Cogn Tech Work (2015) 17:207–218
DOI 10.1007/s10111-014-0295-x

ORIGINAL ARTICLE

Preparing for Airport Collaborative Decision Making (A-CDM) implementation: an evaluation and recommendations

S. Corrigan · L. Mårtensson · A. Kay · S. Okwir · P. Ulfvengren · N. McDonald

Received: 31 January 2014 / Accepted: 14 September 2014 / Published online: 21 September 2014
© Springer-Verlag London 2014

Abstract The key objective of this paper was to report on one of the industrial-based change case studies of the MASCA project (MAnaging System Change in Aviation—EU FP7, 2010–2013). This case study provides a systematic insight into one airport's approach to their preparation for full implementation of Airport Collaborative Decision Making (A-CDM). An action-based methodological approach was applied over a 3-year period, and a particular focus of this paper is on the application of the MASCA system change and operational evaluation tool (SCOPE/Structured Enquiry). Key recommendations resulted in research-led interventions, such as the development of a Serious Game to facilitate co-ordination and communications. The paper also reports on future recommendations for the implementation of A-CDM, such as prioritising social relations and trust building amongst airport stakeholders as opposed to viewing A-CDM solely as an IT-led project. Recommendations and learning from this case study can also be disseminated to other airports who are about to embark on the preparation for full A-CDM implementation and compliance.

S. Corrigan (✉) · A. Kay · N. McDonald
Centre for Innovative Human Systems (CIHS), Trinity College, Dublin, Ireland
e-mail: scorrig@tcd.ie

L. Mårtensson · S. Okwir · P. Ulfvengren
Department of Industrial Economics and Management, KTH Royal Institute of Technology, Stockholm, Sweden

S. Okwir
Department of Industrial Engineering, Business Administration and Statistics, ETS11, Universidad Politécnica de Madrid (UPM), Madrid, Spain

Keywords MASCA · Implementing change · Airport Collaborative Decision Making · Multi-stakeholder collaborations

1 Introduction

Air transport worldwide is growing much more rapidly than the current airport systems' capacity. This creates somewhat of a crisis for modern commercial aviation. In order to reduce congestion, delays and to realise environmental benefits, air transport in Europe is currently going through system changes on local, national and international levels Guimera et al. (2005). The current problems in air traffic management (ATM) both on airside and landside operations are related to aviation infrastructure settings of a particular airport in any particular country. In the process to reconstruct and optimise scarce airport resources, such as runways and terminal gates, a number of new standards have been proposed. Airport Collaborative Decision Making (A-CDM) is one of those standards. It is one of the five core plans of the Flight Efficiency Plan by EUROCONTROL, IATA (International Airport Transport System) and CANSO (Civil Aviation Navigation Services Organisation), which aims at improving Air Traffic Flow and Capacity Management (ATFCM) at airports by reducing delays, improving the predictability of events and optimising the utilisation of resources.

1.1 Airport operations need collaboration

In the turnaround process, the service delivered comes from collaboration amongst at least four major actors: airport operators, airline operators, air navigation service providers (ANSP) and the ground-handling firm. These

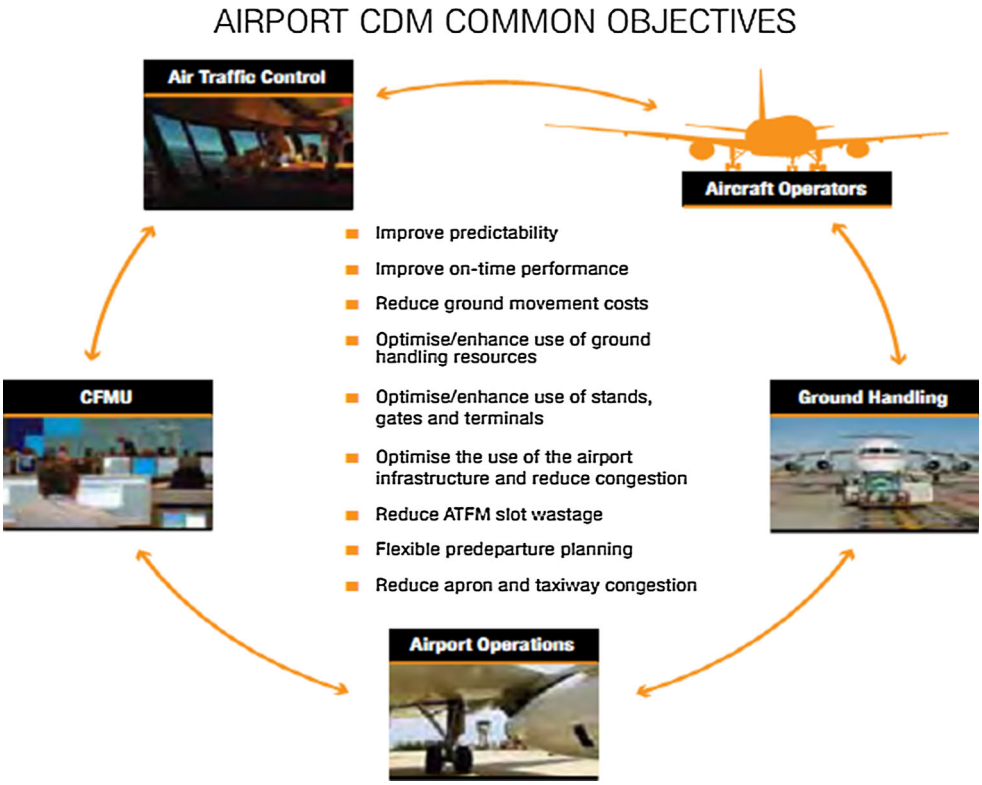

Fig. 1 A-CDM partners and objectives (source: eurocontrol)

stakeholders act as both client and consumer to each other for the efficiency of the overall performance. A dominating stakeholder is the airline operators that land and take off, continuously, hence the turnaround process. However, the other stakeholders have services on several aircraft on ground and continuously fuel, load and unload luggage, clean aircrafts and deliver catering, etc. These tasks need to be co-ordinated in order for as many aircrafts to be tended to in time in order to keep the turnaround process efficiently and timely, which is the only way to free gates and increase airport capacity. This is the objective of the A-CDM.

