CREST

Climate-resilient Coastal Urban Infrastructures through Digital Twinning

Campus Kristiansund Internship Program

Kristiansund kommune

Møre og Romsdal fylkeskommune

NEAS

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1.0 Introduction

In this digital age, efforts are being made by policy makers, governments and people to adopt advanced technologies to address urban problems. Cities are known to account for 75 percent of global greenhouse gas emissions, mainly from the transportation and building sector (United Nations Environment Programme, n.d.). At the same time, climate change has been one of the biggest challenges facing cities. Coastal cities are particularly vulnerable to rising sea levels and extreme weather conditions such as floods and storms, and these pressing problems could have adverse impacts on a city's basic services, infrastructure, housing, livelihoods, and health. However, for a problem to be addressed, it must first be seen and felt. "Visualization is a potential way of increasing the engagement with climate change, and IT developments, such as Artificial Intelligence and Augmented Reality, provide significant advancements that can be transformative in engaging audiences with climate change issues" (CREST Project, n.d.).

Leveraging technology to address climate challenges is at the core of the CREST project,

short for “Climate-resilient Coastal Urban Infrastructures through Digital Twinning”. The goal is to assist vulnerable urban areas in setting up and rolling out collaborative platforms through digital twin (DT) technology and co-creation approaches, to support environmental decision-making and innovative policy practices. This will help enable robust and resilient responses to climate change. The project encompasses four primary objectives:

- Develop and implement an impact assessment framework for sustainability and climate resilience.
- Create DTs to serve as innovative engagement and decision support for urban transformation.
- Promote capacity building and co-creation for greater resilience of urban infrastructure.
- Engage diverse citizen- and stakeholder groups to develop pathways for future adoption and replication of CREST results.

As climate change is something that affects most of the population, multiple target groups have been identified, including public authorities (regional/local governments, municipalities, city halls, etc); researchers (spatial planners, climatologists, social scientists, etc); companies (utilities, transport, construction, real estate, cooperatives, producers, innovators/technologists, etc); civil society (environmental NGOs, Consumer organizations), and; citizens (households/residents) (CREST Project, n.d.).

CREST is funded by the Joint Programming Initiative (JPI) Urban Europe and implemented across three European coastal cities; Kristiansund in Norway, Bordeaux in France and Kolobrzeg in Poland. The partnership involves local authorities and several organizations listed in Figure 1.

Figure 1: CREST project partners.

In Norway, Møre and Romsdal County Council is the project partner and Kristiansund kommune has been chosen as the city where the project is implemented. Ålesund-based technology company AugmentCity serves both as the project coordinator and as the developer of DT technology. The project was launched in April 2022 and is scheduled to end in April 2025. Three consultants from the Campus Kristiansund Internship Program, Kwadwo, Rosemary and Victoria, were involved in the project between October 2023 and May 2024. Our main responsibility has been to ensure the local implementation of the project activities in Kristiansund during our internship period. We have collaborated closely with employees of Kristiansund municipality; Initially, sustainability advisor Jørgen Restad was our main contact person locally. After his departure, communication advisor Ingunn Strand took this role. Furthermore, we have maintained close communication with Møre og Romsdal County Council, mainly project manager Solveig Stornes and international advisor Ingrid Gjelsvik.

2.0 Methods

This chapter will explain the different project activities and how we have approached them. Our work has consisted of capacity building for ourselves and the project through various research activities of both qualitative and quantitative nature. To ensure comparability across the three cities in the project, the partnering Institute of Urban and Regional Development (IRMiR) in Poland has had the main responsibility of developing and distributing the methodologies, while we have implemented them. Through dialogue there has been room for necessary adaptations to the local context.

2.1 Capacity Building on Digital Twins

The first step after joining the project was to build up our own knowledge of the project and the DT technology, which was mostly unfamiliar to us. In October 2023, Kwadwo participated in a CREST workshop in Bordeaux as a representative from Kristiansund. Present from Møre og Romsdal County Council was Ingrid Gjelsvik, as well as representatives from all partner institutions. Time was spent sharing knowledge and assessing the project progress, and additionally, all partners received training in the DT. Furthermore, it was discussed how the tool could be used to address present and future climate threats. After his return, Kwadwo conveyed his knowledge to the rest of the team.

Image 1: CREST partners receiving a tutorial on the DT tool.

