This book presents research tested models, methods and tools that can make the work of the facilities manager more robust and sustainable, help long-term strategic planning and support students and practitioners in FM to improve the way they approach and deal with challenges in practice.

The 34 models, methods and tools are presented in relation to five typical challenges for facilities managers:

- Strategy development
- Organisational design
- Space planning
- Building projects
- Optimisation

The chapters are short and concise, presenting a central illustration of one model, method or tool with explanatory text and short, exemplary case studies. Each chapter includes references for further reading, and the book includes a keyword index. Essential reading for all involved in the management of built assets, this book bridges the gap between robust academic research and practical industry tools. It can also be used as a handy student reference.

**Per Anker Jensen** is professor in Facilities Management and head of the externally funded Centre for Facilities Management – Realdania Research at the Technical University of Denmark since 2008. He holds an MSc in civil engineering and a PhD and MBA. Besides research and teaching, he has 20 years of experience as a consultant, project manager and facilities manager.
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Preface

This book presents ten years of research at the Centre for Facilities Management – Realdania Research (CFM). CFM was established as a national research centre in Denmark with financial support from the private foundation Realdania on 1 January 2008 with the purpose of strengthening the research within Facilities Management (FM).

CFM has had a physical base with management, etc., at the Technical University of Denmark (DTU) and a place at the institute DTU Management, but it has also from the start been a virtual centre with researchers and collaboration partners placed at other Danish universities and companies: Roskilde University, SBi (Danish Building Research Institute/Aalborg University), University of Southern Denmark and the consulting company COWI A/S. CFM initially was established for a period of five years, but it has since been prolonged, including additional financial support from Realdania.

This means that CFM had its ten-year anniversary by the start of 2018. This was celebrated by a whole-day conference on 27 February 2018 at DTU. On that occasion, CFM launched two new publications in Danish – an anniversary book and a Guide to Facilities Management Tools. The present book in English includes a combination of the two anniversary publications.

The idea behind the book is to give a general overview of CFM’s research in the period of 2008–2017 by presenting the most important results of practical, applicable character from CFM’s research projects. It is aimed mainly at FM practitioners, but also students and others with an interest in FM.

The book is divided into two main parts. Part A is a guide to FM tools and introduces a short and concise description of 22 tools related to 5 typical processes in FM practice. Part B is a more in-depth, but still fairly short and concise, description of 34 models, methods and tools of practical application in FM.

The guide is an appetiser and entry to select relevant tools, which can then be understood deeper by reading the related chapter about a specific tool in Part B. Those really interested can find further information in the references included in each chapter in Part B.

The book as a whole has been edited by Per Anker Jensen, who has been head of CFM since the start. The guide to FM tools were, in the original Danish versions, edited by a small task force consisting of Per Anker Jensen; Susanne Balslev
Nielsen, former deputy head of CFM; and Mette Ullersted, graphical facilitator with her own company, Playmaker. It was developed from the involvement of a number of experts in research and practice in two workshops. The current English version in Part A was edited and translated by Per Anker Jensen.

Part B was also edited by Per Anker Jensen. The chapters were prepared in a collaboration between the editor and the author of each chapter, and the authors have approved the chapters based on their research. Each chapter has been supplemented by an evaluation of the practical applicability of the results, and these evaluations have been made by the editor – in some cases together with the researcher in question.

Finally, I wish to thank all the contributors to the book for their participation, all researchers and collaboration partners who have participated in CFM’s activities over the ten years and not least, the foundation Realdania, which, through its financial support, has made it possible for CFM to strengthen the research in FM.

Per Anker Jensen
Head of CFM
It is my pleasure to provide a foreword to this publication. While I am perhaps an unusual choice to be asked to do so, given my bias towards doing it and communicating it rather than theorising about it, I am, however, passionate about True Facilities Management and welcome every opportunity to support members of my peer group, who try and communicate the potential that it offers. I applaud Per Anker Jensen and his team within the CFM of Technical University of Denmark for the work that they have done over many years.

The educational and research communities that I have known over many years play important roles in the recognition and development of what is the ‘new kid on the block’ of the professional disciplines within the built environment sector and is indeed ‘business critical’ for our ongoing development as a strategic professional discipline. Per Anker Jensen is someone I have known since his entry into the educational sector of the Facilities Management community, and I have shared his vision to inform and develop awareness regarding the value that Facilities Management offers the public sector, industry and commerce worldwide.

The subject matter of this publication is important and represents a considerable amount of effort over a prolonged period of time. It represents the developing years of Facilities Management as a distinct discipline as opposed to the more common perception that it is merely a facilities services function. Therefore, it is an important record of that period of time and the evolution of the thinking, as well as the maturing of the discipline itself.