A-CDM allows partners to optimise their decisions in collaboration with other A-CDM partners, knowing their preferences, constraints and actual predicted situation. The partnership involves airport operators, aircraft operators, ground handlers and air traffic control working in collaboration and sharing data in real time (ICAO Doc 7754 2011). See Fig. 1 with this information, all stakeholders should be able to act on it and communicate to the Central Flight Management Unit (CFMU) in order to improve en route and sector planning of the European ATM network. The sharing of accurate and timely information by adapted procedures, mechanisms and tools facilitates decision-making by the A-CDM partners.

In order to implement A-CDM at congested airports, essential change capabilities are required to ensure a smooth transition to bring an airport to a new level of functioning. The A-CDM concept was first tested and implemented at busy airports in Europe like Brussels, Frankfurt, Munich (EUROCONTROL A-CDM Manual 2006). There are 35 major European airports that are planning to implement A-CDM by 2014. Currently, eight of these have done so successfully and a further 28 are in the process of implementation.

Without a doubt, airports are running into a number of very real challenges in their preparations for full A-CDM implementation. Research on implementing A-CDM by Martin (Martin et al. 1998) highlighted that A-CDM scenarios presupposed various levels of collaborations between the key stakeholders. These included enhanced distribution of information ensuring that all stakeholders have the same picture that is as clear as possible (being the lowest level of collaboration) and redistribution of decision-making responsibility with the delegation of responsibility for allocating scarce resources to airport users (being the highest level of collaboration). Collaboration in any A-CDM network can be seen as a shift from individual to group or team decision-making attempting to create common situational awareness in a multi-stakeholder setting is a big challenge. Another challenge identified by Martin et al. (1998) in implementing A-CDM is how airport stakeholders can break down the barriers between them. The IT infrastructural change between and within

airport stakeholders has also been identified as one of the A-CDM challenges. Different partners maintain different IT platforms. Creating one single platform as an A-CDM standard takes time and collective understanding is needed. Another challenge identified is in relation to the lack of a standard framework for some operations. The level of changes required in implementing A-CDM is multifaceted and multidimensional. In order to bring the A-CDM service operation to an effective functioning level, airport stakeholders have to understand the urgency and need for change and manage the very real challenges for effective inter-agency collaboration.

Recent research (e.g. Salas et al. 2005; Salmon et al. 2009; Groppe et al. 2009) on collaborative teams suggests that a number of key human factors concepts are crucial for the collaboration to be successful and efficient, these include distributed situational awareness, distributed cognition, shared mental models, distributed teamwork and adaptability, team leadership, mutual performance monitoring. This research stresses that effective team work cannot function without mutual trust, closed-loop communication and shared mental models of the overall operational picture. Essentially, Salas et al. considered it necessary for team members to be able to trust one another, for their communication to be effectively exchanged and for them to have knowledge of one another's tasks and expectation of how they will interact.

A study of multi-agency co-ordination Salmon et al. (2009) highlighted a number of concerns associated with the co-ordination of teams of multi-agency, civilian and military groups. Some of these key concerns include:

- Limited sharing of key information between agencies
- Communication of inaccurate or incomplete information between agencies
- Poor information management (i.e. collection, collation, organisation and dissemination)
- Inadequate and incompatible communications technologies
- Lack of an appropriate common operational picture
- Lack of clarity and understanding of each agency's roles, responsibilities, actual contributions and available resources
- Lack of clear and effective leadership
- Cultural issues
- Lack of appropriate multi-agency training scenarios
- Inadequate multi-agency response frameworks/procedures/systems
- Lack of experience in collaborating with intra-organisational stakeholders.

Many of the issues identified above have also been identified as key challenges facing many of the European airports as they prepare for change and full implementation of A-CDM.

There is a wide spread acceptance of various change models that offer the capability for ensuring sustainable change (Cameron and Green 2012). However, the evidence from industrial-based case studies on "what factors make for successful change in aviation" has been few and far between and the aviation industry is facing very real challenges in facing great system changes as implications of the future Single European Sky (SES) concept and new requirements for Safety Management Systems (SMS). At the same time, the airline industry is under great financial pressure.

Addressing the very real challenges the aviation industry has in implementing sustainable change was the key focus of the MASCA project (MAnaging System Change in Aviation). The overall work programme took an action-based research approach with a primary focus on the transfer of change management capability into the organisations that are responsible for and involved in change. Thus, the project work programme was driven by the current industrial change management case studies organised around two complementary objectives:

- Providing research-led support and interventions to enable internal change management capability across the change case studies
- Ongoing analysis and evaluation on the progress of the change case studies

The overall objective of this paper was to present an evaluation of one of the industrial case studies in the project focusing on their preparation for full implementation of Airport Collaborative Decision Making in a large European airport, and the paper is organised around the following sections:

- Overview of the current A-CDM case study
- Overview of the SCOPE methodology (incorporating the Structured Enquiry)
- Methodology
- Results of the evaluation
- Overall conclusions and recommendations for the preparation of A-CDM implementation

