AIRPORT ENTERPRISE MANAGEMENT CENTRE

A Step towards an Industry Standard

AIRPORT ENTERPRISE MANAGEMENT CENTRE (AEMC)
INDUSTRY GUIDELINES WORKING GROUP

GUIDELINES - JANUARY 2018

INTERNATIONAL AIRPORT PROFESSIONAL | Community of Practice

ASI INSTITUTE
A DIVISION OF AVIATION STRATEGIES INTERNATIONAL

FOREWORD

To develop a shared perspective on the development of *Airport Enterprise Management Centres (AEMC)*, the International Airport Professional Community of Practice (IAP CoP) and the ASI Institute (ASI-I) assembled a Working Group of International Airport Professionals (IAPs) and industry subject matter experts. The result of their extensive discussions and collaboration led to the development of this White Paper as a first step toward producing industry guidelines for establishing AEMCs, a concept for common situational awareness and collaborative decision making across the whole airport ecosystem.

As you peruse the pages ahead, we believe you will find the contents informative, thought-provoking, and groundbreaking.

Please do not hesitate to share and distribute this paper among your colleagues and also send us your feedback and questions at info@iapcop.aero.

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January 22, 2018

AEMC
WORKING GROUP

These guidelines were developed by a group of airports and consultants who share a common perspective that an advanced management control centre (named an Airport Enterprise Management Centre - AEMC) is an important element of high performance airports.

The Working Group is composed of:

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In addition, we appreciate the contribution made by **David Winstanley**, Chief Operating Officer, and his team, Birmingham Airport

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EXECUTIVE SUMMARY

Many airports worldwide have moved from an operations focus to an enterprise focus. The emphasis now is on total enterprise performance (operations, business efficiency, customer satisfaction) and use of technology to enhance this performance.

In many instances, the first step along this path was the creation of an Airport Operations Control Centre (AOCC) to leverage the advantages of IT systems, optimised communication and coordination to enhance safety and operational effectiveness. Today, however, leading airports are evolving to a higher level of service by becoming "intelligent" airports, focussing on the entire customer experience and the airport's business performance. The Intelligent Airport is focused on providing real-time, on-time, fluid and seamless operations with a consistently high service levels at competitive pricing. This includes ensuring passengers have the necessary information to enable individual decision making and personalization of the travel experience.

The core of the Intelligent Airport is the Airport Enterprise Management Centre (AEMC) which integrates customer service and finance into the centre's decision-making processes, enables data sharing and provides a continuum from strategic planning, through all the functional plans to real-time operations. The AEMC serves the entire airport management team and key stakeholders.

The capabilities that an AEMC can provide include:

- Providing the ability to have a real-time common situational awareness of all aspects of the airport operation;
- Facilitating customer service management and orientation;
- Enabling predictive and fully integrated operations management and airport-wide decision making;
- Combining data from multiple systems in new ways to better manage the airport; and
- Combining current operational data with "what if?" scenarios to provide data based decision making.

The guidelines contained in this document were developed by an industry group of airports, consultants and suppliers with the perspective that by learning from each other and creating some degree of standardization, the path to the AEMC will be easier for all. Several of the participants are graduates of the Global ACI-ICAO Airport Management Professional Accreditation Programme (AMPAP).

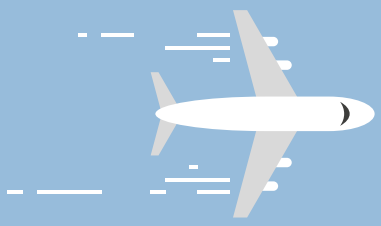
These guidelines address:

- User requirements, key performance indicators (KPI) and "Dashboard" concepts;
- Organizational structures & governance;
- Technology; and
- Physical layout

The implementation of an AEMC is a significant project and, as such, airports might consider taking a phased approach; a proposed implementation process is therefore also included in these guidelines. Of utmost importance is that the implementation of the AEMC should include the entire airport ecosystem emphasising the need for continuous consultation with the stakeholders who will be involved or affected by its implementation.

1

THE INTELLIGENT AIRPORT



INTRODUCTION

Since the emergence of the Digital Economy model around 2000, the business environment has changed dramatically. Many industries have been disrupted to the point that they have either disappeared or have had to make profound changes either through total reorganization or top-to-bottom transformations in order to survive.

The majority of these changes has come about as a result of the massive expansion and ubiquity of data along with the tools and interfaces needed to process these data. These, in turn, have enabled the development of new business and delivery models.

Airports and Change

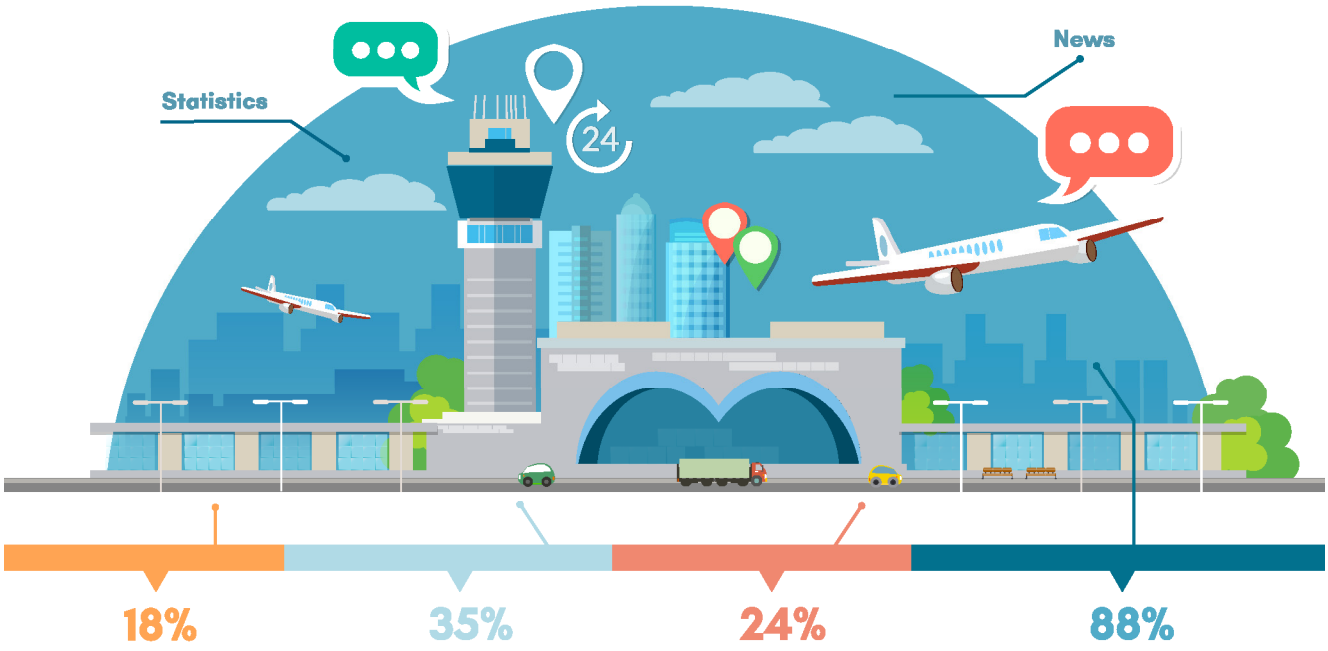
Airports have been affected by the Digital Economy as well and have begun to change, albeit at a slower pace. This is due to the inherent characteristics of the airport industry:

- **Fragmentation**; where each country, or lower jurisdictions, manage airports as largely stand-alone entities;
- **Regulation**; airports are tightly controlled environments that must abide by rigid, slowly evolving rules and recommendations;
- **Operational complexity**; airports are very complex environments that bring together stakeholders that have diverging objectives;
- **Public or semi-public control**; airports are natural monopolies and have strategic value for their owners; and
- **Constant growth environment**; air traffic is constantly growing, unlike other industries, leading to constant capacity issues which inhibit or make business model transformation difficult.

However, driven by airlines, passengers and new airport ownership models, fundamental industry changes are emerging:

- **Passengers** have not only changed the way in which they purchase air travel, but have also come to expect the level of service and control that they are already receiving in other industries;
- **Low-cost carriers** are leading traffic growth in most regions and they, above all else, value quick turn-arounds and low fees. These carriers use Digital Economy tools to drive their growth and by-pass traditional systems;
- **Super-carriers** have redefined the rules of long-haul traffic and created a new competitive dynamic between airports;
- **Privatization/Corporatization** is pushing airports to reorganize as private or semi-private business and to incorporate business objectives; and
- **Emergence of airport groups** are seeking economies of scale and greater integration.

These changes are forcing many airport operators towards the Intelligent Airport concept.



WHAT IS THE INTELLIGENT AIRPORT?

An Intelligent Airport is focused on the entire customer experience as well as the airport's business performance. The building blocks of the Intelligent Airport are predictive models and real-time business intelligence (BI) combined with effective analytics. In essence, the data available through the overall airport IT systems needs to leveraged by as many of the airport stakeholders as possible in order for the entire airport community of carriers, ground handlers, government agencies and concessionaires to more effectively plan and manage their operation.

Executives from Leidos, a provider of airport systems say,

> *"The Intelligent Airport facilitates the transition of airport operators from a real estate model to a much more inclusive and diverse revenue stream model. This means a lot more technological integration and a lot more reach back from airports to passengers throughout all phases of the travel journey. Airports are realizing they have to be service providers. They have to have quality solutions and provide the infrastructure that enables new service offerings in a manner which airlines, tenants, and passengers expect"*

The successful transition to an Intelligent Airport stance requires the BI and related services to be provided as a value to the various users. The value can only be demonstrated with implementation. As James Cherry said while he was Chief Executive Officer at les Aéroports de Montreal;

> *"Airports are the one single point where all stakeholders converge. We are working to show them the value. The trust will come as the value is realized."*

The Intelligent Airport is a data-centric model that is not about collecting or centralizing data and processing it, but rather it is about opening and sharing data with the entire ecosystem, integrating the airport's processes into those of the external players (and the data from external parties into the airport's processes) and, within compliance and operational constraints, sharing control. The core of the Intelligent Airport is the Airport Enterprise Management Centre (AEMC).

2 THE AEMC

THE INTELLIGENT AIRPORT AND THE AEMC

Many airports, governments and industry associations have initiatives underway to help the industry move towards Intelligent Airport concepts, including the European Union, Eurocontrol and ACI Europe (see Appendix A). These tend to be partial steps, with a strong focus on the Air Navigation Services (ANS) – airport interface and primarily with delay reduction or capacity management as the primary interests. Nonetheless, the amount of activity in the area of coordination beyond airside operations is indicative of the overall need to take action in this specific area.

Leading airports that seek high performance are moving towards the Intelligent Airport concept by developing a more holistic control centre that views the airport, and its entire system, as a single enterprise and that provides oversight on all the airports operational and business activities. The main drivers that are encouraging airports to move beyond a focus of coordinating operations only include:

- The need to manage a complex airport system involving multiple service providers in order to provide an integrated high-quality service to airport users;
- Traffic pressures and the need to maximize use of the airport system's physical capacity, including the management of facilities that may not be included in a traditional AOCC, such as ground access;
- The requirement for management to be regularly informed on the level of service offered to airport users and on the occurrence of irregular operations;
- A focus on continuously monitoring and enhancing the customer experience, on site and through social media;
- A growing focus on monitoring business performance, including the levels of service provided and the related return on investment;
- The increasing financial pressure for some airports that require better links between daily operations with the corporate strategy;
- The Internet of Things and the deployment of multiple additional IT systems at airports such as passenger flow tracking and queue management, single token travel, automated bag drops, etc.;
- Advances in the integration of data from multiple systems that are made easier and more affordable;
- A need to use IT systems as an aid to "corporate memory" on methods and responses as experienced staff retire and, in some countries, where there is a shortage of skilled staff; and
- The desire for cost efficiencies achievable from the integration of previously distributed coordination activities.

This broader airport coordination centre has been called the AEMC. As various airports have been developing elements of this concept independently, the AEMC has a variety of other names such as, Integrated Control Centre, Airport Command Centre (ACC), Joint Command Centre (JCC) and Airport Operations Centre (APOC).

The overall purpose of an AEMC is to facilitate the achievement of high levels of enterprise performance (operations, business and levels of service). It integrates finance and customer service into the centre's decision making processes, enables data sharing and provides a continuum from strategic planning, through all the functional plans (Air Service, Risk, Master Plan, Commercial Revenue Plan, etc.) to real-time operations. Perhaps the most significant shift in thinking that promotes the move to an AEMC is that it exists to serve the entire management team and the airport ecosystem, not only airport operations.

Exhibit 1 illustrates the progression from minimal coordination to meet regulatory requirements to the AEMC concept. The AEMC is the tool to achieve the Intelligent Airport.

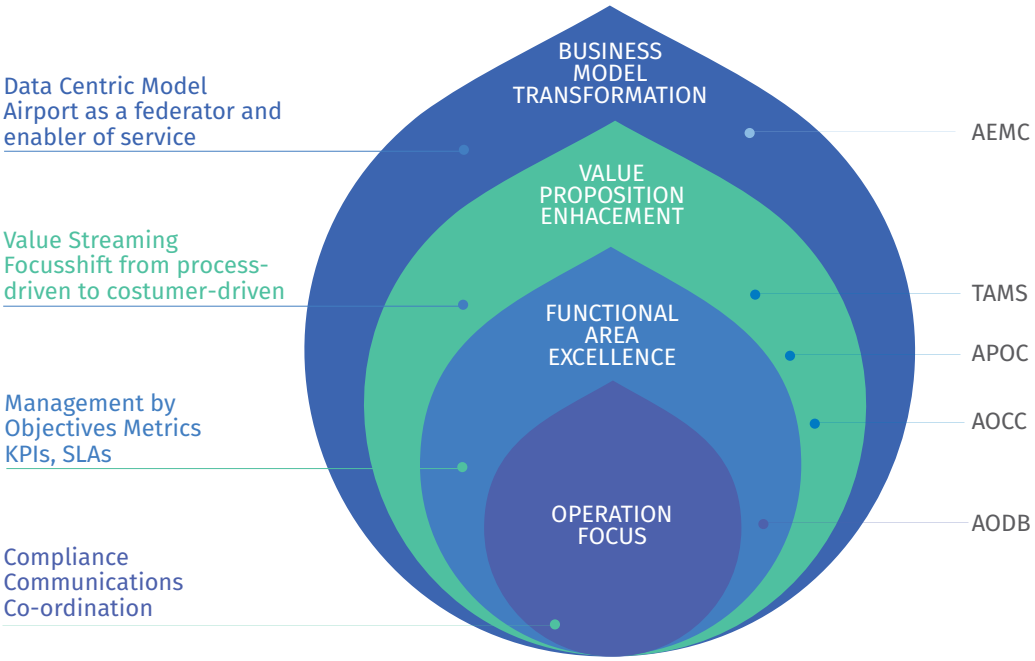


Exhibit 1. *Progression from Operations Coordination to the AEMC*

The overall purpose of an AEMC is to facilitate the achievement of high levels of enterprise performance An AEMC is intended to integrate proliferating IT systems to enhance the customer experience and efficiency in all aspects of the business. Potentially, all elements of customer touchpoints are included – parking availability/delays, queuing congestion and wait times for all terminal processes (check-in, security, concessions, government services and passenger boarding), in-terminal way-finding, availability and cleanliness of washrooms, courtesy and helpfulness of airport, airline and government agency staff, Wi-Fi access, etc. In addition, the airport uses the AEMC to manage the airport's brand by responding to inquiries and complaints and monitoring/responding to social media. Importantly, the capabilities of the AEMC will facilitate the real-time monitoring of safety, security and facilitation issues that support the adoption of a number of ICAO Standards and Recommended Practices (SARPs) (see Appendix B for a listing of relevant SARPs).

One of the key differences of this model, as opposed to a traditional AOCC, is its ability to quickly shift and move with market demand and trends. In this light, big data and business intelligence and analytics are vital elements of the AEMC. Furthermore, simulation and forecasting tools will allow airports to use real predictive data to evaluate new methods and services.

Since self-service and shared control are crucial, the simulations will enable airports to evaluate risks and opportunities and offer the best and most efficient, most profitable services before they are deployed, or modify them quickly if they do not meet targets or expectations. Sandboxing, agile engineering, and rapid prototyping will be key tools and skills that will need to be integrated into the AEMC.

Another key feature of the AEMC will be its ability to integrate with other systems through open platforms such as cloud computing and other means. This, of course, means that the AEMC will need to include cyber security as a key component.

A fully functional AEMC also requires commitment from all stakeholders to share data and information and by sharing information; it means that there will be no barriers to the free flow of data, including airline data to the AEMC.

