incheon Sustainability Report 2014).

Security measures were also the airport's strong points. The airport opened a security training school in 2003 and run over 35 different security courses annually (Airport-Technology 2010). Its security screening procedures have been assessed as exemplary by the T.S.A. in 2013 and in instances requiring additional screening from countries with flights heading to the US, Incheon was exempted due to its known high screening standard. Efforts are being made to have this standard translate to its transit carry-on baggage in Dec 2015 (Incheon Sustainability Report 2014).

**Figure 14.** Incheon Parking Facility



Source: Incheon Airport Information

The airport's social responsibility agenda must be commended. Its acknowledgement of priority issues rose by key stakeholders and documented intention for redress of these issues can be considered to be a manifesto for its policies and goals.

**Sufficient support systems and Emergency services** –I.I.A.C. reported a ground accident rate of 0.35 per million in accidents for the 2015 year, 0.39 ground accidents noted for 2014(Incheon Sustainability Report 2014) and there was only one non-fatal reported aircraft accident on 2013, April 16 involving an Airbus A321-231 (Aviation-Safety.net 2013). The I.I.A.C. continues to implement a preventative approach to safety management by employing information sharing of risks involved with accidents and incidents among national entities. Using this data, it has upgraded its safety training programs as well (Incheon Sustainability Report 2015).

The Incheon airport has invested in additional snow removal equipment with four high capacity haulage snowploughs and a revised snow-removal plan for months with heavy snowfall (Social Responsibility Report 2014). I.I.A.C. has continued to be proactive in its safety management program management and has upgraded its Disaster Response System to a '3C-centered system,' using coordination, command and communication and the efficiency of the ATC Tower using a newly built integrated command system (Incheon Sustainability Report 2014).

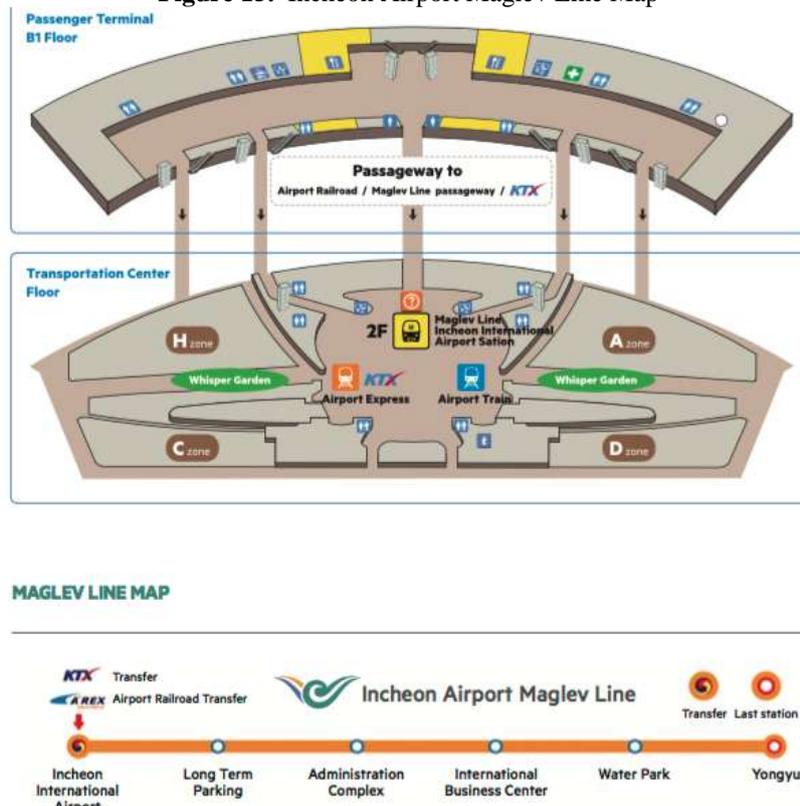
**Employee training and improvement program**–This airport received the Pan-National Disaster Response Safety Drill of Korea award in 2014 – 2015, being ranked the highest within South Korea and in 2014 September, it performed the Comprehensive Aircraft Accident Response Drill. An effort to establish an 'Ethical Culture' within the airport organization was attempted in 2014 – 2015 with internal ethics and anti-corruption training for all employees. I.I.A.C. has conducted over 35 exercises per year baggage emergency scenario training. Throughout 2014, the I.I.A.C. held four safety and security driven exercises, inclusive of multiple government agencies, involving bomb drills, explosives in the terminal scenarios and their responses (Incheon Sustainability Report 2015). These were implementation strategy examples that began in 2013, regarding 410 mandatory training programs for employees, inclusion of new Key Performance Indicators (K.P.I.s), the provision of employee health programs, high level employee compensation packages, the construction of a day-care centre for employees or contractors and the application of a flexible work routine to create an environment that promoted a healthy balance for employees work and private life (Social Responsibility Report 2013).

**Cargo Terminals** – Cargo operation saw 2,560,000 million tonnes of cargo through the cargo facility in 2014 – 2015 and an increase in 0.3% from 2013 – 2014 where 2,460,000 million tonnes of cargo was recorded as being transported (Social Responsibility Report 2013). During 2013, the Airport Logistics Centre launched some new delivery centres, which enabled a rise of 10,000 tonnes of additional cargo through the airport. These new cargo centres were STATS, ChipPAC, Johnson Matthey Catalysts and SJ International. Further initiatives to increase cargo demand were the reduction in the price of cargo terminal parking, increased marketing and lower land lease rates (Social Responsibility Report 2013).

**Terminal Landside Ground Access** - The airport is interconnected to the mainland access transport via the Incheon International Airport Expressway 130 and the Incheon International Airport Railroad link (Subway Line 5 and Line 9), (Airports-Worldwide 2016). Most recently, the Ministry of Land, Infrastructure and Airport commissioned a project that began in 2012 for an airport train that was propelled by magnets, the 'Maglev Line.'

This train serves two stations, the Incheon Transport Center and Yongyoo Tourist Complex Station (Kojects2016).

**Figure 15. Incheon Airport Maglev Line Map**



Source: Airport.kr 2016

**Efficient management of airport operational procedures that affect the environment** –The year 2015 was the first year, that the airport earned the ISO 50001 Energy Management System Certification and Level 3 on the A.C.I. Airport Carbon Accreditation program, after it surpassed its G.H.G. emission reduction target by 3% (Incheon Sustainability Report 2015).The airport has won this accolade for five consecutive years as it continues to diversify its efforts at sustainability. Aside from G.H.G. emissions, the airport has close to zero carbon neutrality with its wind-powered turbines, an airport magnetic powered train called the Maglev(Kojects 2016). It has also developed its green airport environment to extremely low carbon emitting, with Electronic Vehicles and High Speed Electronic Vehicle Chargers, Shuttle Buses that run on Hydrogen Fuel Cells, Hybrid Taxi Cars, bike trails, Solar Parks, Building Integrated Photovoltaic System (B.I.P.V.), natural lighting, Renewable energy model sites, Hybrid street lights, L.E.D. lamps and a low-carbon Green Apron, an Integrated Waste Management Site, Grey-water and Wastewater Treatment Facility and Airplane De-Icing Pads to prevent leakage of de-icing runoff fluid (Incheon Green Report 2014).

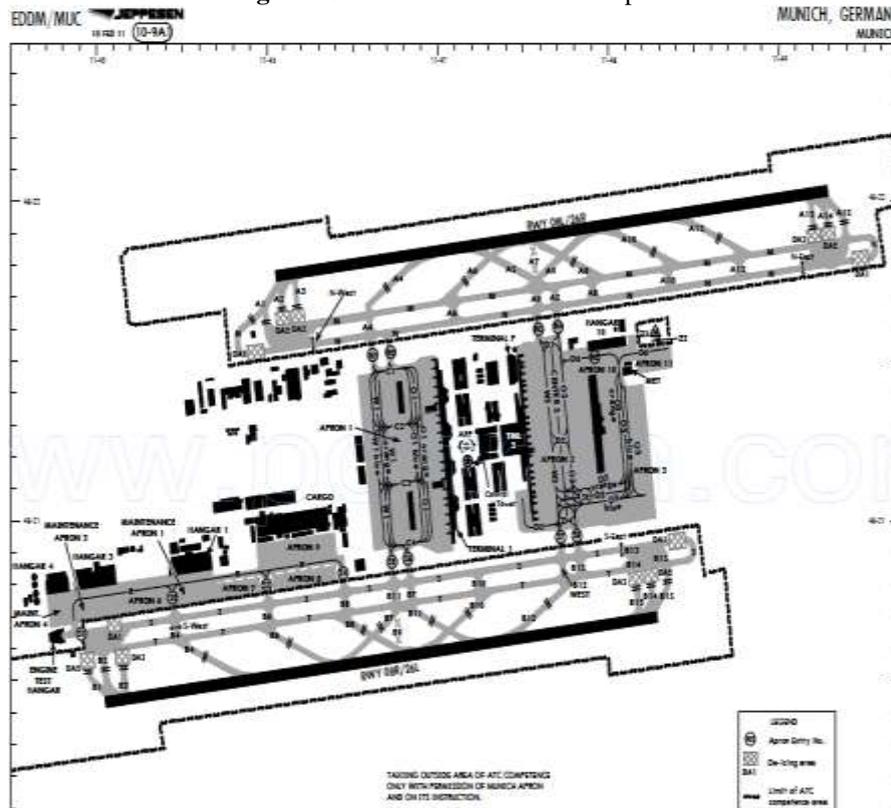
In 2013, I.I.A.C. embarked upon a proactive Impact Analysis of the airport facility and the effects of climate change, in order to be well prepared for it. Because of this the authority realized that specific improvements were required in several areas and began gradually addressing these items in areas such as: the enhancement of airport pavements with temperature change, breakwater safety inspections, earthquake detection systems, abnormal weather proofing the terminal e.g. lightning etc, using Frit glass and high efficiency windows, a (520 kW) Green Heating Geo-thermal system for terminals, the preparation of a low-carbon airport demand management system and the protection and upgrade of Glideslope navigational equipment. The airport's G.H.G. emissions for 2013 were recorded at 179,376 tonnes (Social Responsibility Report 2013) and in 2014, it was recorded as 167,396 tonnes CO<sub>2</sub> respectively (Social Responsibility Report 2014).

