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## Smart furniture and smart city

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**Abstract.** "*S [m2]ART, looking at the city by metro*" is an industrial and development research project funded by the MIUR under Smart Cities and Communities and Social Innovation projects on social inclusion and welfare and security topics. Politecnics of Turin and Milan are partners of the project together with Telecom Italia (coordinator), Reply, Metalco, Thema Progetti Group and an ICT company of the ICT industry. The project aims at experimenting with a scalable system of smart urban furnishings, integrated into the city as a network "node", offering innovative services to the inhabitants and at the same time providing the municipal administration with a network of sensors capable of monitor phenomena and dynamics of the urban environment. The role of the research group within the project was to define specific contributions in two areas: the definition of innovative services to be delivered to citizens through S[m2]ART urban furnishings and the definition of requirements relating to the sustainability of materials and materials technologies for the construction and furnishing of furniture.

The paper presents the results of the research, describing, in particular, the involvement and collaboration between stakeholders (public administration and end users) and industrial partners. The research results are the framework for the definitive and executive design of intelligent urban furniture that could be installed and monitored later in the cities of Turin and Milan.

The research has practical and socio-economic implications [1]. The project is designed in the light of a balance between a service offering able to meet innovative needs [2] and business opportunities of private partners involved with the goal of defining a sustainable business plan [3]. In addition, a network of sensors for the monitoring of urban environment data is envisaged, enabling public administrations to collect useful data to improve the quality of services provided to citizens.

### 1. Introduction

The Project S[m2]ART is the result of the integration of several projects presented on the "Smart Cities and Communities and Social Innovation" competition, issued by the Italian Ministry of Education, University and Research [4], within the area of "Welfare and inclusion technologies". The role of innovative services is related to two main fields: the definition of innovative services to be delivered to the citizens by S[m2]ART urban furnishings and the definition of requirements related to the sustainability of materials for the construction and furnishing of these furniture [5].



## 2. Aim of the research

The project aims to create a scalable system of intelligent urban furnishings connected to each other as nodes of a data collection and processing network, transmitted and processed by a digital platform, which aims to increase citizens' urban well-being by implementing efficiency, accessibility and functionality of public services.

The expected results are: a reduction of the "digital divide" with greater accessibility of the computerized services delivered by the municipalities; greater efficiency and responsiveness of the public administrations in assessing urban dynamics and services to be delivered on time; optimization of the services offered through systems based on "gamification"[6].

The furnishings constitute "digital islands" in which the technological and physical components are integrated and where even mobile terminals of the users can interact. The project has the final objective of allowing the citizen to live in a functional space, well integrated in the urban environment and culture, and to participate in the growth of the city (from Smart to Wiki City), to welcome the services of companies on the territory and utilities reducing costs and time for the design, installation and management of urban infrastructures; help public administrations to know in real time the needs of the city and the dynamics of citizens to allow a more dynamic, efficient and transparent government [7].

## 3. Methodology and steps

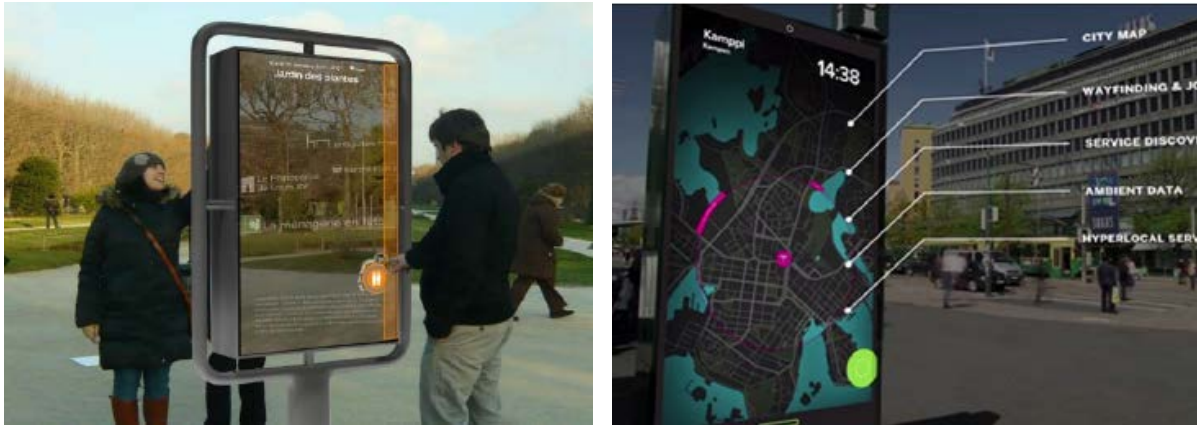
The project has seen an interesting collaboration between the academia (Polytechnic of Milan, Polytechnic of Turin) and industrial world, involving companies with different sizes and specialization (Telecom Italia, Reply, Metalco, Thema Progetti Group, Astrel, H & S, Dimensione Solare, Winext, Neriwolff). The project, currently in its final phase, has lasted for 36 months starting from 01/01/2014 and has been divided into work packages, all characterized by an integrated approach to the project thanks to the constant dialogue between needs, technologies, services.