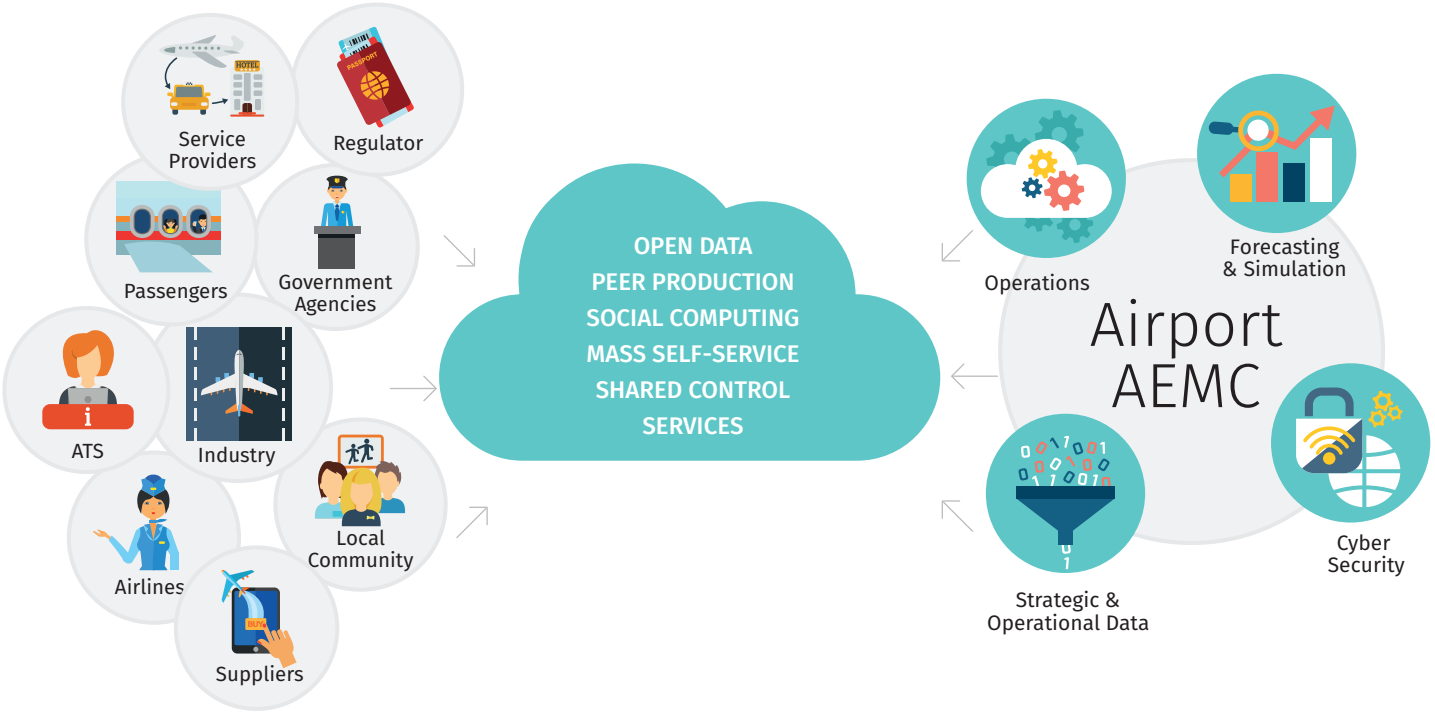


***Exhibit 2**: AEMC and Ecosystem Integration*

CHARACTERISTICS OF AN AEMC

An AEMC incorporates all the functions of a more traditional AOCC, and adds passenger services, business management, maintenance management, safety management, security management and emergency management functions into a single location bringing together all the resources and information needed to manage the airport effectively. The AEMC supports an airport's objectives to:

- Maximize safety and security;
- Maximize capacity and throughput;
- Provide a consistent high level of customer service;
- Maximize workforce efficiency;
- Proactively manage infrastructure and equipment performance and availability;
- Maximize profit through revenue maximization and expense minimization; and
- Minimize environmental impact.

The objective statement for an AEMC can be:

Through centralizing communications and streamlining the management of all the Airport's many functions, the AEMC will enhance the Airport's overall enterprise performance and improve service to passengers, airlines, concessionaires, tenant service providers, governmental agencies, other stakeholders and the surrounding community.

The AEMC Advantage

The capabilities that an AEMC can provide include:

- Providing the ability to have a real-time situational awareness of all aspects of the airport's operations;
- Enhancing customer service management and orientation;
- Enabling strong business continuity actions;
- Enhancing response to emergencies or irregular operations;
- Facilitating airport-wide decision making;
- Enabling predictive and fully integrated operations management;
- Combining data from multiple systems in new ways to better manage the airport.

  For example:
  - Combining Supervisory Control and Data Acquisition (SCADA) data on building temperature, with social media commentary on passenger reactions – "is Concourse D consistently too hot for passengers?"
  - Combining financial, operational and maintenance data, for example; the down time on passenger boarding bridge (PBB) 24 for maintenance is costing $8000/month in lost revenue.
  - Combining data from queue monitoring and other operations systems with internal Wi-Fi messaging to inform passengers of wait times and alternatives.
- Combining current operational data with "what if?" scenarios to provide data based decision making.

  For example:
  - Enabling the air service development team to insert a possible new service into the schedule and rapidly see the impact on operations and finances.
  - Enabling the maintenance team to simulate errors on systems or equipment in day to day operations to determine the optimum alternative. For example, if several PBB's are unserviceable, what is the best alternative in routing passengers or if a fixed ground power unit fails, what is the fastest, most effective solution to delivering power to an aircraft.
  - Enabling simulations "if new XY aircraft" arrives at a certain time, how will this affect capacity? Will the airport have enough ground handling equipment?
  - Running a nominal schedule from the Airport Master Plan through the same systems used for operations to assess operations impacts, gaps in capability and financial impacts.
  - Assessing the operations and financial impact of a major carrier replacing its narrow body service to the airport with more frequent commuter operations.
  - Enabling simulation based tabletop emergency or business continuity exercises using the real systems and positions of the AEMC.
  - Using the Airport Operational Data Base (AODB) and other data to evaluate route performance and to provide early warning of the possibility of discontinued service.

The value of the AEMC is that complete data sets from many functions are collected, sorted and applied to applications that can use the data ***(Exhibit 3***). It specifically eliminates "silos" in the data.

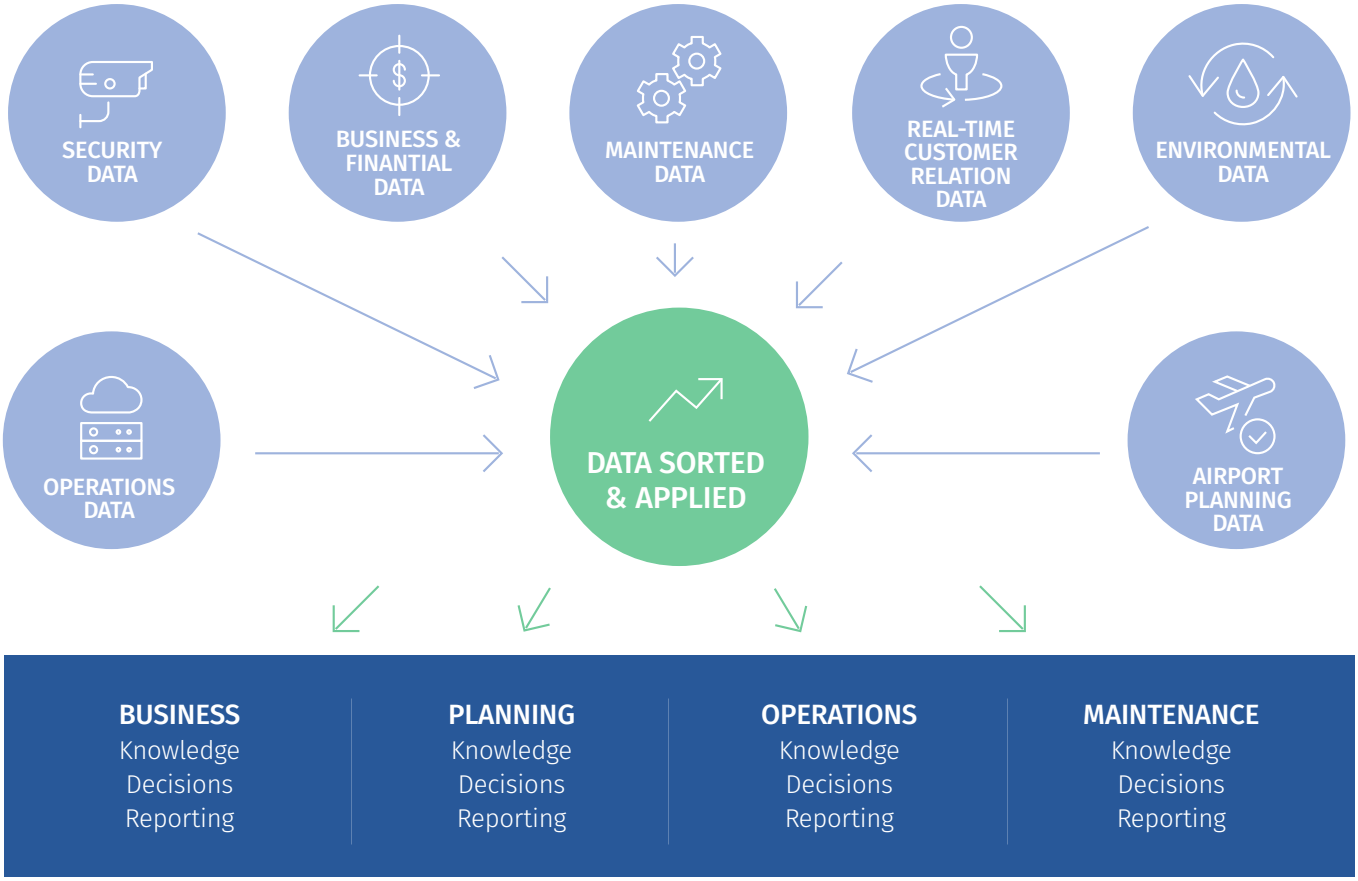


***Exhibit 3**. Airport Enterprise Management System Process*

Importantly, the AEMC approach is intended to be open-ended, in that as new data sources are available and useful, they can be combined into the system.

The AEMC provides the senior management team with relevant Key Performance Indicators (KPI) in an easy to understand way. It also includes automatic alerts on issues relevant to any of the users.

The AEMC includes management processes, enabling goals to be set and monitored, standards to be implemented, strategies to be interpreted and KPI to be monitored. Information that the AEMC provides for management in a dashboard is developed to be relevant, timely and accurate.

Administrative business functions are also part of the AEMC, with data aggregation and presentation on invoicing, revenue and expenses, point of sale information, statistical and financial reports and information that is provided to the staff and to the public.

Depending on the size and complexity of the AEMC, there may also be non-airport staff present. This allows for collaborative decision making. These other resources may include organisations such as the airport's base carrier, ground handling service providers or border services (customs, immigration). Indeed, a well-designed AEMC will have flexible positions that allow the mix to change from time to time depending on needs and local preferences.

The overall purpose of an AEMC is to facilitate the achievement of high levels of enterprise performance Wipro, a global IT provider, has been promoting a fully integrated approach for airports as illustrated in ***Exhibit 4***.

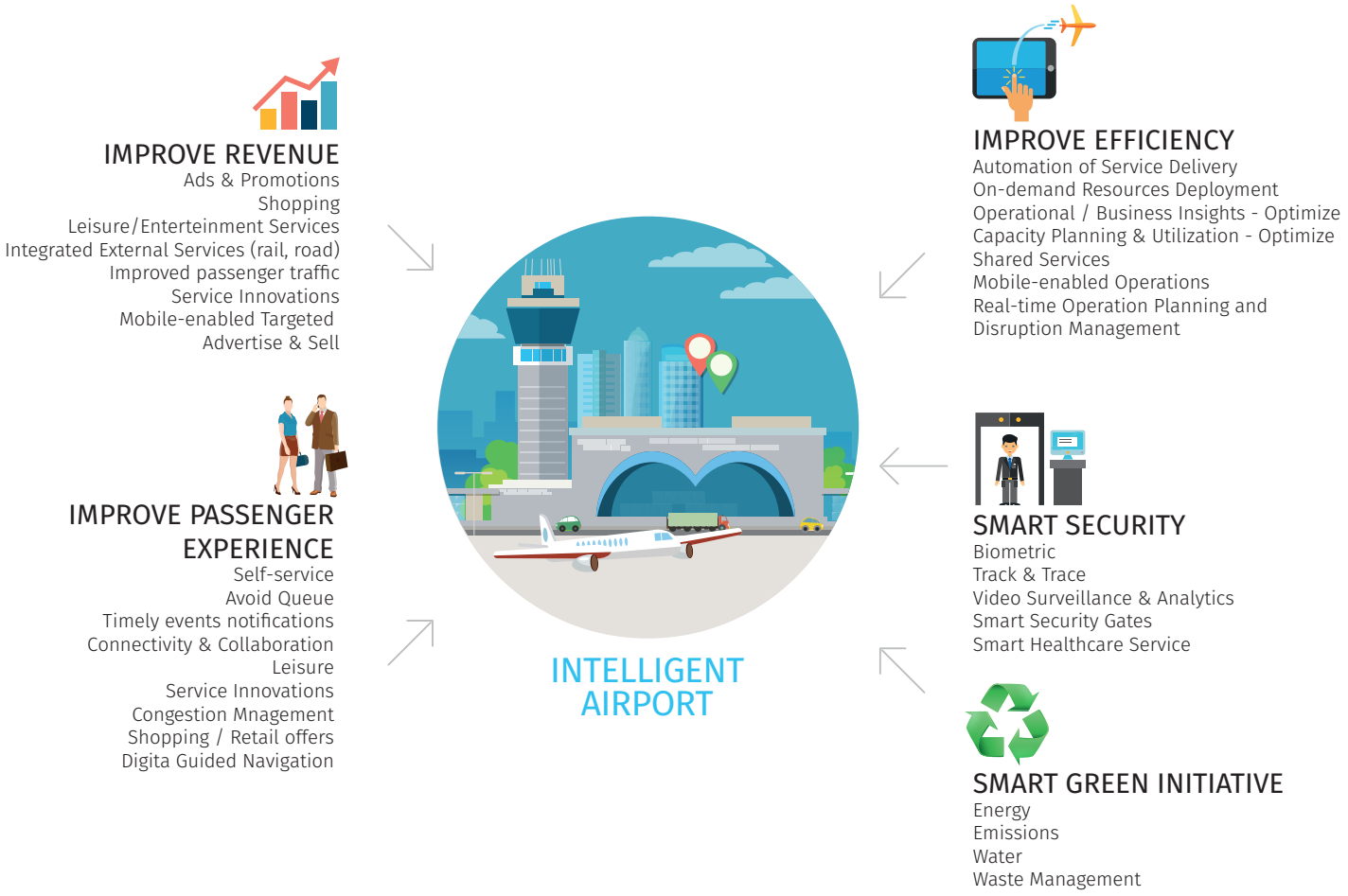


Exhibit 4. *Wipro Concept of a Fully Integrated AEMC (23)*

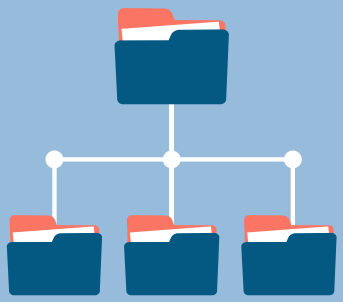
THE BUSINESS CASE FOR AN AEMC

The business case for the AEMC should be built on the incremental benefit and costs beyond the AOCC capital and operating costs. Incremental benefits are based on:

- The "Big Data" possibilities to enhance performance in all areas;
- The combination of current data with new information to provide predictive capabilities;
- The capability to incorporate new data sources in the future; and
- The common provision of information to the entire executive team, enabling a common understanding of the performance and areas that need attention in real-time.

Although the financial benefits are difficult to demonstrate in advance, some related experiences can provide insight. Siemens reports in its *Airport Control Centres of the Future (2012)* that the Total Airport Management System (TAMS) can significantly reduce flight departures with a measured 47% reduction in flight departure delays of more than 15 minutes.

3 AEMC GUIDELINES



WHY HAVE GUIDELINES?

This guideline, for the development and implementation of an AEMC, was developed to assist airport management and suppliers in the strategic planning of an AEMC by providing a recommended framework. This global approach includes a detailed review of business and operational processes, the integration of technology and the methodology to identify user requirements for the building of a modern AEMC. The proposed approach will enable airports to move from a basic Operational Control Centre to a fully integrated business management centre.

In answering the reasons for proposing guidelines, it is useful to answer four questions:

- What problems are we trying to solve?
- Who are going to be the primary users of the guidelines?
- What tasks are the users going to perform with an AEMC, and how often?
- Why now?

WHAT PROBLEMS ARE WE TRYING TO SOLVE?

A well-defined and phased standardized approach to implementing an AEMC will enable an airport to assess the benefits for their operation, determine what elements and phases best suit their operation, and rapidly develop specifications for procurement. Sharing of specifications between airports is enabled because of fundamental commonality.

The AEMC guidelines cannot start with what suppliers have in hand or what can be bought off the shelf. The recommended approach is from lessons learned on infrastructure development; i.e. that unsuccessful infrastructure projects are characterized by a failure to define the requirements prior to the start of design. Those lessons have led to a Project Definition approach, in which no design considerations are included in initially defining the requirements. An airport should decide what elements of an AEMC are the priority. However, guidelines can assist suppliers by reducing the need for customization and by having a relatively clear picture of an airport's needs.

WHO WILL BE THE PRIMARY USERS? WHAT TASKS WILL THEY PERFORM?

By definition, the AEMC is intended to serve the entire airport executive group. Although airport operations may be the most regular user, a well designed AEMC will provide a dashboard tailored to each executive, drawing on the common integrated data.

By definition, the AEMC also serves the rest of the airport ecosystem (see *Exhibit 2*).

WHY NOW?

The rapid proliferation of new systems at airports (passenger location, queue monitoring, geo location, social media - real-time customer satisfaction monitoring, single token travel) points to the need to establish the framework for the AEMC. In addition, there is a pattern of enhanced customer expectations that points to the need for every airport to be customer focused and the AEMC is one tool to assist in achieving that.
In addition, technology is becoming part of everything at the airport. Older electrical/mechanical systems are migrating to computer platforms that share network infrastructure and rely on the same systems as newer operations systems. As SDI points out (22):

> *"Not only do these systems share IT infrastructure, they now communicate with each other in ways that were never envisaged in the past. For example, in many modern Command Centres, data from both base building as well as mission-specific systems all feed into a Situation Management System that acts as a "dashboard", displaying events from many systems in the context of maps, alarms, staff and video cameras."*

The rapid growth and extensive use of social media provides airports the opportunity to monitor the customer experience in near real-time, enabling responses and actions to demonstrate commitment to customer service and to enhance the airport brand.