2.2 Collection of U4SSC KPI Data in Kristiansund

Part of the first project objective, develop and implement an impact assessment framework for sustainability and climate resilience, involved collecting and cross-checking local data connected to the Key Performance Indicators (KPIs) of the United for Smart Sustainable Cities (U4SCC) framework. Among the aims is to use this data to perform comparative sustainability and resilience monitoring, and climate impact assessment, across the three urban areas. Our responsibility was providing the data to partners in France, so that they could take on the task of developing a holistic framework. Luckily for us, Kristiansund kommune had already done extensive mapping of U4SSC KPIs and possessed relatively updated figures from 2022 at the time of commencing this work in November 2023. We received these figures from Jørgen Restad and went through the list to update values where appropriate and identifying reliable data sources where this was lacking. This was done through a systematic review of sources such as Statistics Norway.

2.3 Citizen Survey

From October to November 2023, a citizen survey was conducted in Kristiansund. The survey was named "How Resilient Is Your Municipality to Climate Change?" and was based on a common survey framework for all cities, with minor adaptations such as language to make the questions more clearly understood among the Kristiansund population. In the survey, residents could express their opinions on climate changes today, identify future risks, and contribute suggestions for improvements and actions based on initiatives from the local authorities and themselves. We assisted in the survey promotion by putting up posters across Kristiansund and managed to gather 122 answers, the highest response rate across all partner cities. Thus, Kristiansund's efforts were highlighted as an example to follow among the project partners.

Image 2: Kwadwo and Rosemary promoting the citizen survey in Sundbåten.

Analysis of the survey results was conducted by IRMiR and we received a preliminary overview, although we had familiarized ourselves with the survey answers beforehand. According to the citizens who answered the survey, the climate challenges perceived as the most impactful in Kristiansund include heavy rainfall, strong wind and gale, storm and hail, and heavy snowfall. As for how the municipality should deal with these challenges, points such as ensuring good preparedness plans and improving infrastructure were highlighted. Furthermore, citizens stated that they plan to counteract climate change mainly through reducing consumption and using public transport options rather than personal cars to a larger extent. Apart from the mentioned, the survey provided valuable insights into the local status quo with regards to public opinions on climate change, how the municipality deals with climate challenges, and what can be done better.

2.4 Focus Group Discussion

In November 2023 we invited local experts, working in different fields related to or affected by climate change, to a focus group discussion (FGD). The FGD participants, spanning various age groups and expertise areas, were strategically invited for their ability to provide a comprehensive approach to the city's resilience challenges. The spectrum of

knowledge covered by participants included environmental protection, city preparedness, water management, spatial planning, road maintenance, rescue services, and health care. With basis in the survey data, the goal was to highlight the most relevant climate threats in the city according to their experience and observe the level of consensus between this group and citizens who had answered the survey. Additionally, an important aim was to identify vulnerable places and structures in the city which may be affected by these climate threats.

Image 3: Local professionals discussing climate challenges in Kristiansund.

During the workshop, facilitated by Victoria, the project team first unveiled preliminary findings from the citizen survey. Expanding on these insights, participants leveraged their unique perspectives to discuss and rank the most significant climate threats, as depicted in the image below. It was pointed out that some of the challenges do not necessarily have extensive impacts today; however, these threats were selected based on the seriousness of long-term impacts on the municipality and anticipated escalation as climate change intensifies.

