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Hochschule
für Technik
Stuttgart

SMARTCITYSOLUTIONS

Module Descriptions

International Master Programme Smart City Solutions

Version: May 2023

Contents

Module 1 BS: Basics of Smart Solutions

MODULE LEADER: PROF. DR. IRIS BELLE

Conceptualized as an introduction, this module presents the global climatic, demographic, economic and societal challenges that smart city solutions can potentially redress and how their effect can be measured on a planetary and city scale.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload	ETCS
FT: S1 PT: S1	1 term	winter semester	yes	6	90 contact hours 90 non-contact hours	6

Must have completed	Participation required for	Language of instruction
n.a.	M 7, 9, 10	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
1.1 GDD	Global Climatic & Demographic Development Challenges	Prof. Dr. Iris Belle	Seminar	assignment and presentation	25%
1.2 SME	Sustainable Macroeconomics	Prof. Dr. Katharina Gapp-Schmeling	Seminar	written assignment	25%
1.3 CD	Societal Developments & Challenges	Prof. Dr. Iris Belle	Seminar	assignment and presentation	25%
1.4 SPM	Smart City Parameters & Measuring	Dr.-Ing. Hans-Martin Neumann	Seminar	written assignment	25%

Students discuss how technology, economic and social policy, behavioural shifts and monitoring techniques can help countries, regions or cities to mitigate or adapt to global warming and plan with economic and demographic imbalances to sustain quality of life on a planetary scale.

Learning Objectives

Upon successful completion of the module, students will be able to

- understand how global climate conditions and changes are influencing current and future living conditions in urban and rural regions;
- understand and assess the emergency of our global climatic, demographic development trajectory;
- argue for the use of smart city solutions to mitigate climate change and adapt to shifts in climate patters;
- identify physical and societal dynamics crucial for achieving development targets;
- motivate him/herself and a project team to conceptualize, design, implement and monitor smart solutions for cities and regions using scientific measurements and assessments to monitor effects and benefits;
- understand the 'smart approach' as a holistic method and recognize content and methods employed by researchers and practitioners from various disciplines;
- assess impacts of global and local development activity and inactivity on climate change;
- understand the interdependence of energy provision, of social, economic and ecological development and of the built environment;
- comprehend the impact of demographic shifts on the development of particular regions and cities;
- discuss urban and rural problems and smart solutions in the context of national and international macro- and microeconomic conditions;

- pinpoint impacts of smart solutions to the parameters of the smart city approach in general and apply them to specific locations;
- benchmark own targets and potential solutions against best practice examples for different sectors and establish a habit to monitor research on best practices from all over the world.

Learning Contents

- L.U. 1.1: Basics of climate science, demographic science, drivers of climate change, analysis of related risks and assessment of resulting consequences on regions and cities, avoidance strategies and resilience measures.
- L.U. 1.2: Drivers of macro- and microeconomic dynamics and the leverage of smart approaches; The continuum of public and private economic forces.
- L.U. 1.3: Regional and supra-regional influences on specific demographic developments including economic disparity, labour market, climate conditions, sociological conditions. Systems thinking, foresight and scenario techniques to plan with social and technological change.
- L.U. 1.4: The smart levers in the system; Smart city projects and their approaches to and experiences with Key Performance Indicators (KPIs).

Learning Methods

- Lectures
- Individual and group presentations
- Brainstorming and research sessions
- Field trips
- Practical exercises embedded in M9 Case Study

Applicability to other modules

- M 3 Smart Buildings
- M4 Smart Information Modelling & AI
- M7 Smart Sustainable Finance
- M 9 Case Study
- M 10 Master Thesis

Last update: May 2023

Module 2 SU: Smart Urbanism

MODULE LEADER: PROF. DR. IRIS BELLE

Smart urbanism is about digital, technological and entrepreneurial solutions to the way how inhabitants of an urban areas, such as cities and regions, interact with the built environment and innovative approaches to traditional town planning, land and real estate development.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload	ETCS
FT: S1 PT: S1	1 term	winter semester	yes	6	90 contact hours 90 non-contact	6

Must have completed	Participation required for	Language of instruction
n.a.	M 3, 4, 5, 6, 7, 9	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
2.1 SCC	Smart City & Smart Region	Johannes Schwegler, MBA	Seminar	assignment and presentation	25%
2.2 STP	Smart Town Planning & Land Policy	Prof. Dr. Iris Belle / PhD Carolin Dieterle	Seminar	written assignment	25%
2.3 SSI	Smart Social Infrastructure & Housing	Prof. Dr. Iris Belle	Seminar	assignment and presentation	25%
2.4 SUD	Smart Urban Development Principles & Concepts	Dr. Sc. ETH Haris Piplas	Seminar	written assignment	25%

Smart Urbanism is synonymous for achieving and maintaining liveable and sustainable urban environments. Smart urban planning processes integrate planning sectors and consider the effects of human activities in space across scale from the neighbourhood to the region. They integrate a plurality of stakeholder in the setting of goals and the definition of the planning strategy respecting existing legal frameworks. Urban planners of smart cities must possess integrative competence, enabling them to manage, moderate and monitor simultaneously occurring, dynamic processes.