### **Munich International Airport**

**Background** – The Munchen-Franz Josef Strauss International Airport (I.C.A.O.: EDDM) is public use airport that is owned by the Free State of Bavaria, the Federal Republic of Germany and the City of Munich. It is operated by the FlughafenMunchen GmbH and located 28.5 km northeast of Munich. The airport caters to general aviation, domestic and international passengers and cargo operations as well. The airport consists of

Terminal One, Two, a Satellite Terminal Two, the Munich Airport Center and two parallel runways in use (Airports-Worldwide.com, 2016).

**Figure 16.** Munich International Airport.



Source: Jeppesen

From the data collected for the individual airports, (Figure 3. – Quality of Operational Performance by Top Listed Airports) with closer analysis, we saw that Munich International Airport (EDDM) received a score of 80.21 % out of 100%, had poor reporting for 23% of the operational criteria, 14% reporting for either quantitative or qualitative criteria and excellent quantitative and qualitative reporting for 62% of the operational criteria.

**Airspace and Airfield systems** –Munich Airport’s Air Traffic Management (A.T.M.) is assisted by Communication and Failed Communication procedures, Noise Abatement procedures, Operational procedures for taxiing, De-Icing procedures, Visual Docking procedures, Low Visibility Category II/ III procedures, Startup and Pushback procedures, Data Link Clearance procedures, Instrument Approach procedures and three Arrival and 57 Departure procedures. The airfield expansion project is underway as the increase in aircraft operations from 90 to 120 aircraft per hour is unsustainable.

**Figure 17.** Munich International Airport Aircraft Parking Stands.



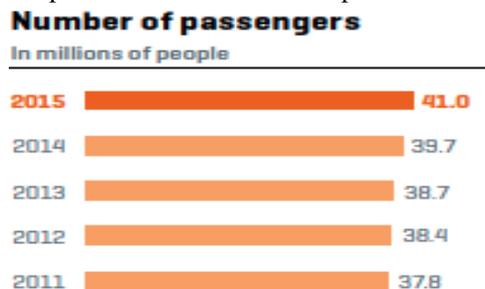
Source: Munich AR 2015.

**Passenger Terminal Facilitation for Visitors, Customer and Employee Experience** - The year 2013 - 2014 experienced 39,700,000 passenger enplanements but rose close to the 41,000,000 mark in 2014 - 2015. The hub also experienced 372,010 commercial operations in 2013 – 2014 and this increased 1% with 380,000 operations during 2014 – 2015. Revenue obtained in 2015 totalled Euro €1,249,306,000 billion, with net profits of Euro €274,839,000 (Munich AR 2014 and AR 2015), which was an increase from 2013 – 2014 revenue of Euro €1,200,075,000 billion, with net profits of Euro €100,052,000

Airport development projects during 2013 culminated in September, with the completion of a Satellite building for Terminal Two that will add 27 new aircraft parking positions in 2015 and refurbishment of Terminal One. There are plans to further develop and expand Terminal One beginning in 2016 and a Third Runway, as the air traffic forecasts for 2025 indicate that two runways cannot accommodate the forecasted increase in demand. Visiting passengers will benefit from an expansion to the Kempinski Hotel Airport München that held 389 rooms but received 162 additional rooms and six more floors (Munich AR 2014 and 2015). They also can be treated at the Medicare Flughafen München Medizinisches Zentrum GmbH or Medicare 24-hour facility at the airport. Additional expansion to the Terminal Two was done with boarding bridges, a hotel wing and in Terminal Two, the renovation of the arrival area.

Further facilitation of quicker passenger movement through the airport was done with the advent of the EasyPass automated border inspection system (Munich AR 2015).

**Figure 18.** Passenger Enplanements for Munich Airport 2013 – 2014 and 2014 - 2015



Source: Munich AR 2015.

It is interpreted that the German air traffic tax that was levied in 2011 has been having a negative effect on airline traffic and cargo operations. The political crisis in the Eastern European region and in Syria has been negative also, as the total aircraft movements were at 376,678 in 2014, giving a 1.4% decline from 2013 (Annual Traffic Report 2014). Nevertheless, the hub did increase its carrier offering by one additional airline (Air Europa) and Vueling and Norwegian Air Shuttle, two existing low-cost airlines had new destinations offered in Spain to the Balearic Islands, Alicante, Madrid, Malaga and the Canary Islands (Annual Traffic Report 2014).

In 2013 – 2014, out of 238 destinations, a newly added destination, that has been expanded at the hub is Lufthansa Airlines to Vancouver and the hub has began facilitating the new, largest carrier aircraft, the B-787 Dreamliner to fly from Tokyo, Narita to the Munich capital (Munich AR 2014). While, in 2014 – 2015, there were two new routes added with Iranian airline Mahan Air providing the Tehran destination and Kuwait Airways adding the Munich to Kuwait option. There were also six new airlines, with one being a cargo airline in that year (Munich AR 2015).

Munich airport now allows for 36,000 parking spaces at 14 car parks in the airport(Munich AR 2015), which is an increase from the 35,000 spaces previously available in 2014 in the four multi-story car park, six underground and a covered area car park (Airports-Worldwide: Munchen 2016). Passengers are able to purchase parking from online, with offers of special savings rates and premium parking options (Munich-airport.com 2016).

Munich passengers experience an average connection time of 35 minutes from arrival to their departure and the walking distance between terminals is noted as approximately 10 minutes, if walking. If passengers require assistance during their connecting flights, there is the 'Meet & Assist Service,' whereby a staff member will assist your transit (Munich-airport.de 2016).

Accurate projections continue to be obtained through valuable input by maintaining open lines of communication with the public, key stakeholders on a regular basis, dialog groups, airline associations, industry professional groups and social projects.

**Sufficient support systems and Emergency services** – Munich's accident reporting has been up to par and because there has been only one reported airfield/ aircraft incident in 2014, involving a Lufthansa Airbus A321-231 (Aviation-Safety.net Reports 2014). It can be assumed that the Munich Airport has a robust and sufficient S.M.S. program and Emergency Response program in operation. The federal customs and police at the Munich airport provide security and they perform passport control at the arrival and departure locations (Munich AR 2015).

Fire fighting capabilities at the airport are separated by location. The southerly-located station is responsible to the south runway, Terminal One ramp area, helipad, and maintenance and cargo areas. The northern station is responsible for the north runway and Terminal Two ramp area. They comply within the I.C.A.O. response time standard of 180 seconds and all terminal buildings have over 52,000 manual and automatic fire alarms. In 2014 a large replica B747 frame with computer controlled smoke scenarios was installed at the airport for fire-fighting training drills (Munich AR 2014).

The airport employees that operate from the Airside are all specially trained to perform Bird Control Management; in an effort to minimize bird strikes on the airfield. The concept used at the airport is to create conditions that are in conducive to large bodied and birds that tend to flock.

**Figure 19.** Munich Bird Sanctuaries.



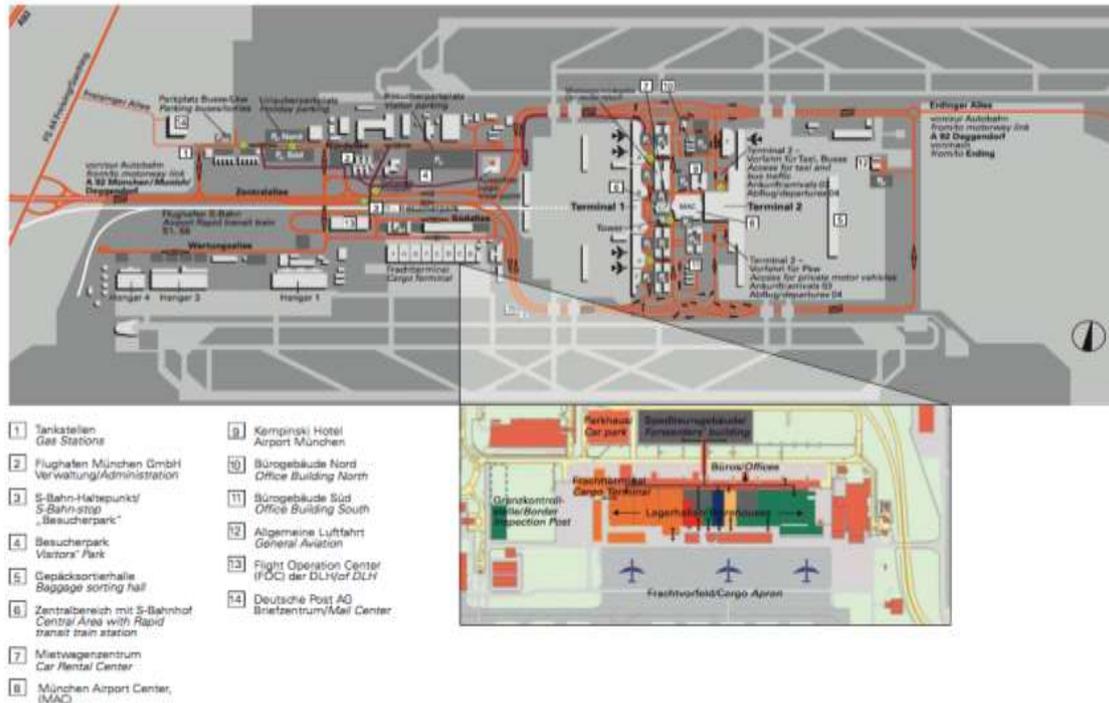
Source: Munich AR 2014.