1.1.1 Overview of the current A-CDM case study

The case study concerns a European airport that is aiming for full A-CDM implementation and compliance in 2014. As one of the 25 biggest airports in Europe, it follows the legislation of the Single European Sky (SES), as well as the guidelines of Single European Sky Air Traffic Management Research (SESAR). In this context, implementation of A-CDM is a prerequisite for economic support to the

airport from the European Union. The implementation of A-CDM at the airport is following the EURCONTROL A-CDM Implementation Manual. This high-level manual is designed to facilitate the harmonised approach to implementing A-CDM at European airports based on a 16-Milestone Approach (EUROCONTROL A-CDM Manual 2006). The 16-Milestone Approach Element describes the progress of a flight from the initial planning to the take off by defining Milestones to enable close monitoring of significant events. In 2003, the airport commenced A-CDM implementation but had to put it on hold in 2005 primarily due to information shortcomings in the IT systems. Furthermore, some key stakeholders at the airport did not give A-CDM the required at that time priority. It was felt that the time was not right for A-CDM. Towards the end of 2011, the airport initiated the preparation for full implementation of A-CDM which was spear headed by a dedicated project management team led by the airport authority and including representatives from the key stakeholder organisations. Whilst there has been good progress in developing a centralised IT system, the next step is ensuring that each of the stakeholders will share their internal information and knowledge. Therefore, a key focus of the A-CDM implementation has been on getting all stakeholders to agree that "we are one big family for the 35–40 min that the aircraft spend on the ground". As A-CDM includes a whole set of new procedures and processes, an overall training strategy was developed for key staff to more fully understand these new features and the overall concept of A-CDM. The initial training involved 150 staff members across the airport with the objective of ensuring that there was an understanding of the concept of A-CDM. This training was the first step in the overall training strategy, and additional training is planned to roll out across all key stakeholder functions. At this stage, the implementation of A-CDM is transitioning from the planning and preparation stage to the trial evaluation and implementation stage. Whilst there does seem to be a positive attitude towards the benefits that A-CDM can deliver to the overall airport operations, the airport stakeholders are encountering a number of challenges in achieving the level of integration required and managing the change (similar to challenges encountered by other airports).

1.1.2 MASCA approach—SCOPE/structured enquiry

A core proposition of the MASCA theoretical framework is that understanding the functionality of a socio-technical system is the key to managing it more effectively, changing it to achieve better outcomes, or designing a better functioning future system (Mc Donald 2014). As a result, a conceptual and software system was developed (SCOPE—System Change and OPerations Evaluation) that has the capability to analyse and create process maps focusing on three interlocking and interdependent levels of analysis: (1) process functionality (operation and management processes); (2) social cohesion (team and trust); and (3) which are mediated through collective knowledge and information cycles (McDonald 2014) see Fig. 2.

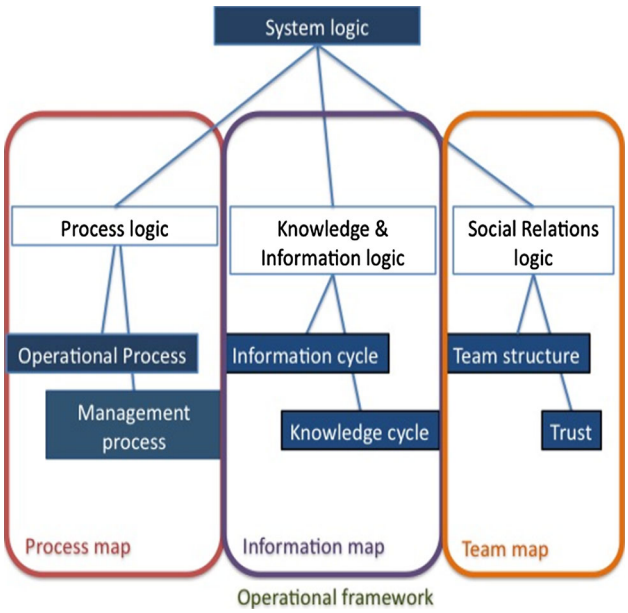

Fig. 2 Schematic architecture of overall system analysis (McDonald 2014)

In each of these modules, the operational system can be mapped and analysed according to each logic.

1. A process map details the sequence involved in transforming input to output. This supports a high-level "decision point map" which can both represent the status of the relevant dependencies and show how the dependencies of intersecting processes can be represented.
2. An information map denotes the flow of information and the sharing of knowledge. It is designed to highlight cycles of transformation and validation of knowledge and information.
3. A social relations/team map describes the network of connections between people involved in the process. This highlights the reciprocal relations amongst subgroups which provide social structure to sustain activity.

The overall evaluation of change was also brought within the SCOPE methodology. This resulted in one comprehensive Structured Enquiry which evolved as the case studies progressed and which synthesises the analysis from the three interdependent levels (process, knowledge

and information and social relations) and complements each of the maps (McDonald 2014). The Structured Enquiry can be deployed as an interview-based tool providing a set of questions driving a further analysis of each of the three levels. However, it is not a simple question and answer process and it is not meant to follow a rigid structure. The interviewer is meant to tailor the enquiry to what is relevant to the initiative at the current stage of the overall change initiative. It is an attempt to build up a dossier of knowledge about the change initiative, at its current state of play in order to draw inferences about the current status and prospects for the future. Such inferences should be powerful enough to drive recommendations that are sufficiently cogent and authoritative to seriously influence the overall change management plan for the next stage of the initiative (McDonald 2014).

2 Case methodology

The methodological approach adapted in the MASCA project involved a longitudinal study and action-based research over a period of 3 years that deployed a number of research methodologies including semi-structured interviews, workshops, Serious Game development, and training and mentoring. As the objectives of this paper are to report on the evaluation of the A-CDM change case study, the methodology section is divided into two parts:

Part 1: The ongoing research methodologies and interventions that were deployed throughout the 3 years and provided a rich dossier on the airport's overall approach to managing change.

Part 2: The application of the Structured Enquiry approach to provide a synthesis and consolidation of the overall evaluation as carried out towards the end of the project.

2.1 Part 1: Ongoing methodological interventions

2.1.1 Semi-structured interviews

Over the 3-year research period, a total of 27 key stakeholders at the airport were interviewed including representatives from the airport, airlines, ground handlers and air traffic control. The objectives of the various interviews changed as the research evolved.