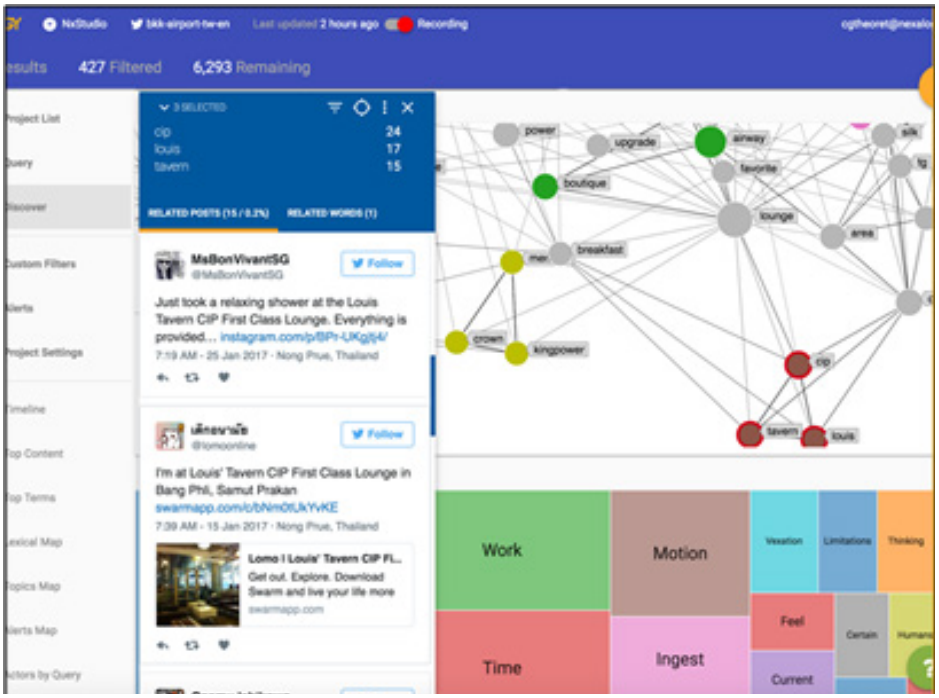


***Exhibit 5**. Example Social Media Monitoring Display (Nexology)*

SCOPE OF THE AEMC GUIDELINES

- These guidelines address: User requirements, Key Performance Indicators (KPI) and "Dashboard" concepts;
- Organizational structures & governance;
- Technology; and
- Physical layout.

USER REQUIREMENTS, KPI AND THE DASHBOARD

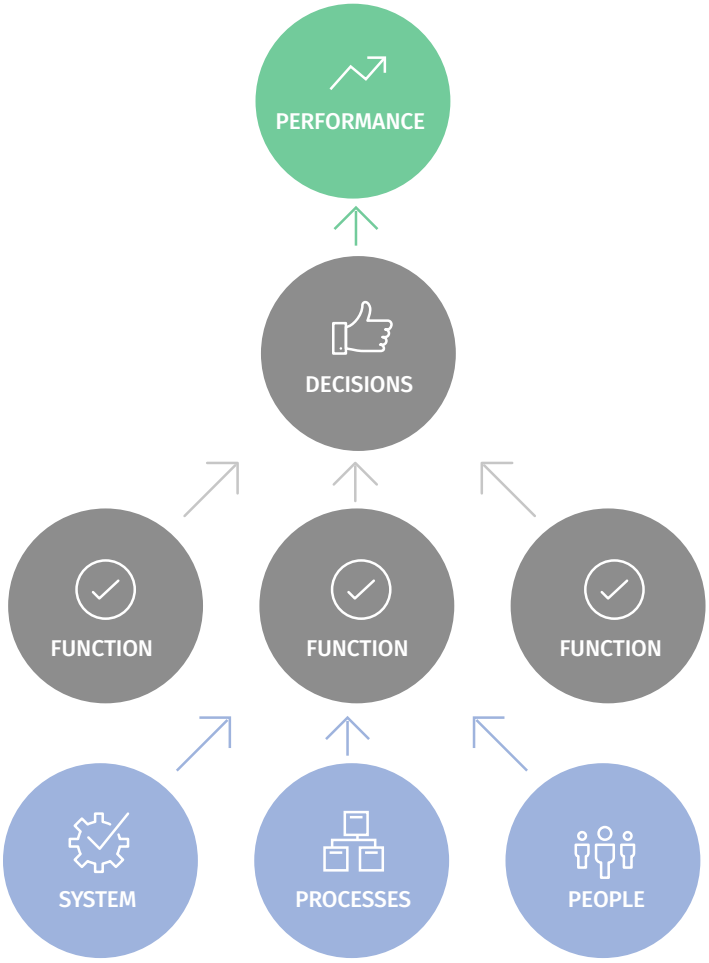


***Exhibit 6**. User Requirements and KPI*

The objective of the AEMC is to provide the management team and other participants with the information needed to meet customer service, safety and business performance objectives. It will support effective decision making by combining systems, processes and human resources.

The combining of data from multiple airport systems creates the possibility of an endless supply of information and the development of KPI. The focus must be on bringing together information needed to create valuable indicators that support the various functions. The question that needs to be answered is:

"What type of critical decisions (if any) will be better informed by the information provided by this particular KPI?"

There is a large body of work on KPI both generally in business and specifically in the airport industry with numerous studies and consultations having been conducted by organisations such as ACI and the Airport Cooperative Research Program (ACRP). Appendix C summarizes this work.

As Appendix C summarizes, there are a variety of proposals for KPI and, in reality, each airport will select the KPI that make sense for their structure and management focus.

What the AEMC does, however, by aggregating the data from all functions and serving the entire management team, is enable better use of real-time information, the ability to tailor output KPI to individual manager's interests and a much stronger ability to provide predictive or strategic information.

Exhibit 7 contains a proposed set of KPI that takes advantage of the aggregation of data in the AEMC. The KPI are presented by performance area and further sub-divided into real-time, periodic and predictive indicators. Items in black are also in the ACI KPI data set (Appendix C, Exhibit C-2). Items in blue are new items, some of which are only possible when data can be combined from multiple sources.

REAL TIME INDICATORS	PERIODIC INDICATORS	PREDICTIVE & STRATEGIC INDICATORS
SAFETY & SECURITY	**SAFETY & SECURITY**	**SAFETY & SECURITY**
FOD Event/Action Critical Infrastructure Inop. Spill Event/Action Abnormal Operations Security Breach/Resolution GSE Breakdown AVOPs Violation	Public Injuries Occupational Injuries Lost work time from Accidents Runway Incursions Airfield Incidents/Accidents Bird Strikes	
OPERATIONS PERFORMANCE	**OPERATIONS PERFORMANCE**	**OPERATIONS PERFORMANCE**
Gate Departure Delay Taxi Departure Delay Baggage Delivery Time Security Clearance Time Border Services Wait Time Taxi-in Times Conveyances Down Time	Practical Hourly Capacity	Forecast Demand Impacts Forecast Capacity Change Impacts Air Service Impacts
BUSINESS PERFORMANCE	**BUSINESS PERFORMANCE**	**BUSINESS PERFORMANCE**
Gate Occupancy Time Concession sales Concession sales/enpl.	O/D Passengers Aircraft Movements Cargo In/Out Non-Stop Destinations Pax/Employee Movements/gate Pax/gate Total Cost/pax Op. Cost/pax Aero Revenue/pax Non-Aero Revenue/pax Non-Aero Revenues % of total Debt/pax Debt to EBITDA Actual to Budget by Unit	Air Service Impacts
ENVIRONMENTAL PERFORMANCE	**ENVIRONMENTAL PERFORMANCE**	**ENVIRONMENTAL PERFORMANCE**
Energy/m2 Water consumption Spill Event/Action	Waste Reduction % Renewable Energy % Waste volume % recycle	Energy budget forecasts Demand Impacts
INFRASTRUCTURE PERFORMANCE	**INFRASTRUCTURE PERFORMANCE**	**INFRASTRUCTURE PERFORMANCE**
Availability Service levels Outstanding Work orders	Preventive Maintenance Actual/Plan Reliability Unit Maintenance Costs	Maintenance Budget Forecasts Effective Life
CUSTOMER EXPERIENCE	**CUSTOMER EXPERIENCE**	**CUSTOMER EXPERIENCE**
Gate Departure Delay On-line Complaints/Response Security Service Time Baggage Delivery Time Border Services Wait Time Holdroom Passenger Loads Social Media Monitoring Ground Transport Queue Time	Customer Satisfaction Survey Results ASQ Results	Congestion Forecasts
COMMUNITY RELATIONS	**COMMUNITY RELATIONS**	**COMMUNITY RELATIONS**
Noise Event/Action		Noise Impact Forecasts Air Service Impacts

Items in Blue are additions to the ACI KPI List in Exhibit C-2 in Appendix C

Exhibit 7. *Proposed AEMC KPI*

Some comment on the KPI in Exhibit 7 follows:

Real-time Indicators

- ***Concession Sales*** – the spreading use of passenger location systems (Bluetooth beacons, digital video, etc.) and point of sales systems means that data from individual concessions can be combined with passenger and flight data to provide data on sales by passenger destination, concession unit staffing, etc.
- ***Infrastructure Performance*** – the various infrastructure performance indicators provide real-time data on which systems are inoperative (escalators, etc.) and actions being taken, comparisons of target availability (say 99.5% for escalators) and actual and outstanding work orders on critical items.
- ***Noise Management*** - real-time indicators can be used in community relations – outlier events tracked and dealt with in advance or in parallel with public complaints.
- ***Customer Experience*** - indicators expand from the traditional indicators of delay to include real-time monitoring of customer complaints/comments and actions taken. Ground transport is added to the delay indicators.
- ***Conveyance systems*** - down time provides real-time information of when escalators, elevators, moving sidewalks go inoperative and when they are back in service.
- ***Responses*** – for a number of indicators, more than the event is required in real-time – the response to the event is also included. For example, Foreign Object Debris (FOD) events, hazardous materials spills, conveyances downtime, on-line complaints and noise events.

Periodic Indicators

- These are the more traditional indicators. A set of infrastructure performance indicators has been added, including preventive maintenance achieved versus planned, reliability/availability of systems and the related costs as indicators of life-cycle costs and the appropriate replacement cycle.

Predictive Indicators

- Like real-time indicators, the AECM should provide new capabilities in predictive KPI. By having an integrated system for periodic indicators, a predictive capability is possible for future events including new flights and changes in traffic levels.
- The impacts of these potential events on levels of service, costs, revenues, energy use, maintenance requirements and community impacts should be generated within the AECM.
- Airline routes' health and stability can be monitored to predict potential problems. The cessation of a route or the failure of a key carrier can have a major financial impact on an airport.

The list of indicators in Exhibit 7 may seem extensive, but it is important to see that each functional manager has a short list of real-time indicators. All the managers, except Customer Experience, should have a longer list of periodic and predictive indicators.

The Customer Experience manager, by definition, is focused on real-time indicators, with a very limited set of periodic and predictive indicators as customer experience should be managed in real time.

AEMC Systems

Appendix D is a nominal list of airport systems in a typical mid-size airport of ten million passengers. Data is potentially available from most of these systems to serve the AEMC. There are more data sets than are practically useful from a high-level management perspective and the approach must be to draw on systems only to serve targeted KPI.

For many of the systems, at a supervisory level, there may already be a monitoring function in place.

TECHNOLOGY

In terms of technology, the approach being implemented by Genève Aéroport is the least complicated and has the most potential to scale up as additional systems are added. Rather than any attempt to purchase an integrated system covering everything, a custom integrator "cap" is developed to pull information from various systems and combine them to provide the dashboard. The technology element of the AEMC can be viewed as a platform drawing data from a wide variety of sources and providers and translating this data into useful information for operations, management and planning.

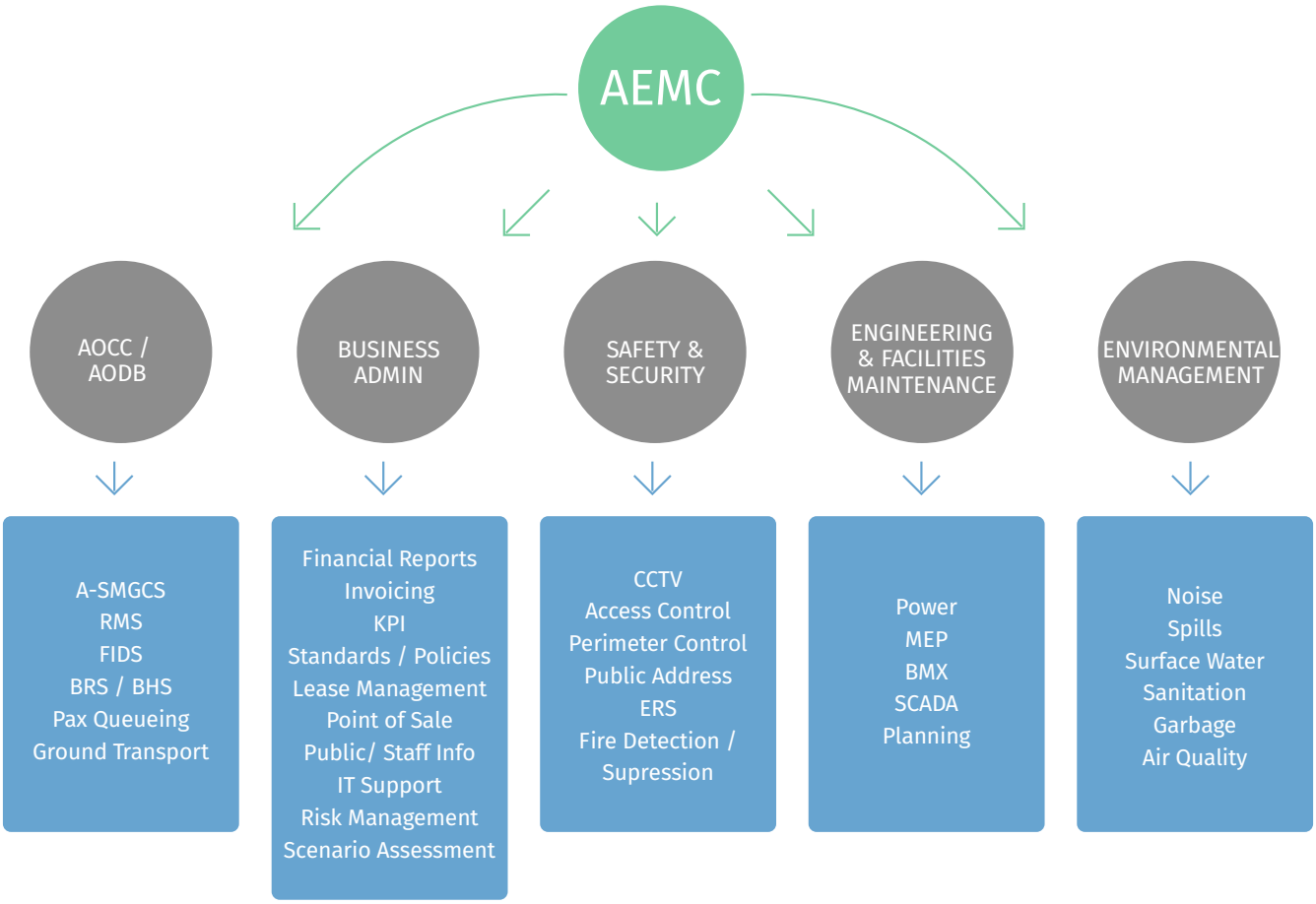


Exhibit 8. *AEMC Integrator Concept*

ORGANIZATION AND GOVERNANCE

There are three key issues in organization and governance:

- Operating principles;
- Reporting relationships; and
- Participation in the AEMC.

Operating Principles

Although each airport will have its own operational approach, the operating principles of the AEMC are:

- The AEMC must be defined as the command and control focal point for coordinating all airport resources to optimize all aspects of enterprise performance- safety, security, operations, environment, infrastructure, customer experience and community relations.
- To the maximum extent possible, considering the size and resources of the airport, every function that has a role in contributing to the enterprise performance and the customer experience should be physically represented in the AEMC.
- All functions that are important to overall enterprise performance should be part of the AEMC or linked to the AEMC in as seamless a method as possible. For example, ANS may not be physically present in the AEMC, but through A-CDM it would be continuously linked to the AEMC for a common situational understanding and collaborative approach.
- The AEMC should report to the Chief Operating Officer (COO) and execute its mandate on behalf of the entire management team.
- The AEMC must be empowered to fulfill its role with the full delegated authority to implement all operational procedures and contingency plans and, in the absence of applicable plans and procedures, use best judgment to make decisions aimed at preventing or troubleshooting operational incidents in an optimal manner.
- The AEMC should be staffed with the appropriate specialist in each of the performance areas, supported by analysis capabilities to develop predictive messages and IT resources.

Reporting Relationships

The most likely reporting relationship is for the designated Enterprise Manager to report to the Airport Chief Operating Officer (COO). The Enterprise Manager is responsible for:

- Managing data and systems to provide each of the line managers in the AEMC the support that they need;
- Coordinating decision making;
- Ensuring that data and knowledge is shared to support a common understanding of performance; and
- The management and functioning of the centre, analytical support and possible future enhancements.