### 3.1. State of the art

The activity has seen the study of international experiences of technological systems (innovative urban furnishings and technological islands) for the delivery of innovative services to citizens and with the interaction of municipal administrations with citizens (information and services in push / pull mode). The technological networks and the urban furnishings present in the contexts of reference have been checked: the City of Turin, the City of Milan as well as several municipalities in the province of Milan. The starting point for the development of this activity was the analysis of the regulations concerning the management of public land and technical instruments [8] such as the Advertising Plan (signs, installations on public and private land), the Urban Furniture Manual (type cards) [9] with the direct collaboration with the technical offices of the cities, able to identify the operational guidelines and the management of the elements present on the public areas under different profiles.

*Figure 1 The study of international best practices and innovative urban furnishings and technological islands.*





### 3.2. Social target

With specific reference to the areas in the two cities chosen for the test, an analysis of different profiles of the future users of the S[m2]ART furniture network has been developed, with particular attention to the weak users and their concrete possibilities of using the network itself. In particular, a general analysis of the social composition of the different areas of the urban territory was developed, taking into consideration geo-referenced data able to characterize the population by age groups, level of education, income, number of households, percentage of foreigner citizens [10].

### 3.3. Needs, requirements, performance analysis

The activity has seen the definition of a meta-project, developed with reference to a demanding-performance approach. On the basis of the aspects highlighted by the analysis carried out in previous work packages, the behavior of urban furnishings S[m2]ART was defined, explaining the needs to be satisfied and the required performances.

According to this approach, each physical entity and technical element that subsequently constituted the object S[m2]ART arose from a system of defined needs and meets certain requirements.

Particularly at this stage the working group has:

- identified and described the potential users of the furnishings;
- defined the kind of innovative services available to the citizen through the furniture network S[m2]ART;
- defined the needs expressed according to safety, welfare, usability, management, integration and environmental impact;
- defined the technical and spatial elements capable of delivering services which meet the needs, appropriately translated into requirements;
- punctually indicated the performances with appropriate specifications.

### 3.4. Guideline for the platform and services

The results of the previous research work packages, and the open data provided by the Public Administration are "the raw material" for the concept phase implemented in this task.

The platform carries 3 data channels:

- machine to machine communication
- communication between furnishings S[m2]ART
- sensors and public service infrastructures.

The smart furnishings S[m2]ART and the existing furnishings, implemented by S[m2]ART technologies, can operate in a synchronous and coordinated way to guarantee their maximum efficiency communication with the Public Administration: the platform is connected to an interface

that acts as a "Dashboard" of urban dynamics conveying the big data elaborated to simplify and guide the governance choices to be implemented in real time.

As regards communication with users, the platform is structured to ensure both the transfer of information to a central database and directly to users who wish to have access to it. Access to the platform can be achieved thanks to individual mobile devices or thanks to the digital components integrated into the furnishings S[m2]ART.

### 3.5. Concept and design guidelines, moodboard e suggestion

The identification of the guidelines led to the development of moodboards and fundamental suggestions to frame the specific project addresses, with which to align the vision of each partner.

In fact, for all the partners, the concept represents the instrument for forecast studies on the industrial and technological processes to be started.

Likewise, the outputs of this phase could highlight the trend of urban dynamics in the city of tomorrow, making it possible to structure the future offer to the needs of society.