Learning Objectives

Upon successful completion of the module, students will be able to

- understand the main aspects and requirements of urban and regional planning and of urban and regional development, their interdependencies and the instruments for steering development towards set goals;
- assess specific situations and recognize potential for improvement;
- interact with experts from other than the own discipline to achieve smart development;
- moderate integrated planning processes that set and pursue planning goals jointly with professionals from various urban planning sectors;
- recognize the importance of land-use types and principles of zoning (including technical infrastructure, social infrastructure and housing);
- recognize land-use rights, understand their historic evolution, and weigh between market forces, ownership rights of individuals and common interests;
- identify and assess smart planning tools and principles to assist in town and country planning

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Learning Contents

- L.U.2.1: Managing migration; Managing growth; Regional resources and the supply of the city; Migration and mobility
- L.U. 2.2: Urban structure; Urban space; Urban policies and sustainability; Planning systems, planning hierarchy and sectoral planning; Formal and informal settlements; Integrated master planning
- L.U. 2.3: Types of social infrastructure components; Demand and cost benchmarks with regard to providing the social infrastructure for health, education, sports; Project briefs for social infrastructure; Social housing; New housing typologies and types of ownership; Examples of centralized and decentralized infrastructure in neighbourhoods
- L.U. 2.4: Challenges and potentials of cities across the globe; Contemporary urban conditions, patterns and processes; Holistic understanding of social, economic and ecological processes in cities; Operational and practical knowledge necessary for developing a conceptual framework of integrated architectural, engineering, policy and urban solutions in cooperation between stakeholders (academia, NGOs, policymakers, and industry)

Learning Methods

- Pre-class reading
- Lectures
- Field trips
- Analysis of reference projects
- Individual and group research
- In-class presentations
- Integration in Module 9 (Case Study Project)

Applicability to other modules

- M 3 Smart Buildings
- M 4 Smart Information Modelling & AI
- M5 Smart Energy & Mobility
- M6 Smart Resources & Resilience
- M7 Smart Sustainable Finance
- M8 Governance, Citizens & Management
- M9 Case Study
- M 10 Master Thesis

Last update: May 2023

Module 3 SB: Smart Buildings

MODULE LEADER: PROF. DIPL.-ING. MARKUS BINDER

Smart Buildings introduces approaches to designing, building, planning and operating buildings resource-efficiently and enables students to make informed decisions about architectural form, material choices, technical, mechanical and digital systems.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload		ETCS
FT: S1 PT: S3	1 term	winter semester	yes	6	contact non-contact	90 h 90 h	6

Must have completed	Participation required for	Language of instruction
n.a.	M 9, 10	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
4.1 SAC	Smart Architecture Concepts	Prof. (em) Roland Dieterle	Seminar	assignment and presentation	25%
4.2 SEC	Smart Energy Concepts	Dipl.-Ing. Cathrin Krumrey	Seminar	assignment and presentation	25%
4.3 SET	Smart Engineering & Technologies	Ruben Pesch, M.Sc.	Seminar	Written assignment	25%
4.4 BIM	BIM & Certification Systems	Dipl.-Ing. Peter Scheibstock / Maroun Aad, M.Eng.	Seminar	assignment and presentation	25%

Buildings are the foundation for an energy-efficient future. Their construction and operation consume vast amounts of energy. The International Energy Agency estimated that one third of the world's energy consumption is used for operating buildings. Measures to achieve energy-efficiency targets in the building sector include zero-carbon-ready and circular-material codes for new buildings and for the renovation of the existing building stock. Building components need to be selected and joined so they can easily be separated at their end of-service life. Non-toxic materials need to be chosen that can be reused or recycled with little energy supply. Where possible heat pumps, solar PV and wind mills need to be installed to increase the share of renewable energy. The number of buildings connected to district heat must be increased significantly and solar thermal technologies applied. Buildings also need to support the shift from fossil fuel powered vehicles to electric ones and integrated electric vehicle chargers with building energy systems. Next to the technological possibilities residential behaviour changes can drastically decrease energy consumption. There is no other area where savings in consumption and improvements regarding circular economy and the use of renewable energy are easier to achieve than in the construction sector. Therefore, and in order to harness the possibilities of digitalisation smart city professionals must have a detailed understanding of the basics of building physics, of circular construction and traditional as well as innovative solutions in building design and operation.

Learning Objectives

Upon successful completion of the module, students will be able to

- understand the role of single buildings in the smart urban system
- assess architectural and technological concepts of smart and sustainable buildings regarding
  - functional and aesthetic quality
  - comfort and health, user satisfaction
  - energy demand and environmental impact
  - economic feasibility
  - robustness and resilience
  - interaction with public infrastructure and energy grids

Learning Contents

- L.U.3.1: Basics of architectural design and building typologies; criteria of architectural quality; Basics of design methods and the architectural planning process; Basics of design methods and the architectural planning process; Basics of sustainable architecture and climate adapted design; Building techniques and materials for sustainable architecture; Best practice buildings from different climatic zones; Architecture responding to life cycle demands and Design for Deconstruction (DfD)
- L.U. 3.2: Basics of climate and meteorology; Principles of passive design strategies; Principles of thermal performance of building envelopes; Basics of resilience; Best-practice concepts from different climatic zones
- L.U. 3.3: Energy efficient systems and components for heating, cooling, ventilation and lighting; Means of building-integrated or on-site energy generation, storage and transfer ; Basics of building automation and integration of subsystems; Energy management in buildings, typical profiles of energy demand and production; Interrelation between building systems and public infrastructure
- L.U. 3.4: Basics of Building Information Modelling (BIM); Basics of building certification; overview of certification systems (LEED, BREEAM, DGNB) and their criteria

Learning Methods

- Lectures, presentations, exercises

Applicability to other modules

- M 4 Smart Information Modelling & AI
- M 10 Master Thesis

Last update: May 2023

Module 4 IM: Smart Information Modelling & AI

MODULE LEADER: HAMIDREZA OSTADABBAS M.SC.