The objectives of the first phase of interviews (March 2011) focused on the airport only. An interview template was designed with the basic concept of change management focusing primarily on the airport's overall strategic approach, the process of change, competence and human resources. This initial phase provided clarification of key strategic goals, assessment of the current change initiatives in the airport, lessons learnt from previous change initiatives, readiness for change and key performance indicators. The underlying aim of the interviews was to link the MASCA change and evaluation programme to initiatives within the company. As a result of this first exploratory phase of interviews, a decision was made to focus on the implementation of A-CDM as one of the key MASCA case studies and a first critical step was for the researchers to more fully understand the current turnaround process (TAP) at the airport.

Therefore, the objectives of the second phase of interviews (December 2011) focused on the preparation for a workshop on the turnaround process. Building on the previous interview template, the questions covered: general questions on the work and working conditions, key patterns of communication across actors, the strategy of the company, its visibility and how it is communicated. Other areas covered competence for change within the company, successful and unsuccessful changes, insufficient knowledge about all stakeholders' roles in the turnaround process and their overall knowledge and understanding on what implementing A-CDM means for their everyday work.

Similar questions were put to two interviewees of an airline at the third phase (May 2012). Emphasis was put on the operations of the airlines.

The focus of the final phase of interviews (October 2013) was twofold (1) to prepare for the future training session on enhancing communication and collaboration amongst key actors and (2) to provide a final consolidated evaluation of the overall progress of implementing A-CDM at the airport based on the Structured Enquiry.

2.1.2 Workshops

MASCA researchers have also facilitated five *workshops* over the duration of the research involving key stakeholders involved in the implementation of A-CDM. Each of the workshops lasted approximately 4 h and included between 10 and 15 representatives from key stakeholders at each workshop. The objectives of the workshops were twofold (1) to understand the key stakeholder roles and their challenges in implementing A-CDM and (2) to facilitate the iterative development of a *Serious Game* to support more effective collaboration and communication amongst the key actors.

Following from the first phase of interviews, the first workshop took place (March 2011). The overall aim was to present the findings of the interviews and to agree on what change management project within the company that would be suitable for a MASCA intervention. At this stage, the A-CDM project was selected. At the second workshop, the aim was to map the turnaround process specific to this airport (June 2011). The workshop involved

representatives from key actors, and an overall map of key roles and tasks was developed. One of the outputs of this workshop was to focus the MASCA research into the development of a training exercise (Serious Game) to facilitate a more collaborative approach amongst stakeholders. Identifying the challenges of implementing change was part of the workshop.

At a third workshop (December 2011), the first model of a Serious Game was tested by the participants representing different stakeholders. The content of the Serious Game was different scenarios from a normal turn around process. The game was highly appreciated, and it was followed by a fourth workshop (May 2012) testing a new version of the serious game.

A fifth workshop (April 2013) was conducted focusing on the "Challenges of Implementing Change". This workshop provided key actors with the lessons learnt from the other change case studies within the MASCA project and provided a number of suggestions on how to further deploy the Serious Game into a more specific training programme.

2.2 SKYBOARD serious game

As it became apparent that the challenge of establishing more effective collaboration and on-going learning amongst the key stakeholders was vital to the overall success, one of the key MASCA interventions involved the development and implementation of a Serious Game (SKYBOARD). The objective of the Serious Game was to initiate a common understanding across the key stakeholder organisations on the shift of the level of collaboration and information sharing required in making the implementation of A-CDM a success. The game involved the four key actors (e.g. airport, airline, ground handler and ATC) where they were faced with a number of obstacles that had to be removed in order to release aircraft. The idea is that if they all work in a more collaborative manner, it will result in overall efficiency across all functions. This game was developed iteratively over a 2-year period and involved the direct participation of the stakeholder representatives in the Serious Game development workshops. The key benefits of introducing the Serious Game to support the implementation of A-CDM in this case included the opportunity for the key stakeholders to spend significant time with each other, getting to know each other in a fairly relaxed and "fun" environment and getting a better understanding of each other's roles and perspectives on the turnaround processes at the airport, and the challenges they were facing with the implementation of A-CDM. A second benefit of the game was that it raised more awareness and initiated a more in-depth discussion of the implementation of A-CDM and what it meant for each of the stakeholders.

2.3 Training on enhancing communication and collaboration

During the ongoing analysis and evaluation with key stakeholders, it was evident that as the implementation of A-CDM progressed, it was becoming more important to ensure the active engagement of a wider stakeholder representation. The initial focus was targeted primarily at four key actors (1) airports; (2) ATC; (3) airlines; and (4) ground handling, however, in order for A-CDM to succeed the other stakeholders (e.g. cleaners, fuel companies, catering) had to be brought into the overall process in a more active and participatory manner. The interviews also highlighted that basic communication skills would also require enhancement between these key stakeholders in order to ensure the necessary level of collaboration. As a result, a 3-h training programme was developed with the objective of enhancing collaboration and communication between the key stakeholders. This training took place in November 2013 and the key learning outcomes centred around raising awareness and the profile of the A-CDM project, creating a shared understanding of the turnaround process and the role of the key actors in delivering this and the criticality of basic communication skills. The Serious Game was also embedded in this training programme.

Where teams are multinational, temporary and short-lived, McHugh et al. (2008) have shown it to be advantageous to create a hybrid "culture" which forges shared mental models for collaborative norms and processes. Doing so fosters more effective collaborative teamwork and decision-making earlier in the lifecycle. Serious games have also been shown to improve decision-making for situation awareness, metacognition and resource management (Caird-Daley et al. 2007). This work also highlighted the relative lack of evaluation of serious games being used to improve decision-making in a live operational environment. This research also comments that A-CDM is a vital tool for addressing the needs of dynamic working environments which present complex operating practices and unanticipated events. Conscious of the importance of (1) shared mental models and (2) the need for a compatible common operational picture in A-CDM, the methodology for this MASCA research designed the training workshop with these two themes in mind. They also included process mapping exercises to strengthen the common operational picture that to ensure that it was compatible for all of the different stakeholder groups represented at the training. The Serious Game was also embedded in this training programme which addresses recent research (McHugh et al. 2008; House et al. 2013) and the importance of scenario-based training, enabling interoperability through multi-agency training using simulated learning environments.