**Employee training and improvement program**–The workplace has created 32,250 jobs thus far at a rate of 2.5 jobs per day. To improve the balance between employee work and private life, the airport has launched a Day Care centre to facilitate airport employees and its contractors. It is capable of accommodating 30 – 48 children. The Munich Airport Academy continued in 2014, to offer mandatory training programsto its staff-

members for areas specifically in security operations and cargo operations (Munich AR 2015). The Airport Academy facilitated on-the-job training for undergraduate and graduate students but not I.C.A.O. curriculum programs. Though it did offer training to 1,000 management staff participated in 74 courses of study in 2014 (Munich AR 2014) and it trained 469 persons in 47 different courses (Munich AR 2015).

Cargo Terminals – The Munich Airport cargo facility consists of the Cargo Apron, Cargo Terminal, Freight Forwarders’ Building and Border Inspection Post and Small Animal Station (Cargo Hub 2008).

**Figure 20. Munich Cargo Facility**



Source: Cargo Hub 2008.

In 2014, the airport cargo operations were recorded as 291,475 tonnes and increased to 337,000 tonnes in 2015. This was a 9% increase. The number of cargo operators increased in 2015 by one. The cargo operations also encompass other operators like AeroGroundFlughafenMünchen GmbH and CargogateFlughafenMünchenGesellschaft für LuftverkehrsabfertigungenmbH, Allresto and Aerogate(Integrated AR 2014 and MunichAR 2015).

**Figure 21. Cargo Catchment Area for Munich Airport**

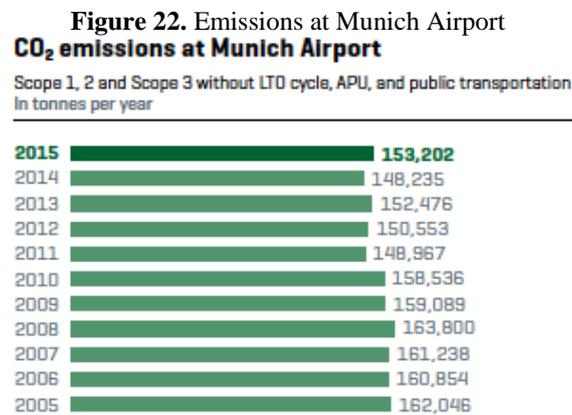


Source: Munich AR 2014.

**The Terminal Landside Ground Access** – Terminal One is accessed via the S-Bahn Rail Station facility. At the station, there are arrivals every 20 minutes. There is also the Lufthansa Airport Bus, which departs every 20 minutes going to the Munich Main Railway Station or Hauptbahnhof (Munich-airport.de 2016). The 2014

AR has explained that the road network and its infrastructure were expanded as well as the parking facility (Munich AR 2014).

**Efficient management of airport operational procedures that affect the environment** –The Munich airport reported savings of over 148,235 tonnes of CO<sub>2</sub> in 2014 (Munich Airport: AR 2014) and increased these savings with 153,202 tonnes of CO<sub>2</sub> in 2015 (Munich Airport: AR 2015). The FlughafenMunich GmbH in 2014, invested heavily in a Combined Heat and Power (C.H.P.) Block that was environmentally friendly and capable of providing 17 mega-watts of power in seven months and reducing G.H.G. emissions by 161,360 per year. The airport also received certification from the Eco-Management and Audit Scheme (E.M.A.S.) and DIN ISO 14001 (Integrated Annual Report 2014).

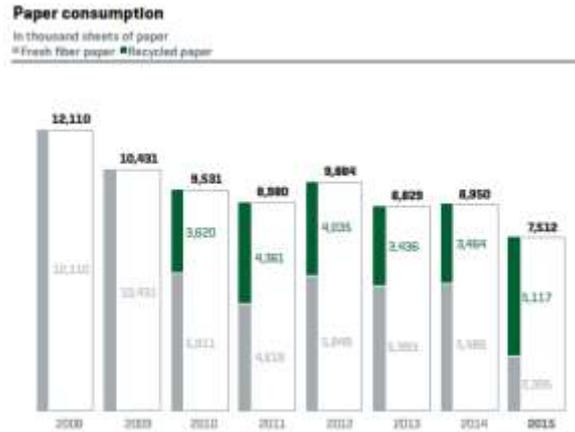


Source: Munich Integrated AR 2015.

The airport utilizes a CO<sub>2</sub> Reduction program and a Climate Protection program, involving the monitoring of all sources of emissions at the airport and actively cutting them. In 2013, the airport joined the Carbon Disclosure Project (C.D.P.), which is one of the largest associations seeking to combat climate change. Some of these efforts involve a plan to replace most of the airport buildings and save 40% of the energy costs, renewable energy biogas sources for its 22 vehicle fleet, 32 apron buses, electric utility vehicles and a car park with 29 electric car charging places. The use of energy saving L.E.D. lights was pioneered by Munich for use in its apron lighting spaces and pollution based and noise based landing charges are levied at airlines (Munich AR 2014).

Considerations for noise impact within the surrounding areas that could result due to the development of the third runway, was assessed and the Bavarian regional government found the new runway to be compatible with the Air Traffic Act, if appropriate zoning took place and if I.C.A.O. Chapter 2 and marginally to Chapter 3 aircraft. Presently, the airport operates, a noise curfew and a noise quota (Munich AR 2015). Lufthansa will soon be using the Munich Airport to launch their fuel efficient and quiet, Airbus A350 (Munich AR 2015). Proper water management of ground water sources and drinking water sources have realized a decrease in the amount of water used in 2014 and 2015. A savings of 950,000 m<sup>3</sup> of water was saved in 2015 but because of the higher passenger enplanements, the water consumption increased within the airport from 2014 to 2015, by 991,557 m<sup>3</sup> to 1,042,166 m<sup>3</sup>. By using ground water for cooling plant purposes, directing well-bourn water for drinking purposes only, and good fortune with a high water table in 2014, was the airport able to achieve this. There was the establishment of De-icing Pads with catchment capabilities for re-use of effluent run-off on aprons. It prevented contamination of water sources and green areas and allowed de-icer to be re-used (Munich AR 2014 and 2015). A waste management program is also in operation, with a waste paper plant that processes film, glass, wood and metal (Munich AR 2014). Between the two years 2014 and 2015, there was a decline in paper consumption at the airport as seen below.

**Figure 23. Paper Consumption at Munich Airport.**



Source: Munich AR 2015.

**Tokyo International Airport**

**Background** – The Tokyo ‘Haneda’ International Airport (I.C.A.O.: RJTT) is a public type international airport and the Tokyo Aviation Bureau, Ministry of Land, Infrastructure and Transport operate its airfields, while Japan Airport Terminal Co. Ltd. operate its terminals. The airport is located in Ota, Tokyo, Japan and consists of four runways; two Parallel runways, one of which is Crossed and another which is a Single runway. The airport caters for domestic and international passengers and consists of Terminal One, Two and an International Terminal (Airports-Worldwide.com, 2016).

Figure 24. Tokyo International Airport



Source: Jeppesen

From the data collected for the individual airports, (Figure 3. – Quality of Operational Performance by Top Listed Airports) with closer analysis Tokyo (Haneda) International Airport (RJTT) received a score of 59.89% out of 100%, had poor reporting for 48% of the operational criteria, 27% reporting for either quantitative or qualitative criteria and both quantitative and qualitative reporting for 25% of the operational criteria.

**Airspace and Airfield systems** –Tokyo International airport’s aerodrome traffic management is controlled by several procedures. These are Continuous Descent and Arrival procedures, Radio Communication and Radio Failure procedures, Low Visibility Category II/ III procedures, Airspace Restriction procedures, De-Icing procedures, Noise Abatement procedures, Runway Construction and Ramp Safety Management procedures, Taxiing procedures, Parking and Visual Docking procedures, Start-up and Pushback procedures, Instrument Approach procedures and Special Operation to Large Aircraft procedures.

