

EFMC 2017 MADRID

RESEARCH PAPERS FOR EUROFM'S 16TH RESEARCH SYMPOSIUM EFMC 2017

25-28 APRIL 2017 IN MADRID, SPAIN

SUSANNE BALSLEV NIELSEN, PER ANKER JENSEN AND RIKKE BRINKØ
(EDITORS)




Polyteknisk
Forlag

**RESEARCH PAPERS FOR EUROFM'S 16TH RESEARCH SYMPOSIUM
EFMC 2016
25-28 APRIL IN MADRID, SPAIN**

© EuroFM and Centre for Facilities Management – Realdania Research

Centre for Facilities Management – Realdania Research
DTU Management Engineering
Technical University of Denmark
Produktionstorvet
Building 424
DK-2800 Lyngby
Denmark
www.cfm.dtu.dk

Published 2017

ISBN: 9788750211129

Coverdesign: Hedda Bank Grafisk Design

Edited by
Susanne Balslev Nielsen, Per Anker Jensen and Rikke Brinkø

Print: Eurographic A/S

Published by
Polyteknisk Forlag
Anker Engelundsvej Vej
2800 Lyngby
Denmark
Tel. +45 7742 4328
e-post: forlaget@poly.dtu.dk

PREFACE

The general conference theme for EFMC 2017 is “*Consolidating the Global Scope of Facility Management*” and this is also the theme of the 16th EuroFM Research Symposium, which is organized as part of the conference. The objective of the research symposium is to present original research that contributes to the understanding of the role of FM in organisations and to encourage discussions and the development of new knowledge amongst researchers, FM professionals and educationalists on this important topic.

This year the research symposium is partly integrated with the business conference to support a strong cross-fertilisation between research and practice. There are 3 sessions dedicated to research papers and 2 sessions include a combination of research and business presentations. All research presentations are based on research papers, which have been through a rigorous review process as used for earlier EuroFM research symposia.

All together 32 abstracts was received and after the review process 19 papers were accepted and they are all included in this publication. Out of the 19 papers, 15 are presented at research sessions and 4 are presented at combined sessions.

EuroFM has agreed an open access mandate. This ensures that the full text of all published research symposium papers (and conference proceedings arising from EuroFM sponsored work) should be deposited in an open access institutional repository, or if that is not available, on the ResearchGate database after the conference.

The publication of the printed proceedings is sponsored by Centre for Facilities Management – Realdania Research (CFM) at the Technical University of Denmark.

We thank all authors and the scientific committee for their dedicated time and efforts. We wish the reader an enjoyable learning experience and lots of inspirations for further research and the application into education and practice.

May the 16th Research Symposium at EFMC 2017 in Madrid become a successful event that will help consolidating the global scope of FM!

Susanne Balslev Nielsen
Chair of the Scientific Committee

Per Anker Jensen
Head of CFM

A WARM THANK YOU TO THE SCIENTIFIC COMMITTEE

- **Assoc. Prof. Susanne Balslev Nielsen**, Technical University of Denmark Oslo and Akershus University College of Applied Sciences (chair)
- **Assoc. Prof. Knut Boge**, Oslo and Akershus University College of Applied Sciences
- **Assoc. Prof. Brenda H. Groen**, Saxion University of Applied Sciences
- **Prof. Jan Bröchner**, Chalmers University of Technology
- **Prof. Per Anker Jensen**, Technical University of Denmark
- **Prof. Tore Haugen**, Norwegian University of Technology and Science
- **Prof. Keith Jones**, Anglia Ruskin University
- **Prof. Antje Junghans**, Zürich University of Applied Science
- **Prof. Mark Mobach**, Hanze University of Applied Sciences
- **Assoc. Prof. Suvi Nenonen**, Tampere University of Technology
- **Prof. Ilfryn Price**, Sheffield Hallam University
- **Dr. Tuuli Jylhä**, Delft University of Technology
- **Assoc. Prof. Theo J. M. van der Voordt**, Delft University of Technology
- **Prof. Sergio Vega**, Technical University of Madrid
- **Dr. Lukas Windlinger**, Zürich University of Applied Science