2.3.1 Mentoring

An excellent relationship of research and industry collaboration was established over the project where the leading researchers developed a role of mentor and advisor to the project management team (e.g. by taking part in critical meetings and joining the project group in visits to airports which had already implemented A-CDM.

2.4 Part 2: Application of the Structured Enquiry to consolidate the overall evaluation

A question bank was created containing questions on each of the main content areas of the Structured Enquiry framework (operational process, management process, social relations/team, social relations/trust, information and knowledge cycles). This question bank was used to structure interviews to ensure that the interview schedules covered each of the key areas. Bespoke interview schedules were created for each stakeholder group using both questions from the bank and novel questions drawn up to address the focus of the final round of interviews (i.e. preparing for the training session and final evaluation). A total of seven representatives from the following stakeholders took part in the final set of interviews: air traffic control; airport authority; airlines and ground-handling companies. Each interview was conducted by at least two researchers, who took independent notes on each interview and then came together to provide an agreed synthesis of the key issues across each of the key elements. This final synthesis not only relied on the final set of interviews but from the insights and findings from the range of methodologies employed throughout the 3 years.

This section provides a summary of the most pertinent outcomes of the evaluation. As already mentioned, this was based on the SCOPE framework that provided a Structured Enquiry which interrogated the operational systems according to the following areas: operational process, management process, social relations–team, social relations–trust, information and knowledge. These findings have been structured under these same areas.

2.4.1 Operational process

Major ground-handling partners were very much aware of the criticality of their role in the overall success of the A-CDM project. Whilst they are very positive that A-CDM will work in the long run, they did raise some concerns about the short-term goals. Their main concerns relate to the uncertainty of how A-CDM will be operationalised, the availability of tools, co-ordinator workload and de-icing. ATC were highly positive about the prospect of A-CDM and felt that it will be a success at this airport. However, they perceived A-CDM to be an IT project that had been brought to the operational space. This perception becomes obvious since automation is key in ATC operations and implementing and integrating A-CDM in ATC environment is more or less dependent on IT solutions. Airline partners are largely positive and can see the obvious benefits and savings that they will make under A-CDM. One concern they did raise was how A-CDM would affect their on-time performance statistics. The airport operator's main concerns rested with getting the stakeholders talking to one another.

The overall attitude towards the A-CDM project and how it has been managed is positive, and the critical issue of ongoing communication between key stakeholders will be kept on the agenda. The airport administration has arranged for local airport regulations to be updated in support of ATC (which will give ATC the mandate they need to request that aircraft stay in their stands until released) and will mitigate any legal implications. The on-time performance focus of airlines will not now be as gravely impacted by A-CDM related delays. EUROCONTROL delay codes will be introduced for A-CDM. These delay codes will be excluded from overall punctuality statistics.

Impact Considerable progress has been made over the past 3 years, and plans are in place to reach compliance in 2014. However in order to achieve this compliance, additional work will be required, (e.g. training) to fully prepare all operational staff and consider the introduction of key tools/methods necessary to facilitate all levels of communication.

2.4.2 Management process

A-CDM has been an airport lead project. In support of this, a steering group and a dedicated project management team have been established comprising all major stakeholders. The project team's main task has been to get all stakeholders to "act as family" during the turnaround processes. Constructive progress has been achieved within the A-CDM project group in the last 6 months. They have hosted discussion on numerous matters concerning the impact of A-CDM on the current and future working practices. During the interviews, it became apparent that senior members within actor groups recognised that key information on the A-CDM project was not being sufficiently communicated within all stakeholder organisations. This issue has been brought up to the steering group at several occasions, and mitigating measures have been put in place by the stakeholders. Other stakeholders from the project group have expressed difficulty with feedback filtering back to their individual organisations. They would

like to engage more management support and involvement to assist in getting the concept of A-CDM and how it will affect working practices back to stakeholders at all levels.

All stakeholder groups highlighted a necessary role for dedicated and collective A-CDM leadership. The issue of leadership is quite a complicated one for this type of change management initiative. There is no actual way to actively enforce the use of A-CDM on any of the stakeholder organisations (Directive 96/97/EC). However, having internal "leaders" within each actor organisation could impose some structure and guidance upon operations and how they should be handled. The leaders within each organisation could then liaise with one another on wider collaborative issues.

Impact A-CDM leaders for each actor need to be appointed at an early state of the project to avoid delays in implementation.

2.4.3 Social relations/team

The A-CDM project group has provided the key co-ordination mechanism between the airport partners. Whilst all partners participate in the planning for A-CDM, they did not always send the most relevant people to the meeting which has caused a level of frustration between key stakeholders. Many of those stakeholders involved in the turnaround process are also competing entities such as airlines and ground-handling companies. The effectiveness of the turnaround process is a matter for the ground handlers and the airlines. As mentioned before, the role of the airport is to provide necessary infrastructure for the handlers to use. The main challenge for the airport administration in trying to implement A-CDM is getting different competing stakeholders' to work as family during the turnaround process.

An imbalance in the extra amount of work they will have to do under A-CDM and an imbalance in rewards for different stakeholders were noted. The airlines are still seen as the big winner under A-CDM, and as such, they should take a more active role in implementing A-CDM. This puts additional strain on people working together when their advantage in being involved is not perceived as great as others'. The A-CDM project group, as well as the steering group, has an in-depth knowledge of A-CDM and how this impacts stakeholder roles. Stakeholder's in lower senior grades demonstrated that they do not have a full understanding of one another's roles. The understanding of roles is especially important in raising awareness of the importance of ongoing communication between the key agencies at the ground level.

Impact Collaboration between stakeholders s must be supported by management and the wider A-CDM project if significant improvement in the turnaround process is to be realised.