**Figure 25.** Tokyo International Airport Aircraft Parking Stands.



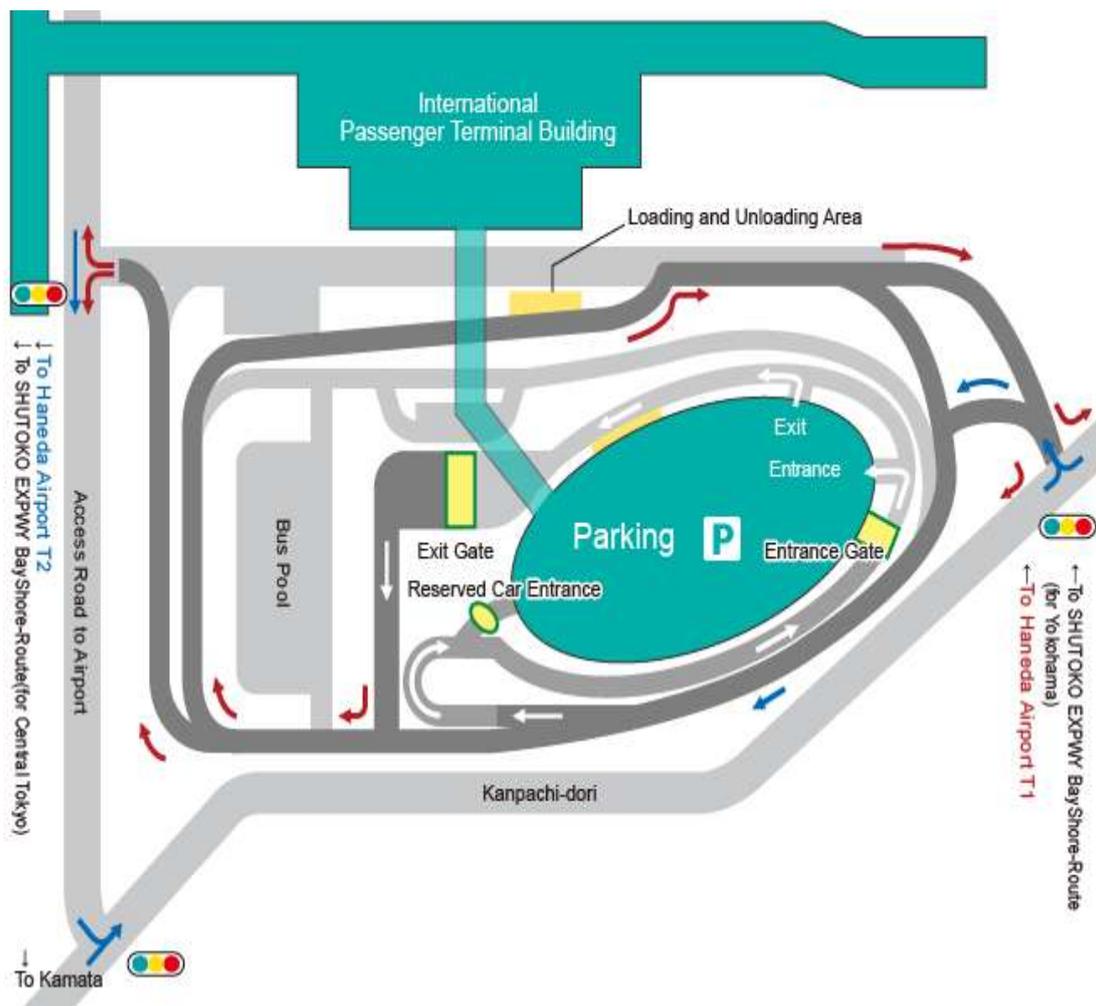
Source: Google Images

**Passenger Terminal Facilitation for Visitors, Customer and Employee Experience** - International and domestic passenger enplanements at the airport had an increase in 2014 – 2015, with 6,090,000 up from 6,030,000 in 2013 – 2014. This was helped by reduced visa requirements for Southeast Asian tourists. Its balance sheets reported YEN 150,000,000 in revenue in 2014 – 2015 and YEN \$135,900,000 in revenue in 2013 – 2014 and an after tax profit (EBITDA) of YEN 17.7 billion in FY 2013 and 19.0 billion in FY 2014 (J.A.T. Financial Report 2015) and (Tokyo Airport Business Plan 2016).

The Japan Airport Terminal Group (J.A.T.) also indicated in their Annual Report (J.A.T. Financial Report 2015, pg.2) that strategic initiatives were employed regarding the charging of a Passenger Service Facility Fee and additional airport visitor capacity was accommodated by the opening of the ‘Royal Park Hotel THE HANEDA.’ This was to generate additional income through customer service and facilitation. There was also construction of a transfer facility between the domestic and international terminals, the expansion of international flights in March 2014, the introduction of the exclusive use of baggage carts beyond the security checkpoints for gates in July 2014, and the commencement of renovations for the domestic Terminal 1, in February 2015, the implementation of a multi-language program, a new multi-purpose restroom in Terminal One (Tokyo-Airport 2016), mobility carts and disabled passenger assistance at terminals, in elevators and guide dog toilet facilities (Tait.co.jp 2016). The airport facilitates general aviation as well and two hangars in Kagoshima have been refurbished for small aircraft and medical helicopter usage (J.A.T. Financial Report 2015).

Parking facilities at Tokyo Airport include parking facilities for 3,000 spots (Haneda-airport.jp 2016) at each of its three terminals. Parking spots can be reserved and is available 24/7, while there are shuttles from the parking garages to the terminals, handicapped spots, disabled special rates, private car, large vehicle, short and long term parking and special rates on weekends.

Figure 26. Tokyo Airport Layout with Parking.



Source: Haneda-airport.jp

**Sufficient support systems and Emergency services** – The airport has had no reported airport or airfield accidents or incidents within the period under review. Notably the database had two accidents reported in 2012 (Aircraft/ Accident Incident Reports 2016) but there was a reported accident in 2016, involving an engine fire for a Korean Air Boeing 777-300 aircraft (AirLive.net 2016). This report was not available in the official database but could be verified via news reporting. The reporting mechanism is supported electronically and methodically for the accident reporting but insufficient for recent incidents and accidents. Because of increased

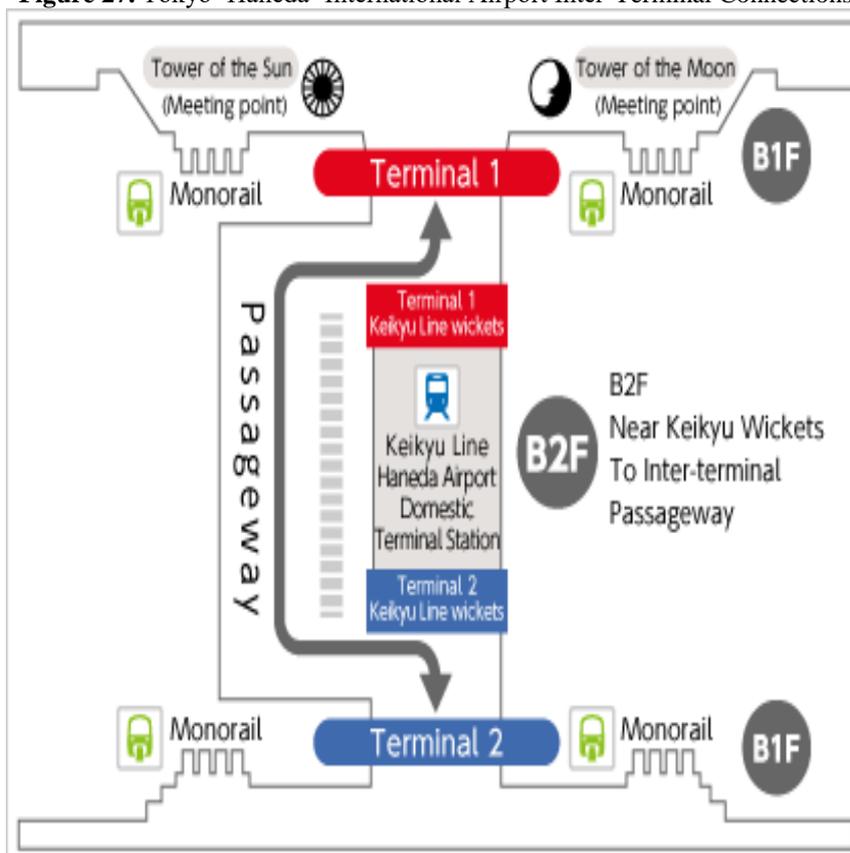
flights, support systems required upgrades. One of these has been, the refurbishment of the former Maintenance Center 3 in March 2014, into a factory that prepares additional meals for international flights.

**Employee training and improvement program**—In December 2013, the airport constructed residences for workers at and contractors at the airport, closely located to the aerodrome, at the Omori Higashi, Ota-ku, Tokyo, close to the railway line, along with the Sky Residence Otorii. Meanwhile, in February 2014, a Maintenance Center annex was built for flight crews to conduct training on, in between flights, using six different simulators.

**Cargo Terminals** – The cargo facilities at the airport, has a reported time of 180 minutes for delivery, after arrival time for general cargo and 60 minutes for document cargo (Jal.co.jp 2016).