Contents

1	Benchmarking in theory and practice	7
1.1	Environmental indicators for non-residential buildings: When, what, and how to measure?	8
	Esmir Maslesa, Susanne Balslev Nielsen, Morten Birkved and Jannik Hultén	
1.2	The prioritisation and satisfaction on Thai's Rating Energy and environmental sustainability criteria: A Case study of Bangkok Green Condominium	20
	Chaiwat Riratanaphong and Pongkorn Jermsiriwattana	
1.3	Linked data for district scale energy management: An indicator based method	32
	Li Yehong, Sergio Vega Sánchez and Raúl García Castro	
1.4	Does modularity trump usability? Assessing modular facility solutions for the public sector	43
	Riikka Kyrö, Tuuli Jylhä and Antti Peltokorpi	
1.5	Taking off: Conceptual Model for FM in airports	54
	Nicole Gerber, Carina Tschümplerlin and Susanne Hofer	
2	FM and knowledge management	65
2.1	Knowledge transfer from building operation to construction	66
	Per Anker Jensen and Stamatia Chatzilazarou	
2.2	Risk management of water systems in residential homes: The 'process' of Legionella prevention	78
	Thomas W. Leiblein, Hans Peter Fuchslin, Hans Anton Keserue, Matthew Tucker and Susanne Hofer'	
2.3	Swiss-COBie: Development of a design for information exchange between planners, constructors and FM in Switzerland	91
	Marc El-Arousy, Simon Ashworth and Carsten Druhmman	
2.4	Co-creation of campus by using Virtual Reality	100
	Daniel Leggat, Suvi Nenonen and Olli Niemi	
2.5	Employer's Information Requirements (EIR): A BIM case study to meet client and facility manager needs	112
	Simon Ashworth, Mathew Tucker and Carsten Druhmman	
3	Workplace design	122
3.1	Factors facilitating effective workplace designs for knowledge workers	123
	Knut Boge, Alenka Temeljotov Salaj, Ida Bakken, Magnus Granli and Silje Mandrup Perrée	
3.2	I need a work space! The benefit of real time occupancy information investigated using customer journeys.	135
	Brenda H. Groen and Diedrik G. Broekman	
3.3	The influence of personal- and business centre characteristics on knowledge sharing types in business centres	147
	Minou Weijis-Perrée, Rianne Appel-Meulenbroek, Theo Arentze and Georges Romme	
3.4	Ways to measure user experience in co-working places	158
	Johanna Horstia, Tytti Vasell, Suvi Nenonen and Nina Helander	
3.5	Modern Learning in Universities of Applied Sciences: How to align bricks with future education?	170
	Jasper Driessen, Hester van Sprang and Brenda Groen	

4	Papers presented at combined business and research tracks	181
4.1	Assessing the Added Value of information systems supporting facilities management business processes	182
	Poul Ebbesen and Per Anker Jensen	
4.2	Employee’s preferences for services and facilities offered in serviced offices: Results of an empirical study	193
	Mike van de Kar, Rianne Appel–Meulenbroek, Pauline van den Berg and Theo Arentze	
4.3	The role of FM in disaster resilience: Integrating the Sendai Framework into disaster risk management	203
	Keith Jones, Andrea Bartolucci and Katie Hiscock	
4.4	Out of the Shadows: Influencing train passengers’ perceptions and satisfaction by increasing visibility of cleaning staff	213
	Martijn C. Vos, Jessica Sauren and Olaf Knoop	
	Keyword Index	220

Taking off: Conceptual Model for FM in airports

Nicole Gerber

Zurich University of Applied Sciences, Institute of Facility Management
nicole.gerber@zhaw.ch
+41 58 934 53 91

Carina Tschümplerlin

Zurich University of Applied Sciences, Institute of Facility Management
carina.tschuemperlin@zhaw.ch

Susanne Hofer

Zurich University of Applied Sciences, Institute of Facility Management
Susanne.hofer@zhaw.ch

ABSTRACT

After different models had been developed for the FM in Healthcare context, the goal was to find out how the developed service allocation model could be used as a basis for structuring service provision of FM in a standardized way to be able to carry out expedient benchmarking for FM across industries with complex and high demanding conditions in the future. By doing so, it is expected that ponderous industries like healthcare can learn from more dynamic environments. To start with, the complex and dynamic environment of airports, causing specific needs for the provision of FM in partially extreme conditions, was chosen as the research subject. Similarities between specific characteristics of and differences between the two industries were investigated and transferred into the principle of the existing model. The adaptation and development of the model was conducted with the Design Science Research approach [DSR]. To develop the model as an artefact, the generally accepted modelling principles were followed. The service allocation model for support services in airports presented provides not only a basis for benchmarking between hospitals, airports and other industries with high demanding conditions, but also findings about developing conceptual approaches for further initiatives to benchmark FM across different industries in the future.

Keywords: FM in special environments, FM in airports, FM in Healthcare, FM models, conceptual model

1 INTRODUCTION

For Facility Management in Healthcare [FM in HC], several standardization initiatives were started in order to provide systematic, empirical, complexity-reducing bases for optimizing the non-medical support services in hospitals and thus to establish FM in HC as a driving force in the development of the healthcare sector. Reasons for choosing the healthcare industry as a field of research were first of all its extensiveness and complexity, which call for systematic approaches in order to reach comprehensive findings, and secondly, the topicality of the development of the healthcare industry worldwide. The norm for Taxonomy, Classification and Structures in Facility Management (SN EN 15221-4: 2011-12) specifically encourages the development of branch specific definitions of FM. Soon after setting up FM in HC

standards for key performance indicators [KPIs] and processes, the need for comparing and benchmarking not only amongst national and international hospitals, but also amongst FM in other (comparable) industries became evident.