Understanding concepts of linking and referencing urban information geographically puts students in the position to design digital platforms and services which encourage sharing, reduce resource demand and monitor achievements of smart solutions.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload		ETCS
FT: S1 PT: S3	1 term	winter semester	yes	6	contact non-contact	90 h 90 h	6

Must have completed	Participation required for	Language of instruction
n.a.	M 9	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
4.1 SDC	Smart Data Components	Hamidreza Ostadabbas, M.Sc.	Seminar	assignment and presentation	25%
4.2 GIS	Geographic Information Systems	Dr.-Ing. Angela Blanco-Vogt	Seminar	assignment and presentation	25%
4.3 CIM	City Information Modelling	Dipl.-Ing. Carsten Rönsdorf	Seminar	assignment and presentation	25%
4.4 DPS	Digital Platforms & Services	Dipl.-Ing. David Hick	Seminar	assignment and presentation	25%

The smart city approach requires a paradigm shift with regard to information management. Evidence-based decision-making needs data. In order to achieve desired policy outcomes, we can model systems in urban environments, monitor and track behaviour, detect patterns and analyse, simulate or monitor interventions. The challenge is to use long-term and short-term data in a coherent model, providing actionable information to public administration and politicians, to interdisciplinary working experts and last but not least to citizens. Smart information modelling requires an understanding and constant reflection of different dimensions of the technical, political, cultural and ethical dimensions of data, which are inseparable. Objectives for collecting, processing linking, and analysing information, need to be grounded on ethical standards, fulfil political goals and mirror cultural values. How data is collected, formatted, processed, stored requires technical knowledge about ICT and IoT.
Digital information is increasingly analysed with the help of artificial intelligence such as pattern recognition algorithms, large language models, neuronal networks. The goal-oriented application of AI requires an understanding of information processing and conceptual skills. Data provision via user interfaces and collection of feedback must anticipate user expectations, needs and behaviours.

Learning Objectives

Upon successful completion of the module, students will be able to

- analyse a given task in the context of a smart city such as flood management and develop a data driven solution to quantify the problem;
- evaluate data-driven solution and the accuracy and appropriateness based on the available data an knowledge about date processing and data visualisation;
- develop a conceptual spatial data model and link geospatial data with smart sensors (mandatory Learning Unit “4.1 City Information Models”);
- use a Geographic Information System together with a spatial database to manage, analyse and visualize the relevant information (mandatory Learning Unit “4.3 Geographic Information Systems”);

- have an understanding about the legal issues pertaining to data privacy and be able to propose such strategies;
- develop strategies for data collection and administer data collection including the evaluation and assessment of collected data;
- know and differentiate between different types of artificial intelligence and their fields of application.

Learning Contents

- L.U.4.1: Relational and object-relational database systems; High-level conceptual data models (XML Schemata and UML); Structured Query Language (SQL) for non-spatial and spatial data; Standard data model of the open geospatial consortium (OGC)
- L.U. 4.2: Map design using a GIS application; Integrate existing data sets into the data model; Connect GIS application with spatial database; Perform spatial analysis in GIS application
- L.U. 4.3: City Information Modelling and Digital Twins; Varity of datasets in cities and approaches to making data accessible; Purpose and objectives of decision support systems; Definition of OKRs (Objectives and Key Results); Ethics framework for provision and use of data; Data availability in data interoperability; Data standards and data structures including CityGML
- L.U. 4.4: Fundamentals: Urban data platforms and the relation to new governance models and urban data economies; Typologies of urban data platforms (city dashboards, open data portals, performance monitoring city scores, data stores and market places); Specific knowledge illustrated with reference projects on: The difference between open data, citizen data and private data; Open data platforms for online engagement processes of citizens, public and private stakeholders; City dashboard applications as reporting tools; Data-driven infrastructure services and applications; Collaborative services; Business models related to city data management platforms; Start-ups in the field of data management platforms; Interface design of urban data platforms

Learning Methods

- Lectures
- Group exercises
- Sprint online search
- Presentation
- Integration in M9 Case Study

Applicability to other modules

- M7 Smart Sustainable Finance
- M8 Governance, Citizens & Management
- M9 Case Study
- M 10 Master Thesis

Last update: May 2023

Module 5 EM: Smart Energy & Mobility

MODULE LEADER: PROF. DR.-ING. MARKUS SCHMIDT

Smart Energy & Mobility looks into optimizing or re-thinking energy and mobility services provided by power grids and storage or transportation networks and vehicle fleets. Students explore mind-shifting perspectives and business models with regards to consumption, distribution, life-cycle costs and maintenance practices.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload		ETCS
FT: S2 PT: S2	1 term	summer semester	yes	6	contact non-contact	90 h 90 h	6

Must have completed	Participation required for	Language of instruction
n.a.	M 9	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
5.1 SEG	Smart Energy Generation	Prof. Dr. Andrej Pustisek	Seminar	assignment and presentation	25%
5.2 SGS	Smart Grid Solutions	Dr.-Ing. Tobias Weißbach	Seminar	written assignment	25%
5.3 SMM	Smart Mobility Strategies & Management	Dr. Barbara Flügge	Seminar	assignment and presentation	25%
5.4 SEM	Smart Operations & Maintenance	Prof. Dr.-Ing. Axel Norkauer / Dipl.-Ing. Johannes Winter	Seminar	written assignment	25%

Smart Cities use only a fraction of energy and this comes mostly from regenerative sources. Multi-modal mobility, intelligent and emission-free traffic systems are additional contributions to saving energy and to pollution reduction. This is locally improving the quality of life: better health conditions, less noise, less danger, more usable urban space and easier mobility. Experts can only speed up the transition to a clean energy future if they think in terms of transportation and transmission infrastructures that respond to innovations in energy creation and mobility demands.