**Terminal Landside Ground Access** –The airport’s domestic terminal is well connected to multiple forms of transport including the Keikyu Train Line, the Tokyo Monorail, Road access via the Shuto Expressway Bayshore route and Bikes, the Inter-Terminal free Shuttle Buses, scheduled city buses within the Kanto area are provided by the Airport Transport Service, Taxis, Water Taxis and pick up and drop off lanes for handicapped persons.

**Figure 27.** Tokyo ‘Haneda’ International Airport Inter-Terminal Connections



Source: Tokyo-airport-bldg.co.jp

**Efficient management of airport operational procedures that affect the environment** –The Haneda Airport has continued the operation of a 2010 built solar facility, which was constructed on the roof of the Hanaeda Airport. The facility has an output of 2,000 kW and was built together with the Tokyo Electric Power Company, ‘Mitsui’ (Environment Related Business 2015).

The airport is described on the Tait.co.jp website to have the following: Building Energy Management, geothermal building heating, rainwater collection and management, solar power collection and usage, natural lighting and ventilation design, to be built eco-friendly and with a greenery network (Tait.co.jp 2016).

### **Hong Kong International Airport**

**Background** – The Hong Kong International Airport (I.C.A.O.: VHHH) is a public type airport that is owned and operated by the Airport Authority of Hong Kong (A.A.H.K.). The airport is located in Chek Lap Kok and utilizes two parallel runways and is situated on a reclaimed island of Chek Lap Kok. The airport serves



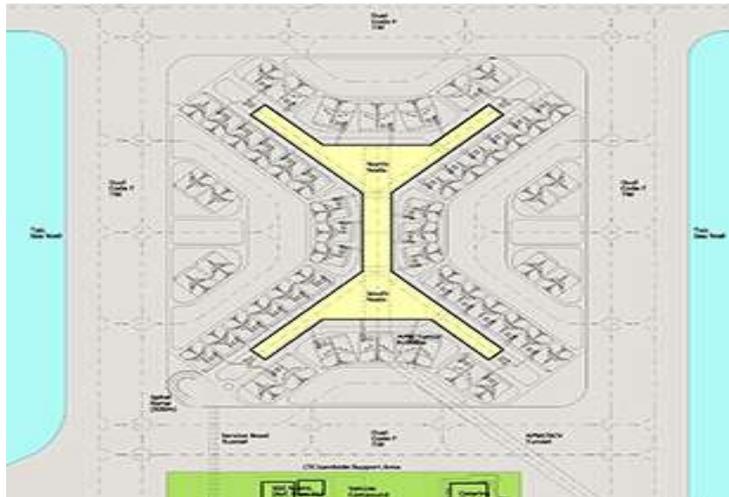
From the data collected for the individual airports, (Figure 3. – Quality of Operational Performance by Top Listed Airports) with closer analysis Hong Kong International Airport (VHHH) though receiving a score of 74.33% out of 100%, had poor reporting for 25% of the operational criteria, 30% reporting for either quantitative or qualitative criteria and both quantitative and qualitative reporting for 46% of the operational criteria.

**Airspace and Airfield systems** –It was noted that, the Hong Kong airport experienced a growth of 6.3% increase in aircraft movements and over the 2013 – 2014 period. Its Air Traffic Management is controlled with the help of six Arrival, 29 Departure Procedures, Instrument Approach procedures, Noise Abatement procedures, Low Visibility Cat II/ III procedures, Taxiing procedures, Terminal Transition procedures, Startup and Pushback procedures and Continuous Approach/ Descent procedures (Fly-Sea.com/VHHH 2016). Its airfield utilizes advanced equipment for air traffic control management of traffic and aircraft navigation. Just to name a few are: A Radar Data Processing and Display System (R.D.P.D.S.), Flight Data Processing System (F.D.P.S.) and simulator system for practicing controllers. The R.D.P.D.S. processes information received from aircraft to manage approach and departure plotting and sequencing. The F.D.P.S. managed flight plans, automatically printing strips for flight following, vectoring etc. The A.T.C. also utilizes a Primary Surveillance Radar (P.S.R.) and Secondary Surveillance Radar (S.S.R.), which are very powerful radar for vectoring aircraft up to 200 NM from the airport. Other equipment used by the airport A.T.C. are Surface Movement Radar (S.M.R.), Advanced Surface Movement Guidance and Control System (A-S.M.G.C.S.), a Control Tower Simulator (C.T.S.), Instrument Landing System (I.L.S.), a Doppler Very High Frequency Omni-directional-radio Range and Distance Measuring Equipment (D.V.H.F.O.R./D.M.E.) system, an Aeronautical Information Database (AIDB) System, an Automatic Message Switching System (A.M.S.S.), Very High Frequency/ Ultra High Frequency (V.H.F./U.H.F.) Communication Equipment, Speech Processing Equipment (S.P.E.), Voice Recording System (V.R.S.), Automatic Terminal Information System (A.T.I.S.), Microwave Link System (M.L.S.), Non-directional Beacon (N.D.B.) and a Backup Air Traffic Control Centre/ Tower (B.A.T.C.C./Backup TWR) all indicated on the C.A.D. website (HK C.A.D. Air Traffic Control Equipment for the Airport 2010). The airport has runways classified as Category II and Category IIIA Precision Approaches, allowing 200-m visibility during landing. Based upon the mix of aircraft for the length and configuration of the runways the handling capacity has increased in 2015 to 68 aircraft movement by the hour (Hong Kong: The Facts - Civil Aviation, 2016).

The airport has evidence of flight restrictions for the purpose of noise and visual disturbance around the Hong Kong Disneyland. It has established a Prohibition Area and procedures to address reasonable deviation from it (Flight Prohibition Area, 2015), an approved airport Height Restriction Plan that is available for public use and Aerodrome Operating Minima (Aerodrome Operating Minima 2013). This demonstrates proper planning regarding airspace and airfield operations. (Control of Obstructions, 2013).

The airfield utilizes a Finger Pier and Pier Satellite Terminal system for aircraft stands at the terminal gates. They have built 20 new aircraft stands in 2013 and eight in 2014. Most recently, the new Midfield Concourse was built with 20 more aircraft parking stands (HK Annual Report 2013/14). This is a widely used design that enables an efficient use of land and space. The airfield has a two-runway system that has been earmarked for upgrade to a three-runway system in the HK Airport Master Plan (Hong Kong Master Plan, 2030). In 2014, the airport saw additions to the west apron, a cross-runway tunnel, 28 new aircraft parking stands, nine cargo stands and seven maintenance stands (HK Annual Report 2014/15).

**Figure 29.** Hong Kong International Airport Parking Stands.



Source: Hong Kong International Airport, 2030 Master Plan (2008-09)

**Figure 30.** Three Runway System



Source: Hong Kong International Airport Three-Runway System

To address the risk of accidents when the number of airfield and ramp activities increased, the Hong Kong Airport undertook the initiative of publishing a new Ramp Safety Handbook for airlines and ramp operators to be aware of the airport's ramp S.O.P.s. They also revised the procedures for the Airside Driving Offence Points Scheme, the Airside Safety Demerit Point Scheme and the Foreign Object Damage (F.O.D.) prevention programme. These measures were not the only attempts that the airport did to address airfield and ramp operational safety. Several internal intensive safety audits were performed and focused on compliance and safety culture and they were administered with a new surveillance program and weekly ramp inspections. Lastly, a critical aspect of the human factors aspect that was addressed and could be very valuable during severe weather and night operations, was the implementation of wireless headsets for aircraft line maintenance staff for communicating with the cockpit crew and dispatch and the review of aircraft towing out of the hangar procedure during the Red Airport Lighting Warning(Sustainability Report 2014/15).

To improve on methods of efficiency within the airfield environment, the A.A.H.K. introduced full G.P.S. tracking for 3,500 airside vehicles in order to improve safety and relieve bottleneck areas through analysis of mobile data and for further improvements in ramp operations, was the introduction of cooling vests equipped with cooling packs and fans, intended to prevent heatstroke among ramp operators. Internal safety videos were improved on and new videos were made for mandatory viewing by all employees during safety training (Annual Report 2013/14).

Aircraft refuelling operations increased on the airfield by 40% due to new refuelling contracts being awarded in 2013/ 2014 to China National Aviation Fuelling Group (C.N.A.F.). HK Refuelling Ltd. This was in preparation to meet additional demand after the three-runway project was completed (HK Annual Report 2014/15). Further demand following the third runway still to be expected, was anticipated with the signing of a lease for an Aviation Training Centre for construction on 0.6 hectares of land in 2015 (HK Annual Report 2014/15).

The airport also has the facility of an Airport Meteorological Office (A.M.O.) of Hong Kong on the aerodrome and it provides weather updates that are immediately transmitted to the airport services, airlines and airport authority (Airports-worldwide.com 2016).

**Passenger Terminal Facilitation for Visitors, Customer and Employee Experience** - The airport comprises of Terminal One, Terminal Two with a Sky Plaza, North Satellite and a recently built Midfield Concourse (HK Annual Report 2013/14). Its passenger movement increased by 6.1% over the 2013 – 2014 period and its passengers are checked-in and are processed at Terminal Two and are shuttled via the underground trains on the Airport Express Main Train Station (MTR 2007) to Terminal One. The airport can facilitate over 3,000 parking spaces among for Car Park locations able to accommodate private cars, motorcycles, a 30-minute complimentary parking, hourly, daily, monthly and comfortable payment support with Visa, Mastercard etc (Hongkongairport.com Parking, 2016).

