

A workshop on designing and prototyping a smart city

Pietro Battistoni
Department of Computer Science
University of Salerno
Fisciano (SA), Italy
pbattistoni@unisa.it

Andrea Antonio Cantone
Department of Computer Science
University of Salerno
Fisciano (SA), Italy
acantone@unisa.it

Rita Francese
Department of Computer Science
University of Salerno
Fisciano (SA), Italy
francese@unisa.it

Francesca Perillo
Department of Computer Science
University of Salerno
Fisciano (SA), Italy
fperillo@unisa.it

Monica Sebillo
Department of Computer Science
University of Salerno
Fisciano (SA), Italy
msebillo@unisa.it

Genoveffa Tortora
Department of Computer Science
University of Salerno
Fisciano (SA), Italy
tortora@unisa.it

Giuliana Vitiello
Department of Computer Science
University of Salerno
Fisciano (SA), Italy
gvitiello@unisa.it

Abstract—Smart cities represent one of the most promising innovations of the last century, integrated with advanced technologies to improve the quality of urban life, efficiency of public services, and environmental sustainability. This paper presents a workshop conducted with high school students to design and prototype a smart city. The workshop was structured into brainstorming, design, and prototyping phases. This activity is an innovative and effective way for students to understand the crucial role that information technology can play in daily life and bring them closer to the well-being of their community.

Index Terms—smart cities, Internet of Things, workshop

I. INTRODUCTION

Smart cities use digital solutions to improve the efficiency of traditional networks and services, benefiting both residents and businesses [1]. Beyond using digital technologies to optimize resource use and reduce emissions, smart cities go deeper into innovation [2]. They require smarter urban transport systems, improved water and waste management, and more efficient ways to light and warm homes [3]. As a vertical of the Internet of Things (IoT) [4], smart cities represent a network that connects not only people but also the objects around them.

The Smart Cities market worldwide is expected to witness significant revenue growth, with projected revenue reaching US\$104.80bn in 2024. This growth is further expected to continue at a compound annual growth rate (CAGR) of 12.15% from 2024 to 2028. As a result, the market volume is anticipated to reach US\$165.80bn by 2028 [5].

This rapid growth in the smart cities market highlights the increasing importance of digital innovation in urban development. These investments are not only transforming infrastruc-

ture but also improving the quality of life for residents by providing smarter solutions to everyday challenges. As smart city initiatives continue to evolve, we can expect even greater advances in the integration of technology and urban life, leading the way to a future where cities are more connected, efficient, and resilient [6]. In order to further explore the development of smart cities, we conducted a workshop on the construction of a prototype city using creative materials and then the integration of Arduino sensors, with the aim of transforming the prototype into a smart city. The workshop was divided into three sections, including brainstorming, design, and prototyping. This hands-on approach provided valuable insights into the practical challenges and opportunities of developing smart city technologies. The workshop highlighted the importance of creativity and collaboration in building the cities of the future.

II. THE WORKSHOP

We conducted a workshop to build a prototype city with creative materials and then integrate Arduino sensors, with the goal of making the prototype into a smart city.

The workshop was structured into three sections:

- Brainstorming
- Design
- Prototyping

A. Brainstorming

Brainstorming is a crucial technique in the research process, as it encourages the generation of innovative ideas and creative solutions. During the brainstorming session, participants were

encouraged to freely express their thoughts without fear of criticism, creating an environment that simulates creativity and divergent thinking.

We asked participants three questions to understand (i) what services and infrastructure the prototype smart city should include to improve the quality of life, (ii) how we could involve citizens in the design of the smart city prototype to ensure that it meets their expectations and (iii) which specific urban areas or neighborhoods would benefit most from a smart city approach.

Each participant was given three post-it notes on which to write the answers to the three questions. The brainstorming lasted 20 minutes, and the answers were analyzed at the end. After the analysis, students were divided into 4 groups, each of which was responsible for building a prototype of a specific area of the city: downtown, parking, historic center, and suburbs.

B. Design

During the design phase, the groups began to define on paper an idea of what their part of the city should look like, what elements it should contain, and what aspect it could become smart.

C. Prototyping

During the prototyping phase, groups built their part of the city with creative materials, e.g., boxes, cardboard, bottle caps, sheets, various objects, etc., as shown in Fig.1. At the end, the different neighborhoods were combined to create a single prototype city.



Fig. 1. Prototyping activity.

III. INTEGRATION OF ARDUINO

To transform the prototype city into a smart prototype, the concept of Arduino programming and several sensors in the Starter Kit were introduced to the students. The sensors in the Starter Kit were used to build several smart objects, like a smart light bulb and traffic light, integrated with the proximity sensor. In addition, the humidity and temperature sensors were set up to monitor a greenhouse (Fig.2). The students also used the servo motor sensor to open a barrier gate and a parking lot.

This integration demonstrated the practical application of IoT technologies in urban environments and highlighted the potential for real-time data collection and analysis. This emphasized the importance of involving citizens in the design and

implementation of smart city initiatives. Through participatory design processes, cities can better address the needs and preferences of their residents, leading to more inclusive and sustainable urban development.



Fig. 2. Example of application of Arduino sensors.

IV. CONCLUSION

The development of smart cities represents a significant step forward in urban innovation, using digital technologies to improve efficiency, sustainability, and quality of life for residents. Our workshop, which focused on creating a prototype smart city using creative materials and Arduino sensors, demonstrated the practical challenges and opportunities inherent in this field. The workshop was conducted with high school students, who engaged in brainstorming, design and prototyping phases, highlighting the importance of collaboration and creativity in addressing urban challenges. The integration of Arduino sensors demonstrated how technology can be used to create responsive and interactive urban environments. This activity not only allowed us to put more focus and emphasis on this topic but also brought students closer to the important role that information technology can play and make them participate in the well-being of their community. As cities and citizens continue to invest in smart solutions, they are likely to become more connected, efficient, and resilient, opening the way to a future where urban life is significantly improved.

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