I have personally held the view that within Europe, which has led much of the development of Facilities Management as a strategic professional discipline, it has been the Nordic countries, along with perhaps the UK and the Netherlands, that have been at the forefront of the thinking within the sector. Therefore, it is in this context that I believe this publication is a significant contributor towards recording the journey that has been the evolution of Facilities Management to date and also a record of the significant contribution that has come from Denmark.

Regarding the content of the research profiled in the book, within Part A: Guide to FM Tools, you will find subject matters such as strategy development, organisational design and optimisation. All of these are fundamental to the delivery of an effective Facilities Management regime and coincidentally all are also
fundamental within the recently published ISO Management System Standard for Facilities Management ISO 41001, in which I have been involved.

Within Part B: Models, Methods and Tools, my attention was drawn towards Section V titled ‘FM and Added Value’. Why? Because if this is not fundamentally relevant to what Facilities Management is, then we do not have any real relevance in the organisations in which we operate!

For me, True Facilities Management is no more and no less than good management and common sense. However, I also believe that True Facilities Management is a people business. Everything that we do is ultimately about people and how we can influence them in the widest sense. Publications such as this are extremely important when considering that some of those people will be tomorrow’s facilities managers and leaders. They need to have an understanding of where Facilities Management has come from and why and how it has been used to great effect across the world, and perhaps more importantly how it is being used today and harnessing technology to improve the quality of life for all as is stated in the ISO 41011 published definition, which states that Facilities Management is ‘organizational function which integrates people, place and process within the built environment with the purpose of improving the quality of life of people and the productivity of the core business’.

I, therefore, applaud the work of CFM and those similar institutions around the world who undertake such research and capture it for the education and awareness of all. I especially applaud those who undertake the task of communicating it in order that others can benefit. I do not envy them and therefore will continue to focus on the ‘doing’ aspect of it for as long as I can.

Stan Mitchell
CEO Key Facilities Management International
Chairman ISO TC 267 Facility Management

When I was first asked to write a foreword for *Facilities Management Models, Methods and Tools*, I was slightly surprised and wondered what I could say about the publication and to others involved with the many aspects of Facilities Management.

After reflecting on my concerns, I realised that the content spoke for itself. After ten years of research activity, the Centre for Facilities Management – Realdania Research (CFM) is well placed to offer up a wealth of material, which will benefit and give support to Facilities Management professionals. These professionals include those working in education and research, as well as those who face customers and clients.

The *Facilities Management Models, Methods and Tools* is split into two distinct areas and acts as a guide to FM tools and an outline of models, methods and tools. The collection of chapters in this book provide a great deal of thought on leadership and practical suggestions. The chapters highlight some approaches, which will enable all those interested in Facilities Management to become aware of the ideas and themes that we all face to differing degrees on a regular if not daily basis.
Forewords

The themes covered by the research strands range from strategic thinking to space planning to service and added value. When looking at the work that had been undertaken and the models and methods that are presented, there is a wealth of information that covers the workplace, sustainability and innovation, as well as the more recent work concerning the transfer of knowledge between Facilities Management and construction projects.

This is a publication that has much to offer to those starting out in the world of Facilities Management, but it is also a valuable resource for seasoned professionals. The content will offer a degree of new insights as well as confirm that you are on the right track with what you are doing.

Gordon Campbell McMillan
Facilities Manager (UK and Ireland) Medtronic Limited
Former Board Member of the European Facility Management Network (EuroFM)
Former Chairman of the EuroFM Corporate Associates Network Group

Facilities Management is still a young discipline in practice as well as in an academic perspective. My own way into Facilities Management started in the early 1980s from working with property and building management, and then actively joining the EuroFM and International Facility Management Association (IFMA) networks back in early 1990. In relation to these network activities, more than 20 years ago, I met Per Anker Jensen. From the first time we meet, I got to know Per as a very knowledgeable professional in Facilities Management, focusing both on the professional development in practice and developing education and research.

From 2005 when Per Anker Jensen started working on developing FM education at DTU, our collaboration has been focussed on developing education and research in FM in close cooperation with practice. This work represents a common understanding of a knowledge triangle between FM research, practice and education, where students, educators and researchers cooperate with professionals. The learning process is based on interaction, giving the possibilities for implementing research results and testing new solutions for tomorrow’s FM activities. In order to succeed, the knowledge development with research and implementation of new FM models, tools and methods needs to be documented and published.