2 RESEARCH OBJECTIVE

The objective was therefore to find the comparable aspects for FM in industries other than HC and to develop a conceptual model as a basis to compare and benchmark FM in different complex environments in the future, starting with airports. As for the HC context, the goal was to show the greatest possible scope – bigger sized enterprises are thus represented in total, smaller sized enterprises will be able to leave out services not provided.

3 METHODOLOGY

As the goal is to set up a (conceptual) model as a visualization basis for further discussions, the methodology of Design Science Research [DSR] according to Hevner et al. (2004), Hevner and Chatterjee (2014), Peffers et al. (2007) and Vaishnavi and Kuechler (2008) was applied. Based on the DSR principle illustrated in Figure 1, an iterative approach combining explorative elements and expert interviews was chosen.

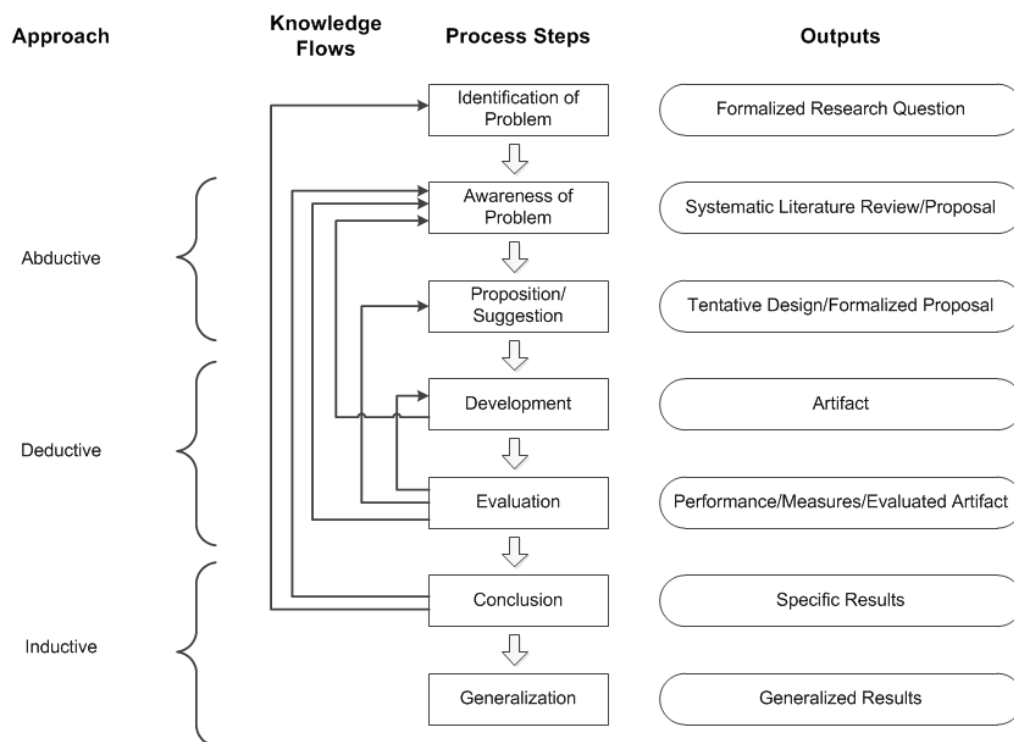


Figure 1 The general methodology of design science (based on Vaishnavi & Kuechler, 2008 and Dresch et al., 2015)

The *Identification of the Problem* and formulating the *Research Question* was derived from on-going research and development projects and previous publications. The *Awareness of the Problem* was underpinned by a *Literature Review* on the subjects of FM in Healthcare and (FM in) Airports. As a *Proposition*, modelling was suggested as a *Tentative Design*. In the *Development* phase, the model as an *Artifact* was developed using a concurrent exploratory

approach combining design and empirical principles according to Huysmans & Verelst (2012). To ensure for the choice of the services listed in the model to be systematic, first a list was created where the hospital specific services listed in LemoS 3.0 (Gerber, 2016) such as sterilization and maintenance of medical technology were excluded, leaving all services that are not exclusive to the hospital environment. In a next step, information found in airport-specific literature was added to this list. Then the services were – where possible – allocated to the four domains of LemoS (Gerber, 2016): Infrastructure, Facility Services, Hotel Services and Logistics. Since there are many airport-specific services which cannot be allocated to one of these pre-defined fields, a fifth field – Airport-Specific Services – was created. In addition the areas were divided into Airside and Landside where applicable. The continuation of the further development is two-fold. Firstly, the model has to go through an *Evaluation* by more specialists of FM in HC and FM in Airports. Secondly, the inclusion of specialists of FM in other complex environments might raise more specific *Awareness of more Problems* and will thus lead to more iterations (illustrated by the upward directed arrows in Figure 1) before final *Conclusion* and *Generalization* can occur.

The conceptual bases for developing the model was the Service Allocation Model for non-medical Support Services in Hospitals [LemoS] (Gerber, 2016) as depicted in Figure 2.



