



Using Microelectronics from Infineon for the Challenge of Data in a Sustainable Smart City.

“Planting Seeds of Change guided through IoT Technologies, and
the citizens of the Smart City of Munich”

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1. Introduction

The United Nations Economic Commission for Europe highlights cities as responsible for around 75% of global CO₂ emissions. For this reason, cities must be at the forefront of fighting climate change. During a round table on this topic organized by the UNECE, and the Food and Agriculture Organization (FAO), experts from national governments, city governments and civil society, identified sustainable urban forestry as a cost-effective option to future-proof cities against climate change while also helping to mitigate the impact caused by urbanization. Taking into consideration that, over 1 year, a single mature tree could take up to about 22 kg of carbon dioxide from the atmosphere [1], and that the same tree can house thousands of flowers providing sustenance to populations of pollinating insects maintaining our local food production, and can be home to hundreds of species of insects, fungi, moss, mammals, and plants, ultimately contributing to preserving urban biodiversity that act as significant carbon sinks [2], trees and urban forests, without a doubt, can and will play a key role in helping to achieve the Sustainable Development Goals (SDGs) and make the cities resilient to the future impact of larger populations, higher temperatures, pandemics, weather extremes and natural disasters [2].

In Munich, between the years 2010 to 2022, there was a total net loss of 24,751 trees. During the same time period, there were a net total of 9,533 new trees planted [3]. Because of the net decrease of trees in the city, in its 2021-2022 work report, the Department of Urban Planning together with the Lower Nature Conservation Authority proposed the further sensibilization for developers, planners, and citizens in the importance of trees and how they impact the city and its citizens by providing shade, purifying the air, attenuating traffic noises and serving as habitat of animals and insect species. Both also highlighted the importance of advocating planting more trees on both public and private spaces [4].

As part of the the “Digitainability Project Week: Sustainable Smart Cities 2023” challenge provided by TUM and Infineon Technologies AG, Germany’s largest semiconductor manufacturer, recognizing the important role that trees currently have, and will continue to have in a short-term and long-term future for cities and its citizens, and the necessity, highlighted in the 2021-2022 work report by the Department of Urban Planning and the Lower Nature Conservation Authority, of the city of Munich to preserve and plant more trees through citizen participation, we decided to create a small organization and a phone application called “EcoChamp” under the concept of “Planting Seeds of Change” that will be forefronted by the citizens and different stakeholders of the city of Munich, and where Internet of Things (IoT) and Smart City technologies will be the main tool utilized to promote the change to a sustainable future.

2. The Challenge and Some Background

Infineon Technologies AG, currently ranking among the 15% most sustainable companies in the world, as part of its target to become carbon-neutral by 2030 [5] and its sustainable initiatives has proposed the challenge, during the “Digitainability Project Week: Sustainable Smart Cities 2023” at TUM, of utilizing microelectronics to monitor urban forests.

Smart cities rely on microelectronics to enable a multitude of applications, from traffic management, energy optimization, and environmental monitoring. Urban green infrastructure plays an increasingly significant role in environmental monitoring in cities and in sustainable urban development planning, as it provides important regulating and cultural ecosystem services. The monitoring of such dynamic and complex systems requires technological solutions which provide easy data collection, processing, and utilization at affordable costs [6]. Thus, it is important to use real-time monitoring data to deepen understanding of the processes of urban forests and how to preserve them. Another big challenge is to address both citizens and other stakeholders on the importance of having such a system, how it helps in the preservation of urban forestry, what is the role of urban forestry in our city and why it is important, and how to incentivise them to utilize and provide valuable feedback to the system.

3. Proposal of our Idea

Our proposal is to empower citizens to lead the way in urban forest changes through digitainability and interactivity. In regards to the digitainability aspect, we came up with the idea of using the NFC tags suggested by Infineon Technologies A.G., and for interactivity we have created the idea of a phone application under the name, similar to our group’s name, called “EcoChamp”. Its main functions will be explained further in the next section of this report. The main mission of the application is to educate citizens about the importance of green areas in the city and encourage them to contribute to its preservation.