2.4.4 Social relations/trust

The key stakeholders in the turnaround process are in a competitive commercial relationship. However, there was a fundamental level of trust between partners and that "trust" was not an issue in the success of A-CDM at the airport. The only concern with trust highlighted was in relation to trust in the "system" and trust in A-CDM rather than a lack of trust between the different stakeholders. An inequity in the perceived benefits of A-CDM was also seen to contribute to this sense of imbalance between stakeholders.

A theme that has featured in interviews, workshops and in most sections of this case study so far is a lack of specific objectives and goals. Even though these have been communicated, they may not have been sufficiently shared or understood to foster trust. The objectives should apply globally to A-CDM and locally to each individual stakeholder roles within the organisation. The benefits of being involved in A-CDM should also be outlined at that level too. Agreed ways of working and clearer procedures for A-CDM could foster greater trust in CDM as a "system". There is no history of mistrust; however, there is a reluctance to share some information due to commercial sensitivity. Levels of disagreement about perceived benefits from being involved in A-CDM may also stem from each stakeholder having their own targets and priorities.

Impact Fundamental trust exists between stakeholders, but greater trust in the A-CDM system would ensure more open engagement from partner groups on all levels.

2.4.5 Information

Information sharing is the first and most essential element of A-CDM as it creates a foundation by fostering a common situational awareness and a common operational picture between stakeholders. It also brings predictability and resource efficiency benefits. Whilst there has been good progress in developing supporting IT system, the next step is ensuring that each of the stakeholders will share their internal information and knowledge. For the project to be a success, the information must flow freely between the right people at the right time. Although the airport as a matter of credibility ensures protection of sensitive business information, there is an issue surrounding which data and information will be shared amongst competitive organisations. If too much sensitive information is shared, this could affect contracts with current and future partners. If not enough information is shared, how will stakeholders be able to improve on their performance?

Due to the nature of ground-handling companies sub-contracting other companies to perform specialised duties, stakeholders also highlighted the lack of information available on other job roles in the turnaround process. They stressed that they may be aware of the consequences of what they do or do not do in their daily job and the impact that this may have on the turnaround process. However, they do not know how this fits into other roles in the turnaround process.

The airport administrator understands that communication efficiency must be improved by means of various information/communication channels such as web-based solutions, App, and Gate index systems. This is a partial solution to the communication difficulties. MASCA held a training workshop on communication and collaboration. It is hoped that this made an impact on those whom attended and that further such training is introduced as a matter of urgency in the interim. Trainees stressed that it was important to carry out process mapping tasks from the workshop with people from all organisations. They also requested further access to the Serious Game from MASCA workshops. The issue of how performance data will be validated and fed back to all stakeholders is a crucial one. It serves not only as a motivator for collaboration and a dissuader for non-collaboration, but also as a measure of equity and transparency. The airport administrator stated that only information pertaining to the A-CDM process will be made available to stakeholders so that more sensitive data will be reserved.

Impact A lack of timely information could result in blockers to an affective turnaround process.

2.4.6 Knowledge

The initial training given by the airport administrator involved 150 staff members across the airport with the objective of ensuring that there was an understanding of the concept of A-CDM. This training is planned to roll out across all key actor functions. One of the outputs of the MASCA intervention, following a workshop dedicated to change management, was also a decision to develop and roll out specific training targeted at key roles (e.g. dispatchers). Global understanding of the A-CDM concept is required and shared understanding and values are important for the success of A-CDM. This can be achieved through an appropriate training programme and management planning of how this information will be filtered down from senior management and throughout the organisation. Building a common operational picture and creating shared understanding has been focussed mainly on the IT systems. However, A-CDM will not realise its full potential unless a greater focus is given to the non-technical skills. This has been the focus for the project team as well as for the steering group as previous experience has shown that non-technical skills are vital for the success of the project.

It is not clear that there is a common operational understanding amongst those playing a key co-ordination role in A-CDM. Having their shared collective understanding of their role in the wider A-CDM picture is vital. The A-CDM project group agreed that all relevant airport personnel will get basic training in the principles of A-CDM and familiarisation training with the new software system. The MASCA serious games intervention has been successful in the workshop environment in widening the knowledge of other roles and operations within the turnaround process. A call for this to be extended within stakeholder operations was made on several occasions.

Impact Less than a full understanding of the A-CMD process will prevent improved turnaround times, as those involved in the turnaround process will not know or understand what is expected of them.

This airport is aiming for full compliance in 2014, and overall very solid foundations have been laid in order to address some of the challenges raised. There is confidence from the project team that this full compliance will be reached in 2014. Table 1 below provides a summary of some of the recommendations that were highlighted following the evaluation.

3 Conclusions

The implementation of A-CDM at the airport has been a case study of some significance for at least three reasons:

1. It provided a comprehensive and systematic insight into one airport's approach to preparing the ground work for full implementation of A-CDM
2. An action-based methodological approach was applied over a 3-year period that resulted in research-led interventions and future recommendations for the implementation of A-CDM
3. Identification of key dimensions in the management of change and incorporation of these into the overall SCOPE framework. This allowed for a structured and systematic approach to an overall analysis and evaluation of the progress of the change initiative that was validated by the industry

3.1 Assessing the structured enquiry

This case study adopted an action-based research approach in following and supporting the airport over a 3-year