Figure 2 Service Allocation Model [LemoS] (Gerber, 2016)

4 DEFINING COMPLEX INDUSTRY CONDITIONS BASED ON HOSPITALS AND AIRPORT CONTEXTS

To start with, the definition of complex conditions for FM based on the environments of hospitals and airports are shown based on literature reviews. Then, a derived general definition of complex conditions will be presented.

4.1 Complex Conditions in HC

The provision of the services in a hospital requires **hybrid collaboration** between the immobile and mobile infrastructure with their inherent highly complex (information)systems (e.g. medical device and their integration in the information system) and humans of very different disciplines. This causes not only technical, but also human and techno-human **interfaces** operating within limited availability of resources. (cf. Angerer, et al., 2012; Braun von Reinersdorff & Rasche, 2014; Burwitz, et al, 2013; Kriegel, 2012)

The **provision of the service(s) is complex and can only partially be planned**, as the need for a medical treatment can be sudden and the course of healing might vary (Bornewasser, 2013; Fritsche & Hermann, 2009; Marsolek & Friesdorf, 2009).

In the healthcare context, **many different internal and external stakeholders** can be identified. To name a few according to Abel (2009), DIN 13080:1999, Fritsche & Hermann (2009) and Kriegel (2012):

- Patients (insured or not) receive medical treatment
- Different medical and care specialists provide medical treatment
- Non-medical support entities provide services for staff, patients and external visitors
- Governmental and private health insurers decide upon financial streams and regulations
- Politicians and governmental institutions regulate conditions, prices and degree of subsidizing
- Owners of the hospital require shareholder value

The healthcare industry is subject to **rapid medical/technological and socio-cultural change** (Abel, 2009; Busse et al., 2009; Fischlein & Pfänder, 2008; Marsolek & Friesdorf, 2009). Medical treatment processes themselves are becoming increasingly complex due to developments in medicine, pharmacology, care and medical engineering. At the same time, a request for more service quality prevails on the patient side.

Hygiene is a very important (quality) aspect in hospitals which has to be treated with high sensitivity not only during medical operations, but also when running technical installations like ventilation systems or while conducting cleaning (Abel, 2009; sanaCERT suisse, 2011).

The politically motivated supply of the population with healthcare leads to a specific market situation which implies **many regulations** (Abel, 2009; Kriegel, 2012; Rasche et al., 2010).

Digitalisation leads to a high demand for investment in IT within the healthcare industry, where IT has not been treated with high priority in the past. The penetration of information technology is additionally hampered by many **data-protection requirements** due to sensitive patient records and the lack of IT competence amongst staff who up until recently have been highly focused on medical issues instead of business administration aspects (cf Bornewasser, 2013; Günther & Hartmann, 2007; Hartmann & Günther, 2015).

Requirements for **logistics** in HC are complex because for procurement, storage, transport and disposal & recycling, many different kinds of material, food and pharmaceuticals have to be handled, some of which are subject to strict regulations and have to be handled with specific care and/or accommodated in specially conditioned areas. In addition, transportation has

to be provided for different kinds of goods as well as for people – sick or healthy. (cf. Bornewasser, 2013; Kriegel, 2012; Walther, 2005).

4.2 Complex conditions in Airports

Within an airport, **many stakeholders** are involved, e.g. airlines, handling agents, government agencies, concessionaires, retailers, providers of food and beverages, entertainment, tourism, business localities or internet access as well as passengers and visitors (Ashford et al., 2013; Graham, 2014; Young & Wells, 2011)

According to Graham (2014), airports face a high demand for air transport and are therefore undergoing **rapid growth**.

Security is a very important aspect for airports and aviation in general. Airport security includes badge regimes, protecting staff restricted areas, checks of passengers, visitors, staff, baggage and cargo, terrorism prevention, armed protection, parked aircraft protection, video supervision, perimeter fencing and lighting, barriers, road inspections Graham (2014), Kazda & Caves (2015), Young & Wells (2011) and are provided by the government (inspection of passengers and cabin baggage), by the airport (security for areas behind the security check and the airport premises) and airlines (passenger baggage and ground equipment) (Kazda & Caves, 2015).

According to Kazda, & Caves (2015), several **technical interfaces** for navigation aids are necessary such as instrument, microwave or transponder landing systems, global navigation satellite systems, VHF omnidirectional radio ranges, non-directional radio beacons, UHF distance measuring equipment, precision approach, surveillance and surface movement radars and advanced surface movement, and guidance and control systems.

For special cargos like live organs, human remains, livestock, dangerous or radioactive goods, meat, flowers or plants, **special accommodations or hygienic standards** have to be guaranteed (Kazda, & Caves, 2015).

Kazda & Caves (2015) also emphasize the **impact on the environment** is important for airports in different respects: noise, air pollution, contamination of water and soil, wildlife control, waste, construction and possible accidents or incidents.

