

Table of Contents

Preface.....	xxiii
Acknowledgment	xxxii
Chapter 1	
Smart Cities and Sustainability: A Complex and Strategic Issue – The Case of Torino Smart City	1
<i>Caterina Mele, Politecnico di Torino, Italy</i>	
Chapter 2	
Generative Computational Urban Planning Through Big Data Analysis	16
<i>Luca Saverio Valzano, Politecnico di Torino, Italy</i>	
<i>Carlo Caldera, Politecnico di Torino, Italy</i>	
<i>Carlo Luigi Ostorero, Politecnico di Torino, Italy</i>	
<i>Valentino Manni, Politecnico di Torino, Italy</i>	
<i>Andrea Galli, Accurat, Italy</i>	
Chapter 3	
Digital Twins Concepts, Challenges, and Future Trends.....	48
<i>Amged Sayed A. Mahmoud, Department of Industrial Electronics and Control Engineering,</i>	
<i>Faculty of Electronic Engineering, Menoufia University, Egypt</i>	
<i>Ezz El-Din Hemdan, Department of Computer Science and Engineering, Faculty of</i>	
<i>Electronic Engineering, Menoufia University, Egypt</i>	
Chapter 4	
A District Heating Socio-Technical System Approaching the Energy Transition: Issues of Energy	
Data Flows at the Urban Level.....	61
<i>Osman Arrobbio, Università di Torino, Italy</i>	
<i>Dario Padovan, Università di Torino, Italy</i>	
<i>Alessandro Sciullo, Università di Torino, Italy</i>	
Chapter 5	
Planheat Tool: A Bottom-Up Approach at District Level to Plan Low Carbon Future Scenarios	84
<i>Matteo Porta, Rina Consulting, Italy</i>	

Chapter 6	
BIM Simulation Lab: Fostering Digital Transformation in Local Small-Medium Enterprises and Public Administrations.....	106
<i>Gabriele Pasetti Monizza, Fraunhofer Italia Research, Italy</i>	
<i>Christoph Paul Schimanski, Fraunhofer Italia Research, Italy & Free University of Bolzano, Italy</i>	
<i>Giada Malacarne, Fraunhofer Italia Research, Italy</i>	
<i>Dominik T. Matt, Fraunhofer Italia Research, Italy & Free University of Bolzano, Italy</i>	
Chapter 7	
Smart Cities and Smart Societies: The Shock, or the New Paradigm for a Smart Society.....	129
<i>Roberto Pagani, Politecnico di Torino, Italy</i>	
<i>Gian Vincenzo Fracastoro, Politecnico di Torino, Italy</i>	
Chapter 8	
The DIM Approach for Digital Twin.....	153
<i>Matteo Del Giudice, Politecnico di Torino, Italy</i>	
Chapter 9	
KPIs to Drive Smart City Assessment	172
<i>Arianna Fonsati, Politecnico di Torino, Italy</i>	
Chapter 10	
EEB Project System Integration and Technology Sperimentation Matrix	196
<i>Francesca Maria Ugliotti, Politecnico di Torino, Italy</i>	
Chapter 11	
Connected BIM Models Towards Industry 4.0.....	219
<i>Daniela De Luca, Politecnico di Torino, Italy</i>	
<i>Monica Dettori, Politecnico di Torino, Italy</i>	
<i>Matteo Del Giudice, Politecnico di Torino, Italy</i>	
<i>Anna Osello, Politecnico di Torino, Italy</i>	
Chapter 12	
Smart City and Digital Twins: Definitions, Methodologies, and Applications	243
<i>Sara Giaveno, Politecnico di Torino, Italy</i>	
Chapter 13	
BIM Bin: Waste Management Through BIM and Digital Twin	265
<i>Ricardo Codinhoto, University of Bath, UK</i>	
<i>Olivia Becher, Oxford University, UK</i>	
<i>Jonathan Neil Heron, University of Bath, UK</i>	
<i>Vincenzo Donato, Università degli Studi di Firenze, Italy</i>	