Learning Objectives

Upon successful completion of the learning unit, students will be able to

- understand and in their projects refer to the main elements of smart energy generation and smart grid solutions;
- understand and assess key components of (smart) energy systems;
- understand current and future interactions and interdependencies between key sectors and systems in energy provision and consumption, particularly between power supply and mobility;
- understand instruments of regulation and deregulation;
- appraise the political environment of regulatory instruments;
- approximate the economical results of energy and mobility policies;
- understand the potential of smart-grids and their specific requirements;
- distinguish between and know the characteristics of the main elements of smart mobility;
- know the key elements of traffic;
- know new types of mobility concepts and their role in the complex problems of traffic systems;
- assess the development of transportation in the near and more distant future using models and scientific prognoses;
- know about planning, maintenance and operation of traffic, road and urban cable car.

Learning Contents

- L.U.5.1: Key (physical and commercial) principles and definitions of: Basics of the energy industry; Primary energy production, transport, and consumption/utilization; Electrical power generation, transport and consumption/utilization; Different types of power plants, their basic functional principles, their advantages and disadvantages – with special emphasis on urban distributed, renewable power generation; Energy storage and transportation: functions, principles and economics; Interactions and interdependencies between heating, electrical power and mobility infrastructures today and in the future
- L.U. 5.2: "Smart" infrastructure with a high level of adaptability and changing requirements; Integration of large fluctuating power sources (e.g. wind energy) in power grids; increased Europe-wide transportation of energy; Deployment of increased decentralised generation capacities in distribution grids and efficiency of energy management systems; Networks of generating sources on a local and regional level using smart grid with central computers; Energy supply prognoses and resulting price calculations; Business models for smart grids; Technical and financial risks of smart grids; Current applications and trends in global energy management
- L.U. 5.3: Basics of technology and application of all traffic systems, rail-bound and non-rail-bound transportation, railways, underground, trams, cars; Elements and composition of local and supra-local traffic systems; Function and effectiveness of traffic systems; Technical operation of traffic systems; Maintenance of traffic systems (inspection, service and maintenance); Optimization of traffic systems, control plans; Models and technology for the future for handling prospective traffic; Reference projects (national and international)
- L.U. 5.4: Public Transport: Overview of Operation and Maintenance Centres ("depots") in light rail (tramway) / heavy rail; Utility relocation: a key issue in early phases of tramway projects; Overview of procurement options in tender processes; Roads: Overview of road operation and maintenance including organization and financial funding; Particular Operation and Maintenance procedures (winter maintenance, road inspection service, summer maintenance); Examples of contemporary issues in road operation and maintenance and possible responses balancing the conflict between ecology and economy; Savings potential in the highway operations service; Cable-propelled transport systems: Overview of Life Cycle Management tools to define a long-term O&M contract; Overview of performance criteria within a contractual framework; Basic definitions and processes for defining a scope of service for contracts; Overview of the sustaining process to guarantee the performance of the system, people and processes within the lifecycle of the transport system

Learning Methods

- Lectures
- Presentation
- In-class exercises and instructed workshops

Applicability to other modules

- M9 Case Study
- M 10 Master Thesis

Last update: May 2023

Module 6 RR: Resources & Resilience

MODULE LEADER: PROF. DR.-ING. MARKUS SCHMIDT

Understand and apply methods that help cities and regions managing or mitigating imminent threats like overheating, storm, flooding, drought, and fire by integrating eco-system services, foresighted planning and monitoring.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload		ETCS
FT: S2 PT: S2	1 term	summer semester	yes	6	contact non-contact	90 h 90 h	6

Must have completed	Participation required for	Language of instruction
n.a.	M 9	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
6.1 SWW	Smart Water & Waste Management	Dipl.-Ing. Lutz Deeken MBA; M. Eng. Dipl.-Ing. Markus Bleier	Seminar	assignment and presentation	25%
6.2 PPR	Pollution Prevention & Recovery Strategies	Prof. (em) Dr. Jürgen Breuste	Seminar	assignment and presentation	25%
6.3 SUB	Urban Biosphere & Habitat	Prof. (em) Dr. Jürgen Breuste	Seminar	assignment and presentation	25%
6.4 RSM	Resilience Strategies & Measures	Dr.-Ing. Nicole Baron	Seminar	written assignment	25%

Without air, water and soil life is impossible. Smart cities control and eliminate emissions and reduce the ecological footprint of human activity. Accelerating climate change confronts cities with new environmental challenges. They need to develop new solutions to become resilient against storm, flooding, drought, and fire.