**Figure 31. Hong Kong Car Park**



Source: Hongkongairport.com

The airport Sustainability Report has described over 99.7% of passengers experience security screening that lasted a maximum of four and a half minutes or less, and shorter queue times for boarding because of three kiosks with personalized Flight Information Display System (FIDS) at landside and airside locations in Terminal One. This assisted in reducing the minimum flight connection time to 50 minutes (Sustainability Report 2014/15). Innovative techniques have been used to facilitate passenger movement over the period, in addition to infrastructural works. Some of these are trials done in 2014 for mobile checking-in, where an agent printed boarding passes using a handheld device, improvement in the WiFi service to a 400 megabit per second service and the launching of a mobile app called ‘HKG My Flight,’ that allows passengers to get flight updates for schedules and airport information in real-time and in 2015 January, this grew to include a channel called ‘WeChat’ which was a free Voice Over IP Chat App (HK Annual Report 2014/15). Then there was the strategic departmental effort to revise the flight information display system that was launched in 1998 and badly required and upgrade. The new system was able to include many additional and complex areas of airport operations. Other areas that were upgraded to accommodate passenger facilitation were 12 female washroom areas, the facilitation of passengers with disabilities and reduced mobility with accessible payphones, 45 accessible washrooms with sensor operated equipment and automatic sliding doors, customer service counters and public areas serviced by hydraulic lifts (HK Annual Report 2013/14). Public charging facilities began being installed in 2009 and by 2014 there were 400 locations. In April 2015, public charging facilities extended into Terminal 2 and the Sky Pier with 510 locations and 16 i-Tables, four hot water dispensers in Feb 2015 and 15 more in the next quarter in Terminal 2 (HK Annual Report 2014/15).

The A.A.H.K. worked with Cathay Pacific Airline, to launch a self check-in system or Flight Information Display System (FIDS), where passengers could check by themselves and print their bag tags. The trial went so well that four stations were installed and the processing times were cut from three minutes to 69 seconds.

In 2014 the airport tested a new baggage system called STACK@EASE, for one month. It sought to increase efficiency and ease heavy lifting, while using a flexible system that has a user-friendly moving arm that can load 200 – 300 pieces per flight. The system also uses a Radio Frequency Identification (R.F.I.D.) reader to

read bag tags and simplify the baggage facilitation process. Feedback from the trial was positive, as it reduced the risk of injury and increased efficiency (Sustainability Report 2014/15). In March 2014, Guadalajara, Mexico and Irkutsk, Russia were the two new destinations that joined the airport's route schedule, inclusive of four airlines: Aurora Airlines, City Airways, Easter Jet and Scoot (HK Annual Report 2013/14). While in March 2015, one additional flight destination (Hong Kong) was brokered with American Airlines, Sam Air, Vanilla Air and Jetstar Japan airlines.

Security measures by the Airport Authority of Hong Kong (A.A.H.K.) were performed via the subcontracted firm AVSECO. For the period, I.C.A.O. S.A.R.P.s were implemented, along with a Quality Assurance Programme and an ISO 9001 certified Integrated Management System. Members of the airport authority, tenants, stakeholders and airline's leadership comprise the Airport Security Committee and assist the AVSECO leadership.

The Committee implemented the extension of the baggage screening system and the installation of long-range C.C.T.V. cameras in Restricted Areas (RAs). In order to address potential threats to the concession operations, a Business Continuity Management System was formulated with an Operational Risk Register (ORR), an Emergency Response and Business Continuity Plan and over 121 regular validation drills and exercises, involving 5,317 airport personnel (Sustainability Report 2014/15).

Further security concerns were addressed by installing 100 more C.C.T.V. cameras in cargo and baggage areas to consolidate monitoring of resource management during real-time positions. This has facilitated surveillance and communication, especially after the expansion of existing Wi-Fi coverage, to include business partners and increase productivity and connectivity, to ultimately enable more informed decision-making and facilitate better Airport Collaborative Decision Making (A-CDM) (Sustainability Report 2014/15).

In December 2013, the airport commissioned a new hotel with a capacity of 1,000 rooms (HK Annual Report 2013/14) to increase passenger accommodation, in preparation for later airport upgrades and increases in passenger movement.

**Sufficient support systems and Emergency services** – The A.A.H.K. has partnered with the Hong Kong Observatory and the Civil Aviation Department (C.A.D.) in an effort to understand how adverse weather affects the airport environment. The A.A.H.K. employed a new program intended for use during adverse weather. This was the Centralized Aircraft Tractor Deployment Procedure, which was used when severe weather disrupted airfield and ramp operation negatively. It involved utilizing A.A.H.K. and C.A.D. personnel to assist in the control tower and to deploy airport tractors and additional ground crew, to push back and tow aircraft quickly into arrangement.

The A.A.H.K. has established evidence of a robust safety management program that has been established based upon direct S.A.R.P.s from the I.C.A.O. S.M.S. manual (Hong Kong Safety Programme 2014 – 2017, Ch.3). This manual outlines the audits that are performed, training, state safety indicators and the C.A.D. regulations that govern the A.A.H.K. based upon ratified I.C.A.O. S.A.R.P.s.

The HK Aircraft Engineering Company (H.A.E.C.O.) and China Aircraft Services perform routine Line Maintenance for aircraft at the HK airport. They have rigid standards for aircraft turn around times and can accommodate a wide variety of wide and narrow body aircraft with 18 maintenance positions (Hong Kong: The Facts - Civil Aviation, 2016).

The Rescue Fire fighting capacity at the Hong Kong airport boasts two stations, two sea rescue units operating 24-hours, 260 officers, 14 appliances that can respond to any location within two minutes, two command boats and eight speed boats, all within I.C.A.O. requirements (Hong Kong: The Facts - Civil Aviation, 2016).

**Employee training and improvement program** – Safety Promotion by the HK airport takes place during their recurrent training that is administered by the H.K. C.A.D. and the A.A.H.K. and its employees take part in these training programmes (Hong Kong safety Programme 2014 – 2017, Ch.5). Hong Kong CAD has also made courses like the AVSEC MP by A.C.I. and I.C.A.O. available to the AAHK (Concordia 2016).

In September 2013 a mock training drill was performed to simulate a nuclear spill due to a crash and in total, 100 specific drills were held (HK Annual Report 2013/14). In 2014, there were 30 training drills, where over 750 people took part. This was followed by a weather preparedness test, consisting of 650 people. In total, there were 90 internal training programs performed to equip airport employees (HK Annual Report 2014/15).

**Cargo Terminals** – The A.A.H.K. experienced an increase in cargo operations during 2014 – 2015 of 5.5% with a 4,400,00 million tonnes of cargo (HK Annual Report 2014/15) and in 2013 – 2014 by 3.4% to 4,200,00 million tonnes (Hong Kong Annual Report 2013/14) due to, uses of an advanced baggage and ramp handling system called a Baggage Handling System (B.H.S.). It utilizes Bar Coding, Radio Frequency Identification (R.F.I.D.) that can read I.A.T.A. baggage labels, a 34-kilometre long conveyor belt, a detached remote transfer facility for tight connecting flights, 12 reclaim carousels and boasts a 20 – 40 minute collection of baggage for passengers of arriving aircraft (Hong Kong: The Facts - Civil Aviation, 2016).

A.A.H.K. has five cargo operators that service the airport's cargo needs. HK Air Cargo Terminal Ltd. has a cargo operation that handled 4.38 million tonnes of cargo for 2015 even though its handling capacity is 3.5

million tonnes per year. Asia Airfreight Terminal Company Ltd handled 1.5 million tonnes, DHL can handle over 35,000 parcels and 40,000 documents each hour and the Cathay Pacific Cargo Terminal, which was newly commissioned in February 2013 (HK Annual Report 2013/14), handled 2.6 million tonnes per year. Lastly, Hong Kong Post's Air Mail Centre handles 700,000 parcels each day. This is a testament to the capacity of the A.A.H.K. cargo operation.

