Hochschule für Technik Stuttgart
Master Programme
Smart City Solutions

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Hochschule
für Technik
Stuttgart

Master Programme SCS

Module Descriptions

June 2019

1 Basics of Smart Solutions

Module Leader: Prof. Roland Dieterle

Learning Units	
1.1 Global Climatic & Demographic Developments/ Challenges	Dr. Nadine Kuhla von Bergmann
1.2 Sustainable Macroeconomics	PhD Katharina Gapp / Dr. Holger Rogall
1.3 Societal Developments/Challenges	Dr.nat.rer. Stefan Carsten
1.4 Smart City Parameters & Measuring	Prof. Roland Dieterle / Dr. Andrea Bräuning

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 1	6	6	84/96	Seminar	Assignment/Presentation

Learning objectives:

Prefaces (UN / Habitat III):
Half of humanity – 3.5 billion people – lives in cities today. By 2030, almost 60 per cent of the world's population will live in urban areas. 95 per cent of urban expansion in the next decades will take place in developing world. 828 million people live in slums today and the number keeps rising. The world's cities occupy just 3 per cent of the Earth's land, but account for 60-80 per cent of energy consumption and 75 per cent of carbon emissions. Rapid urbanization is exerting pressure on fresh water supplies, sewage, the living environment, and public health. But the high density of cities can bring efficiency gains and technological innovation while reducing resource and energy consumption.

These statements specify the basics of the Smart City Agenda on a global and also on a local level.
Students will have the ability to:

- Understand the 'Smart Approach' as a holistic method and recognize different contentual and methodical emphases of different providers and reseachers
- Understand how the global climate conditions and changes are influencing the current and future living conditions in particular regions; in return they are able to conceive how global and local developments, activities and inactivities can cause impacts on the global climate.
- Comprehend the impact of demographic movements on the development of particular regions and cities
- Understand the impact of societal developments for future urban structures
- See cities and smart measures in the context of national and international macro- and microeconomic conditions
- Understand the parameters of the Smart City approach and to analyse the specific situation in different places
- benchmark own targets and potential solutions against best practice examples for the different sectors and to do continuous research on best practices all over the world

Learning contents:

- L.U. 1.1: Basics of Climate Science, drivers of Climate change, resolving consequences on regions and cities
- Analysis of involved risks, avoidance strategies and resilience measures
- L.U. 1.1: Regional and supra-regional influences on specific demographic developments including economic disparity, labour market, climate conditions, sociological conditions etc
- L.U. 1.2: Drivers of macro- and microeconomic conditions and its conjunction with Smart approaches; The interplay of public and private economic forces
- L.U. 1.3: The Smart 'Adjustment Screws'; different Smart City models and approaches, divergent and corresponding stakeholder interests,

Learning methods:

- Lectures
- Case Studies
- Individual and Group research and presentations

2 Smart Urbanism

Module Leader: Dr. Nadine Kuhla von Bergmann

Learning Units	
2.1 The Smart City in an Smart Region	Johannes Schwegler, MBA
2.2 Smart Urban Development Principles & Concepts	Dr. Nadine Kuhla von Bergmann
2.3 Smart Social Infrastructure & Accommodation	Dr.-Ing. Florian Wiedmann
2.4 Smart Town Planning; Land Policy	Dr. Nadine Kuhla von Bergmann/ PhD Carolin Dieterle

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 1	6	6	84/96	Seminar	Assignement/Presentation

Learning objectives:

Prefaces
Smart Urbanism is a key instrument in order to achieve and maintain liveable, manageable and bankable urban enviroments in very different framework conditions. Smart urban planning processes are strongly interlinked with all other components of the smart approach. All stakeholder are required to know the success factors and means of urban development and urban planners need more integrative competence, enabling them to manage and moderate more and more simultaneous and dynamic procedures.

Students will have the ability to:
- understand the major criteria of urban development, its interdependencies and the 'leverage' tools in order to make intended developments happen
- assess the specific situation and recognize the potential to change things to the better
- interact with other experts with regard to Smart Development and take moderate interactive planning processes
- outline the functions of urban demand (including technical and social infrastructure and housing) and principles of zoning

Learning contents:

According to actual description of particular learning units (appendix...), e.g.:
- The city in its regional context
- The principles of urban structure and space
- The planning approaches and tools
- The legal framework for urban planning and related processes
- The social facilities of a Smart City
- Affordable accommodation
- The relation between public and private and the in-between

Learning methods:

- Lectures
- Case Studies
- Individual and Group research & presentation
- Field Trips

3 Smart Buildings

Module Leader: Prof. Markus Binder

Learning Units	
3.1 Smart Architecture Concepts	Prof. Roland Dieterle
3.2 Smart Energy Concepts	Dipl.-Ing. Cathrin Krumrey / Dr. Dilay Kesten Erhart
3.3 Smart Engineering & Technologies	Dr. Tobias Erhart / Dr. Dilay Kesten Erhart
3.4 Planning & Building Processes (incl. BIM, Certif.)	MArch Dipl.-Ing. Thomas Kraubitz

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 1	6	6	84/96	Seminar	Assignment/Presentation

Learning objectives:

Prefaces
Up to 80 percent of energy demand in cities is caused by the construction and the operation of buildings. There is no other area where savings in consumption and improvements regarding circular economy are easier to achieve than in the construction sector. Therefore it is crucial that Smart City managers have a detailed under standing of physical fundaments, traditional and also innovative solutions in building conception and operation.