Learning Objectives

Upon successful completion of the learning unit, students will be able to

- identify physical threats for citizens by pollution of air, water and soil;
- take measures in order to rehabilitate those basic resources;
- develop concepts to avoiding future pollution;
- comprehend how waste can be avoided and can be utilized as a valuable resource;
- understand cityscapes as well as natural biospheres and habitats;

Learning Contents

- L.U.6.1: Water and wastewater: Definition of water sources, their characteristics and usage; Basics of water and wastewater treatment technologies; Basic pipeline and network hydraulics (introduction of software modelling software); Definition of water losses and introduction to techniques to reduce water losses; Water quality standards; Organizational and business models common in the water and wastewater sector; Maintenance in water and wastewater systems; Examples (national and international) of smart water and wastewater systems
  Solid waste management: Objectives of waste management; Constraints and technologies for collection; Constraints and technologies for waste treatment; Content of a waste management concept

- L.U.6.2: Quality of water resources – prevention and recovery from contaminations; Quality of soil in urban environments – prevention and recovery from contamination; Quality of the air in urban environments – prevention from pollution and improvement measures
- L.U. 6.3: The socio-ecological context of urbanism; Natural areas for protecting from disaster events; Food security; Habitat and green spaces; Impact on health and wellbeing; Livelihoods and green economy; Water resources
- L.U. 6.4: Flood events in combination with heavy rainfall; Flood events in coastal urban areas; Storm events, also in combination with flood; Drought and water shortage; Rising sea levels
- analyse potential and existing environmental threats and propose measures to protect urban agglomerations from flooding, storm damages, drought and fire risks.

Learning Methods

- Lectures and guest lectures
- Sprint online search
- Field trips
- Reference projects
- Individual and group research and presentation
- Peer-to-Peer feedback
- Scientific short paper, including detailed feedback

Applicability to other modules

- M9 Case Study
- M 10 Master Thesis

Last update: May 2023

Module 7 SF: Smart Sustainable Finance

MODULE LEADER: PROF. DR. TOBIAS POPOVIĆ

Understanding the aspects and the state of sustainable finance helps students assessing possibilities of funding for smart city solutions and identify new approaches particularly related to financing the built environment and related technology and concepts.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload		ETCS
FT: S2 PT: S4	1 term	summer semester	yes	6	contact non-contact	90 h 90 h	6

Must have completed	Participation required for	Language of instruction
M1 Basics of Smart Solutions, M10.1 Academic Writing	M 9	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
7.1 FMI	Financial Markets & Institutions	Andy Yarahmadi, MBA	Seminar	assignment and presentation	25%
7.2 SFI	Sustainable Finance	M.Eng. Sven Stein, MBA	Seminar	assignment and presentation	25%
7.3 IPF	Infrastructure & Project Finance	Mehul Patwari, MBA	Seminar	assignment and presentation	25%
7.4 DFI	Digitalization, Financial Innovation & Technology	B.Sc. Svenja Gillé	Seminar	written assignment	25%

The so-called "grand challenges", namely climate change and multiple disruptions like digitization foster a complex and rapidly changing environment of metropolitan areas and industries. The technological progress that shapes this environment, and ideally contributes to a more sustainable way of life, requires significant investments. This is especially true in cities of less and least developing countries where particularly the implementation of smart city-concepts can help to leapfrog development. It is crucial to understand how to tap financial markets to undertake these investments and make a positive impact.

Learning Objectives

Upon successful completion of the learning unit, students will be able to

- understand the relevance of financial markets and institution for finding adequate and innovative financing solutions for smart cities;
- comprehend in what way smart cities provide an ecosystem to foster sustainable innovation and understand how the concept of sustainable finance and its instruments enables smart cities to finance activities in the field of sustainable development (e.g. renewable energies);
- understand smart cities' needs for sustainable and smart infrastructures, apply investment appraisals and capital budgeting methods with infrastructure projects in smart cities and implement adequate financing concepts;
- comprehend how technological disruptions like digitization and artificial intelligence provide for significant challenges as well as for major opportunities for smart cities. In addition, students will understand in what why digitization and artificial intelligence and related technologies (e.g. blockchain) can foster financial innovations and how smart cities can use these innovations to unlock their own potential.

Learning Contents

- L.U. 7.1 Financial Markets & Institutions: Financial Markets' Relevance for Smart Cities; Background: financial markets and banking crisis, Euro crisis, debt crisis; Financial markets and

their segments; Portfolio theory and management; Typology of financial institutions; (Regulatory) framework for financial institutions
- L.U. 7.2 Sustainable Finance: Background: smart cities as ecosystems for sustainable innovation; Basics of sustainable development and sustainability management; Sustainable finance; Sustainable investments (SI); Sustainable innovation/entrepreneurship for smart cities; Areas of application
- L.U. 7.3 Infrastructure & Project Finance: Background: smart cities' needs for sustainable and smart infrastructures; Infrastructure investments; Investment appraisal and capital budgeting; Financing concepts and instruments; Financials (statement) analysis, ratios and ratings; Risk and risk management
- L.U. 7.4 Digitization, Financial Innovation & FinTech: Background: smart cities as ecosystems for innovation; Financial innovation; FinTechs, InsurTechs, etc. as challengers for traditional financial institutions; Areas of application in the context of smart cities

Learning Methods

- Lectures
- Reference project analysis
- Tutorials
- Individual assignments
- Presentations

Applicability to other modules

- M9 Case Study
- M 10 Master Thesis

Last update: May 2023

Module 8 SM: Smart Governance, Citizens & Management

MODULE LEADER: PROF. DR. IRIS BELLE

Understanding the mechanisms of good governance and the techniques of management will enable smart city experts to set goals, navigate decision-making and organisational structures, and complete projects for the benefit and with the acceptance of all citizens.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload		ETCS
FT: S2 PT: S4	1 term	summer semester	yes	6	contact non-contact	90 h 90 h	6