According to Young & Wells (2011) and Richter (2013), an airport is a **transportation** facility with high complexity because people, goods and information have to be delivered in the correct state, at the right time at the correct place and different kinds of service receivers with different needs like aircrafts, passengers, cargo and surface vehicles have to be served.

In airports, a number of **regulations** like transportation security regulations, airport tenant security programs, airport safety rules or local, regional, national and international regulations and agreements have to be considered (Young & Wells, 2011; Ashford, et al., 2013). According to Ashford, et al. (2013), the local interrelationships between the governmental institutions or quasi-governmental bodies and the airport influence the operation of an airport tremendously.

According to Ashford et al. (2013), the **size** of the airport indicates the complexity factor of an airport. While small airports are easier to handle, medium- or large scale airports become very complex.

4.3 Definition of Complex Conditions

From the findings of the above chapters, the following factors for defining complex conditions for industries can be derived:

- Hybrid collaboration between humans, technology and humans with technology and complex processes with high interdisciplinary interactions and numerous technical interfaces
- Many different internal and external stakeholders of different disciplines and/or cultures
- Rapid change of framework conditions or rapid growth
- Only partially plannable service provision
- High degree of (data) security requirements
- Many regulations and/or high degree regarding hygienic standards
- High need for transportation of people and goods
- Size of the enterprise
- These definitions have to be taken in consideration and discussed when thinking about conducting benchmarking between industries in the future and when comparing figures.

5 FM IN HC AND FM IN AIRPORTS

As a basis for the development of the model, an attempt to set the scope for FM in HC and FM in Airports has been undertaken.

5.1 FM in HC

For the definition of FM in HC, the holistic approach described in LemoS 3.0 (Gerber, 2016), which is based on the norm EN 15221-4, was used as depicted in Figure 1. It comprises the subject areas Procurement, Inventory Management, Transport & Distribution, Disposal & Recycling, Maintenance, Space Management, Energy, Safety, Security, Cleaning, Sterilisation, Catering, Textiles, Accommodation Administration & Operation of Properties and Hotel Various.

5.2 FM in Airports

According to Young and Wells (2011), airports are gradually coming to rely on the private sector in order to cut costs and improve quality. This results in most facilities and services being provided by organizations other than the airport operator itself (Graham, 2014). Graham (2014) points out that therefore the identity of each airport operator is different, but still they have the overall control and responsibility. As stated by Ashford et al. (2013), an ideal one-size fits all solution regarding the administrative structure of airport operations does not exist and it becomes clear that a holistic definition of FM in Airports had not been undertaken. The conceptual model in Chapter 6 will provide a systematic basis.

6 CONCEPTUAL MODEL FOR FM IN AIRPORTS

The service allocation model for support services is a conceptual model illustrated in Figure 3 and was developed through the adaption of LemoS 3.0 (Gerber, 2016), applying information from airport-specific literature (ACRP, 2015; Ashford et al., 2013; de Nuefville & Odoni, 2013; Graham, 2014; Kazda & Caves, 2015; Richter, 2013; Young & Wells, 2011) and subject experts like managers of FM in airports.

The model follows the same main structure as LemoS 3.0 (Gerber, 2015) with a division into three levels: the Strategic Management Services level, the Business Support/Management Support level and the industry specific Support Level, which in this industry is also named Aviation/Non-Aviation Support Services. The first and second level both integrate all services listed in the first two levels of LemoS 3.0, adding airport-specific services, such as Public Safety as a strategic management service or Public & Government affairs for business and management support.