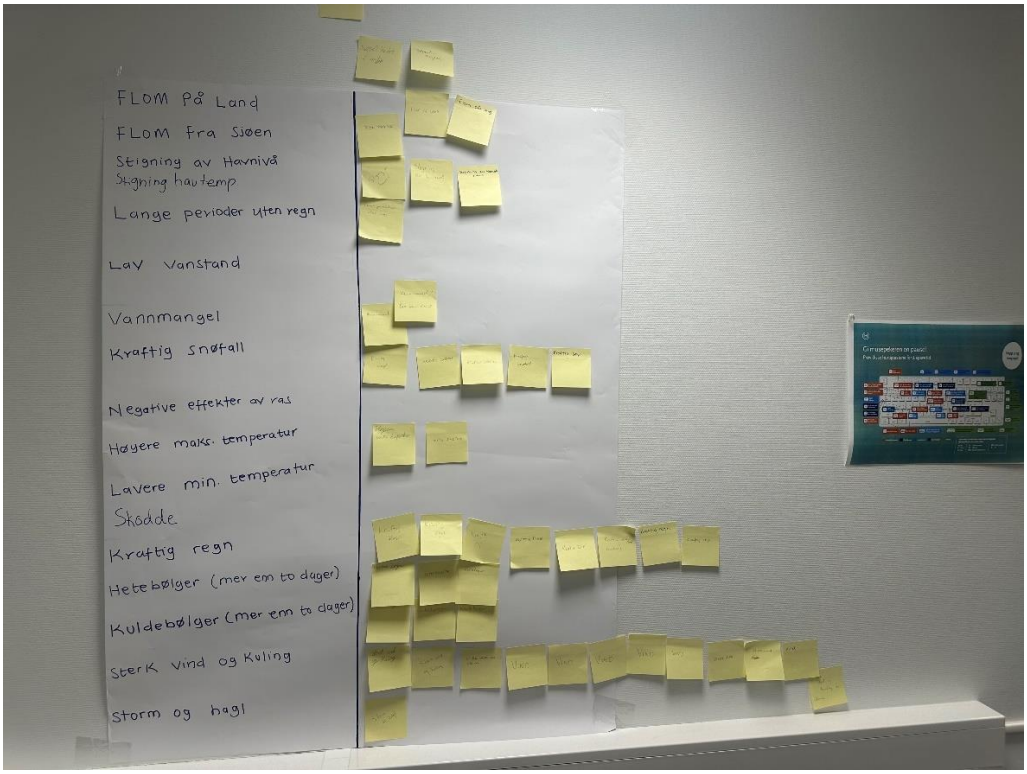

Image 4: Prioritization of climate challenges in Kristiansund.

In the end, challenges posed by strong wind was pointed out as one of the main threats in Kristiansund. The discussion around wind was largely centered around challenges with mobility in the form of transport. All modes of transport may be heavily impacted by strong wind, in large due to the city's location and the reliance on highly exposed bridge infrastructure. The knowledge gained after the FGD was key for identifying potential use cases to further visualize and simulate in the DT.

2.5 Development of Digital Twin

In the time after the FGD, the main focus in the project was developing the use case and gathering respective data to feed into the DT. We have supported AugmentCity in this process through collecting local data related to climate and infrastructure, which was necessary to create visualizations of potential scenarios related to climate change. Most of the required data has been collected via public, reliable sources such as Statistics Norway. What was not publicly available was identified through conversations with relevant stakeholders. After reviewing the available data, AugmentCity decided which concrete use case to further develop; Mobility challenges caused by strong wind. The

choice was based on an overall assessment of the high ranking of wind as a threat in the FGD and survey, data availability, and opportunities for visualization in the DT tool.

2.6 Co-creation Workshops

Our final project activity before finalizing the internship was conducting two co-creation workshops based on the use case related to wind and mobility. The workshops were conducted based on an adapted variety of the "Charrette" methodology, which is commonly used in urban planning. The workshops were experimental in nature and the aim was twofold:

- Engaging a broad group of citizens in creating solutions to concrete climate resilience challenges.
- Test the effect of the DT as a tool for problem-solving through visualizing the challenges.

With regards to the first point, we managed to recruit a total of 20 participants for the two workshops. The group consisted of people with different backgrounds, experiences and situations; County and municipality employees, retired citizens, citizens with disabilities, politicians, and so on. This helped provide depth and various perspectives into the discussions.

As for the second point, one workshop was conducted with the DT available, while the other was based exclusively on traditional maps. This was to try to observe in which ways the tools utilized during the workshops may have any significance for the discussion and co-creation process. To test this further, we conducted one survey before and one after the workshops, among all participants. Here they could anonymously provide their feedback on climate resilience matters in the city, as well as on the tools utilized during the workshop. Our impression during the workshop was that the DT evoked curiosity among participants.

Image 5: Co-creation workshop using analogue maps.