Table 1 Summary recommendations as per the Structured Enquiry elements

Structured enquiry element	Recommendations
Operational process	1. Focus more attention on key staff and identify the support required
	2. Engage more buy-in (acceptance) from all stakeholders to get people talking. Deploy a Serious Game as part of the overall learning process to encourage more active participation and buy-in
	3. Start the official implementation and get the test period up and running for feedback on operational performance
Management process	1. Foster relations between management of different stakeholder groups so that they deal with potential problems directly and only escalate if there is serious incompatibility
	2. Identify key challenges that need to be overcome in order to involve those stakeholder that are seen as less "invested" and more neutral in the A-CDM process
Social relations (team)	1. Solve communication support issues—the impact of collaboration problems will be minimised if communication support is provided. Additional training focusing specifically on improving communication
	2. Prioritise the visiting of other stakeholder's operational space on a regular basis make this a fundamental tool for ensuring a common operational picture between actors
Social relations (trust)	1. Make stakeholders aware of the negative aspects of A-CDM (e.g. substantially increased workload for ground handling and ATC)
	2. Focus on fostering trust in the system—designated A-CDM co-ordinators' roles could involve re-iterating clarity on procedures
Information	1. Provide standard interface for communication tools—all stakeholders need tools to communicate. They must be able to view the information that they need to be able to do their job at a glance
	2. Involve third party IT experts in helping to develop new software and to develop guidelines for software development at this airport
	3. Increase availability to more test data and information on turnaround statistics from CDM implementation so that stakeholders can improve their performance, e.g. updated taxi times, on-time statistics
Knowledge	1. Develop a competency profile of what new skills and competencies are required for every job role and for every group within organisations under A-CDM
	2. Use the competency profile to update procedures for A-CDM operations
	3. Outline a feedback mechanism for actors to suggest ways of improving A-CDM after implementation—use their operational expertise to improve A-CDM at this airport
	4. Set up a forum for "like-roles" such as dispatchers within different ground-handling organisations to meet and gain a common operational understanding of their key role within the wider A-CDM context

period. By taking an action-based research approach, the research adopted the definition put forward by (Shani and Pasmore 1985) "…an emergent and ongoing inquiry process in which a scientific approach is integrated with existing organisational knowledge and applied to solve real organisational problems…". It is simultaneously concerned with bringing about change, developing and transferring competencies and capabilities back into the organisations responsible for implementing change and adding to scientific knowledge. The methodology adopted in this research has been an evolving process that has been undertaken in the spirit of collaboration and co-inquiry. It has involved a more qualitative approach to understanding the complexities of A-CDM including interviews with key stakeholders at various stages over the 3 years, workshops with key stakeholders in relation to developing the Serious Games, a training intervention and mentoring of key management staff all of which have been guided by the evolution of MASCA evaluation methodology, the Structured Enquiry.

This methodological approach provided an invaluable insight into the different stakeholder roles and their views and perceptions on A-CDM and what it would mean for their everyday working practices. The approach also allowed the researchers to establish an effective research–practitioner relationship that enabled mutual support and respect and also enabled the development and implementation of actual interventions to support the implementation of A-CDM (e.g. development of the Serious Game, training and ongoing mentoring).

The overall evaluation tool (Structured Enquiry) was found to have high face validity and strong user acceptance for its concepts and general approach. It generated a cogent analysis of the change initiative and raised a number of questions about the direction of the change initiative and potential, and by in large, this analysis has been entirely shared between the relevant industry and research partners. It generated a large number of recommendations for the next phase of the case study, fully endorsed by the airport. Thus, as a methodological approach, it has achieved the

first criterion of descriptive adequacy and relevance (McDonald 2014).

3.2 Recommendations for airports preparing to implement A-CDM

Those airports that have already implemented A-CDM have highlighted the benefits they have achieved. For example, they have highlighted that the savings so far are reduced waiting times by 1, 5–3 min per flight at the runway. They also claim improved situational awareness about aircraft status at outstations, improved predictability, improved operational efficiency and reduced delays. Furthermore, reduced ground movements costs, mainly fuel costs, are part of the benefits (Metoffice 2012). However, these airports have highlighted similar challenges to those encountered by this case study and the very real challenge of implementing A-CDM need to be fully understood and disseminated.

In summary, some of the key challenges included:

- The overall high-level objectives of A-CDM requires more specific goals in order to highlight key operational performance benefits for all actors and ensuring actors are able to understand and to quantify the benefits of A-CDM in order to drive them towards a more collaborative approach.
- Shift away from A-CDM being an IT project to one about real co-ordination and collaboration between stakeholders and in many ways is a "cultural change" in every day working practices. Working according to the concept of A-CDM requires a totally new way of thinking and as such takes long time to implement.
- A-CDM awareness not sufficient amongst all airport partners. This includes not only the four key stakeholders as identified by ECTL but all stakeholders, for example cleaners, fuel and catering companies.
- The overall attitude towards the A-CDM project and how it has been managed is positive, but the critical issues of information flow, co-ordination and communication issues will need to be continually prioritised in order to ensure the successful implementation of A-CDM.
- The issue of leadership is quite a complicated one for this type of change management initiative (especially in those airports who do not have a hub monopoly). There is no actual way to actively enforce the use of A-CDM on any of the stakeholder organisations (ref. Directive 96/97/EC).
- Stakeholders are reluctant to release more sensitive data/information. There is a lack of timely information and poor quality or insufficient data.
- Insufficient system integration.

These recommendations are in-keeping with those made in (Salmon et al. 2009), research on multi-agency co-ordination. The MASCA study also put forward a number of specific recommendations for the effective implementation of A-CDM. The following provides a consolidated overview of the key recommendations that were accepted by the stakeholders at the airport in this case study.

- Appoint a dedicated A-CDM coordinator in all stakeholder organisations (airport, ground handling, airline, ATC, fuel, cleaning, catering etc.) that can attend all project meetings.
- Each coordinator develops a communication strategy for their respective organisations. Create a project team to develop an overall airport-wide communication strategy.
- Create a sense of collective leadership across all actors to ensure a win–win attitude for all actors.
- Clearly define and agree objectives and key performance indicators at global and individual stakeholder organisations.
- Prioritise the visiting of other stakeholders' operational space on a regular basis. Make this a fundamental tool for ensuring common operational picture between stakeholders. This may be developed into a regular programme of cross-training.
- Encourage the use of the MASCA "process mapping" exercise to enable key clusters of actors to agree on a common operational picture, current blockers to implementing A-CDM and an agreed strategy and plan to deal with those blockers.
- Develop an agreed strategy for rewarding collaborative behaviour and discouraging non-collaborative behaviour.
- Develop a dedicated training programme to deal with the softer issues of communication and collaboration.
- Address the issue of what communication support and methods are required to support the turnaround process operations.