Figure 3 Service allocation model for support services in Airports

Strategic Management Services		IT management IT-strategy definition Risk management Risk policy definition	Identity Innovation facilitation Resources & sourcing strategy Public safety	Sustainability Life cycle planning Environmental management system Energy strategy definition Project consult	Asset & portfolio management Management of investments, portfolio & multi-projects Financing management Aviation planning & development	Quality management Standards & guidelines Process management Aviation operation design & construction
Business Support/Management Support		Finance & controlling Infrastructure & environmental affairs	HRM Public & government affairs	Legal services	Administration Information services	Marketing & communication Real estate & development IT Services Planning
Aviation/Non-Aviation Support Services						
Airport-Specific Services		Hotel Services		Facility Services		
Airside Operations FOD inspection & self-inspection Ground-vehicle control Airport-wide communications Gate allocation & apron control Airside Construction (development) Airside Capacity Management Airside Emergency Services Fire fighting Rescue Airside Ramp Handling Baggage handling & sorting Operation of load equipment Boarding & deplaning Catering loading/unloading Cleaning & servicing of aircrafts Routine & non-routine inspection/maintenance of aircrafts Aircraft marshalling & push back Communication/aircraft dispatch Airside Cargo Handling Cargo handling & sorting	Landside Passenger Operations Parking management Information services Baggage services Landside Traffic Handling Passenger handling Assistance of disabled & elderly passengers Baggage handling Executive lounge/club operation Landside Cargo Handling Processing of cargo export/import Cargo handling Quarantine	Landside Commercial Retail & duty free Food & beverages (incl. vending machines) Essential & leisure services Event management Car rental Advertising	Airside Safety Occupational safety Health protection Ramp safety No hazards on board / runway Airside Security Ramp security Airside barriers Access control Armed protection Protection on parked aircrafts Fire detection & protection Lightning protection	Landside Safety Occupational safety Health protection Landside Security Passenger screening Immigration, customs & health inspection Baggage screening & reconciliation Cargo & airmail screening/ agricultural inspection Employee identification Armed protection Landside barriers Personal security Fire detection & protection Protection of property Technical protection of information Landside Cleaning Areas for employees with granted access Areas for checked passengers & employees with granted access Public areas	Tactical Resource Management	
Airside Maintenance Maintenance of ramp equipment & vehicles Infield maintenance Wildlife management Winter operation FOD Minor servicing & alteration of cabin fittings/seats Airside Energy Ground power supply Fuel & oil Compressed air	Infrastructure Landside Maintenance Maintenance of spaces Parking lot maintenance Building maintenance & technical building management Operational technology/ tenants specification Fittings & furnishings maintenance Maintenance of internet facilities/kiosks/workstations Facility improvement Landside Space Management Internal rental & space management Property administration Landside Energy	Airside Procurement Tactical & operational procurement Incoming goods control Airside Inventory Management Airside Transport & Distribution Catering transport Passenger transport Baggage/cargo transport Airside Waste Management Disposal & recycling Airside Environmental Control	Logistics Landside Procurement Tactical & operational procurement Incoming goods control Landside Inventory Management Landside Transport & Distribution Catering transport Passenger transport Baggage/cargo transport Fleet management Mail/courier services Relocation Ground transportation desks Landside Waste Management Disposal & recycling			

The third level covers five domains. The domains known from LemoS 3.0 are Infrastructure, Facility Services, Logistics and Hotel Services. In the airport context, the field Airport-Specific Services had to be added. Moreover, each subject area contains clustered services which were matched with the services in LemoS 3.0 and completed with services named in airport-specific literature and by FM in airport experts. With respect to the airport industry's customary division, a distinction between landside and airside services was made (exception: Hotel Services).

The Infrastructure domain on the airside consists of Maintenance and Energy, and of Maintenance, Space management and Energy on the landside.

The domain of Facility Services comprises Safety and Security on the airside and on the landside Safety, Security and Cleaning.

Under Logistics as domain Procurement, Inventory Management, Transport & Distribution, Waste management and Environmental Control are listed on the airside, and on the landside Procurement, Inventory management, Transport & distribution and Waste management.

Hotel Services as domain consists of Landside Commercial - there is no commercial department on the airside.

Airport-Specific Services include Operations, Construction (development), Capacity Management, Emergency Services, Ramp Handling and Cargo Handling on the airside, and on the landside Passenger Operations, Traffic Handling and Cargo Handling.

Tactical Resource Management is placed in the middle to indicate that it is involved in all five fields.

7 CONCLUSION, LIMITATIONS AND OUTLOOK

It is becoming clear that hospitals and airports as industries have several analogies: both have many different internal and external stakeholders which leads to a multi-layered collaboration and a great number of (technical) interfaces. Both environments are subject to numerous regulations and they both rely on specific transportation systems and sophisticated logistics. In addition, both environments can partially plan the service provision but are subject to changes due to emergencies or weather conditions. Several aspects are similar but have different characteristics due to varying surroundings; both industries need to focus on security, on hygiene aspects and on data-protection, however security is a much more compelling aspect in airports while hygiene and data-protection requirements are much more prevalent in hospitals. Finally, there are also some differences: while airports are going through a period of rapid growth, HC is currently heavily influenced by medical/technological and socio-cultural changes. The size of the enterprise seems to have a much greater impact on the complexity of airports than on hospitals and environmental impacts have been a strongly present topic within the airport context but so far very little in HC.

Focusing on the support services context, similarities are that the domain Logistics with the subject areas Procurement, Inventory, Transport & Distribution and Waste Management, the domain Infrastructure with the subject areas Maintenance, Space Management and Energy, the domain Facility Services with the subject areas Safety, Security and Cleaning and the domain Hotel Services are provided in both environments.

Hospital-specific is the subject area Sterilization; airport specific is the clear division of the service provision in Airside and Landside and the domain Airport-Specific-Services with the subject areas Airside Operations, Airside Construction, Airside Capacity Management, Airside Emergency Services, Airside Ramp Handling, Airside Cargo Handling, Landside Passenger Operations, Landside Traffic Handling, and Landside Cargo Handling. As safety & security as well as environmental aspects have a higher prioritization in airports, this is also represented in the model.