Here the new book ‘Facilities Management Models, Methods and Tools’ edited by Per Anker Jensen, represents an important international publication contributing to the development of FM. The new book represents the most comprehensive overview of multiple facilities management models, methods and tools collected, systemised and documented in one publication.

The overview of the research results for practice developed by CFM over a period of ten years show that FM has developed to be a recognised professional and academic field. The book describes FM in line with the European FM standard EN 15221–1 from 2006 and the new global ISO 41011 from 2017, and not at least the understanding of FM that has been the foundation of the Danish Facilities Management Association (DFM).
The previous publications ‘CFM’s Anniversary Book’ and ‘Guide to FM Tools’, published in Danish, have been important for FM practitioners and education in Denmark, and useful for readers in Norway and Sweden. Taking into account that many potential readers are not familiar with the Scandinavian languages, I am glad that Per Anker Jensen has edited and translated the two books into one book published internationally in English to reach a far larger group of international readers from practice and academia.

The new book *Facilities Management Models, Methods and Tools: Research Results for Practice* is first and foremost an impressive comprehensive and thorough documentation of ten years of research at the Centre for Facilities Management (CFM) at DTU. Realdania’s support for the establishment of CFM at DTU in 2008 has been central to strengthening the research and development of the FM field.

I am very pleased with the work Per Anker Jensen has done to document the CFM research, and I am looking forward to using the new book as a basis for future research and cooperation with FM practice. In addition, I am curious to see how we can use and develop the many models, methods and tools in our FM educational programmes in the coming years.

*Tore Brandstveit Haugen*

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Abbreviations

BIM | Building Information Model/Modelling
BREEAM | Building Research Establishment’s Environmental Assessment Method
CAD | Computer Aided Design
CAFM | Computer Aided Facility Management
CAS | Campus Service at DTU
CEO | Chief Executive Officer
CFM | Centre for Facilities Management, Technical University of Denmark
CREM | Corporate Real Estate Management
CSR | Corporate Social Responsibility
DFM | Danish Facilities Management association
DGNB | German Building Sustainability Certification (Deutsche Gesellschaft für Nachhaltiges Bauen)
DTU | Technical University of Denmark (Danmarks Tekniske Universitet)
EFMC | European Facility Management Conference
EMS | Energy Management System
ESCO | Energy Service Company
EuroFM | European FM association
FM | Facilities/Facility Management
FS | Facilities/Facility Service
GIS | Geographic Information System
ICT | Information and Communication Technology
IEQ | Indoor Environmental Quality
IFMA | International Facility Management Association – based in the US
IS | Information System
IT | Information Technology
IWMS | Integrated Workplace Management System
KPI | Key Performance Indicator
LCC | Life-cycle costing
LEED | American Building Sustainability Certification (Leadership in Energy and Environmental Development)
NTNU | Norwegian University of Science and Technology (Norges Teknisk-Naturvitenskapelige Universitet)
| Abbreviation | Description |
|--------------|-------------|
| NWoW         | New Ways of Working |
| O&M          | Operation and Maintenance |
| PDCA         | Plan, Do, Check and Act |
| POE          | Post Occupancy Evaluation |
| PPP          | Public-Private Partnership |
| RUC          | Roskilde University |
| SBi          | The Danish Building Research Institute (Statens Byggeforsknings-institut), part of Aalborg University |
| SCM          | Supply Chain Management |
| SDU          | University of Southern Denmark (Syddansk Universitet) |
| SFM          | Sustainable FM |
| SLA          | Service Level Agreement |
| SWOT         | Strengths, Weaknesses, Opportunities and Threats |
| VAM          | Value-Adding Management |
Contributors

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Rikke Brinkø Berg (born Rikke Brinkø) was educated as a civil engineer at DTU in 2013 with specialisation in urban and construction management, and she completed a PhD study concerning Facilities Management and Shared Space at CFM during the period of 2012–2016, with Susanne Balslev Nielsen as the main supervisor and Juriaan van Meel as the co-supervisor. Chapters A.11 and B.5 are based on her PhD study. Rikke was granted the European Researcher of the Year Award in 2016. She worked as a postdoctoral researcher at DTU Management in 2016–2017 and is now working as the space manager at DTU Campus Service. Rikke can be contacted by e-mail: rikbk@dtu.dk.

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Jesper Ole Jensen was educated as a civil engineer at DTU in 1991 and earned a PhD degree from Aalborg University in 2001. He works as a senior researcher at the Danish Building Research Institute (SBi), Aalborg University, with specialisation in buildings, city development and sustainability. During the period from 2009 to 2012, he was lead researcher on CFM’s project on Energy Service Companies (ESCO) together with Susanne Balslev Nielsen, among others. Chapter B.9 is based on the project. Jesper Ole can be contacted by e-mail; joj@sbi.aau.dk.