These activities led to the following deliverables:

- Formulation of the guidelines for the Hub design (moodboard and case studies)
- Guidelines for executive design

### 3.6. Technological solutions and platform design

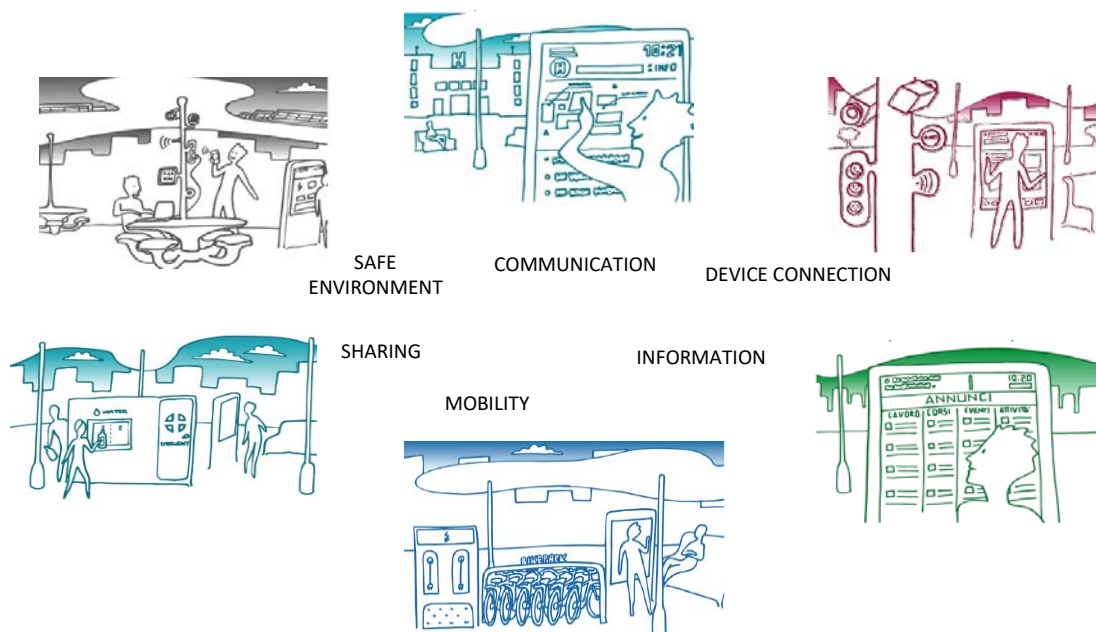
Starting from the concept, innovative technological solutions have been proposed and identified, in terms of hardware, software, IT platforms and materials that meet the needs expressed.

Furthermore, this phase led to the definition of an intelligent platform for data management (environmental, coming from the furniture network and the people who use them) and the provision of services made available by the furniture network.

With regard to the identified application areas, these are:

- Digital & Energy
- Welfare & Security
- Shopping and personal service

Figure 2 A conceptual map in order to lead to a meta-project, developed with reference to a demanding-performance approach.





The nodes and other external components/applications can exchange data and information with the platform S[m2]ART through the platform managed by one of the industrial platform [Hi Reply Platform] which, through modular and configurable HW and SW modules, provides all the elements necessary for the construction of vertical solutions secure, scalable and flexible based on the interaction and cooperation of "Smart Objects" connected to the network.

The platform manages and controls not only the data flow from sensors, but also data flows to and from mobile devices (eg. Smart Phones) - equipped with RFID, WiFi, NFC technology and also equipped with proximity communication technologies - used by people who will benefit from the services provided by the furnishings in the public spaces.

### 3.7. *Welfare and security*

This activity has defined the physical structures of the "island" starting from the real comfort structures (such as benches, worktops) up to the structural and covering parts. Comfort is therefore to be understood in a broad sense, including not only the physical comfort, but also psychological comfort taking into account the design of objects and their harmonious integration.

As concerns the elements properly dedicated to the physical comfort of citizens, including benches and worktops, innovative technological solutions have been studied that make objects intelligent, including charging modules, connectivity devices, NFC devices for interaction with the terminals furnishings.

Once the solutions to make objects intelligent were identified, the technical and aesthetic solutions needed to incorporate the technological part in the furnishings were found in order to optimize the structure; there are also advanced solutions for environmental sensors to be installed in urban furnishings, with particular attention to their positioning and functionality.

Particular attention was paid to the integration of furnishings in such a way as to minimize the impact on the territory (minimum size of the furniture).

Among the tasks that can be virtually achieved through the sensor system are:

- Monitoring of city pollution (even fine dust);
- Monitoring of emissions such as control of chemical and industrial processes;
- Indoor monitoring of substances hazardous to health;
- Acoustic Maps (monitor in real time the acoustic levels in the streets of a city);
- Implement intelligent lighting systems;
- Monitor urban parking areas by detecting the presence of cars in parking stalls.

This activity also had the objective of defining other solutions related to safety aspects, in particular with regard to:

- Video surveillance;
- Sensor-based solutions for presence control;
- Panic devices.