However, the clear and generally applicable division between core services and support services in HC by Gerber (2016) could not yet be identified in the airport context. As depicted in Figure 1, another iteration will have to be conducted before the model can undergo final evaluation and generalization for other industries, like for example the production of pharmaceu-

ticals with their numerous regulations and need for strict hygiene, or event management with their high degree of unplanned occurrences.

For the future, at least three superordinate benefits should result from these developments. Firstly, the ponderous industries like healthcare should be able to learn from dynamic industries like airports in order to become more efficient and effective and to develop a better focus on the patient as a customer and thus increase the medical and non-medical service quality. Secondly, the basis for benchmarking of FM across different industries pointing out similarities and differences between the different contexts will be given. Thirdly, once specific results can be presented in different industries, it should be possible to refine the context of the EN 15221-4 norm by defining more clearly the common FM service provision and the industry specific areas, possibly adding several industry-specific issues. By doing so, FM will benefit as a discipline and as an industry.

ACKNOWLEDGMENTS

We thank all the subject matter experts for their participation and John Bennett for proofreading.

REFERENCES

- Abel, J. (2009), *Ein produkteorientiertes Verrechnungssystem für Leistungen des Facility Management im Krankenhaus*, Universitätsverlag Karlsruhe.
- ACRP. (2015), *Optimizing Airport Building Operations and Maintenance: A Whole-Systems Approach*. Washington D.C.: Transportation Research Board.
- Angerer, A., Auerbach, H., Früh, M. (2012), *SpitalPuls 2012 Prozess- und Changemanagement in Schweizer Spitälern. Vom Symptom zur Diagnose*, Crossing Borders. Winterthur: ZHAW SML, Abteilung General Management.
- Ashford, N. J., Martin Stanton, H. P., Moore, C. A., Coutu, P. & Beasley, J. R. (2013), *Airport Operations*, McGraw-Hill Education.
- Becker, J., Ehlers, L., & Schütte, R. (1998), „Grundsätze ordnungsmäßiger Modellierung“, Projektträger des BMBF beim DLR (Eds.), *Tagungsband zur Statustagung des BMBF Softwaretechnologie*. Bonn.
- Bornewasser, M. (2013), „Prozessreorganisation im Krankenhaus: Lassen sich auch logistische Konzepte der Industrie im Krankenhaus umsetzen?“ Bouncken, R., Pfannstiel, M.; Reuschl, A. (Eds.), *Dienstleistungsmanagement im Krankenhaus I - Prozesse, Produktivität und Diversität*, Wiesbaden: Springer Gabler.
- Braun von Reinersdorff, A.; Rasche, Ch. (2014), „Mobilisierung strategischer und operativer Leistungsreserven im Krankenhaus - Gestaltungsfelder und Grenzen der Service-Industrialisierung“, Bouncken, R.; Pfannstiel, M.; Reuschl, A. (Eds.), *Dienstleistungsmanagement im Krankenhaus II - Prozesse, Produktivität und Diversität*. Wiesbaden: Springer Gabler.
- Burwitz, M.; Schlieter, H. & Esswein, W. (2013), “Modeling Clinical Pathways Design and Application of a Domain-Specific Modeling Language”, *Wirtschaftsinformatik Proceedings, 11th International Conference on Wirtschaftsinformatik*, 27.2. 1.2.2013, Leipzig.
- Busse, R.; Tiemann, O. & Wörz, M. (2009), „Veränderungen des Krankenhausmanagements im Kontext des Wandles internationaler Gesundheitssysteme“, Behrendt, I., König, H-J, Krystek U. (Eds.), *Zukunftsorientierter Wandel im Krankenhausmanagement*, Out-