The Enterprise Manager (at some airports) may be the COO. Each participant in the AEMC reports to their functional manager. For example, the Duty Manager (AOCC) reports to the Vice President Operations and the Immigration representative to his/her Immigration Manager. Although this may sound complex, it is a typical matrix organization structure. However, the numerous participants and complexity of the relationships points to the need for a Management Charter for the AEMC that would define operations.

Participation

Airports are moving to the AEMC approach to take advantage of IT and to overcome the natural tendency towards “silos” in organizations. As stated by Ashford and Coutu:

> *“… optimization of the individual parts of a system rarely leads to optimization of the system as a whole. In this context, the airport enterprise, as landlord of the premises and the holder of the aerodrome license (i.e., certification), must exert decisive leadership to ensure that all activities are managed in an integrated manner to deliver performance, safety, and security for all users. In so doing, it must secure the active support of all stakeholders.” (10)*

The impact of the physical presence of stakeholders cannot be underestimated. A problem that can be

seen as somebody else's problem is more difficult to overlook when you are with people you work with every day in an AEMC environment.

For example, at one airport the Immigration staffing shift change is in the middle of the daily traffic peak and results in the Immigration desks closing one by one as officers' change out. Queues build up and fill the Immigration Hall in this period and subsequent queue time for service can be up to 45 minutes. It has been like this for 20 years or more. In an AEMC environment, where the Immigration Manager is working with colleagues in airport operations and air carriers, it is much more difficult to let this type of situation continue.

The caveat for participation is that not all airports can afford the human resources and the facility infrastructure to support a large centre. The need for a complete AEMC and the resources to support it will increase with airport traffic levels. ***Exhibit 9*** proposes representation in the AEMC as a function of airport size. This table is intended to be a suggestion only. Although operating in a common location is an excellent practice, each airport will determine the organizations that will participate in the AEMC based on local objectives, conditions, constraints and operating methods.

Whether co-located, or remotely connected, the critical focus is common situational awareness (or what NATO calls Common Operational Picture – COP.

The decision on physical presence in the AEMC The decision on physical presence in the AEMC should be based on operating principles relating to the following questions:

- Is it needed for common situational awareness?
- Will it contribute to sharing problems, identifying with problems and solving problems?
- Are informal rapid exchanges important?
- Will it enhance coordination during disruptions or irregular operations?
- Will the position be a decision maker and not simply a conduit to a decision maker?

The AEMC also includes a supporting analysis function. This function is particularly useful for the analysis and development of the strategic and predictive indicators and for identifying how existing and new data sets can be deployed to maximum benefit. Upon request, support team members should be able to sit with operational functions to help solve issues. Therefore, the support team should be located near operations and additional available workstations should exist in all operation sections.

A valuable test for presence in the AEMC is that there should be enough positions to host all those expected to be named under certain irregular conditions.

LESS THAN 5 MILLION E/D	5 TO 10 MILLION E/D	MORE THAN 10 MILLION E/D
Airport operations Ground handlers De-icing control Work order Control (Eng./Maint) Security Duty Manager	Airport Operations Ground handlers De-icing control Work order control (Eng./Maint) Security Terminal Duty Manager	Airport Operations Ground handlers De-icing control Work order control (Eng./Maint) Security Terminal Duty Manager
	Passenger experience manager Major carriers Air navigation services Technical services (IT) Resource allocation Border control (govt. agencies) Analysis & new applications	Passenger experience manager Major carriers Air navigation services Technical services (IT) Resource allocation Border control (govt. agencies) Analysis and new applications
		Finance & Admin Meteorology Key concessionaires

Exhibit 9. *Participation in AEMC as a Function of Airport Size*

DESIGN GUIDELINES

An AEMC requires significant space and serious consideration to design in terms of layout and ergonomics. As an AEMC is expected to have more participants than an AOCC, airports that currently have a basic AOCC may need an enlarged area and re-design to develop the optimum AEMC.

Proposed design elements for the AEMC include:

Functional Requirements

- Access to critical information in visual and audio formats;
- Access to SITA messages;
- Intelligent and interactive software with information capturing/ dissemination systems integrated into a high performance decision-support system enabling real-time, periodic and predictive management;
- Communication systems that take advantage of mobile audio and video capabilities to improve enterprise performance;
- Advanced ergonomics for all command and control positions and a layout that enables status-display walls, contiguous rooms for related analytical and IT support functions, and emergency management;
- Flexible work stations and flexible overall layout;
- Sufficient space for support infrastructure, including a data centre. An AEMC requires considerable computing capability and a suitable computer room, with appropriate air conditioning, power, security, etc.;
- Access to terminal simulation software to enable “what if” scenario assessment;
- Access to fault simulation software for airport systems and equipment; and
- Access to environmental monitoring stations (noise, emissions, surface water).

Physical Assets

- Landline and cellular network access;
- Direct link to ATC;
- Links to the access control system for monitoring/ control;
- Airport electronic maps – layout plans, surrounding areas, Master Plan future layout maps, emergency plan map;
- Digitized aerial photos of the airport and surrounding areas;
- Airport facilities database including digitized floor plans of buildings;
- Airport operational database;
- Audio and video recording system;
- Baggage information display system;
  Closed-circuit television system with coverage of movement areas and the Passenger Terminal
- Building (PTB);
- Computerized airport operations log;
- Critical equipment-monitoring system;
- Flight information display system (operational and public channels)—arrivals and departures;
- Intercom and hotlines to strategic units and locations;
- Master clock;
- Operational, maintenance, security, and emergency telecommunication systems;
- Public-address system;
- Television screens with cable;
- Uninterrupted power supply;
  VHF air-ground transceiver;
- Resource Management System (RMS); and
  Fire alarm system for monitoring/control.

The organization and layout of the AEMC are based on the operational objectives to be achieved. The main premises are usually:

- Operations room, or supervision room;
- Meeting room and visitor's room;
- Crisis/ emergency management facilities including situation room, communication cells and other facilities;
- Support Team room;
- AEMC Management offices;
- Interim offices for stakeholders;
- Kitchenette and rest area;
- Toilets; and
- Technical rooms for servers, networks, HVAC, etc.

Exhibit 10 is a nominal configuration for a 30 million passenger airport.

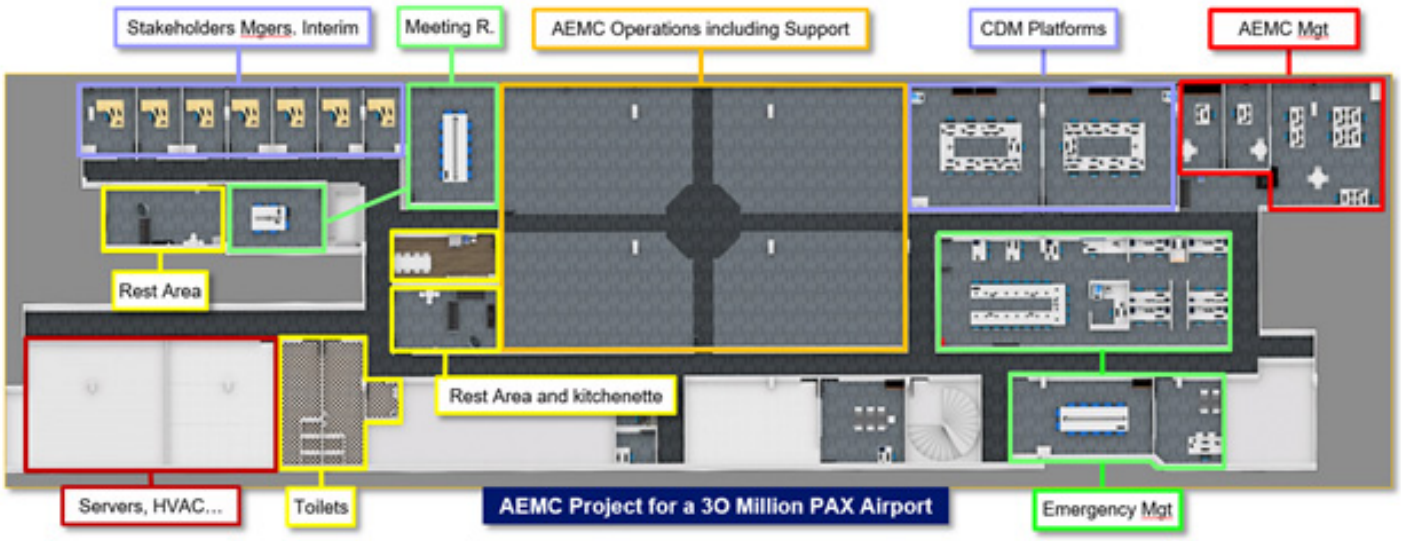


Exhibit 10. *Example AEMC Configuration for a 30 million Passenger Airport (Pixys)*

An AEMC requires significant space. In this example, the operations room encompasses four operations poles arranged around a central coordination place. Each pole has workstations for operators and support and a collective display (video wall). Small workspaces are provided to accommodate small collaboration meetings. Sound-insulated communication spaces are used to deal with noisy communications. The layout of the operations room is made according to a simple and readable geometry.

The overall AEMC space requirements will vary from airport to airport based on objectives, physical presence, space availability, etc. In the 30 million passenger example in Exhibit 10, the overall AEMC area is 1,600 square meters or 17,200 square feet. A preliminary estimate of AEMC area requirements as a function of airport size indicates that:

- For airports with traffic less than 5 million passengers: 300 – 500 square meters or 3,200 -
- 5,400 square feet;
- For airports with traffic from 5 to 10 million passengers: 500 – 800 square meters or 5,400 - 8,600 square feet; and
- For airports with traffic greater than 10 million passengers: more than 1,000 square meters - 10,700 square feet.

At 2017 prices, the workstation build-out and equipment and video displays will average approximately $3,000 to $5,000 per square meter, exclusive of the floor space costs.

The location of the AEMC requires careful consideration. A view of the airfield is normally required for the Emergency Operations Centre. So, if it is co-located with the AEMC, then an airfield view is recommended for the AEMC. Otherwise, apron, taxiways and runways video views should be provided on AEMC video walls and, when necessary, on operator's workstations. From a strictly productivity perspective, an exterior view is preferable.

The premises should be located in a secure area. Access to premises should be secured, but it should also be easy for external authorities and stakeholders to access in the event of a crisis.

Special attention must be paid to the ergonomics of the AEMC:

- The levels of illumination should be thoughtfully designed, with devices of circadian variations for the adaptation of human physiology to variations of natural light;
- HVAC must be treated with care so as to ensure optimum comfort;
- Noise and noise pollution are major disruptions.
- The use of telephone and radio communication inevitably results in an increase in noise levels.
- The premises should be adequately soundproofed to minimize speech interference with steps taken to minimize the noise levels of equipment (HVAC, computers, video walls, etc.). The use of noise level indicators may help operators become aware of their own contribution to noise levels.

Noise Level Indicator

Workstation Ergonomics

Workstation ergonomics is one of the major challenges of the design phase. Operator's workstations are often over-equipped with computer equipment and video screens, creating decision making problems due to a lack of information hierarchy and cognitive saturation.

Workstation applications are operations legacies, office tools, external applications (e.g. weather), platform performance indicators applications and video (see Appendix D: Table of Airport Systems). In today's airport workstations the average number of applications is 10 to 15 per operator, while an ideal ergonomic workstation is a simple workstation, comprising a keyboard, a mouse, 2 or 3 screens and communication means.

The implementation of an ergonomic workstation involves rethinking information systems in a contextual approach, in order to offer operators the resources that they need according to their operating context. The objective of this approach is to obtain totally versatile workstations that will present the mix of information and applications required according to the profile of the operator and the tasks that they have to perform. This approach also makes it possible not to be constrained by the location of technical resources on operator's workstations, guaranteeing flexibility of the organization and scalability.

Courtesy of Pixys

Exhibit 11 shows the operator workstation of Nice Côte d'Azur Airport baggage handling system. The partial views of seven different applications are integrated on an ergonomic workstation comprising three screens, a keyboard and mouse. Depending on its operating context, the operator calls the display combination they need and interacts with the applications, as if they were in front of their old workstation. The central part of the workstation is dedicated to the main interactions with the operator. The side parts present the necessary information syntheses in the form of dashboards. Application integration is non-intrusive, using software designed specifically for these functions.

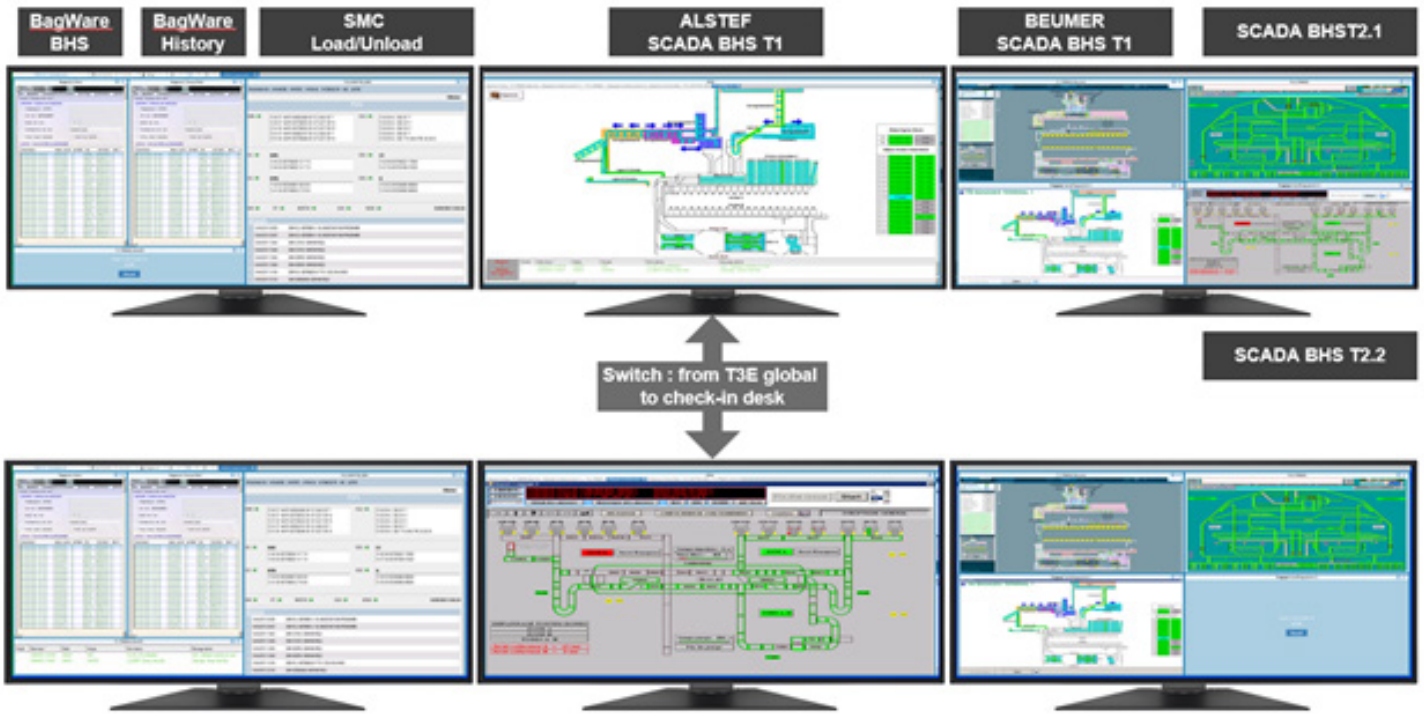
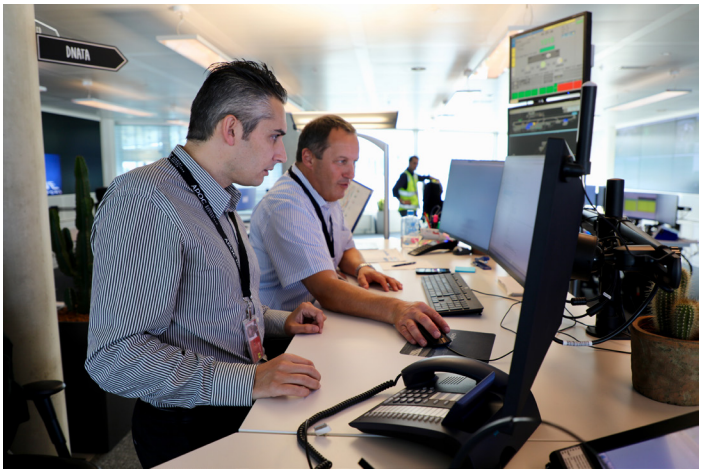


Exhibit 11. *Nice Côte d'Azur Airport Baggage Systems Workstation (Pixys)*

Traditional workstations in which the operator sits in front of a multitude of screens and equipment prevent the development of collaborative working relationships. The sitting position creates a sense of space ownership and the use of armchairs complicates the simultaneous presence of two people.

Collaboration at ADM workstation



Courtesy of Genève Aéroport

The use of sit-stand workstations reduces the distance between operators, developing new forms of relationships in which people feel equal in front of the screens. The use of working positions of this type allows an active dialogue around the data which are visualized simultaneously. Problem solving becomes faster and more efficient.

Workstation ergonomics is one of the major challenges. A key focus in the design of the AEMC is that the functions and systems that we have today and want to be part of the AEMC will very likely change in the future. Flexibility and growth must be a constant feature as the design progresses. The average lifetime of an AEMC will be approximately 10 years. The original vision that supports the design of the AEMC must be able to evolve over time, without questioning the initial fundamentals. Therefore, the design must offer flexibility, scalability and agility. Pressures for change will come from traffic growth, changes in regulations, competition, new potential revenue sources, etc.