Must have completed	Participation required for	Language of instruction
M10.1 Academic Writing	M 9	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
8.1 PPG	Principles of Public Policy & Governance	Felix Bossner, MA	Seminar	Written assignment and presentation (8.1 and8.2 combined)	50%
8.2 PSS	Public Services & Public Sector Management	Felix Bossner, MA	Seminar		
8.3 LAM	Smart & Agile Management Approaches	Prof. Dr. Iris Belle	Seminar	assignment and presentation	25%
8.4 LSM	Leadership & Stakeholder Management	Prof. Dr. Iris Belle	Seminar	written assignment	25%

Governance is the coordination of decision-making based on mutual agreement in the best common interest. Governance can span decisions across administration, the private economy, individual and organized citizens. Governance is not synonymous with government. Government, in democratic societies is legitimized by vote and acts according to a ratified constitution. Governance is also different from public administration which usually operates along defined processes and hierarchies. Yet, governance relies on its actors' trust in institutions, state organs like government departments and public administration as well as traditional institutions like the family or religious organizations. Management strives to define and organize tasks with the aim of delivering outcomes. Attributes of good governance are transparency, responsibility, accountability, participation, responsiveness, access, equity, equality, fairness and voice. Management techniques help to set up enterprise or administrative structures, determine strategic relevance and direction.

Learning Objectives

Upon successful completion of the module, students will be able to

- discuss basic theories and methods of public governance and public policy;
- apply those methods to smart city project-related problems, particularly when planning and implementing smart city projects;
- discuss the reasoning behind governmental activities and governmental decision-making;
- understand the differences between public and for-profit acting, deciding and steering;
- assess differences in organizational patterns with regards to their pros and cons;
- identify innovative ways for public administration and for organizations in general;
- understand lean and agile management principles and is their limits in public administration contexts;
- know the difference between management and leadership;
- discuss characteristics of leadership with regards to individual leadership experiences;
- assess the applicability of leadership models for their future working environment;
- anticipate or recognize and solve problems in a team from a leader's perspective;

- know and be able to apply strategy tools for leaders;
- understand stakeholder management concepts, tools and practices for their involvement;
- perform a stakeholder analysis and identifying potentials for leveraging participation from stakeholders from various backgrounds;
- discuss approaches towards stakeholder management with regards to balancing short-term and long-term interest and change aversion;
- appraise the role of leadership and stakeholder management for the smart city approach.

Learning Contents

- L.U. 8.1 Principles of Public Policy & Governance: General concepts and frameworks of policy science (e.g. issue attention cycle, policy cycle…); What is policy making?; Difference between policy, politics and polity; Why is the implementation phase the critical phase and why does implementation fail?; Intervention strategies
- L.U. 8.2 Public Services & Public Sector Management: Organization theories; Organizational behaviour in general and in particular for public services; Bureaucracy as an organizational form and its boon and bane; Public sector reforms; Power of bureaucracy in western democracies; Organization culture and its impact on change initiatives; Change management basics and methods; Basic insights in citizen involvement
- L.U. 8.3 Smart & Agile Management Approaches: Management Concepts; Projects and Project Management; Agile Project Management; Tools and techniques in Agile Project; Management; Lean Management; Tools and techniques in Lean Management; Organizational requirements for Agile and Lean Management; Key Performance Indicators to measure success
- L.U. 8.4 Leadership & Stakeholder Management: From expert to leader; Lateral leadership; Basic strategic competence and strategy tools for leaders; Leading teams; Characteristics of a team; Solution oriented leadership; Motivation; Managing conflicts; Stakeholder analysis and mapping; Stakeholder analysis methods in urban planning contexts; Stakeholder management methods and techniques

Learning Methods

- Lectures, presentations, group exercises, self-assessment of leadership skills, presentations and discussions

Applicability to other modules

- M9 Case Study
- M 10 Master Thesis

Last update: April 2023

Module 9 CS: Case Study

MODULE LEADER: PROF. DR. IRIS BELLE

With the Case Study students develop a smart city strategy and outline possible solutions, explore synergies and highlight benefits of integrated design. The case study is a real-world urban project that gives students the opportunity to demonstrate an understanding of the potential of the site, the requirements of the Case Study host and the ability to transfer knowledge gained in Modules 1 – 8 in a coherent and goal-oriented way.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload		ETCS
FT: 1, 2 PT: 1, 2	2 terms	Summer semester	yes	12	contact non-contact	180 h 180 h	12

Must have completed	Participation required for	Language of instruction
Must participate in M1, 2 for M 9.1 and in M5, 6 for M9.2	M10 Master Thesis	English

Learning Unit	Type	Lecturers	Type	Assessment	Weight
9.1 CS1	Basics, Urbanism, Buildings, Information	Prof. Dr. Iris Belle, Damian Wagner-Herold, M.Sc.	Seminar	assignment and presentation	50%
9.2 CS2	Infrastructure, Management, Finance, Governance	Prof. Dr. Iris Belle, Damian Wagner-Herold, M.Sc.	Seminar	written assignment and presentation	50%

The Case Study is the integral part of the application-oriented study course. It links theoretical content studied, reference projects examined and smart city solutions analysed, described and adapted in Modules 1–8 to a real-life project. Lecturers give examples how students can integrate the newly acquired knowledge and methods in the case study project. The Case Study host varies each year. Host can be municipalities, real-estate developers, real estate departments of corporations, utility companies or any organisation that seeks to develop or re-develop a site or develop and implement a smart city strategy for an existing geographically defined area.
The case study will be organized and facilitated by two lectures. The Case Study module leader will brief all lecturers on the case study each September and share material and objectives. Two weeks before their first teaching day lecturers will receive a progress update. Contents of the learning units will be integrated sequentially into the case study projects. They are invited to join the kick-off, the mid-term review and the final review.