The Serious Game (SKYBOARD) was one of the more innovative outputs of the research and provided a very effective medium for highlighting and addressing issues to do with collaboration. Inevitably, there was a considerable focus on ensuring adherence to good principles of gamification during the development of the game. However as the game was deployed, this created the opportunity to link the game into a wider training and learning programme supporting the enhancement of communication and collaboration amongst multi-agency actors.

3.3 Overall conclusion

The origin of this change programme predates the MASCA project and will continue beyond the end of the project.

However, this case study was a test bed for the development of a framework for understanding the notion of organisation's capacity to manage change and the development of a methodology to evaluate the progress of change. This overall approach is a part of a long-term strategy to develop a more powerful model of change evaluation by progressively testing predictions against actual outcomes of change initiatives. Research studies similar to this need to be carried out at the other airports aiming for full compliance and to ensure full compliance in a timely manner. It is imperative that the future research adopts methodologies that are capable of understanding the complexities of such change and to direct interventions to ensure the capability to manage the emergent features of the A-CDM change process so as to increase the probability of success.

It will be very interesting to monitor the progress of the remaining airports aiming for full A-CDM implementation and compliance. In a joint press statement released in November 2013 by ACI Europe and EUROCONTROL, they referred to A-CDM as "a tool that allows for real-time sharing of operational data and information between the actors using an airport, thus creating "common situational awareness". This in turn improves interaction between airport operators, air traffic control and airlines on the ground, allowing for a more optimised use of scarce airport capacity".

However, the recommendations from this study would highlight that the focus on implementing A-CDM needs to move away from it being seen primarily as an IT/tool-driven project. One of the interviewees who took part in this study summed it up as "A-CDM is 10 % technology and 90 % people, process and culture".

It is fundamental to consider the fact that A-CDM is a concept to facilitate enhanced collaboration between multi-agency stakeholders to ensure more timely decision-making. Therefore, the focus can not only be on the tools and software integration but more importantly on the issues of social relations and cohesion (particularly for multi-agency actors), the right level of information and knowledge processes and systems (that will engage people and make future systems work) and the capability of the new process (both operational and management) to deliver the key strategic performance targets of A-CDM at the local airport levels and to the wider European air space.

Acknowledgments This research was carried out as part of the MASCA project EU FP7.

References

Caird-Daley A, Harris D, Bessel K, and Lowe M (2007) Training decision making using serious games. Report ref: HFIDTC/2/WP4.6.1/1, July 2007, Human Factors Integration Defence Technology Centre, part funded by the Human Capability Domain of the U.K. Ministry of Defence Scientific Research Programme

Cameron E, Green M (2012) Making sense of change management: a complete guide to the models tools and techniques of organizational change. Kogan Page Publishers, London

EUROCONTROL (2006). Airport CDM Operational Concept Document, Version 3.0, September, EUROCONTROL Publication. http://www.euro-cdm.org/library/cdm_ocd.pdf. Accessed on 28th April 2014

EUROCONTROL (2014). Rome Fiumicino A-CDM Implementation Gears Up To Critical Mass For Full Benefits, EUROCONTROL Publication. https://www.eurocontrol.int/news/rome-fiumicino-cdm-implementation-gears-critical-mass-full-benefits. Accessed on 15th May 2014

Groppe M, Pagliari R, and Harris D (2009) Applying cognitive work analysis to study airport collaborative decision making design. ENRI International Workshop on ATM/CNS (EIWAC2009), March 5–6, Tokyo, Japan

Guimera R, Mossa S, Turtschi A, Nunes Amaral L (2005) "The worldwide air transportation network: anomalous centrality, community structure, and cities' global roles. Proc Natl Acad Sci 22(102):7794–7799

ICAO Doc 7754 (2011) Volume I, Part V.III

House A, Power N, and Alison L (2013) A systematic review of the potential hurdles of interoperability to the emergency service in major incidents: recommendations for solutions and alternatives, Cognition Technology and Work. doi:10.1007/s10111-013-0259-6. Published on-line March 2013

Martin P, Hudgell A, Bouge N (1998) Improved information sharing: a step towards the realization of collaborative decision-making. http://www.atmseminar.org/seminarContent/seminar2/papers/p_041_FOC.pdf. Accessed on 28th April 2014

MASCA D4.1 CMS Development (2010–2013) (June 2012) EU FP7 Collaborative Project (266423)

MASCA D6.1 Overall Evaluation (2010–2013) (December 2013) EU FP7 Collaborative Project (266423)

Mc Donald N (2014) The evaluation of change (in this issue)

McHugh AP, Smith JL, and Winston RS (2008) Cultural variations in mental models of collaborative decision making, Chapter 8 in naturalistic decision making and macrocognition. Schraagen JM, Mitiello LG, Ormerod T, and Lipshitz R (eds), Ashgate, Hampshire, UK

Metoffice (2012) Airport- collaborative decision making round table metoffice publication. http://www.metoffice.gov.uk/media/pdf/6/f/11_0548-aviation-roundtable-summary.pdf. Accessed on 29th April 2014

Salas E, Sims D, Burke CS (2005) Is there a "Big Five" in teamwork? Small Group Research 5(36):555–599

Salmon P, Jenkins D, Stanton N, Walker G (2009) Co-ordination between the Military and Civilian Organisations: issues and solutions. Report ref HFIDTC/2/WP3.1.4/3., May 2009, Human Factors Integration Defence Technology Centre, part funded by the Human Capability Domain of the U.K. Ministry of Defence Scientific Research Programme

Shani AB, Pasmore WA (1985) Organizational Inquiry: Towards a New Model of the Action Research Process. In: Warrick DD (ed) Contemporary Organization Development: current thinking and applications. Scott, Foresman and Co, Glenview