**Terminal Landside Ground Access** - A fully integrated ground transportation centre for passenger facilitation, from curbside arrival to departure, 45 different bus routes bring passengers within 24 minutes from downtown using the MTR Airport Express. The terminal also is directly connected to the New Lantao City Bus, Long Win Bus and Discovery Bay Buses. Another convenient connection is the direct ferry from the terminal that goes to several locations on the Pearl River Delta and the ferry terminal is before immigration services for arriving customers. A number of taxis are also available and can be used if desired at the terminal (Airports-worldwide.com 2016)

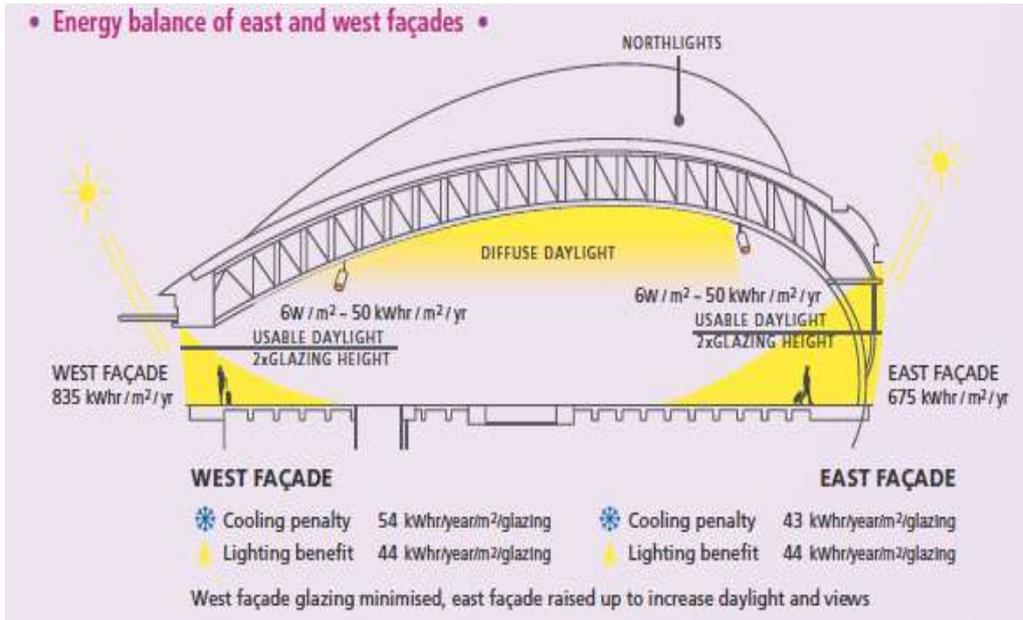
**Efficient management of airport operational procedures that affect the environment** –The A.A.H.K. produced its first Sustainability Report in 2013, August “Sustaining our Capacity – Our Blueprint for Shared Growth, 2013” (HK Annual Report 2013/14) and it has been utilizing the FAA's Integrated Noise Model (I.N.M.) for plotting noise contours to assess the impact of noise within the airport environment and have been guided by the I.C.A.O. noise impact assessment guidelines to also produce a Noise Exposure Forecast (N.E.F.) and Environmental Impact Assessment (N.A.M.P-E.I.A.) outlined in its airport master plan. This has moved the A.A.H.K.'s hand to employ noise mitigation procedures for arriving and departing aircraft since Oct 1998 and most recently in March 2014, aircraft that are marginally compliant to Chapter Three noise cannot depart between hours of 11 pm – 7 am, (CAD website Aircraft Noise Management, 2016).

The A.A.H.K. also submitted an Environmental Assessment for the impact of the intended 2030 expansion project, which addressed 12 different environmental areas within the project. This was mentioned in order to identify that the A.A.H.K. has been attempting to maintain compliance with industry, legislative and I.C.A.O. regulatory practices regarding Environmental Assessment (E.A.s) and airport development projects. (Hong Kong Annual Report, 2013/14).

The authority has upgraded its 179 vehicles, 48 electric saloons, four staff buses, 10 single cab and 20 dual cab apron buses so that they became compliant with European V emission standards in 2015 (HK Annual Report 2014/15). Continued strides in meeting environmental standards continued as the authority changed over 100,000 incandescent, halogen and fluorescent bulbs to those with light emitting diodes (L.E.D.s). This will save the airport 15 million kW hours. Concession organic waste has also been collected and converted into fish food and landscaping manure at an off-site location. (HK Annual Report, 2014/15). Using the support of I.A.T.A. and A.C.I., the H.K.A.A. has held discussions to reduce the incidence of air carrier cabin waste (Hong Kong Carbon/ Waste Program 2016).

The terminal buildings at the airport were designed using heat reflecting glass and the terminal roof allow daylight to illuminate the terminal. Light sensors detect when daylight is diminishing and increase output to the lights. (Hong Kong Airport.com 2016). The concept for the newly built Midfield Concourse was very similar. Below is a technical outline of the environmental concepts used:

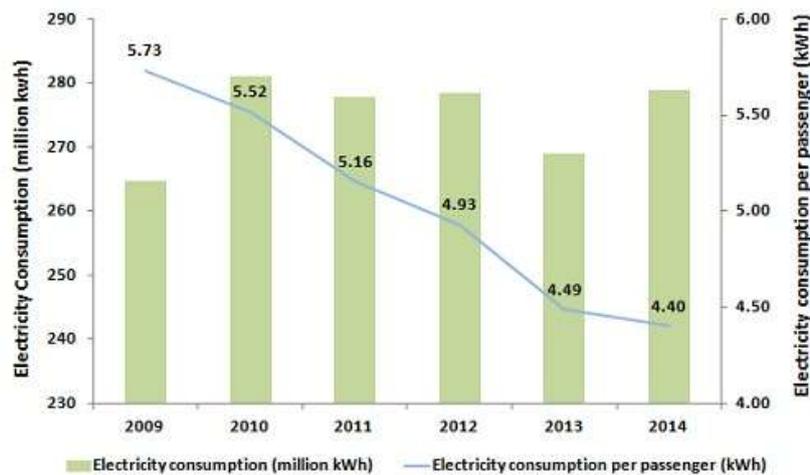
**Figure 32.** Hong Kong International Airport Midfield Concourse Facades.



Source: HKAA Sustainability Report 2014/15

Below is a depiction of the HK Airport Authority's energy consumption from Oct – Dec 2014, which shows the diminishing energy consumption requirements per passenger.

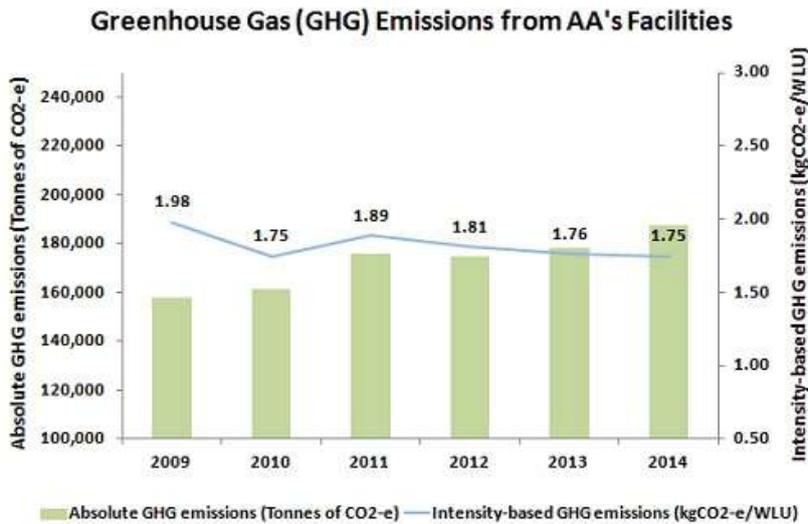
**Figure 33. AAHK Electricity Consumption.**  
**Electricity Consumption of AA's facilities**



Source: Hongkongairport.com

The H.K.A.A. seems to also have heavily invested in its Carbon Reduction and Management by engaging airlines, employees, airport tenants, and utilizing its own Carbon Auditing System, tracking Carbon Emission performance and partaking in A.C.I.'s Airport Carbon Accreditation program (Hongkongairport, Carbon/ Waste Program 2016). The under-mentioned table indicated H.K.A.A. G.H.G. emissions for 2013 – 2014 1st 2014 – 2015.

**Figure 34. Greenhouse Gas (G.H.G.) Emissions from H.K.A.A. Facilities**



Source: Hongkongairport.com

#### 4. Specific Recommendations

Incheon International Airport (RKSI) –Incheon has done an excellent job. Its G.H.G. emissions fell, even though the passenger enplanements and commercial operations rose between the two years. The heavy thrust that the airport has taken toward emission control and monitoring must be applauded. It could be a standard for other Aisan-Pacific airports. The airport can still improve on its reporting of infrastructural developments. It has also developed a competitive advantage in using I.C.T. software and hardware to propel its business strategies. Any area that it has not developed in this manner should be given an action plan for further development. Notably, if these I.C.T. applications provide exceptional results in improving safe global transport, it should seek to market these ideas and provide implementation at other airports authorities to help improve their passenger transport and its facilitation.

Munich International Airport (EDDM) –This airport had excellent reporting for most areas. It is recommended though that it provide additional information for areas that are reported with only qualitative data, as was the case with most. Munich’s cargo operational data was lacking mostly, though we know that it exists, as its cargo operations grew the following year. The airport should also provide more data regarding the development of its Airport Concessions and the development of its Aircraft Cargo and and Parking Stands. Overall, its infrastructural developments should be explained more in-depth. This would identify its capacity to facilitate larger passenger enplanements. This information identifies growth in infrastructure and in the ability to satisfy customer demands at the airport.