Learning Objectives

Upon successful completion of the learning unit, students will be able to

- analyse a project with regard to the topics of the modules 1–4 Basics of Smart Solutions, Smart Urbanism, Smart Buildings, and Smart Information Modelling;
- analyse the same project with regard to the topics of the modules 5–8: Smart Energy & Mobility, Smart Resources & Resilience, Smart Sustainable Finance, and Smart Governance & Management;
- define a project vision and derive project goals;
- develop purposeful location-based concepts for smart city solutions (combining traditional urban design and architecture strategies with information and technology-based strategies);
- specify and request information and data to further their concepts in a structured manner;

- put themselves in the role of various stakeholders in the case study project (developer, citizen, architect, planning officer, engineer, project manager, technology provider);
- design, prepare, conduct and document a goal-oriented discourse in the form of a moderated workshop;
- demonstrate how synergies between urban sectors can create benefits;
- deal with the frequent and unpredictable change immanent to technological innovation in all smart-city domains through research strategies, agile work flows and continuous consultation of sources about smart city solution news;
- act in a socially and ecologically responsible manner and reflect upon the impact of theory and practical application to liveability and climate friendliness.;
- present a concept in a convincing manner, graphically, in text, as a booklet, as posters and oral presentations;
- contribute to the SCS database of smart city solution cards.

Learning Contents

- L.U. 9.1: Project development in a dynamic master planning process (M2); Actors in the process, interests and goals and motivations and decision-making powers; SWOT analysis in urban planning; Visons based on social and demographic trends (M1); Goal setting with climate and social inclusion targets in mind; Devising a project-specific system of key performance indicators; Date requests: asking for data in a goal-oriented manner and using it in planning (M4); Transfer theory into practice, concept development of smart city solutions (M1-4); Examples of consistent urban and architectural design and planning strategies; Presentation design and presentation strategy
- L.U. 9.2: Development of a Smart City toolkit; goal-oriented stakeholder workshop, including documentation; Project management competence (M8); Stakeholder management and action plan (M8); Synergy map; Poster-presentations and booklet-making

Learning Methods

- Site visits (supervised and unsupervised)
- Role play/ role model canvas
- SWOT analysis
- Trend analysis / trend molecules
- Goal-based scenarios
- Design thinking
- Data request sheet
- Presentation of work outcomes to the case study host
- Guest lectures
- Discussions
- Workshop preparation, conducting, evaluation and documentation
- Poster and booklet design

Applicability to other modules

- M 10 Master Thesis

Last update: May 2023

Module 10 MT: Master Thesis

MODULE LEADER: PROF. DR. IRIS BELLE

The master thesis is an 18-weeks deep-dive where the candidate explores one main smart-city field in relation to selected others and develops either a tool to approach the stated problem and suggests solutions or applies a transferable methodology to a specific context thereby solving an urban challenge.

Semester	Duration	Frequency	Compulsory subject	Hours/week equivalent	Workload		ETCS
FT: S1, 2, 3 PT: S1, 4, 5	3 terms	any semester	yes	30	contact non-contact	105 h 795 h	30

Must have completed	Participation required for	Language of instruction
48 credit points of the total credit points to be gained, of which at least 6 modules from modules 1-8 and the module 9	n.a.	English

Learning Unit	Type	Semester	Lecturers	Type	Assessment	Weight
10.1 ACW	Academic Writing & Smart City Literature	FT: S1 PT: S1	Prof. Dr. Iris Belle	Seminar	written assignment	5%
10.2 MTP	Master Thesis Proposal	FT: S2 PT: S4	Prof. Dr. Iris Belle	Seminar	written assignment	5%
10.3 MTR	Master Thesis Research	FT: S3 PT: S5	Prof. Dr. Iris Belle	Seminar		
10.4 MTPSC	Master Thesis Project	FT: S3 PT: S5	All professors and lecturers	Thesis project	written assignment	90%
10.5 MTAP	Master Thesis Presentation & Abstract	FT: S3 PT: S5	Prof. Dr. Iris Belle	Seminar		

In the thesis project students further their academic skills and reflect their future career path. Specifically, the Master Thesis Project requires students to develop more detailed expertise in a single smart city field. The joint academic and industry supervision ensures that students work on their projects both in an academical way and in a way that is relevant to the industry. The thesis project is conducted in individual consultation sessions with the supervisors.
Students acquire and demonstrate universally applicable skills like academic writing, proposal writing (including the feasible drafting of the master thesis project plan in terms of relevancy, state-of-the-art, research methodology, time-schedule and supervisor management), the command of various research methods, master thesis presentation and written abstract. This knowledge is conveyed in seminar-style formats.