Furthermore, small size transducers able to detect the presence of people or objects in a specific area of interest have been studied and realized. Possible applications of these sensors are:

- lighting controlled by presence detectors
- access control in areas forbidden to the public
- activation of devices in the presence of the public (multimedia presentations, etc.)

It is possible, depending on the field of application of interest, to use sensors with different ranges of use, ranging from a few cm to 20-50 m. The devices that can be used are essentially optical sensors, able to detect the presence of an object based on the reflection of a beam of infrared rays by the object itself.

### 3.8. Shopping and personal services

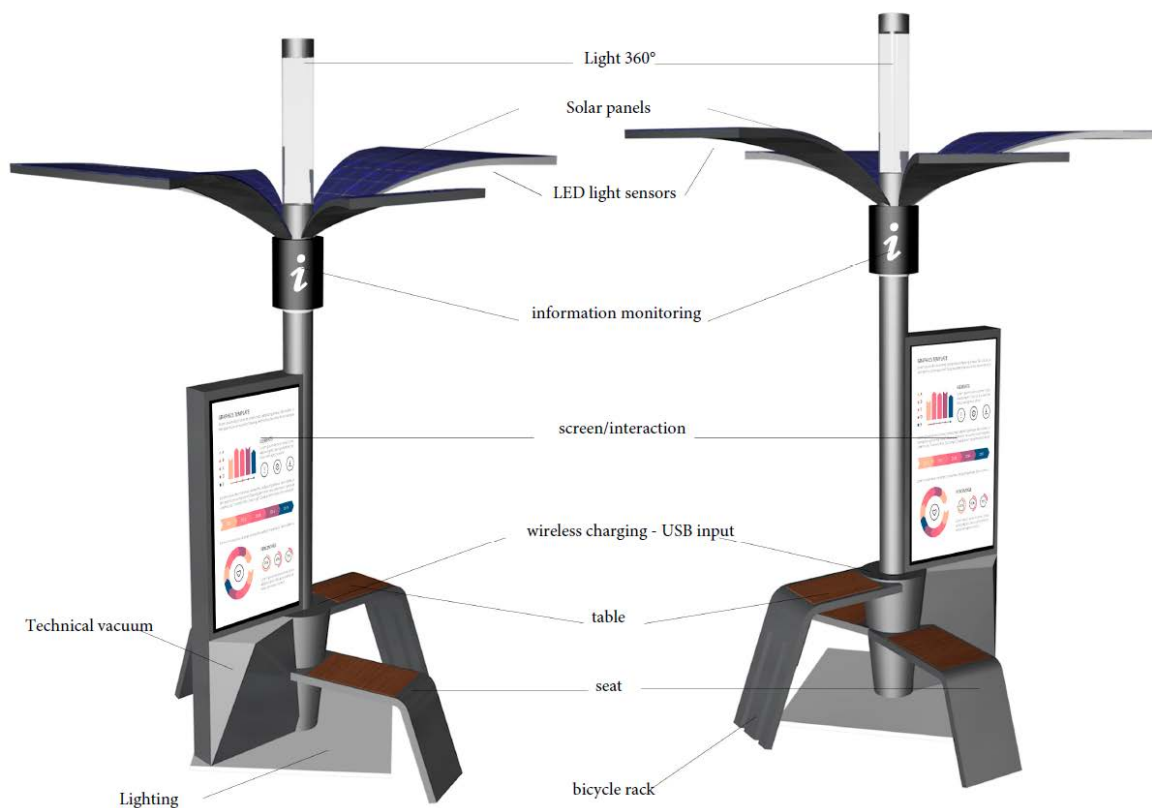
This module has identified the methods for delivering personal services from the smart furnishings network, including through the use of people's mobile devices. In addition to the services outlined in previous activities, attention was also paid to the provision of tangible and intangible assets and other services not mentioned above, including those relating to the mobility of persons. All the ways to open the digital island to physical third-party services, such as vending machines, bike sharing stalls, parking meters, etc. have been planned and identified. The activity will address this theme by examining both the functional aspects and those more properly related to design.

## 4. Final results

The final result of the activity carried out in the 36 months of work is the basis for the realization of the prototypes of the single modules and their integration. The integration activities in particular will concern both the integration with the platform elements and the physical and functional integration of the various elements of the digital island between them. This activity sees a large participation of the working group as it is the point of connection between all the research, concept and prototyping activities in order to carry out the final experimentation.

Anyway, the most important result is above all the strengthening of a model of collaboration between university and industrial partners already engaged on a European and international scale on development and investment programs concerning the smart cities of the future.

Figure 3 A rendering of the S[m2]ART solution.



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