Example Layouts

Layouts of advanced AOCC or AEMC concept from airports that are moving in the AEMC direction are included below in ***Exhibits 12 to 16***.

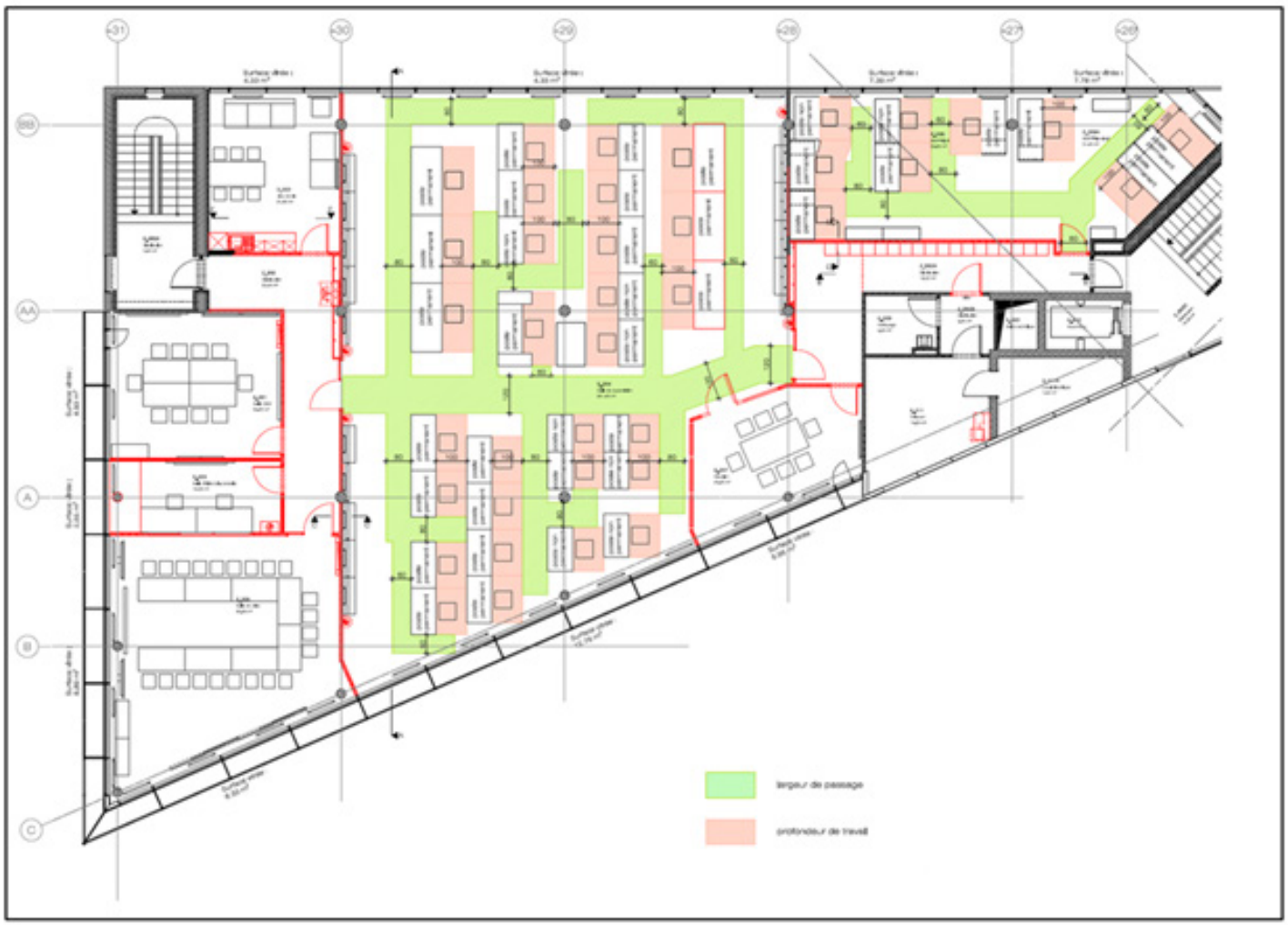


Exhibit 12. *Genève Aéroport AOCC/AEMC*

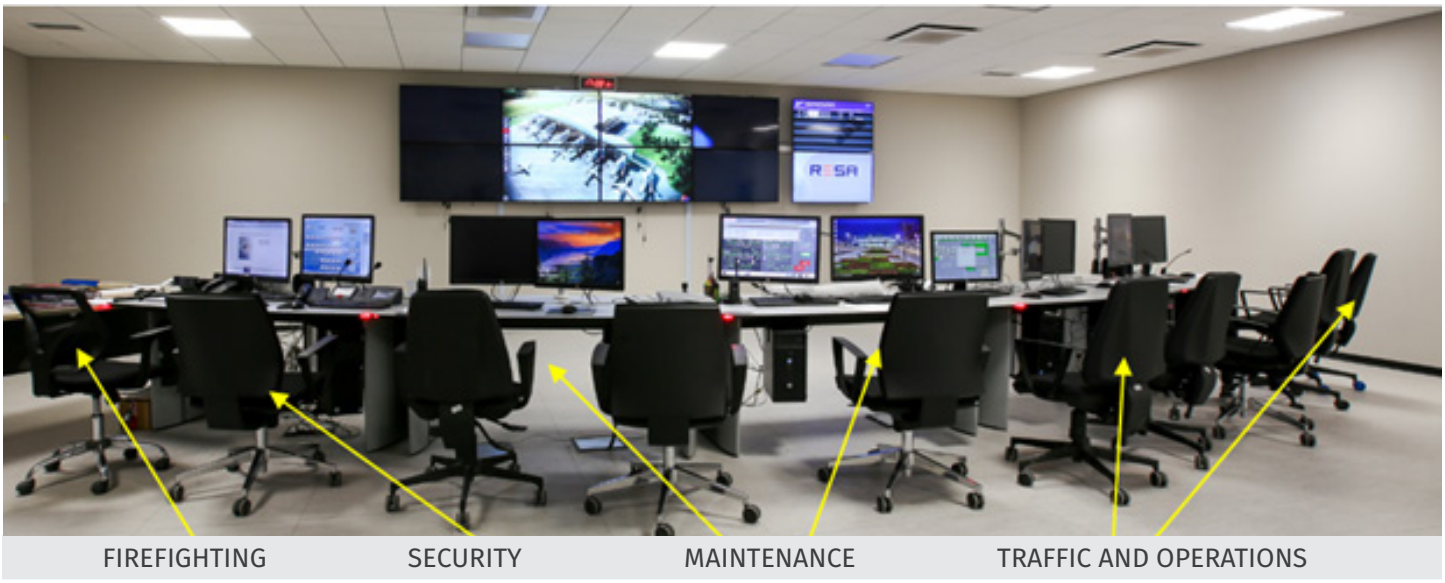


Exhibit 12. *Zagreb International Airport AOCC, Croatia*

Exhibit 13. *Beijing Capital Airport AOCC/AEMC, China*

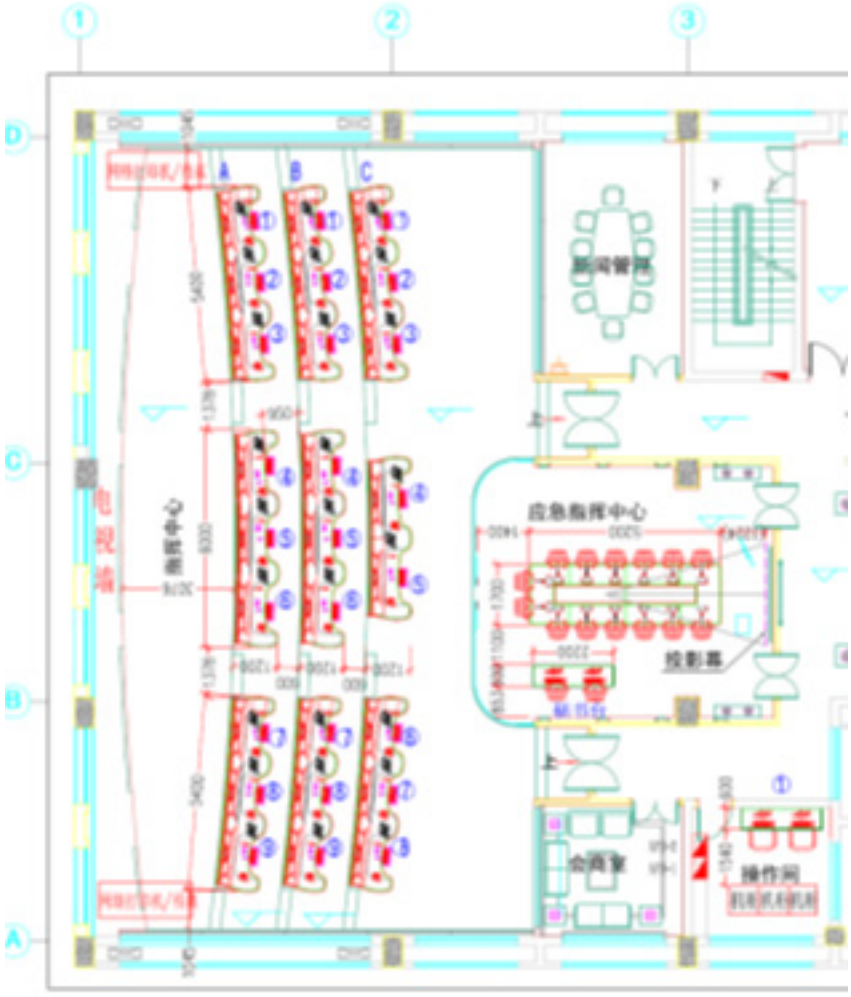


Exhibit 14. *Hangzhou International Airport AOCC/AEMC, China*

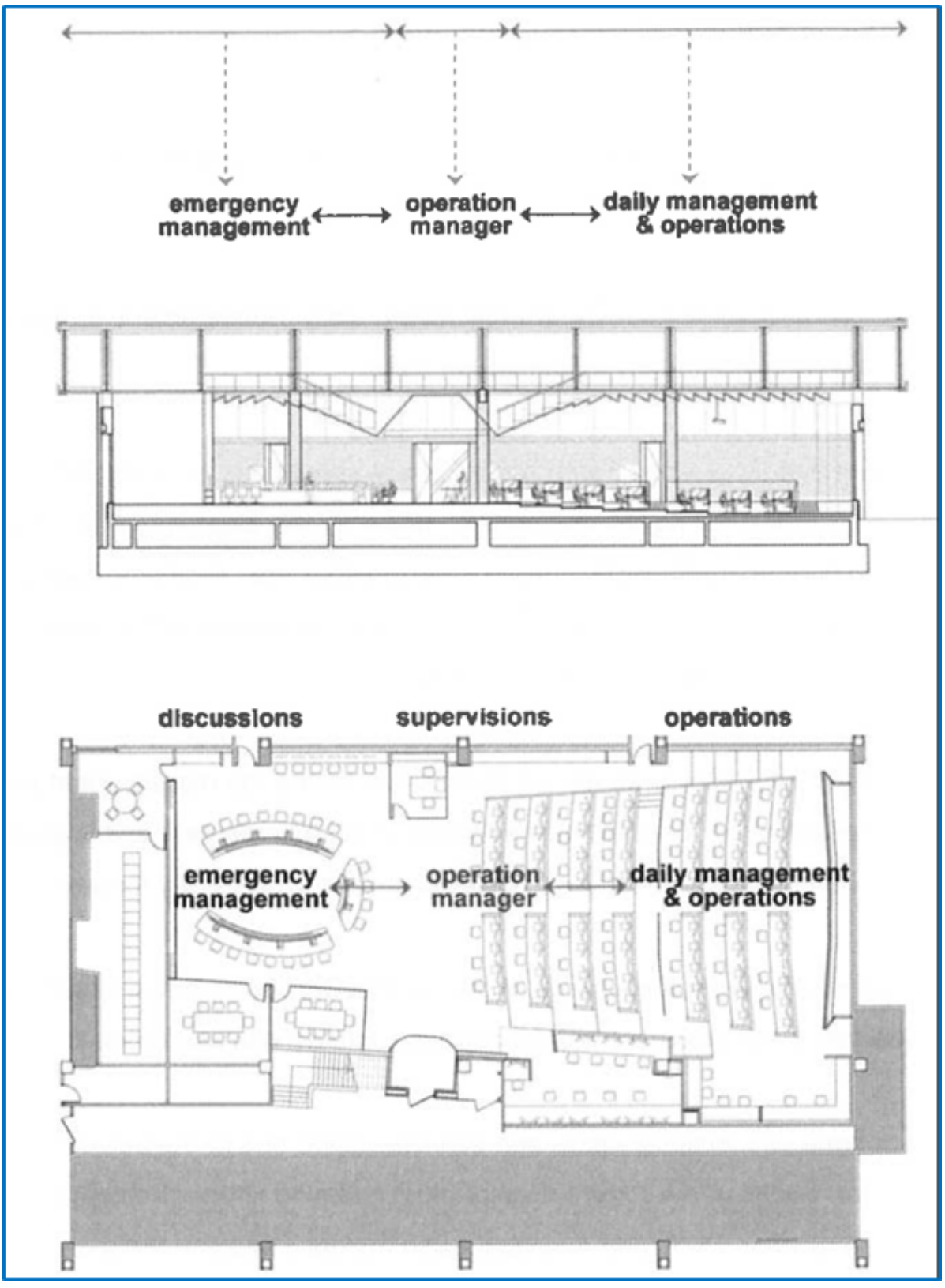
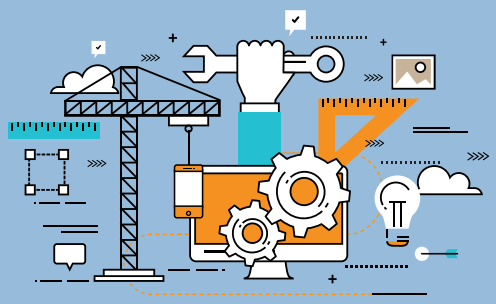


Exhibit 16. *Hong Kong International Airport AOCC Section and Floor Plan*

4 IMPLEMENTATION



Implementation of an AEMC is a significant project and many airports will likely take a phased approach. The framework, however, needs to be established early in the process so that all parts fit together when complete. The initial questions to be answered are:

- What are our business drivers for creating an AEMC? What are the expected benefits? How will we evaluate success?
- What processes that we use today should be changed and optimized before integration?
- Who will be the primary users of the integrated information flow?
- In the physical AEMC, who needs to be in the centre – all the time, in emergencies?
- What technologies will be needed?
- What is the optimum mix of human resources and technologies?
- What will the ultimate layout and size be?
- How can scalability be ensured as new technologies are added within the airport and traffic continues to grow?
- What is the optimum phasing for implementation?
- How will the impact of transition to the AEMC concept be managed?

The implementation of an AEMC is a complex task that will require a shift from traditional models. Exhibit 17 illustrates an implementation process. Each of the steps in the exhibit is described below. Importantly, implementation will involve the whole airport ecosystem and continuous consultation with the stakeholders who will be involved or affected should be a part of every step.

1. DEFINE OBJECTIVES

The AEMC must serve the Vision and strategy of the airport. The airport's management team should develop a long-term vision and plan based on a multidisciplinary understanding of the Digital Economy model, its related technologies, as well as its own analysis of its constraints, its particular ecosystem, and the future of its business.

2. DEFINE FUNCTIONS

Defining the functions of the AEMC involves all the stakeholders. It may take some time as the various stakeholders engage and overcome the natural tendency to adopt silo thinking. A well-defined concept of operations (CONOPS) should be the outcome, along with fundamental governance issues.

The functions may be layered into core and value added, with a phased approach to moving beyond the core.

3. MAP AND REFINE PROCESSES

Existing processes that are part of the functions being proposed for the AEMC, whether manual or digital, require mapping. This is also the stage to question the efficiency and effectiveness of these processes. Is there a better way? Does automation or new technologies enable a new, faster, simpler process?