Students will have the ability to:
- understand the role of single buildings within the superordinate smart urban structure
- 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:

According to actual description of particular learning units (appendix...)

Learning methods:

- Lectures
- Presentations
- Exercises

4 Smart Information Modeling

Module Leader: Dr. Sebastian Seelig

Learning Units	
4.1 Smart Data Components	Dr. Sebastian Seelig
4.2 Geographic Information Systems	Satyendra Singh, Smart City Consultant (tbc)
4.3 City Information Modeling	Dipl.-Ing. Carsten Rönsdorf, Ordnance Survey, UK
4.4 Digital Platforms & Services	Dr. Nadine Kuhla von Bergmann Dipl.-Kfm. Thortsen Milsmann

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 1	6	6	84/96	Seminar	Assignment/Presentation

Learning objectives:

Prefaces
The Smart City approach requires a paradigm shift with regard to information management. The challenge is, to interweave long-term and short-term data into a coherent model, providing tangible information to public administration/ politics, interdisciplinary working experts and last but not least to the citizens. Although being even more complex due to incoherent data and more/ more diverse stakeholders, the change process could be compared to the development of BIM in the construction sector, where so far segmented planning and operating activities are requested to be integrated in one joint database / approach. E-Government and E-Participation are additional fields of application demanding not only new ICT-solutions but different organizational procedures. Always to be considered: Data security and privacy.

On successful completion of this module, students will be able to:
- analyze a given task in the context of a smart city such as flood management and develop a data driven solution to quantify the problem, to come up with solutions and to evaluate the proposed solution based on the available data and knowledge.
- Develop a conceptual spatial data model and link geospatial data with smart sensors. (lecture Smart Information model, mandatory)
- Use a geographic Information system together with a spatial database to manage, analyze and visualize the relevant information. (lecture Geographic Information Systems, mandatory)
- Collect the available information and is able to manage the legal issues concerning the information (lecture Geospatial data infrastructure and data privacy, optional)

Learning contents:

According to actual description of particular learning units (appendix...), e.g.:
- Basics of data generation and transfer
- Digital platforms, applications and services

Learning methods:

- Lectures
- Tutrorials
- Presentations
- Group tasks

5 Smart Energy & Mobility

Module Leader: Prof. Dr.-Ing. Markus Schmidt

Learning Units	
4.1 Smart Energy Generation	Prof. Dr. Dr. Andrej Pustisek
4.2 Smart Grid Solutions	Dr.-Ing. Tobias Weißbach
4.3 Smart Mobility Strategies & Management	Prof. Dr. Lutz Gaspers / Dr. Barbara Flügge
4.4 Smart Operations & Maintenance	Prof. Dr.-Ing. Axel Norkauer / Dipl.-Ing. Johannes Winter

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 2	6	6	84/96	Seminar	Assignment/Presentation

Learning objectives:

Prefaces
Smart Cities use only a fraction of energy and this comes mostly from regenerative sources. Multi-modal mobi lity, 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. Globally it is the only way to match the UN climate goals by drastically reducing emission of greenhouse gases.

Students:
Will learn the main elements of smart mobility which are:
- Sharing models (car sharing and bike sharing), e.g. free floating sharing models
- Digitalisation of mobility
- Modern impowering of mobility (electricity and hydrogen)
- Intermodality and connection of traffic elements
- Development of autonomous driving

- Will learn 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 urban environments, e.g. between power supply and mobility

- Will learn the main elements energy and mobility policies
    - Understand the systems of regulation and deregulation
    - Judge the political environment of regulation systems
    - Learn the economical results of energy and mobility policies

Learning contents:

According to actual description of particular learning units (appendix...), e.g.:
- Fundamentals of technology and application of all traffic systems, rail-bound and not 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
- Key (physical) principles and definitions of
    - o Energy extraction, transport, and consumption
    - o Electrical power generation, transport and consumption
- Guidelines of corporate mobility and energy policies

Learning methods:

- Lectures
- Presentations

6 Resources & Resilience

Module Leader: Prof. Dr.-Ing. Markus Schmidt

Learning Units	
6.1 Smart Water & Waste Management	Dipl.-Ing. Lutz Deeken, MBA Dr. Dipl.-Ing. (FH) Andrea Fuchs
6.2 Pollution Prevention & Recovery Strategies	Dr. Marius Mohr
6.3 Smart Urban Biosphere & Habitat (incl. Nutrition)	Prof. Dr. Jürgen Breuste
6.4 Resilience Strategies & Measures	Dr. Nadine Kuhla von Bergmann / Dipl.-Ing. Nicole Baron

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 2	6	6	84/96	Seminar	Assignment/Presentation

Learning objectives:

Prefaces
Air, water and soil are basic resources being necessary for life. Cities are smart when citizens visibly benefit through controlling and eliminating emissions and through reducing the ecological footprint of settled areas. With regard to Climate change more and more cities need to solve new environmental challenges – they need to become resilient against storm, flooding, drought, fire.

Students will have the ability 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
- Analyze potential and existing environmental threats and release countermeasures in order protect urban agglomerations from flooding, storm damages, drought and fire risks

Learning contents:

According to actual description of particular learning units (appendix...), e.g.:
- Water Management
- Waste reduction and recycling
- Pollution prevention and recovery, I
- Urban agglomerations as a biosphere and habitat
- Identification of enviromental threats and resilience strategies & measures

Learning methods:

- Lectures and guest lectures
- Field trips
- Case studies
- Individual and group research & presentation

7 Smart Sustainable Finance

Module Leader: Prof. Dr. Tobias Popovic

Learning Units	
7.1 Financial Markets & Institutions	Prof. Dr. Tobias Popovic
7.2 Sustainable Finance	Prof. Dr. Tobias Popovic
7.3 Infrastructure & Project Finance	Laura Canas da Costa, MPA
7.4 Digitization, Financial Innovation & FinTechs	Prof. dr. Tobias Popovic, Dr. Sebastian Glock

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 2	6	6	84/96	Seminar	assignment/Presentation

Learning objectives:

Prefaces
The so-called "grand challenges" (e.g. climate change) and multiple disruptions (e.g. digitization) provide for a complex and a fast changing environment of metropolitan areas as well as different industries. At the same time, due to technological progress in various fields as well as the necessity of a more sustainable way of life, espe cially in the so-called developed world, the implementation of smart city-concepts will require significant invest ments. Against this background, in order to be able to undertake these investments, it will be crucial to under stand how to tap financial markets.

Students will have the ability to:
- understand the relevance of financial markets and institution for finding adequate and innovative financing solutions for smart citites
- 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:

According to actual description of particular learning units (appendix...), e.g.:
- Financial Markets & Institutions
- Sustainable Finance
- Infrastructure & Project Finance
- Digitization, Financial Innovation & FinTechs

Learning methods:

- Lectures
- Individual tasks
- Tutorials
- Workshops
- Case Studies
- Presentations

8 Smart Governance, Citizens & Management

Module Leader: Prof. Dr. Sabine Rein

Learning Units	
8.1 Principles of Public Policy & Governance	Prof. Dr. Sabine Rein
8.2 Public Services and Public Sector Management	Prof. Dr. Sabine Rein
8.3 Smart & Agile Management Approaches	Prof. Roland Dieterle
8.4 Leadership and Stakeholder Management	Dr. Nadine Kuhla von Bergmann

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 2	6	6	84/96	Seminar	Assignment/Presentation

Learning objectives:

Prefaces
Only with good governance, effective management and managers in public administration and Smart projects the Smart City approach has a chance to succeed. Also well informed, good educated and socially integrated citizens are required. Smart City experts need to know the specifics of public (policy) decision making and of public management in order to succeed with Smart City solutions. By nature, Smart City projects are always complex with many direct and indirect stakeholders involved. Therefore strong leadership and management skills are required in order to create integrated solutions and acceptance.

In detail, students will have the ability to:

- Discuss basic theories and methods of public governance and public policy
- Apply those methods to smart city project-related problems, particularly when planning/implementing smart city projects
- Discuss mechanisms for governmental decision-making
- Discuss the reasoning behind governmental activities
- Understand the general differences between public and commercial acting/deciding/steering
- Assess differences in organizational patterns with regards to their pros/cons
- Identify innovative ways/patterns for public administration and for organizations in general
- Be aware of different leadership theories and practices and their applicability to their personal professional field.
- Discuss approaches towards stakeholder management with regards to smart city solutions

Learning contents:

According to actual description of particular learning units (appendix...)