Per Anker Jensen was educated as a civil engineer at DTU in 1978 and earned his PhD in 1985 and his MBA at Copenhagen Business School in 2014. For 20 years, he worked as a consultant, project manager, facilities manager and deputy project manager in the client organisation of a new media centre for the Danish Broadcasting Corporation. Since 2005, he has worked on developing FM as a new subject at DTU, and since 2008, he has been the head of CFM. During the period from 2009 to 2016, he was appointed a professorship with special assignments in FM. He is now the associate professor and coordinator for FM at DTU Management. Per has been and is the main supervisor and co-supervisor for many of CFM’s PhD students. Many chapters in both parts A and B present results from his research. Per can be contacted by e-mail; pank@dtu.dk.

Akarapong Katchamart earned a bachelor’s degree in food technology from Chulalongkorn University, Thailand, in 2005 and has a master’s degree in facility management from Pratt Institute, New York, in 2009. He did a PhD study about FM and added value at CFM from 2009 to 2012, with Per Anker Jensen as the main supervisor and Juriaan van Meel as the co-supervisor. Chapters A.2 and B.26 are based on results from the PhD study. Today, he works in FM at a public hospital in Bangkok. Akarapong can be contacted by e-mail: akatchamart@gmail.com.

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Esmir Maslesa was educated as a civil engineer at DTU in 2011. Afterwards, Esmir worked for CFM from 2011 to 2014 as a research assistant on a project concerning sustainable building renovation (see Chapters A.15 and B.10). At present, Esmir is an industrial PhD fellow researching how FM systems and dynamic data can be used to optimise environmental building performance. The PhD study takes place in the period from 2017 to 2019 in collaboration with the Information Technology company KMD. Chapter B-12 is based on results from the PhD study. Esmir can be contacted by e-mail: esmas@dtu.dk.

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Susanne Balslev Nielsen was educated as a civil engineer at DTU in 1993 with a specialisation in sustainable city development, and she did a PhD study on the transition of municipal infrastructure in 1994–1998. Until the end of 2016, Susanne worked as an associate professor at DTU, and she was the deputy head of CFM with a main focus on sustainable FM. She has been the main supervisor and co-supervisor of several of CFM's PhD students. Susanne was granted the European Researcher of the Year Award in 2010. Some of her research results are presented in Chapters A.3, A.8, B.6 and B.33. She now works as the FM expertise director at the consulting engineering company NIRAS. Susanne can be contacted by e-mail: subn@niras.dk.

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This book is for those of you who work with Facilities Management (FM) in practice or as students. It presents 34 models, methods and tools that can make your work and decisions more robust and sustainable, and can, for instance, help you to change from firefighting towards long-term planning or from de-centralisation to centralisation. Or help you to develop a strategy with a broad-based support from the organisation.

The book presents the results of ten years of research at the Centre for Facilities Management – Realdania Research (CFM). CFM was established as a national research centre in Denmark with financial support from the private foundation Realdania on 1 January 2008 with the purpose of strengthening the research within Facilities Management.

This means that CFM had its ten-year anniversary by the start of 2018. This was celebrated with a whole day conference on 27 February 2018 at DTU. On that occasion, CFM launched two new publications in Danish: an anniversary book and a Guide to Facilities Management Tools. The present book in English includes a combination of the two anniversary publications.

The idea behind the book is to give a general overview of CFM’s research in the period from 2008 to 2017 by presenting the most important results of the practical applicable character from CFM’s research projects. The aim is to support students and practitioners in FM to improve the way they approach and deal with challenges in practice and help them to do their work and make decisions that are more robust and sustainable. The book is divided into two main parts.

The first part is a guide to 22 new tools for FM presented in an easily accessible way. The guide is organised in relation to five typical processes, that facilities managers often are involved in during their daily work. Four or five tools are presented for each process. The FM staff intended as users of the processes and tools are identified as five-person profiles. Each tool is presented with texts describing what, why, who and how, and an illustration with explanation. There is for each tool a reference to a chapter in the second part of the book where the tool is presented in more depth.
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The second part consists of 34 short chapters, which cover a project or result, including a central illustration of a model, method and/or tool, and often together with short case presentations. Twenty-two of the chapters concern tools that are introduced briefly in the first part of the book. Texts and illustrations are mostly based on earlier publications, but they have been edited in a standardised and concise form. Each chapter includes references to the most important literature with more detailed information about the results.