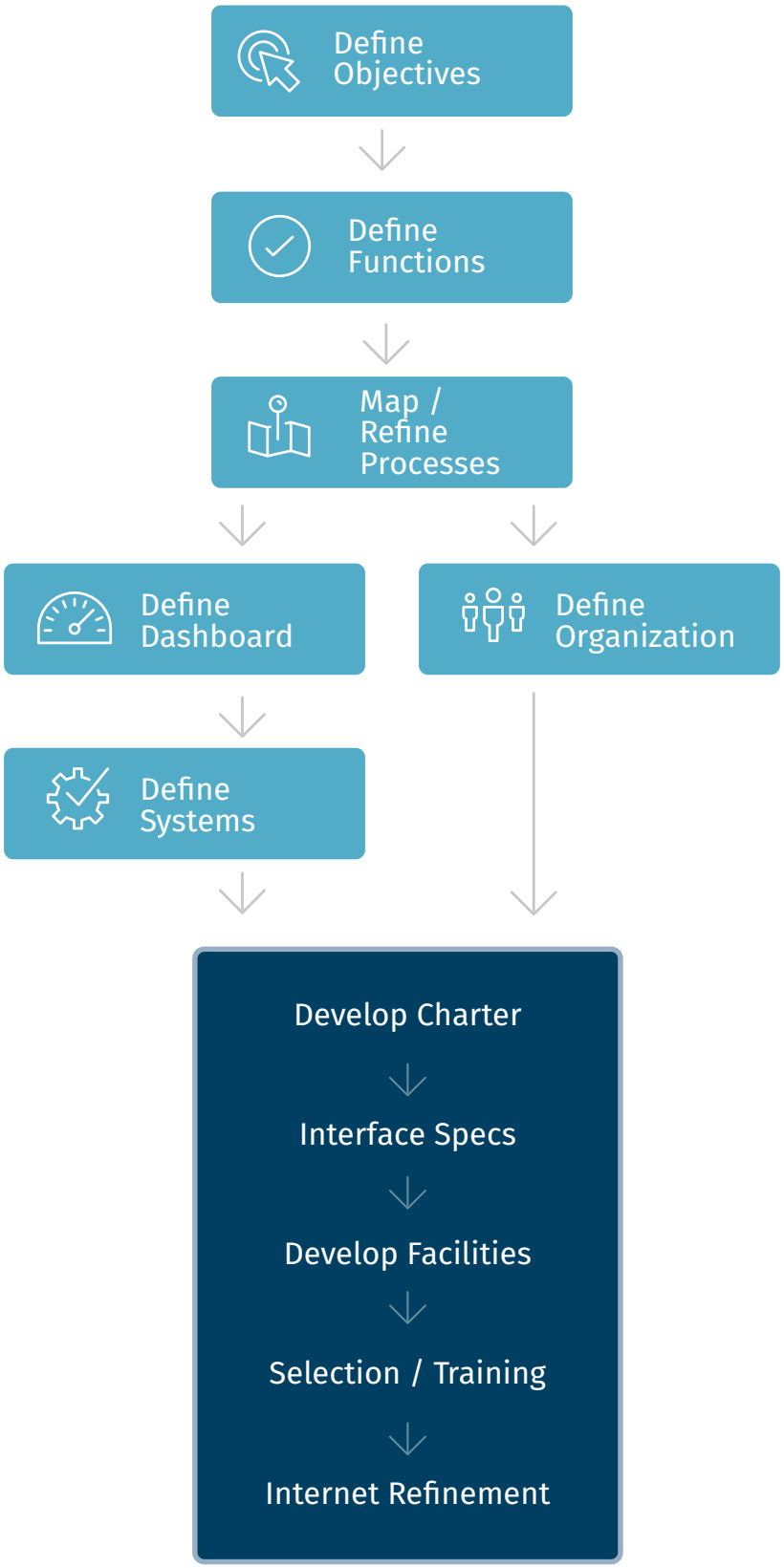


Exhibit 17. *AEMC Design Process*

4. DEFINE ORGANIZATION

With the functions and processes defined, the organization of the AEMC can be developed. Once the organization concept is developed and has stakeholder support, the second part of this step is mapping how to get there. What is the change management approach that will be needed? Will the organization be built in phases?

It should be anticipated that the proactive involvement of the airport management team at all levels will be needed throughout the process. The management team must map out the start and end points of the journey, communicate them clearly, and ensure that they have the right skill sets and people. They may need to look outside to mix internal experience with external players who have had first-hand experience with disruptive technologies and implementation.

Ultimately, this step should include a clear identification of who will perform the tasks, with what data, and with what other workstation requirements and training.

5. DEFINE DASHBOARD

In this step, it will be necessary to determine what KPI, what data and what analytical capability are needed to meet the objectives of the AEMC. What will be displayed? Who will view it? Who controls it?

6. DEFINE SYSTEM

The systems needed to serve the dashboard should be defined, considering the revised processes. Are these in place today, are new systems needed? Is only an integrative “cap” needed to tie together existing systems?

For the AEMC to be successful, airports must become a trusted and pivotal platform that enable their partners and customers to carry out their tasks and services efficiently and cost-effectively. The natural evolution of this requirement is that airports should provide common Information Communications Technology (ICT) infrastructure and a platform to all of their partners, as well as some of the applications needed to manage the airport’s operations and to comply with its regulatory mandates. This platform approach will:

- Enhance the level of service provided to users;
- Lower user costs;
- Increase commercial revenues;
- Optimize data sharing; and
- Enhance cyber-security and business continuity.

The platform should be open and flexible so that the partners may implement their own applications and services within it. This will ensure that the airport is the ultimate custodian of the system’s security, both from the IT and human perspectives. As progressively more complex systems are in place, the airport will start behaving more like an ICT service provider and should provide services structured along those lines, as illustrated below.

The aviation industry is not the first to go through this transformation process and there are many tools that will help manage and master the journey. Some of these tools are already being used to a certain extent in the industry, but their reach and scope must typically be extended. ***Exhibit 19*** is a suggested list of some of these and the context in which they can be used.

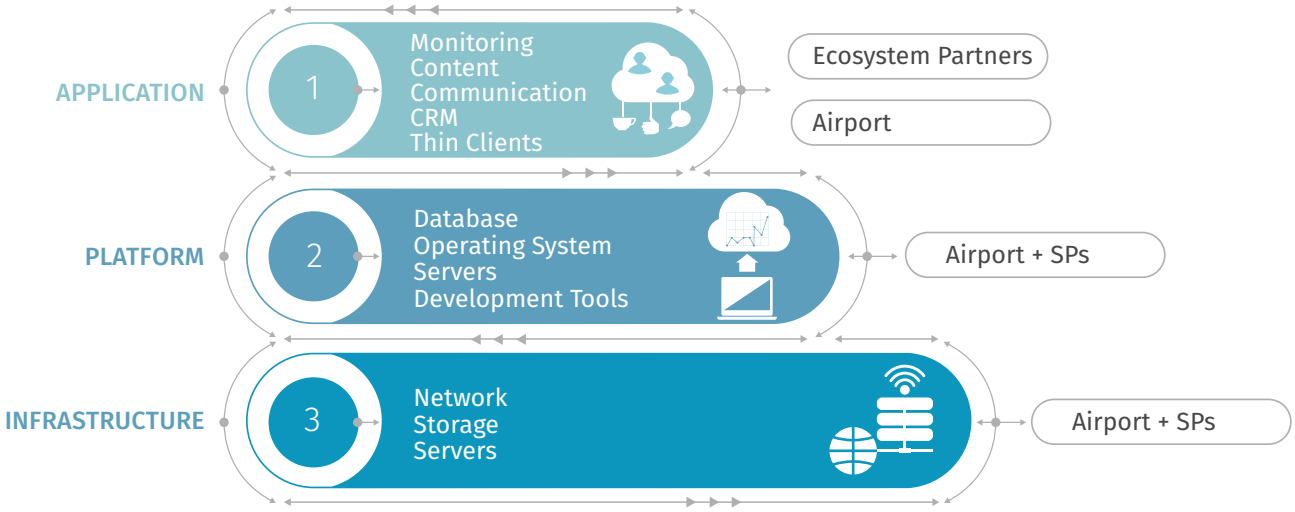


Exhibit 18. *Airport ICT Architecture*

TOOL/DISCIPLINE	PURPOSE	COMMENTS
Six Sigma/ISO 13053-1:2011	Methodology for business process improvement	Comprehensive tool to analyze and understand the business that leads to the identification of real value streams based on customer expectations
Lean Management	Method that looks at waste minimization while improving productivity	Focus on process flow to eliminate waste. It also focuses on rapid adaptation and change.
Kanban/JIT	Just-in-time method focuses on getting the right goods/services at the right time to optimize asset/facility utilization and eliminate delays and rejects	Real-time data-driven, JIT forces very close integration with the ecosystem partners. High degree of flexibility for in- or out-sourcing of services/goods.
Kaizen/CIP	Continuous or breakthrough process improvement method	Kaizen is a bottom-up approach where changes originate from the on-site staff. It fosters a high degree of ownership.
Agile Management	Iterative, incremental method to design and build new products and services focused on communications and non-hierarchical relations	Based on breaking down large tasks into 2-3 week cycles with frequent scrums and feedback loops and multiple deliveries
Rapid Prototyping	A group of techniques originally used in the manufacturing industry to quickly produce rough models to validate and refine products or services	Widely used in cloud computing to validate outputs and cycle through various versions to improve the output. Emphasis is on speed.
Business Intelligence	Set of strategies, methods and tools used to support data collection, analysis and benchmarking. Supports decision-making trough analytics, forecasting, and simulations.	Uses data warehouses or cubes to isolate data so that it may be analyzed to facilitate simulations and predictions

Exhibit 19. *Tools Available to Assist the Transformation to AEMC*

7. DEVELOP CHARTER

The airport team will need to integrate itself into its wider ecosystem. The main requirements here will be the sharing of data and decisions, as well as more integrated strategic planning with the ecosystem partners. This will be done via ICT means (data, communications) as well as enlarging the mandates of the various working committees that are already active at most airports. The ecosystem also consists of passengers for whom social media and self-service tools are key components, and these must become central elements in this architecture.

Development of a Charter is an essential part of reaching an understanding on the AEMC operations prior to making investments in new facilities. The Charter will define:

- The objectives and methods of the AEMC;
- Organization structure;
- Functions;
- Operating principles and decision making processes;
- An operational concept for each position;
- Situational awareness;
- The data input from each stakeholder and any limitations on the use or dissemination of the data;
- Data distribution and data protection;
- Key performance indicators;
- Reporting relationships and coordination for day to day operations;
- The reporting relationships and coordination for irregular operations and for emergencies;
- Mechanisms for the AEMC participants to deal with new data types; and
- Establishment of an AEMC user group to work on enhancements, resolve issues.

8. DEVELOP INTERFACE SPECIFICATIONS

The human-IT interface will be critical to the success of the AEMC. Data and analysis must be provided to the appropriate individual in a method that facilitates understanding.

9. DEFINE SYSTEM

Implementation of the AEMC is an opportunity to get the layout and ergonomics right. Again, flexibility is important. Workstations should be completely flexible with the data and programs provided at any one station linked solely to the logon of an individual's profile. Simply, we do not know who or what functions we will want in the AEMC 5 years from now.

The development of design options and a review of these options with stakeholders is part of the process of reaching a common commitment to the AEMC. Time spent on engaging the future participants will pay off in terms of the speed of adapting to the AEMC. The alternatives should be evaluated against agreed upon criteria. The use of detailed simulations will enable stakeholders to fully understand the layouts and any related issues.

Courtesy of Genève Aéroport

10. SELECTION AND TRAINING

The personnel assigned to the AEMC will be filling the positions agreed to in the Charter. The early stages of the AEMC may require some skills in terms of adaptability and cooperation. These could have an impact on the individuals assigned to the AEMC.

Training will be required for all participants. Training should cover such things as the basics of day-to-day operations, irregular operations (IROPS) and emergencies. Simulation tools, integrated into the AEMC, will enhance training. Geneva has included a change management process to ease the transition.

Regular newsletters
Information wall
Information sessions

Technical training (IT systems and tools)
Theoretical training (Organisation, operations and CONOPS)

Assitance by ekey users for the integration of new staff

11. INTERNAL ORGANIZATION AND PROCEDURES REFINEMENT

As the participants in the AEMC work together and develop information solutions to problems that arise, it is very likely that changes may be needed in procedures and in the organization of the AEMC.

For many airports implementation of the AEMC will be a significant change and will require a period for people to adapt.

Implementation Schedule

Depending on the complexity and the number of systems that need integration, the planning and design phase (Steps 1-8 and part of Step 9 in ***Exhibit 17***) could take at least 12-18 months. The construction phase could need another 12-18 months, meaning that most facilities could make the transition to an Intelligent Airport within three years according to Leidos.

Pixys reports that from initial studies to completion, the average overall project duration varies from 24 to 36 months (***Exhibit 20***). In the early stages, major difficulties come from the transformation of visions into clear specifications and in the extraction of the best from the existing situation.

All stakeholders must be kept aligned during the full period and communication and project sharing are essential at all stages.

The facilities and team could be in place in 36 months, but full implementation of the initially scoped software could take up to 60 months. If planning starts in 2018, full implementation would likely be achieved by 2023.

Airports are under pressure from airlines and passengers for more efficiency, better use of technology and an enhanced customer experience. Those are real challenges for current and future airport managers and the only solution for making accurate and quick decisions is to have all the essential information in one place and as much is possible in real-time.

Establishing an AEMC is the solution to meet these challenges and to maintain airport sustainability in the future.

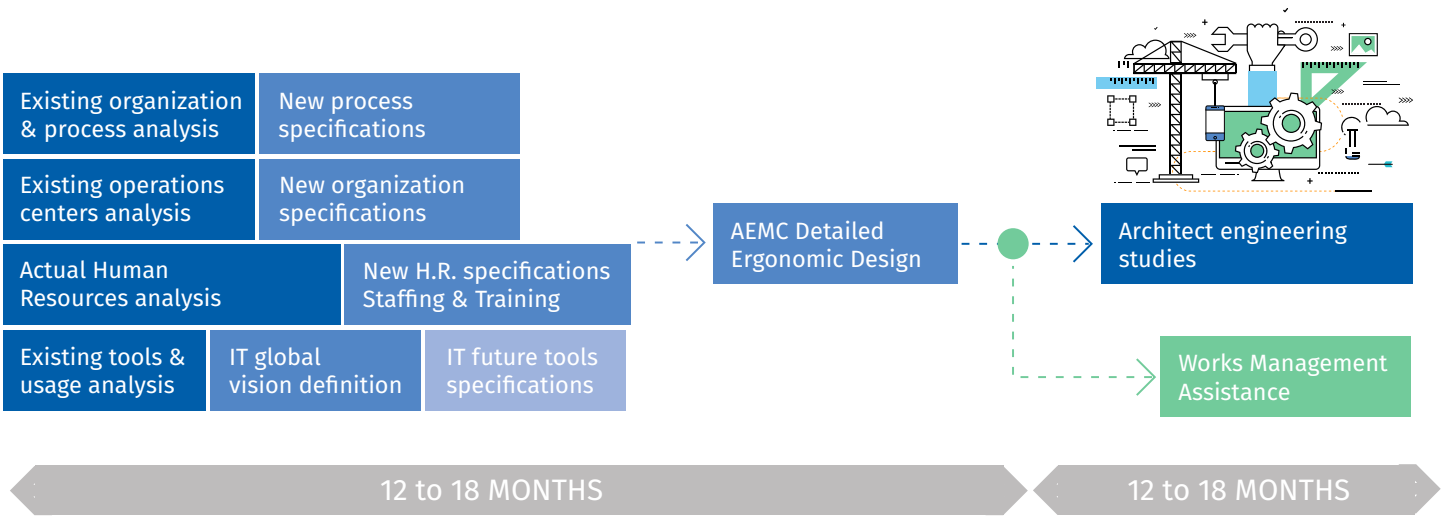


Exhibit 20. *Implementation Schedule (Pixys)*

Implementation Case Studies

Dublin Airport

Dublin Airport has an AOCC, which primarily has the conventional objectives of streamlining day to day operations, enabling recovery after disruption and improving decision making. However, it also has in its objectives for this centre the improvement of the public perception of the airport. With this objective, level of service is explicitly added to the centre's operations. Passenger queues for security screening are monitored through IT solutions. (4)

Geneva Airport

Geneva Airport has a program underway that is well beyond the traditional AOCC. The Geneva Airport integrates both the A-CDM functions and the traditional AOCC (or APOC) as illustrated in Exhibit 21. The new APOC opened in May 2017.

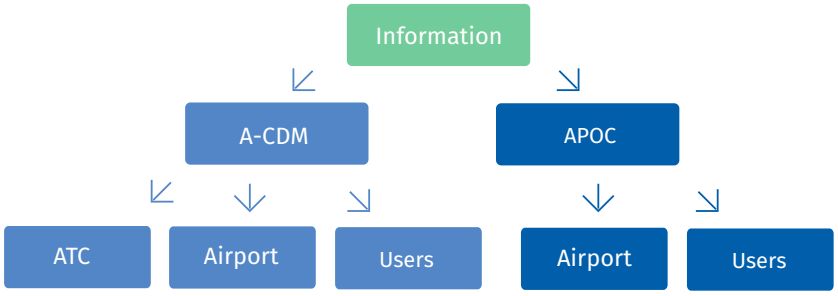


Exhibit 21. *Geneva Airport's Integrated Control Concept*

The mission of Geneva's APOC is to:

- Improve punctuality;
- Maximize capacity;
- Enhance efficiency;
- Enhance the quality of service; and
- Respect the needs of the local communities.

It includes all aspects of the airport's operations from ground access roads and railway, passenger processing, aircraft docking/pushback and aircraft arrival/departure.

It also is following the ACI Europe Ground Coordinator path, in that in is intended to support strategic (seasonal) planning, pre-tactical planning (7 days) as well as current day operations.

The APOC includes the following airport and stakeholder personnel:

- Airport operations;
- Passenger Experience Manager;
- Major carrier;
- Security;
- Resource allocation;
- Ground handling service provider;
- De-icing control;
- Border Control (government agencies); and
- Meteorology.

The composition of the APOC illustrates that the intent goes beyond the AOCC operations focus. Although operations are a core focus, the intent is to bring all stakeholders into one location to ensure a common situational awareness and a common commitment to meeting the objectives. The design of the APOC enables changes in participation. All work stations are flexible and can be tailored to the user login credentials.

Most importantly, the development and operation of the APOC was built on a commitment that no new staff resources would be required.

The early months of operation have highlighted some issues that will be important to all airports moving beyond a conventional AOCC:

- It is difficult to determine the return on investment (ROI) until a specific capacity gain can be identified. (What capacity gain would be needed to provide the target ROI?);
- The ground handling service providers have already seen the benefits;
- Data ownership is important. Sharing data does not mean a free-for-all use of data because it raises the risk of conflicting interpretations;
- The centre has analytical capabilities which are needed, however, if centralized analysis is taken too far, it could stifle innovation in the use of data; and
- The APOC needed to create its own software for "supervision" which integrates the data from the various systems.