In order to achieve our mission, it is necessary first to provide citizens valuable information about the urban forest and biodiversity of their city. In our case, in the city of Munich, the idea is to hang visible NFC tags (a contactless semiconductor) in several trees of the city where citizens can easily approach their mobile phones to these NFC tags. Once they approach their phones to the tag, they will be directed to the “EcoChamp” application where they can obtain essential details about the tree, including, for example, the tree’s species, its CO₂ absorption rate, and the type of biodiversity that it can house. Individuals can also contribute, using the application,

with real-time issue reports about the tree's health, whether it's currently blossoming, or if there any damages in the tree, among other functions.

4. Solution and its process

To test the NFC tag, we design with CAD (computer-aided design) software a prototype of a coverage for the NFC chip. It is made out of recyclable material (biodegradable PLA) and it has a very simple engraved drawing (Figure 1 in the Appendix) at the front of the tag where citizens can intuitively see that they can access the internal information in the NFC tag by approaching their phones to the tag. In the same tag, it is also engraved that chips are securely protected by Infineon Technologies security internal system.

The interactive mobile phone application “Ecochamp” that can be accessed through the NFC Tags and also by downloaded in an android or IOS system, seeks to enhance the management and conservation of tree and green spaces in the city, and motivate public engagement. The main two components of the application are the “Information Section”, and a “Gaming/Collaborative Section”. The two sections are further explained in the following texts:

1) Information Part:

NFC (Near Field Communication) tags that can be used in urban forestry to enhance management, conservation, and public engagement efforts. Here are several ways the NFC tags can be utilized in our plan for conserving and maintaining urban forestry:

- **Tree Identification:**
 - Link the NFC tag to a database or a mobile app that allows urban foresters and the public to retrieve detailed information about the trees in the area, such as its species, age, health status, and historical significance.
- **Maintenance, Health Monitoring, and Reporting Issues:**
 - Individuals can contribute, using the application, with real-time issue reports about the tree's health, or if there any damages in the tree.
- **Guided Tree Tours:**
 - Create self-guided tree tours for the public by placing NFC tags on significant trees or along a designated tree trail.
 - Visitors can use their smartphones to access audio or text descriptions of each tree's history and ecological importance through the application.
- **Inventory and GIS Mapping:**

- Use NFC tags in conjunction with GIS (Geographic Information System) mapping to create a detailed inventory of urban trees. This data could be used for urban planning, risk assessment, and sustainability initiatives.
- **Volunteer Engagement:**
 - Encourage community involvement in tree care and maintenance by using NFC tags to provide information about volunteer opportunities and events related to urban forestry.
- **Research and Data Collection:**
 - Researchers can use NFC tags to facilitate data collection in urban forestry studies, including tree growth patterns, carbon sequestration, and wildlife interactions.

2) Gaming Part:

We thought that the most attractive and best way to collaborate could be through a game, so we came up with the idea of the "Goochitree" game. It would be similar to a tamagotchi¹ mode but instead of taking care of a virtual subject, the user would be taking care of a real tree, called a "Gotchitree", having also the opportunity to adopt or plant their own tree in a green space in Munich. Stakeholders like Green City Munich, who have experience in the field and working with volunteers in tree planting around the city of Munich, could assist in finding a tree planting area and the tools for planting the tree, or could even help, with their collaborators at the Department of Urban Planning from the City of Munich and the Lower Nature Conservation Authority. Also there is the possibility to adopt a tree from the city instead of planting one

Some of the several stakeholders that we have approached to contribute with our initiative are: the Technische Universität München, Infineon Technologies AG, Green city, WOW urbane utopien, City of Munich department of urban planning, Bayerisches Staatsministerium für Umwelt und Verbraucherschutz, etc.

Our group also performed a survey where we asked 20 citizens in Munich to see how they perceive the idea of gamification, the management of a tree, and if they would ever consider planting or adopting a tree. We got a very positive response from the survey², with most respondents claiming that they would like such an idea.

5. Some Key Learnings

¹ The Tamagotchi is a toy that changed the way we play when it was released in 1996. It is like a virtual pet that needs to be cared for and played with. If you don't take good care of it, it can die after a while.

² Results of the survey can be observed in the appendix of this report.