Chapter 14	
Representing a Digital Twin City Model Using Open Source Tools and Integrating It With Dynamic Sensor Data	295
<i>Fabrizio Massara, CSI Piemonte, Italy</i>	
<i>Tatsiana Hubina, CSI Piemonte, Italy</i>	
<i>Sara Mannoni, CSI Piemonte, Italy</i>	
<i>Adelaide Ramassotto, CSI Piemonte, Italy</i>	
<i>Fabrizio Barbero, CSI Piemonte, Italy</i>	
Chapter 15	
Digital Twin for Smart School Buildings: State of the Art, Challenges, and Opportunities	320
<i>Valentina Villa, Politecnico di Torino, Italy</i>	
<i>Bernardino Chiaia, Politecnico di Torino, Italy</i>	
Chapter 16	
Exploiting BIM and Sensor Data Through Web-Based CAFM: The AR4FM Project	341
<i>Umberto Di Staso, Territorium Online, Italy</i>	
<i>Marco Piovano, Fraunhofer Italia Research, Italy</i>	
<i>Ambra Barbini, Fraunhofer Italia Research, Italy</i>	
<i>Dominik T. Matt, Fraunhofer Italia Research, Italy & Free University of Bozen-Bolzano, Italy</i>	
Chapter 17	
From Sketches and Installations to Bioinspired 5D Printing Models: Representation Interactions for Smart Cities	365
<i>Silvia Titotto, Federal University of ABC, Brazil</i>	
Chapter 18	
Quality of Urban Walking Routes: Interaction of Knowledge Systems for Integrated Representations	388
<i>Maurizio Marco Bocconcino, Politecnico di Torino, Italy</i>	
<i>Mariapaola Vozzola, Politecnico di Torino, Italy</i>	
<i>Anna Rabbia, Fondazione Sviluppo e Crescita CRT Torino, Italy</i>	
Chapter 19	
Combining BIM, GIS, and IoT to Foster Energy Management and Simulation in Smart Cities.....	425
<i>Edoardo Patti, Politecnico di Torino, Italy</i>	
<i>Francesco G. Brundu, Politecnico di Torino, Italy</i>	
<i>Andrea Bellagarda, Politecnico di Torino, Italy</i>	
<i>Lorenzo Bottaccioli, Politecnico di Torino, Italy</i>	
<i>Niccolò Rapetti, Politecnico di Torino, Italy</i>	
<i>Vittorio Verda, Politecnico di Torino, Italy</i>	
<i>Elisa Guelpa, Politecnico di Torino, Italy</i>	
<i>Laura Rietto, Politecnico di Torino, Italy</i>	
<i>Enrico Macii, Politecnico di Torino, Italy</i>	
<i>Andrea Acquaviva, Università di Bologna, Italy</i>	
<i>Alexandr Krylovskiy, Fraunhofer Institute for Applied Information Technology, Germany</i>	
<i>Marco Jahn, Fraunhofer Institute for Applied Information Technology, Germany</i>	

Chapter 20	
Customized Data Capture for BIM: Using APIs and Visual Programming	448
<i>Kjartan Gudmundsson, KTH Royal Institute of Technology, Sweden</i>	
<i>Giuseppe Digregorio, KTH Royal Institute of Technology, Sweden</i>	
<i>Jiayu Cui, KTH Royal Institute of Technology, Sweden</i>	
Chapter 21	
Participatory Design of Use Cases for an IoT Open Platform to Support Smart Urban Development: Approach and Method	469
<i>Alice Schweigkofler, Fraunhofer Italia Research, Italy</i>	
<i>Katrien Romagnoli, Fraunhofer Italia Research, Italy</i>	
<i>Gabriel Sanz Salas, Systems s.r.l., Italy</i>	
<i>Dieter Steiner, Fraunhofer Italia Research, Italy</i>	
<i>Michael Riedl, Fraunhofer Italia Research, Italy</i>	
<i>Dominik Matt, University of Bolzano-Bozen, Italy</i>	
Chapter 22	
Building Stock Energy Models and ICT Solutions for Urban Energy Systems	490
<i>Ilaria Ballarini, Politecnico di Torino, Italy</i>	
<i>Vincenzo Corrado, Politecnico di Torino, Italy</i>	
<i>Matteo Piro, Politecnico di Torino, Italy</i>	
Chapter 23	
Semantic Data-Driven Models to Improve Energy Efficiency in Buildings and Cities.....	515
<i>Álvaro Sicilia, ARC, Engineering and Architecture La Salle, Ramon Llull University, Spain</i>	
<i>Gonçal Costa, ARC, Engineering and Architecture La Salle, Ramon Llull University, Spain</i>	
<i>Leandro Madrazo, ARC, Engineering and Architecture La Salle, Ramon Llull University, Spain</i>	
Chapter 24	
BIM Tools for the Energy Analysis of Urban Transformation Projects and the Application to the Development of Healthcare Infrastructures	540
<i>Ezio Nicolas Bruno Urbina, Istituto Giannina Gaslini, Italy</i>	
<i>Elisa Spallarossa, Archimede s.r.l., Italy</i>	
Chapter 25	
Digital Twin for Maintenance Information Management: Scenarios and Perspectives for Sustainable Smart Cities	575
<i>Umberto Mecca, Politecnico di Torino, Italy</i>	
<i>Giuseppe Moglia, Politecnico di Torino, Italy</i>	
<i>Francesco Prizzon, Politecnico di Torino, Italy</i>	
<i>Manuela Rebaudengo, Politecnico di Torino, Italy</i>	

Compilation of References	602
About the Contributors	657
Index.....	669