Birmingham International Airport

Birmingham International Airport (BHX) is working towards a complete AEMC. The centre is located on the executive floor and is intended to serve the entire C-suite. BHX's focus in developing the AEMC has been on the following:

- A value-stream approach was used, whereby BHX started by examining the various processes at BHX from the passenger's perspective from end-to-end, rather than by functional area or by specialty;
- The focus was on the overall outcome of the value stream, such as facilitation or efficiency, rather than narrow intermediate results;
- A holistic approach was used. BHX included all players within a value stream, whether internal or external, and both within and outside of BHX boundaries; and
- There was a proactive management involvement at all levels and a sustained presence over time.

As BHX has been implementing its new approach, the lessons learned to-date have been:

- The need for flexibility; implementing the various changes required a greater level of polyvalence and cross-training than anticipated;
- The need for greater inclusivity and sharing for all participants involved and at all levels, both to foster the flexibility above, as well as facilitating buy-in;
- The need for separate production and test environments, not only for project implementation, but to create a real sandbox environment to test things out;
- The opportunity to create forward-looking simulation tools that enable BHX to go beyond the

short-term operations focus and move toward a medium/long-term planning horizon;
- Existing tools from other industries such as Six Sigma, Lean Management or Agile Engineering methods can be used to structure the approach, rather than create new methods;
- Flexible structures or processes are needed, so that the overall system can accommodate changing patterns of in-sourcing and out-sourcing over time;
- Getting the right people centralized is useful, but there is no need to get everyone in the same room; and
- Stakeholders can be reluctant to give up control of their own systems or to change the way they operate.

BHX's approach has been to set itself up as an ICT service provider, acquiring and operating most of the systems, and then sharing the relevant data and feeds as a service to the other departments and stakeholders. This was very well received, as it removed the need for costly systems, maintenance, and ICT expertise for these users. It also made in- and out-sourcing much easier as new stakeholders were given access to the systems right away without having to bring their own. This is also the main reason why their AOCC started off with the CCTV system, as it is the most expensive and bandwidth intensive of all the systems in place -and it is believed that this was probably their largest success factor for launching the initiative.

BHX sees the complete integration of communications and wireless data as the next step in its process. It is currently running a geo-tagging pilot where it is able to locate all of the buses on the apron, and plan on extending this application for all airside assets. A 5G/ integrated wireless ICT system is the next logical step to replace and unify all data/communications feeds and is consistent with the airport's vision as a service provider.

Kuala Lumpur International Airport

Kuala Lumpur International Airport (KLIA) is moving into an Integrated Airport Management Centre (IAMC) (a similar concept to the AEMC) which is planned to be in service by 2019. The IAMC will essentially house all stakeholders and the various sub centres in one location. Stakeholders will include KLIA in-house sub-centres, the airlines, the government agencies and all other support agencies including land transport.

This is also in preparation towards technology-centric Customer Experience Management which will come online in 2019 through the use of apps and a passenger tracking system via a Big Data and Digitalisation project.

Zagreb International Airport

Until the opening of the New Passenger Terminal (NPT) at Zagreb International Airport, the AOCC was located in the middle of Air Traffic Control Tower with a direct view of the apron. The AOCC had two work stations and was directly focused on airside traffic (apron stands, apron and ground handling activities and terminal activities). All other department representatives were located in different locations.

Today, the bigger, technologically more advanced AOCC is located in the NPT. In the new AOCC, representatives from several departments are present thereby increasing effectiveness and collaboration. The four positions that are located in the new AOCC are:

1. Traffic Resource Allocation Officers (2 employees) – their responsibility is to assign aircraft stands, support ground handling activities, gate determination, tracking departure/arrival times, providing leadership during emergencies and following information about SLOTs, etc.)

2. Maintenance Officer (1 employee) – The main role of the Maintenance Officer is to monitor all segments related to terminal equipment, heating, cooling and electricity. The Maintenance Officer is the also the focal point where all failure reports are collected via phone, e-mail, BMS or SCADA. Maintenance response includes a 3-tiered maintenance approach; the first level includes

attempting to address a problem directly using AOCC systems, the second level includes calling maintenance crews. If airport crews are unable to address the problem, then an outside contractor is called in.

3. Security Officer (1 employee) – The Security Officer monitors 24H all CCTV and door indicators. The entire airport is monitored from the AOCC; airside, terminal, and landside). The AOCC Security Officer is the direct contact for all airport security officers. The AOCC Security Officer also works closely with the Traffic Resource Allocation Officer when aircraft gate changes take place or other NPT problems occur.

4. Firefighting Officer (1 employee) – The Firefighting Officer monitors 24H the entire airport infrastructure and operations for fire. This officer, together with the Traffic Resource Allocation Officer, are the main persons responsible for the coordination of the firefighting department and all the other departments during emergency situations. They are in direct communication with all the departments at the airport.

During 24/7 operations at Zagreb International Airport all of these officers are involved in direct communications and collaboration.

This approach increases efficiency in fast information sharing and unit repositioning, as all the persons responsible for traffic planning, maintenance, security and emergency decisions are in one location.

Exhibit 22 below is an illustration of the airport's AOCC.

Exhibit 22. *Zagreb International Airport AOCC*

The AOCC is located in the centre of the NPT and is without windows. As such, monitors are available and are connected directly with the cameras on each apron stand and throughout the passenger terminal. In addition, two cameras monitor each runway threshold.

Glossary of Terms

A-CDM – Airport Collaborative Decision Making

AEMC – Airport Enterprise Management Centre

AOC – Airport Operations Centre

AOCC – Airport Operations Control Centre

Ground Coordinator - control centre that includes and coordinates all operational process partners at an airport

SESAR - Single European Sky ATM Research Programme

TAMS – Total Airport Management System

TDM – Terminal Duty Manager

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APPENDICES

APPENDIX A: MOVING BEYOND AIRPORT OPERATIONS

The European Union, ACI Europe and various airports are all moving to implement integration and control centres that go beyond airport operations. A brief summary of these initiatives is provided below.

SESAR/TAM

The European Union, through its SESAR (Single European Sky ATM Research) and TAM (Total Airport Management) initiatives has been working with airports on A-CDM developments to (20):

- Improve predictability
- Improve on-time performance
- Reduce ground movement costs
- Optimise use of infrastructure & reduce congestion
- Reduce ATFM slot wastage
- Enable flexible pre-departure planning
- Reduce apron & taxiway congestion

The TAM concept integrates existing functions and systems - Arrival Managers, Departure Managers, A-SMGCS (Advanced -Surface Movement Guidance and Control System), CDM, etc.

It is intended to be a platform enabling operational decisions to be made by the airport operator or ATC with the full knowledge of airline operational constraints and/or priorities.

The focus of the SESAR/TAM approach is on enhancing the integration of each airport with the air navigation system. To the extent that it considers groundside congestion and delay, it is from the perspective of potential delays to the overall system.

Return on Investment

A-CDM has been defined by ICAO as one of the most promising optimization measures for airports around the world. "We are still in the early days, but so far the required investments have been proved to cost 5 to 10 times less than the resulting benefits," says Gates. "Some of the results of an impact assessment, made in 2016 by Eurocontrol, include a saving of three minutes on taxi-out times, increased peak departure rates, and dramatically improved take-off time predictability."

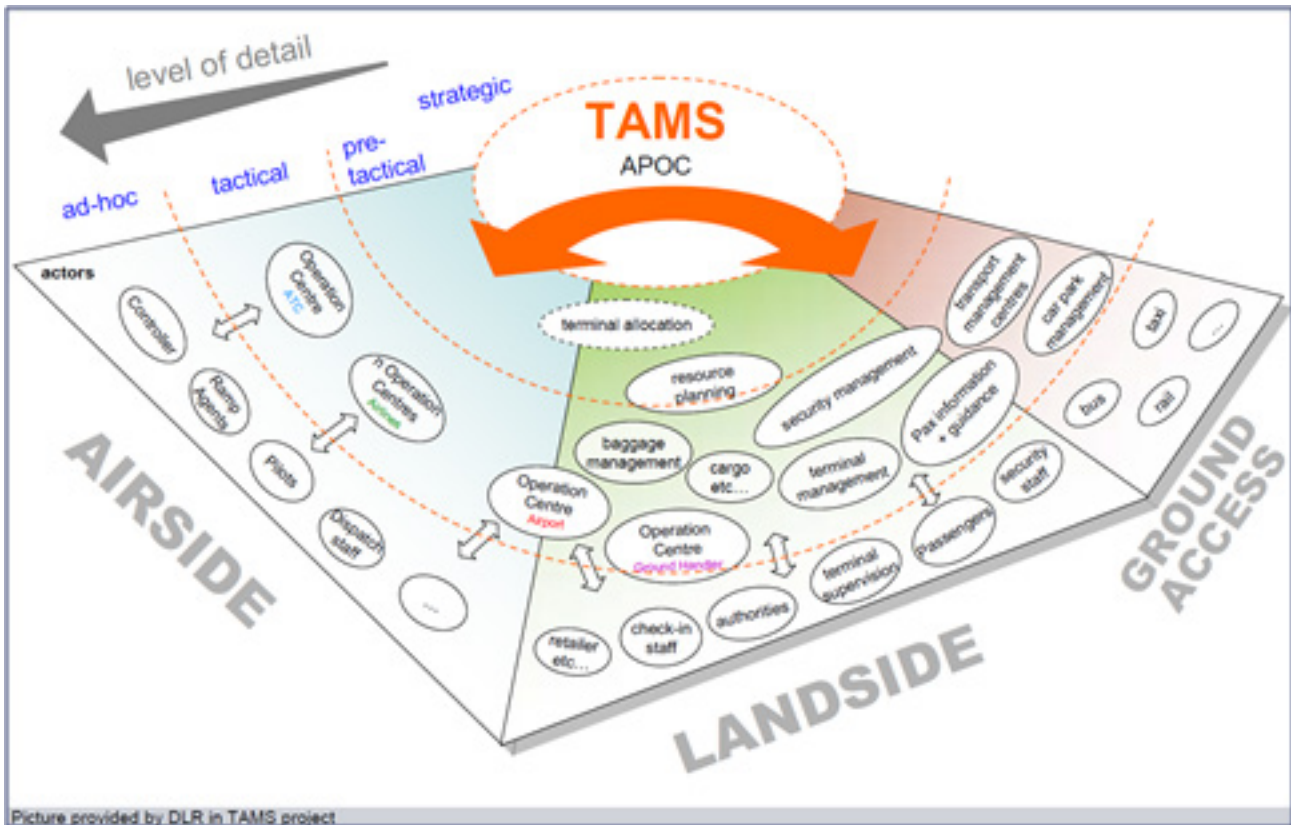

Exhibit A-1. *TAMS Concept (11)*

GROUND COORDINATOR CONCEPT

ACI Europe's Ground Coordinator concept (6) explicitly targets enhanced customer experience and goes beyond the current moment to enhance the planning of operations.

The focus of the Ground Coordinator concept work is on the function of a single control point, as ***Exhibit A-2*** illustrates.

The Ground Coordinator concept is built on the principles of common situational awareness and a holistic view on performance.

These are defined as (6):

Exhibit A-2. *The Ground Coordinator Concept (6)*

- *"**Common Situational Awareness** - occurs when all partners at an airport share information and hence develop a joint view and understanding of the normal operation as well as any disruption or irregularity."*

- *"**Holistic View of Airport Performance** across all operational partners involved is ensured first and foremost through the sharing of data. With the provision of a consolidated set of data made available in one place, managing airport system performance by collaboratively setting and monitoring key performance indicators (KPI) also becomes possible."*

The Ground Coordinator is intended to be the facilitator for the collaborative management of airport operations, executing functions during the strategic, pre-tactical as well as the tactical phase defined as:

- The strategic phase comprises the period until one week before the day of operations:
- The pre-tactical phase comprises the period of 6 days before the day of operations until one day before the day of operations; and
- The tactical phase comprises the day of operations.

In addition, the Ground Coordinator may also conduct certain functions after the day of operations (post-operations). ***Exhibit A-3*** illustrates the Ground Coordinator scope compared to other functions.

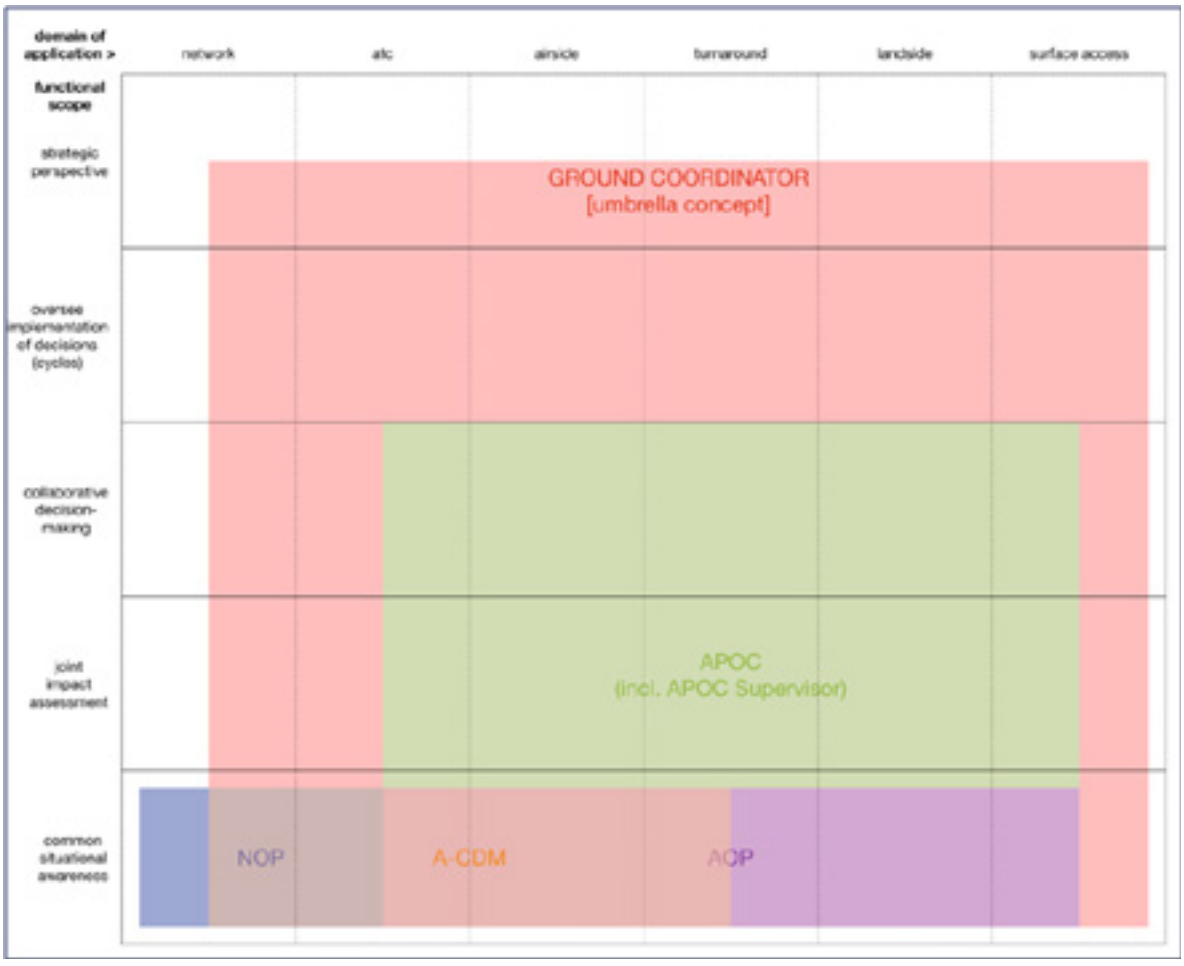

Exhibit A-3. *The Ground Coordinator Concept Compared to Other Concepts (6)*

APPENDIX B: THE AEMC AND ICAO SARPS

AOCC/EOC

The AEMC includes all the functionality of the AOCC and EOC. Specific elements of the AOCC/EOC are found in the following ICAO recommendations.

ICAO DOC 9137

ICAO Document 9137: Airport Services Manual, Part 8: Airport Operational Services, 1st ed. (1983), Chapter 2 (Section 2.4, "Operations Room") states

2.4.1 A co-coordinating centre should be established where information relating to the operation of the airport can be received and distributed. This may combine the functions of the Apron Management Unit as well as the Movement Area Safety Unit.

2.4.2 The room should be provided with direct telephone lines to ATC and any other operational control rooms as well as MET and AIS. Radio communications should be provided so that operational staff can be contacted whether on foot or in vehicles. Arrangements should be made for the preparation and issue of NOTAMs.

2.4.3 Communications should be established with any management duty control room which is provided to cover the overall operation of the airport.

ICAO Document 9137: Airport Services Manual, Part 7: Airport Emergency Planning, 2nd ed. (1991), Chapter 5 (Section 5.2, "Emergency Operations Centre") states:

5.2.1 The main features of this unit are:

- its fixed location;
- it acts in support of the on-scene commander in the mobile command post for aircraft accidents/incidents;
- it is the command, co-ordination and communication centre for unlawful seizure of aircraft and bomb threats; and
- it is operationally available 24 hours a day.

5.2.2 The location of the emergency operations centre should provide a clear view of the movement area and isolated aircraft parking position, wherever possible.

5.2.3 The mobile command post will usually be adequate to coordinate all command and communication functions. The emergency operations centre is a designated area on the airport which is usually used in supporting and co-coordinating operations in accidents/incidents, unlawful seizure of aircraft, and bomb threat incidents. The unit should have the necessary equipment and personnel to communicate with the appropriate agencies involved in the emergency, including the mobile command post, when this is deployed. The communication and electronic devices should be checked daily.

