



Smart Cities and Future Mobility

Coordinator: DSc. PhD. Eng. Grzegorz Sierpiński, professor of SUT

The activities undertaken by the Silesian University of Technology under Priority Research Area 4: Smart Cities and Future Mobility are inextricably linked with the notion of **sustainable development**. What provides its foundation is managing development in such a way as to satisfy both current and future needs, without compromising the capabilities of future generations. According to these assumptions, the research and implementation activities currently underway fall under two major sub-areas:

- **identification of the needs** connected with the existing infrastructure as well as those of the society
- **technological and spatial development** making it possible to satisfy the needs previously identified, to overcome contemporary limitations, to improve the efficiency of solutions, and to reduce the negative impact of human activity on natural environment and quality of life.

The research intended to address the needs pertaining to the existing infrastructure and the systems implemented in cities as well as the social needs is performed by employing various measures, including:

- **spatial surveying of municipal resources, diagnostics and structural monitoring of built features and municipal systems, including the aspects of safety of buildings and infrastructure as well as risk management**, using robotic systems, state-of-the-art sensor technologies, and dynamic neural network-based models, fuzzy inference, and predictive algorithms,
- research on the **environmental impact exerted by means of transport** and by waste generation as a consequence of design, production and use of vehicles, as well as of vehicle operation and decommissioning, and on the development of **air pollution profiling systems** and the application of **Life Cycle Assessment** as a tool for analysis of the environmental impact of smart urban solutions,
- development of methods and technologies intended for **acquisition and processing of data on urban traffic and condition of transport infrastructure as well as means of transport** (detection, lidar use, vehicle diagnostics, etc.),
- **qualitative and quantitative social surveys** used to describe various phenomena related to the **human factor in urban transport and logistics**, and particularly problems of transport psychology, including safety in its broad perspective, human factors engineering, and behaviour control mechanisms, pertaining to the challenges of technological and social progress, as well as the overall body of problems related to the functioning of individuals in a diversified environment supported by new technologies perceived from

the perspective of both architecture and urban planning, and assessment of urban space and buildings from the perspective of the quality of life, standards, and availability for all social groups,

- research on the application of diverse solutions based on the technologies of **internet of things, satellite navigation and indoor positioning systems** as well as their integration with the urban space combined with state-of-the-art sensor technologies using, among other solutions, integrated photonics (optics) structures or optoelectronic sensors offering a variety of functions including health condition monitoring for elderly and physically active persons.

In response to the emerging needs of infrastructural and social nature, the Silesian University of Technology has been involved in multifaceted research and implementation projects, especially in the fields of construction, modern architecture, urban planning, spatial planning, and smart urban transport for future cities supported by information and communication technologies, some examples of which are represented by the following subjects:

- **optimised design and planning of buildings along with their management systems as well as building automation and control systems** with regard to the problems of energy consumption, thermal comfort, acoustic climate, as well as heating, ventilation and air conditioning systems, and development of control technologies and methods intended for reducing noise, creating and developing silence zones, deploying state-of-the-art noise barriers and active equipment housings,
- application of **modern design solutions as well as high-end and eco-friendly materials for construction and reinforcement of built features**, particularly in respect of circular economy, as well as solutions related to **state-of-the-art construction materials for aviation applications**, technologically advanced protective coatings and their production technologies intended for the aircraft industry, as well as ultra-high-temperature materials and technologies enabling regolith to be used in space exploration applications,
- studies on the energy self-sufficiency of buildings attained by **implementing RES-based technologies** in urban areas and by utilising municipal structures to improve the performance of turbines and thermal stores,
- **protection of the urban environment resources and making use of the potential of local cultural heritage**, including post-industrial heritage, to strengthen regional identity and to build modern smart space on the foundation of local tradition in its broad understanding through renovation and adaptation of historical buildings as well as **reclamation of degraded post-industrial areas**,
- **application of state-of-the-art computational methods, artificial intelligence, spatial analysis and visualisation techniques (BIM, VR i GIS)** for purposes of assessment and utilisation of urban areas, buildings, urban and transport infrastructure, as well as to support design and planning processes,
- **development of means of road and off-road transport**, with special emphasis on environment-friendly and performance-improving solutions (including those related to power supply systems, powertrains,

adaptive suspension systems of variable parameters, as well as development of control algorithms and their implementation in equipment), and refining the standards applicable to such means of transport,

- using **Intelligent Transport Systems** for information processing and data transmission for purposes of efficient management of traffic streams in the transport network, and for developing **collective public transport** systems available to different passenger groups, with particular regard to the persons of special needs and limited mobility, as well as development of methods for data management and exchange between smart city systems,
- research on **autonomous transport systems**, e.g. monorail, APM, light metro, and development of new forms of organisation for the means of transport already in use, including studies on **urban sharing systems** (carsharing, bikesharing) and other eco-friendly forms of travelling, along with development of methods aimed to facilitate decision making processes related to implementation of **urban electromobility**,
- **solutions providing the travelling population with comprehensive information** about the transport system's capabilities, which will affect making decisions in favour of eco-friendly modes of transport, and in the future also **trigger a change in the modal split of traffic**, as well as those which enable application of modelling methods, artificial intelligence and simulation for identification of existing problems and for **supporting local authorities and enterprises** in the rectification process,
- research on the various ways to increase the **capacity of transport networks** for road, rail and air transport, and on **integration of the flow of goods, passengers, and information** within an urban logistic system, as well as creation and development of algorithms intended for supporting **first and last mile deliveries**,
- activities aimed at **traffic safety improvement**, related to designing and planning of infrastructural solutions, **technologically advanced aircraft constructions, new air navigation systems, and rail transport control systems, as well as safety systems for means of transport**,
- design and implementation of **smart city building/transformation strategies**, as well as transformation of public/municipal services towards smart services,
- research concerning cloud computing and Big Data technologies towards data transmission efficiency improvement, **state-of-the-art hardware and software solutions, and methods for signal processing, data storage and analysis**, including development of new-generation mobile broadband networks (5G/6G).

Making the most of its research activity and collaboration with partners, the Silesian University of Technology provides an important interface linking the social sphere and the business environment in Silesia, in Poland, and worldwide.