Hong Kong International Airport (VHHH) – The airport undergoes a safety I.C.A.O. audit every six years. The unique method used was a five-man team, comprising of Hong Kong Civil Aviation Authority and Airport Authority personnel to identify operational issues, in addition to other issues and address them or commence a process to address them. This stage one process is usually accepted during an audit, as it shows, acknowledgement of the process, a way or method forward for resolution. It would be followed up in any successive audits (I.C.A.O. U.S.O.A.P. on Hong Kong Aviation System, 2016). The result was a very successful passing grade by the I.C.A.O. of 94.47, placing fifth among 120 countries. The group identified over 2,500 issues. This method could be applied to other airports, in preparation for I.C.A.O. audits. The team should consist of key technical members but remain small, so as to efficiently utilize manpower. Advantages of this are that it prepares the airport and aviation organization for these important audits and it identifies issues that can be addressed on their own before and an actual audit. It was admitted by members of both organizations, that they both had a better understanding and appreciation for each other during the process. This networking usually facilitates easier back channelling and corroboration of information for expedience and useful productivity. The airport still needs to supply additional information regarding it infrastructural developments in detail and analysis of its concession development. Excellent reporting was seen in all other areas except these. G.H.G. emissions were kept low even though the commercial operations increased by almost 10%. Continued monitoring of these levels must be continued and expanded as demand rises. This is to prevent any runaway of the levels. It is also highly recommended that this airport remain within the A.C.I.-A.C.A. Program and continue to utilize the management strategies that it has employed to increase its facilitation and cargo operational capacity. This can be a template for other airports to follow.

Changi International Airport (WSSS) – The reporting capabilities of this airport has done justice in identifying its approach to improving its airport operation. The strategic management initiates that Changi has

taken must be applauded. It still needs to improve on it reporting of items 25% of the criteria items in order to improve its score. These may well be present but unmentioned in its official Annual Reports. This airport should seek diligently to re-enter the A.C.I.-A.C.A., since it has left it. This can be understood to be because of the increase in development and construction machinery at the airport, the G.H.G. levels would have risen considerably, even though just temporarily. This airport seems to be expanding rapidly and simultaneously focusing on increasing passenger demand directly but not through strategic methods with the airlines. It has not increased any commercial operators over the 2 periods but its enplanements still grew. After the infrastructure is completely developed, it is recommended that strategy be shifted to grow airline operator presence at the airport. This will have exponential effects on the enplanement numbers.

Tokyo International Airport (RJTT)–Tokyo International Airport did not present a favourable depiction of its airport operations. This airport could possibly have a well developed and efficient airport operation but the reporting aspect on these items were very lacking in both quantitative and qualitative data. For this airport, in addition to data reporting, it is recommended that emphasis is placed on the following areas as most were non-existent in their Annual Report: Infrastructural developments in detail, Concessions performance for the year, results of strategic management strategies such as airline operator increases, cargo operations, cargo operational data and commercial operations data. Sustainability and environmental management around the airport was unsatisfactorily reported. There is a question as to if it even exists and to what degree. Airfield systems that are lacking are Low Visibility procedures, Startup and Pushback procedures and Operational procedures for large aircraft. Lastly, data needs to be provided and evidence proved for the existence of satisfactory Support Systems and Emergency Systems, which I am sure exists but have not been reported satisfactorily.

## **5. General Recommendations**

Most of these airports have identified their own methods of addressing their areas for improvement, which is commendable, as a S.W.O.T. analysis would identify, that they all have their inherent weaknesses, disadvantages, strengths and advantages. Continuous use of this an analysis of this nature during a strategic audit maybe, every three years would prove useful in pinpointing areas quickly and allowing implementation of systems to fully develop in their application.

The efforts to address the reduction of aircraft emission have been mostly fruitful in (I.C.A.O. Media Release, 2016), concept. The way forward to this dilemma should be to monitor the emission frequency and amounts and mitigate using steps such as fines, technology improvement, procedures and limitations but this cannot be implemented on a worldwide basis, unless legislature is administered. With this understanding, airports can however continue to establish procedures that they believe will address their particular situation based upon the aircraft mix for their airport and the frequency of arriving and departing airport.

Airports can greatly reduce their environmental footprint, by implementing ‘Green Techniques,’ such as the Continuous Descent Operations:C.D.O.s (I.C.A.O. Doc 9931, 2010) and Continuous Climb Operations: C.C.O.s(I.C.A.O. Doc 9993, 2016) facilitated by Air Traffic Management (A.T.M.) at airports with communications, navigation, surveillance and air traffic control would facilitate an appreciation and greatly emphasize the outcome of emission mitigation and control. Establishing these measure through internal airport A.T.M. is also a way forward and a recommended I.C.A.O. step (I.C.A.O. Global Air Navigation Plan 2013) to greatly reduce the noxious air emissions from aircraft around, departing and arriving at airports. It has also enabled airlines to experience millions in reduced fuel costs. Benefits that can be derived from this will be for airport management success, community members and airline passengers. A computer simulation program made by Eurocontrol, has shown that C.C.O.s can save an average of 200 kg of fuel per flight. This is equivalent to a reduction of 620 kg CO<sub>2</sub> in the atmosphere. This can also translate to lower ticket prices for passengers (I.C.A.O. Journal 2009).

Community Noise Monitoring and Community Noise Funds are another way that airports can address aircraft noise levels within a community. The fines administered go towards this fund can be used by the airport to-reinvest in community projects for development, education, housing, social work or healthcare.

Though it is undesirable for translation of higher ticket prices to the passengers, it is also inevitable. It should be the last stage in translating responsibility regarding green solutions for global air transport. The passengers do play a major part but their expectation is that the airports and airlines will be present a service in alignment with global environmental trends. A fraction of the cost of the maintenance of these procedures should also be fairly borne by the passengers but not to overburden them.

It is recommended that developing airports that are seeking to begin mitigating or for those that have been attempting to reduce environmental impacts of their airport operations can assess the financial impact that their actions have had. This is a good method to determine if the campaign is justified, if airport authorities need to convince their shareholders or to motivate their staff and the community. The I.C.A.O. has developed a ‘Fuel Savings Estimation Tool (I.F.S.E.T.)’ that can be used for this purpose (I.C.A.O. Global Air Navigation Plan 2013. Ch.3).

Continued maintenance and upgrading of the Self-Bag Drop Service, Web/ Mobile Check-In Service, Fast Check-In services and any other automated check-in facility is highly recommended as there are numerous benefits to be gained by it, such as: It reduced passenger check-in time tremendously, it also minimizes the size of queues at check-in counters, it enable check-in counters to devote human resource and time at addressing legitimate emergencies or concerns for passengers experiencing difficulty in checking-in and it screens fraudulent passports in advance and prevents them from entering the system.

Of the five airports that were analysed, all had large open-air car parks. These facilities could be put to significant double use with careful consideration and implementation of renewable energy initiatives. The installation of canopy parking structures is an affordable alternative to a multi-story structure, if building a large multi-story parking structure is too much of a financial burden at the time. Much like the Denver facility that has a close to zero carbon footprint and is still very competitive among other competing car parks, the facility decreases the energy cost of the airport over the cumulative years, resulting in millions of savings. The possibility of future development could come after. The installation of Solar Photovoltaic Cells could generate large amounts of green energy for the airport's use and the remaining energy could be stored in DC batteries much like those sold by the Tesla Corporation, for night-time usage or transmission unto the city's power grid. Examples of this can be seen at the Denver International Airport Parking (Canopy airport Parking, 2013) and India's Cochin International Airport, which runs completely on renewable solar energy (ScienceABC, 2015). Projects such as these, if established would also command accolades from the A.C.I. Carbon Accreditation Program for many successive years.

Incheon Airport and Haneda Airport have both embraced the sustainability by energy management, waste management, land use management, Information and Computer Technology and Human Resources (I.C.T.&H.R.) management and water management concepts and integrated these with its operations for Incheon to repeatedly win the (A.C.I.) Carbon Accreditation Level 3, for five times in a row, it has not fully embraced the concept of renewable energy, which it should. The other 3 airports are still challenged in this aspect of major sustainability operations. Their sustainability integration is limited to a one-time pilot project or small concepts that are not actually scalable to their airport application. They seem to be merely to show that a pilot project on sustainability could be performed for a few days.

All of the airports, with the exception of Changi International, did not have Minimum Climb Gradient instructions for airfield operations. This is a critical aspect to an aerodrome with obstructions and if there are any in the immediate vicinity. The inclusion of this into the published procedures for an airport, increases the predictability of the safety margin and should be encouraged.

Reporting on existing water management procedures of achievements were lacking at all airports except, Munich International. Some of these are A.C.I.-A.C.A. members and simply focusing on data for G.H.G. emissions is insufficient. Waste management and energy efficiency should also be areas that are focused on, quantified with data monitoring and reported to assess productivity and provide projections for future guides toward development. Tokyo 'Haneda' International stood out prominently with unsatisfactory data reporting for any incidence of these initiatives.

## 6. Conclusion

The analysis of the five airports should not be interpreted as a black and white issue of which airport did well or which did not. It is a guide to show what airports have been doing a good job at their operational efficiency and the reporting on this data. It also shows what specific areas need improvement in reporting or development for eventual reporting. Because it is a detached assessment it may not be completely accurate but it is accurate according to reporting capacity. From the results however, Incheon International Airport, Munich International Airport and Hong Kong International Airport seemed to be the top performers that have been maintaining a pace of airside and landside development, strategic management, support system preparedness, employee development and sustainable practices that are akin to a consistent increase in airport passenger increases, each year. It is expected that these developments will plateau, unless constant revisions are made to an Airport Master Plan and it remain a flexible, working document capable of adjusting its scope for any eventuality.

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