Learning methods:

- Goal-based scenarios
- Problem-based cases
- Lectures
- Presentations

9 Case Study (Integration of all Modules)

Module Leader: Dr. Nadine Kuhla von Bergmann

Learning Units	
9.1 Urbanism, Buildings, Information	All professors and lecturers
9.2 Infrastructure, Management, Finance	All professors and lecturers

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 1-2	6+6	6+6	168/192	Case Study	Project report & presentation

Learning objectives:

Prefaces
The case study is a central integrated part of the study program and interlinks the more theoretical contents of the modules in semester 1 and 2 with real-life projects. All lecturers of the modules 1-8 are consultants for their topics. The project partners are municipalities, local companies and institutions preferably in and around Stuttgart, Germany, Europe or if suitable even worldwide. The Case Study comprises in-depth analysis of existing solutions and the elabortion of own proposals. The case study offers students the opportunity to deepen their studies in a subject area of their choice. They can deepen their knowledge in a topic of the assigned modules.

The case study will be organized and held by 3 out of the 4 lectures of each term, which will be chosen flexibly by SCS. All lecturers should join the start and the end of the case study to integrate the case study into their lectures throughout the term and give the whole term a joint start and defined ending.

- analyze a project with regard to the topics of the modules 1-4: Basics of Smart Solutions, Smart Urbanism, Smart Building and Energy Mobility
- analyze the same project with regard to the topics of the modules 5-8: Resources and Resilience, Financial Feasibility, Smart Information Modeling and Smart Governance & Management
- develop alternative optimization suggestions with respect to Smart Solutions
- transfer the learned topics to an own valuable contribution, an own individual concept with different focal points
- probably develop a Master thesis Projects from the concepts (not mandatory)
- present a concept in a convincing manner

Learning contents:

According to actual description of particular learning units (appendix...), e.g.:
- Analysis of a multitude of aspects of Smart City Solutions in the context of a real-life project
- Transfer from theory into practice
- Develop own smart concepts
- Presentation of work outcomes to those involved in the project and to the team
- Project management competence

Learning methods:

- Goal-based scenarios
- Problem-based cases
- Lectures
- Presentations
- Workshops

10 Master Thesis Project

Module Leader: Prof. Kappei

Learning Units	
10.1 Thesis / Project Preparation	Prof. Roland Dieterle
10.2 Thesis - Project	Prof. Roland Dieterle / Dr. Nadine Kuhla von Bergmann

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 3	10	10	140/160	Seminar	Assignment / Presentation

Learning objectives:

Prefaces
The complex Smart City 'Theme-Web' can only be understood and translated into relevant reality when com bining theory and practice. The intention is to extend this approach as well to the Master Thesis. Consequently the Master Thesis consists of a theoretical part, following the acknowledged rules of scientific working (Module 10) and as well of a Case Study in direct conjunction with the theoretical work , subject to the subsequent de scription.

Students will have the ability to:
- apply theoretical research into practical results
- derive research questions from real-life scenarios
- demonstrate that always changing tasks can be tackled in a methodological way
- navigate within complex projects and
- effectively handle own and external resources

Learning contents:

- Interaction between theoretical research and project work
- Communication skills
- Methods of Decision Making and of Prioritization
- Methods of briefing / self-briefing
- Managing complexity
- Introduction into PMI tools of project management

Learning methods:

- Lectures
- Group tutoring sessions
- Individual tutoring sessions

11 Master Thesis

Module Leader: Prof. Dieterle

Learning Units	
11.1 Academic Writing	
10.2 Master Thesis	All professors and lecturers
10.3 MT Presentation & Abstract	

Semester	Hours / week	ECTS	Contact hours / non c. h.	Type	Assessment
Semester 3	10	20	140/320	Seminar	Assignment / Presentation

Learning objectives:

Prefaces
The Master Thesis is a the final important component of the entire Postgraduate Master Programme. Beside of subsequently described competences to be proved the choice of the right topic is releasing a process in which students gain clarity about their future career in line with personal strengths, preferences and targets. Ideally a subject is selected which connects with future employers or with specific chances in a certain market or region. Therefore support and coaching in this process is an essential element which consequently starts already in parallel to the learning units.

Students will have the ability to:
- be mentally prepared for composing a scientific essay as opposed to their initial engineering-specific project which was mainly based on practical work
- have the methodological knowledge and the practical skills required to commence and complete their master thesis independently, taking into consideration the lay-out, complexity, scientifically and required outcome
- be introduced to a master's thesis-theme proposal which relates to the acquired knowledge and the career perspectives of the student

Learning contents:

- Aspects of research methods
- Finding relevant reading materials and their utilization
- Scientific writing style
- Statistics/ Quantitative and qualitative research methods
- Data analysis and evaluation
- Methods of argumentation: Questionnaires, interviews etc.
- Methods of lay-out
- Chronological structuring
- Presentation of possible topics
- Coaching into the choice of topics taking into consideration personal development targets

Learning methods:

- Lectures
- Essay
- Individual research
- Workshop with practical exercises