- sourcing, *IT-Nutzenpotenziale, Kooperationsformen, Changemanagement*, Berlin Heidelberg: Springer.
- de Neufville, R. & Odoni, A. R. (2013), *Airport Systems - Planning, Design, and Management*, 2nd Edition, McGraw-Hill Education.
- DIN 13080:2003. *Gliederung des Krankenhauses in Funktionsbereiche und Funktionsstellen*, Berlin: DIN Deutsches Institut für Normung.
- Dresch, A., Lacerda, D. P., Valle A. & José, A. (2015), *Design Science Research - A Method for Science and Technology Advancement*, Cham et al.: Springer.
- Fischlein, J.; Pfänder & T. (2008), *Industrielles Klinikmanagement*. München: FinanzBuch Verlag.
- Fritsche, A. & Hermann, M. (2009), *Prozessorientierte Organisation in öffentlichen Spitälern der Schweiz*, Bern: KPM-Verlag.
- Gerber, N. (2016), LemoS 3.0 – *Leistungszuordnungsmodell für nicht-medizinische Supportleistungen in Spitälern angepasst an neue Erkenntnisse*, Working Paper. Wädenswil: Institut für Facility Management.
- Graham, A. (2014), *Managing Airports. An International Perspective*, 4th Edition. New York: Routledge.
- Günther, U.; Hartmann, L. (2007), Organisation der Krankenhaus-IT. *Krankenhaus-IT Journal*, 2, 22-23.
- Hartmann, L. & Günther, U. (2015), „Moderne IT-Strukturen im Krankenhaus“. *Krankenhaus-IT Journal*, 2, 30.
- Hevner, A., March, S. T., & Park, J. & Ram, S. (2004), “Design Science in Information Systems Research”, *MIS Quarterly*, March, 28, 1, 75 – 104.
- Hevner, A. & Chatterjee, S. (2010), *Design Research in Information Systems - Theory and Practice*, New York et al.: Springer.
- Huysmans, P. & Verelst, J. (2012), “Towards a Normalized Systems Analysis Method: A Design Science Project Incorporating Empirical Research Methodologies”. Helfert, M. & Donnellan, B. (Eds.), *Design Science: Perspectives from Europe. European Design Science Symposium*, EDSS 2012 Revised Selected Papers. Cham et al.: Springer.
- Kazda, A. & Caves, R. E. (2015), *Airport Design and Operation*, 3rd Edition. Bingley: Emerald Group Publishing Limited.
- Kriegel, J. (2012), *Krankenhauslogistik - Innovative Strategien für die Ressourcenbereitstellung und Prozessoptimierung im Krankenhauswesen*, Wiesbaden: Springer Gabler.
- Kuechler, W., et al. (2008), “The Aggregate General Design Cycle as a Perspective on the Evaluation of Computing Communities of Interest”, Vaishnavi, V. K. & Kuechler, W. J. (Eds.), *Design Science Research Methods and Patterns - Innovating Information and Communication Technology*, Boca Raton: Auerbach.
- Marsolek, I.; Friesdorf, W. (2009), „Changemenagement im Krankenhaus - im Mittelpunkt der Mensch“. Behrendt, I., König, H-J. & Krystek, U. (Eds.), *Zukunftsorientierter Wandel im Krankenhausmanagement. Outsourcing, IT-Nutzenpotenziale, Kooperationsformen, Changemanagement*, Berlin Heidelberg: Springer.
- Peppers, K., Tuunanen, T., Rothenberger, M. A. & Chatterjee, S. (2007), „A Design Science Research Methodology for Information Systems Research“. *Journal of Management Information Systems*, 24, 3, 45 – 78.
- Rasche, Ch.; Margaria, T.; Braun von Reinersdorff, A. (2010), “Value delivery through IT-based healthcare architectures Towards a competence-based view of services”. Stephan, M.; Kerber, W.; Kessler, T. & Lingenfelder, M. (Eds.), *25 Jahre ressourcen- und kompetenzorientierte Forschung Strategisches Kompetenz-Management*, Wiesbaden: Springer.

- Richter, A. (2013), *Gepäcklogistik auf Flughäfen. Grundlagen, Systeme, Konzepte und Perspektiven*, Berlin: Springer-Verlag.
- sanaCERT suisse (2011), *Qualitätsstandards für die Akutsomatik und die Langzeitpflege - Normative Grundlage für die Zertifizierung der Qualitätssicherung im Gesundheitswesen*. Version 18/2011, Bern: Stiftung sanaCERT Suisse.
- Schütte, R. (1998), *Grundsätze ordnungsmäßiger Referenzmodellierung. Konstruktion konfigurations- und anpassungsfähiger Modelle*, Wiesbaden: Deutscher Universitätsverlag.
- SN EN 15221-4:2011-12, *Facility Management Teil 4: Taxonomie, Klassifikation und Strukturen im Facility Management*, Schweizerische Normenvereinigung SNV.
- Vaishnavi, V. K. & Kuechler, W. Jr. (2008), *Design Science Research Methods and Patterns - Innovating Information and Communication Technology*, Boca Raton: Auerbach.
- Walther, M. (2005), *Auf der Suche nach operativer Exzellenz im Krankenhaus - Logistik als Rationalisierungsinstrument und strategischer Wettbewerbsfaktor in einem dynamischen Marktumfeld*, Erlangen-Nürnberg: Friedrich-Alexander-Universität.
- Young, S. B., & Wells, A. T. (2011), *Airport Planning and Management*, McGraw-Hill Education.

2 FM and knowledge management

2.1 Knowledge transfer from building operation to construction

Per Anker Jensen and Stamatia Chatzilazarou

2.2 Risk management of water systems in residential homes: The ‘process’ of Legionella prevention

Thomas W. Leiblein, Hans Peter Fuchslin, Hans Anton Keserue,
Matthew Tucker and Susanne Hofer

2.3 Swiss-COBie: Development of a design for information exchange between planners, constructors and FM in Switzerland

Marc El-Arousy, Simon Ashworth and Carsten Druhmnn

2.4 Co-creation of campus by using Virtual Reality

Daniel Leggat, Suvi Nenonen and Olli Niemi

2.5 Employer’s Information Requirements (EIR): A BIM case study to meet client and facility manager needs

Simon Ashworth, Mathew Tucker and Carsten Druhmnn