Learning Objectives

Upon successful completion of the module, students will be able to

- distinguish between different genres of essays and compose a scientific essay that follows other criteria than the engineering-specific projects which are mainly based on practical work and which most of them are familiar with since their first higher education degree;
- align their career goals and professional aspirations with the knowledge acquired during the programme and formulate a research project proposal accordingly;
- commence and complete their master thesis independently by formulating a research objective, performing literature review, deriving a research question, conceptualising and executing the research design including the design of the research methodology;
- present their research in text and graphics to a readership and orally to a live audience, take questions and answer them in a reflected, balanced and professional way.

Learning Contents

- L.U. 10.1 Academic Writing & Smart City Literature: Text analysis; Structure of an academic essay; Literature review and types of literature; Note taking; Mind maps; Harvard Anglia Style referencing system; Referencing software; Plagiarism; Peer-review and peer-reviewing techniques; Chat GPT and others
- L.U. 10.2 Master Thesis Proposal: Finding and testing a thesis topic; Most common problems with thesis topics; Thesis outcome and goal-oriented research; Preparing the research outline; Master thesis structure; Introduction to SCS Master Thesis Guide; Time and task management (steps composing the proposal); Research design; Master thesis timeline; Identifying, approaching and managing a supervisors
- L.U. 10.3 Master Thesis Research: Research techniques and research design specific to participants projects; Supervisor management, schedule management, progress reports; Methods of data collection: questionnaires, interviews etc.; Strategies for data analysis and evaluation; Strategies for data presentation; Methods of layout
- L.U. 10.4 Master Thesis Project: Master thesis research and writing; Self-reliance in research and time management
- L.U. 10.5 Master Thesis Presentation & Abstract: Dealing with different native and non-native accents, intonation patterns, subject language and vocabulary; Presentation language and terminology, sign posting, structure and technique; Improving slides and visuals; Delivery skills, fluency development, articulation, clarity and pronunciation including pacing, pausing, rhythm and intonation; Non-verbal communication; Managing questions; Group and individual practice activities; Feedback and correction; Assessment; Requirements of journal for research abstract, elements of research abstracts, strategies for writing clear and concise research abstracts.

Learning Methods

- Lectures
- Essay
- Peer-review
- Proposal
- Pitch-coaching
- Brainstorming, mind-mapping and presentations
- Matching with potential external supervisors
- Monthly stand-ups (progress reports and commitments for next steps)
- Passive listening as a problem-solving tool
- Independent study
- Regular progress feedback, assessment, practical demonstrations
- Peer-feedback
- Individual desk review sessions

Applicability to other modules

- L.U. 10.1 for all L.U.s with written assignments
- L.U. 10.5 for all L.U.s with presentations

Last update: April 2023

Module recommendations to top-up a 180 ECTS bachelor

Please discuss modules to top-up with Dean of Studies. You may propose Modules from following Master Degrees:

Master Programme International Project Management
Language: English
Faculty of Architecture and Design
Point of contact: Ms. Kristina Sassenberg, ipm@hft-stuttgart.de
Teaching days: Thursday, Friday, Saturday, Monday
Mode of teaching: Block seminar
All Modules on offer are suitable except for Summer Semester Module 1 Technical Basics (Joint course with Smart City Solutions).

Master Stadtplanung
Language: German
Faculty of Architecture and Design
Point of contact: Mr. Henning Mackwitz M.Eng. stadtplanung@hft-stuttgart.de
Teaching days: Tuesday, Wednesday, Thursday, Friday
Mode of teaching: weekly classes
Selected Modules

Document version update history

15.05.2023
- Learning Unit 1.2 Mehul Patwari, MBA lecturer
- Learning Unit 2.3 renamed as “Smart Social Infrastructure & Housing”

01.05.2023
- New layout
- Update of all lecture units
- All lecture units expanded by “Type of assessment”, “scope of assessment”,” Composition of Grade”
- Module recommendations to top-up a 180 ECTS bachelor added
- Learning Unit 1.2 Prof. Dr. Iris Belle Module lecturer
- Learning Unit 2.4 Dr. Haris Piplas lecturer
- Learning Unit 2.2 Smart Town Planning & Land Policy and Learning Unit 2.4 Smart Urban Development Principles & Concepts were swapped in sequence as result of Student Committee Decision
- Module 4 expanded “& AI”, Hamidreza Ostadabbas, M.Sc. Module leader
- Module 4.1 Hamidreza Ostadabbas, M.Sc. lecturer
- Module 6.1 Dipl.-Ing. Lutz Deeken, MBA & M. Eng. Dipl.-Ing. Markus Bleier lecturers
- Module 7.2 Sven Stein, M. Eng. MBA lecturer
- Learning Unit 10.1 expanded “& Smart City Literature”

September 2022
- Learning Unit 2.4 Dipl.-Ing. Ruben Pesch lecturer
- Learning Unit 3.4 Dipl.-Ing. Peter Scheibstock & Maroun Aad, M.Eng.

February 2022
- Module 1 Prof. Dr. Iris Belle Module Leader
- Module 2 Prof. Dr. Iris Belle Module Leader
- Learning Unit 7.4. Prof. Dr. Tobias Popovic & Svenja Gillé, B.Sc. lecturers
- Module 8 Prof. Dr. Iris Belle Module Leader
- Module 9 Prof. Dr. Iris Belle Module Leader, Prof. Dr. Iris Belle, Damian Wagner-Herold M.Sc. lecturers for all learning units
- M10 Master Thesis and M11 Master Thesis Project merged to M10 Master Thesis, Prof. Dr. Iris Belle Module Leader and lecturer for all Learning Units.

2018
- First accreditation