ICAO ANNEX 9 - *FACILITATION*

The AEMC can provide a real-time picture of facilitation in action. Although Annex 9 deals with procedures, the underlying objective is to "facilitate" passenger flows. The AEMC can provide queuing and delay data in real time for action to address immediate problems and for improved resource planning.

ICAO ANNEX 14 - *AERODROMES*

Annex 14 provides the SARPs for operational and physical planning of airports. It gives the dimensions and design parameters for all airport categories in order to ensure a safe and uniform operation at international airports. The forward-looking planning capabilities of a fully implemented AEMC enable on-going, AI driven projections of potential capacity or capability problems.

The last chapter in Annex 14 provides SARPs for maintenance of those airport systems that are vital for safe operations – runways, taxiways, lighting, signing and markings. By incorporating all the features of maintenance management system and the features of the safety management system, the AEMC can provide real-time or near real-time data for problem identification and actions to address any deficiencies.

ICAO ANNEX 16 – *ENVIRONMENTAL PROTECTION*

Public debate is continually increasing on environmental issues such as CO2 emissions (carbon dioxide) and climate change that related to air traffic. Annex 16, which regulates with these issues, is divided into three parts:

- Part 1: Aircraft noise
- Part 2: Vented fuel
- Part 3: Emissions

The Intelligent Airport will have the capability to manage noise and noise complaints as an integral part of AEMC dashboard. In addition, the reporting elements of the SMS, combined with the maintenance management system will enable rapid response to spills, leaks or other environmental damaging events.

ICAO ANNEX 17 - *SECURITY*

Annex 17 covers ICAO SARPs for the security of international aviation. Although airports have comprehensive security plans and actions in place today, the Intelligent Airport integrates security data (to the extent permitted by national law) with other airport systems to enable rapid response by operations or maintenance to address security gaps.

ICAO ANNEX 19 – *SAFETY MANAGEMENT*

Annex 19 – Safety Management is the newest of the ICAO Annexes, adopted in 2013. This Annex requires a proactive strategy to improve safety performance. Further guidance on SMS is contained in the Safety Management Manual (Doc 9859).
The Intelligent Airport, through the AEMC, will use digital communications, IT and AI to monitor and enhance the airport's SMS and monitor safety KPI.

ICAO DOC 9082 – *ICAO'S POLICIES ON CHARGES FOR AIRPORTS AND AIR NAVIGATION SERVICES*

The council of ICAO endorsed the application of principles of best practices of good corporate governance for airports. With the aim of promoting transparency, efficiency and cost-effectiveness, airport management should apply best practices in operation and management in all areas of an airport regardless of whether it is owned and operated by the public or private sectors, and of whether or not it is profitable.

APPENDIX C: KPI RESEARCH

In a review of KPI from a first principles approach, Eckerson (13), in his textbook on KPI, proposes that effective KPI are:

- ***Aligned***. KPI are always aligned with corporate strategy and objectives.
- ***Owned***. Every KPI is "owned" by an individual or group on the business side who is accountable for its outcome.
- ***Predictive.*** KPI measure drivers of business value. Thus, they are leading indicators of performance desired by the organization.
- ***Actionable.*** KPI are populated with timely, actionable data so users can intervene to improve performance before it is too late. They are used to effect change.
- ***Few in number.*** KPI should focus users on a few high-value tasks, not scatter their attention and energy on too many things.
- ***Easy to understand.*** KPI should be straightforward and easy to understand, not based on complex indexes that users do not know how to influence directly.
- ***Balanced and linked.*** KPI should balance and reinforce each other, not undermine each other and sub-optimize processes.
- ***Standardized.*** KPI are based on standard definitions, rules, and calculations so they can be integrated across dashboards throughout the organization.
- ***Context-driven.*** KPI put performance in context by applying targets and thresholds to performance so users can gauge their progress over time.
- ***Reinforced with incentives.*** Organizations can magnify the impact of KPI by attaching compensation or incentives to them. However, they should do this cautiously, applying incentives only to well-understood and stable KPI.
- ***Relevant.*** KPI gradually lose their impact over time, so they must be periodically reviewed and refreshed.

Frost and Sullivan (14) surveyed a cross section of airports and arrived at a short list of KPI and proposed target levels for those indicators (Exhibit C-1)

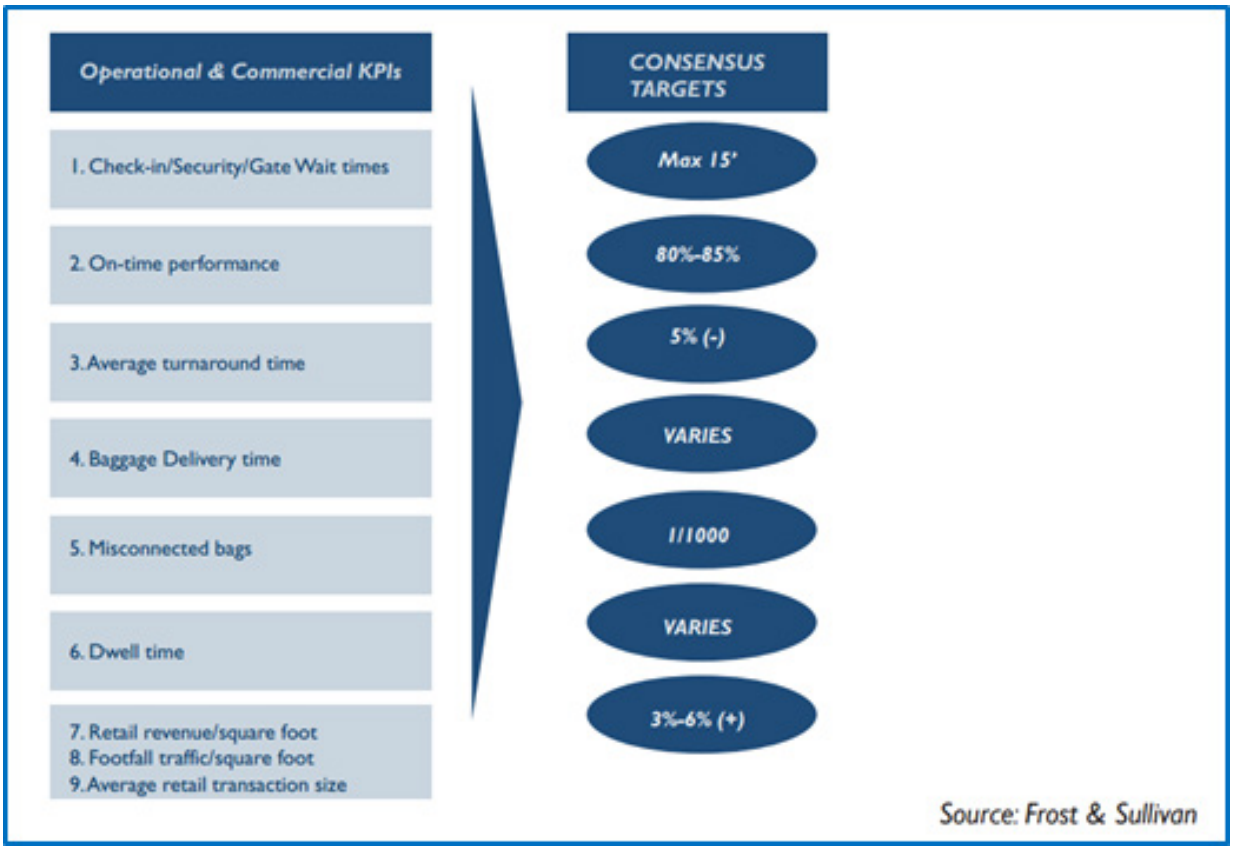

Exhibit C-1. *Proposed Short List of Operational & Commercial KPI (14)*

ACI World and ACI Europe have developed various reports and recommendations on KPI (5). They grouped KPI in six broad areas - core, safety and security. service quality, productivity/cost effectiveness, financial/ commercial and environmental. Exhibit C-2 summarizes

Core	Safety and Security	Service Quality	Productivity/Cost Effectiveness	Financial/ Commercial	Environmental
1. Passengers	1. Runway Accidents	1. Practical Hourly Capacity	1. Passengers per Employee	1. Aeronautical Revenue per Passenger	1. Carbon Footprint
2. Origin and Destination Passengers	2. Runway Incursions	2. Gate Departure Delay	2. Aircraft Movements per Employee	2. Aeronautical Revenue per Movement	2. Waste Recycling
3. Aircraft Movements	3. Bird Strikes	3. Taxi Departure Delay	3. Aircraft Movements per Gate	3. Non-Aeronautical Operating Revenue as Percent of Total Operating Revenue	3. Waste Reduction Percentage
4. Freight or Mail Loaded/Unloaded	4. Public Injuries	4. Customer Satisfaction	4. Total Cost per Passenger	4. Non-Aeronautical Operating Revenue per Passenger	4. Renewable Energy Purchased by the Airport (Percent)
5. Destinations—Nonstop	5. Occupational Injuries	5. Baggage Delivery Time	5. Total Cost per Movement	5. Debt Service as Percentage of Operating Revenue	5. Utilities/Energy Usage per Square Meter of Terminal
	6. Lost Work Time from Employee Accidents and Injuries	6. Security Clearing Time	6. Total Cost per WLU	6. Long-Term Debt per Passenger	6. Water Consumption per Passenger
		7. Border Control Clearing Time	7. Operating Cost per Passenger	7. Debt to EBITDA Ratio	
		8. Check-in to Gate Time	8. Operating Cost per Movement	8. EBITDA per Passenger	
			9. Operating Cost per WLU		

Note the absence of a KPI related to noise in the Environmental category

Exhibit C-2. *ACI Proposed KPI (5)*

ACI World, in its Recommended Practice 300A12 (7), proposes KPI for passenger processes as summarized in Exhibit C-3 below.

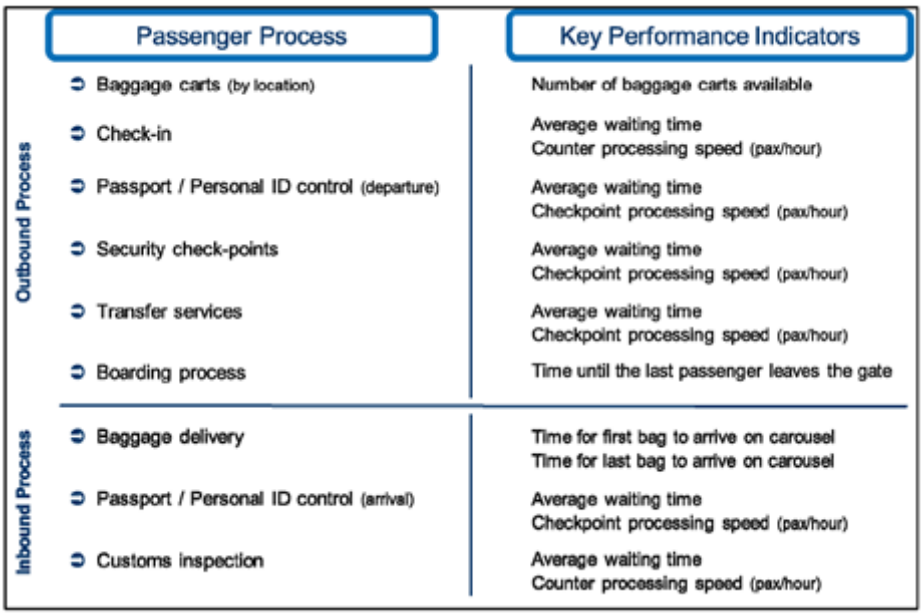

Exhibit C-3. *ACI Proposed Passenger Processing KPI (7)*

The 10th Edition of the International Air Transport Association (IATA) Airport Development Reference Manual (16) (ADRM) has level of service criteria that are useful in considering KPI. Exhibit C-4 is extracted from the ADRM.

		SPACE STANDARDS FOR WAITING AREAS (m²/pax)			WAITING TIME STANDARDS FOR PROCESSING FACILITIES (Minutes)			WAITING TIME STANDARDS FOR PROCESSING FACILITIES (Minutes)			PROPORTION OF SEATED OCCUPANTS (%)		
Passenger Terminal Processor					Economy Class			Business Class / First Class					
ADRM 9th Edition / ADRM 10th Edition		A B Over design	C Optimum	D E Suboptimum	A B Over design	C Optimum	D E Suboptimum	A B Over design	C Optimum	D E Suboptimum	A B Over design	C Optimum	D E Suboptimum
Public Departure Hall		>2.3	2.3	<2.3									
Check-in	Self-Service Boarding Pass / Tagging	>1.8	1.3 - 1.8	<1.3	0	0-2	>2	0	0 - 2	>3			
	Bag Drop Desk (queue width 1.4 - 1.6 m)	>1.8	1.3 - 1.8	<1.3	0	0-5	> 5	0	0-3	>3			
	Check-in Desk (queue width 1.4 - 1.6 m)	>1.8	1.3 - 1.8	<1.3	<10	10-20	>20	Business Class Check-in Desk: < 3	3-5	> 5			
								First Class Check-in Desk: 0	0-3	>3			
Security Checkpoint (queue width 1.2 m)		>1.2	1.0 - 1.2	<1	<5	5-10	>10	Fast Track: 0	0-3	>3			
Emigration (Passport Control) (queue width 1.2 m)		>1.2	1.0 - 1.2	<1	<5	5-10	>10	Fast Track: 0	0-3	>3			
Boarding Gate Lounge	Seating	>1.7	1.5 - 1.7	<1.5									
	Standing	>1.2	1.0 - 1.2	<1							>70%	50%-70% [1]	<50%
Immigration (Passport Control) (queue width 1.2 m)		>1.2	1.0 - 1.2	<1	<10	10	>10	Fast Track: <5	5	>5			
Transfers					<5	5	>5	0	0-3	>3			
Baggage Claim Area					First passenger to first bag			First passenger to first bag					
	Narrow Body	>1.7	1.5 - 1.7	<1.5	<0	0-15	>15	0	0-15	> 15			
	Wide Body	>1.7	1.5 - 1.7	<1.5	<0	0-25	>25						
Public Arrival Hall		>1.7	1.2 - 1.7	<1.2				a.o. Priority bags to be delivered before Economy			>20%	15%-20% [1]	<15%
CIP Lounges			4.0										

[1] The lower limit is only to be considered if extensive F+B seating is provided in the departure lounge, or, concession zone seating available

Exhibit C-4. *IATA ADRM Levels of Service (16)*

Wait times for all processes are part of the level of service criteria, as are space provisions. The latter is interesting and doesn't show in other KPI lists, but an AEMC would enable both real-time and predictive measure of loading in hold rooms/boarding lounges and the related levels of service. For example, a hold room designed for a Category E aircraft load might have an acceptable level of service for a Category F load, if the adjacent gate is not in use.

The ACRP produced a number of reports on KPI (1,2,3). In ACRP 13 Integrating Airport Information Systems (1), it is proposed that:

> *"At an airport with integrated information systems, senior managers can access desired information from their desktops by use of a dashboard, which the managers have customized to provide the level of information needed to efficiently and effectively address the most business-critical decisions of that airport. Information such as the following could be available and reviewed at will on the manager's dashboard:*
>
> - *The airport's current financial picture;*
> - *Current operational issues and the immediate effect on the budget;*
> - *Return on investment analyses for alternative development proposals;*
> - *Projected arriving and departing passenger counts, by hour, day, and week;*
> - *Percentage gate usage by airline;*
> - *Current and forecasted airfield conditions; and*
> - *Percentage delays by terminal."*

APPENDIX D: TABLE OF AIRPORT SYSTEMS

Operations
Resource Management System (RMS)
Availability key facilities- runways, air bridges, etc,
Availability key equipment - ERS,
Current, planned availability of staff
Advanced Surface Management & Guidance (A-SMGCS)
FIDS
Baggage systems (BRS/BMS)
Passenger queuing management.delay monitoring
Delay information- terminal services/systems , access systems
Ground transport management
Weather information - current, forecast, historic
Airline movement data (arr, dep, sched, actual, gate use)
Gate, systems utilization (400hz, pre-conditioned air,etc.)
Airfield conditions (real time) - braking, etc
Roadway conditions (real time)
Public complaints, incidents
Taxi, bus, transit availability
Curb occupancy
Complaint management
Business
Financial reports
KPI
Accounts recievable
Accounts payable
Standards/policies
Lease management
Contract management
Point of sale systems/concession Data
Public/staff Information
Risk management
Scenario assessment (forward looking - hours, days, etc.)
Budgets to actual comparisons
Rates & charges
Traffic data
Capital investment plan
Competitiveness analysis
Personnel statistics
Training performance Information
IT Systems reliability data
IT performance/maintenance data
Firewall/hacking data
Commercial ground tranport records (for billing taxis, etc)
Parking inventory, real time usage,
Parking revenue management
Passenger wait times for ground transportation
Document management system

Safety & Security
CCTV
Access control
Perimeter control
Public address
ERS
Fire detection/suppression
SMS
Unauthorized entry incidents
Security clearances, badging
Vehicle access to secure areas - record
Incident/accident history
Training records
Screening wait times, delays
Screening incidents
Engineering & Maintenance
Utility usage
Mechanical electrical plumbing (MEP)
Building Management System (BMS)
SCADA
Infrastructure planning
Log of work orders created, actioned, closed by shift
Preventative Maintenance Program - Planned, Actual
Asset inventory
Materiel inventory
Vehicle fleet Inventory
Equipment status
Parts/material expenditures
Equipment unplanned downtime
Capital program
Design & construction schedules
Change order/RFI status
Digitized drawings
Traffic forecast data, traffic data
Environment
Flight tracking/noise management
Noise violations/penalty management
Noise complaint management, records
Water quality compliance
Air quality compliance

CONTACT

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