Throughout the conceptualization of the project we came across several key learnings that will help us moving forward on our future endeavours:

- **Project Scope:** At the beginning of the project conceptualization we had several ideas as a group, but at some points they were difficult to connect in a concrete matter to what was the scope of the project, based on the challenge given to us.
- **Management of Time:** Due to the nature of the challenge week, the time that the group had to work on the project was very limited, and only with two members on the team. For this reason, we had to learn how to optimize and manage our time in the best way possible.
- **Adaptability:** Being open to external feedback from our advisors was very important for the group to conceptualize a solid idea to work on. We had to adapt and be flexible to the input of others, and not be rigid on one single idea.

6. Next Steps and Future Outlooks

There exists a new opportunity of applying IoT technology not only to measure trees functionality through fluxes of water and carbon, but also to establish a smart urban green infrastructure operational system for urban forestry management [5]. Using individual tree physiology sensing devices in trees and storing this information and make it accessible through the “EcoChamp” application and the NFC tags for citizens, planner, conservation authorities, among other stakeholders, will facilitate real-time observations of soil moisture content for the Trees, water transpired, amount of carbon stored, absorption of particulate matter (PM10) among other parameters that will help to highlight the functionality and importance of the tree in a particular area of the city. It will facilitate the management of trees by citizens and authorities. Ultimately, in an ideal scenario, each citizen will have at least one tree planted in the city that they can take care of and for which they can monitor and oversee its functioning in the larger scheme of urban forestry and the health of the city. However the current sensing technologies are still expensive and outweigh the economic and social gains of having them implemented [5]. For this reason, “EcoChamp” identified parklets around the city of Munich, as a potential first place to implement this sensor as these parklets, according to information provided to us by the organization “WOW! Urbane Utopien” who are in charge of the building and maintenance of some of these parklets in Munich, have an infrastructure with solar panels where the tree physiology sensors could be implemented and give valuable output to their organization. This could be a potential start up point to oversee the value of our application and methodology.

7. References

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Figure 1 NFC Tag prototype

If you had the opportunity to adopt or plant a real tree or take care of a green area in the city, would you do it?

20 responses



Figure 2 Survey results on citizen tree planting/adoption

In the info app there will be also a gaming mode called "Gochitree" (its kind of game like tamagotchi) where you can, in an interactive mode,...gen and more. What do you think about this idea?

20 responses

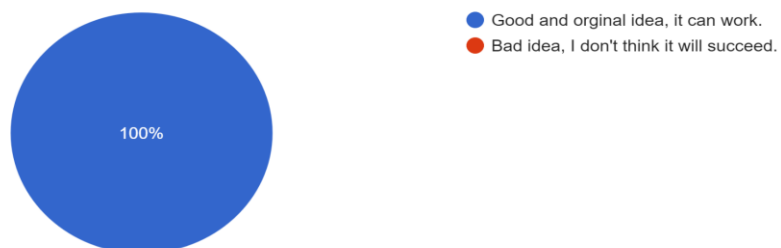


Figure 3 Survey response on citizen perception of the “Gochitree” concept

Regarding the Gochitree game, do you think you could give it a try?

20 responses

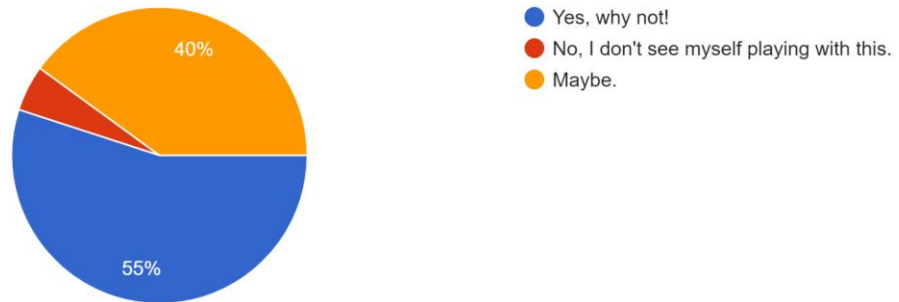


Figure 4 Survey response on “Gochitree” usage by the citizen