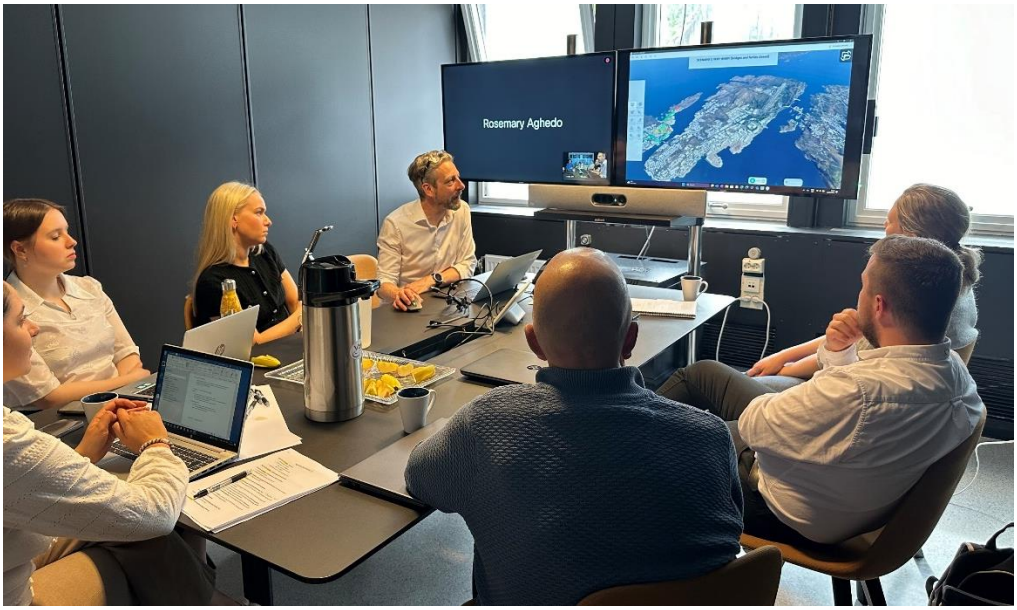

Image 6: Co-creation workshop using the DT, showcased by AugmentCity.

The results of the workshop still remain to be thoroughly analyzed in order to draw conclusions on the effect of the DT. On another side, the workshop has created concrete output for Kristiansund municipality, as the team made a summary of concerns and expectations to local authorities which emerged during the workshop. This was sent to the head of preparedness in the municipality, and will help provide further insights into these matters.

3.0 Results

The various activities we have carried out have contributed to different parts of the project objectives, as well as to developing valuable knowledge for Kristiansund municipality.

Firstly, compiling local KPI data has been central to developing a sustainability assessment framework across all cities. Secondly, a DT of Kristiansund with possibilities of visualizing climate change has been developed, which we are certain will be a valuable tool for decision-making. Furthermore, the survey, focus group and workshops have all been conducted based on a citizen science approach to resonate with the objectives of fostering engagement, participation, and co-creation. Our impression based on these activities is that citizens find the CREST-project exciting, particularly the concept of visualizing climate change through a DT in order to create a climate-resilient city. Additionally, these activities have contributed to a better understanding of specific climate challenges in Kristiansund and their potential effects, as well as citizens' opinions on the municipality's handling of these challenges.

Overall, our most significant accomplishment has been to successfully collaborate towards implementing all required project activities according to the planned timeline. We hope that these efforts will contribute to help Kristiansund and other cities on their paths towards more efficient, inclusive, and future-oriented urban planning for climate change.

4.0 Discussion

As the project involves several partners spread across Norway and Europe, continuous collaboration at different levels has been crucial. Here in Kristiansund, us interns have had daily dialogue and worked both together and separately on different tasks. We have maintained close contact with the project managers from Møre and Romsdal County Council, who are based in Molde, through Teams. There has been a low threshold when it comes to asking for assistance and discussing different matters, which has been crucial

to the successful implementation of CREST in Norway. Furthermore, we have participated in regular coordination meetings between the Norwegian partners and AugmentCity, and between all project partners. For our part, this has been important to ensure that we carry out the local activities in a way that serves the project as a whole.

The process has not been entirely without challenges. Among them were difficulties in identifying all the necessary KPI data and benchmark values, although great work had previously been done in the municipality. Furthermore, it has at times been challenging to navigate the communication with all the different project partners, as we all have different work cultures and at times different understandings of project activities. As reaching a common agreement before carrying out an activity is important, our ambition to meet the set project deadlines has in some instances meant a somewhat short time to plan local activities. In turn, this has led to challenges with for instance recruiting participants for the workshops on a somewhat short notice. Another point is that Kristiansund is a substantially smaller city than the other partners, meaning that the challenges faced here have at times been different to the other cities. This has for example applied to the task of recruiting participants for project activities that represent all the target groups set by the project, as there for instance is no local research institution in Kristiansund.

Considering that many people, like us, have and will join the project on a limited basis, we suggest that the various partners' roles are made clearer from the start. Additionally, we suggest leaving even more space earlier on for discussions on how project activities can be best adapted to the local contexts without compromising the intended comparability, as we believe this may lead to better results. Furthermore, we suggest that various stakeholders make use of the DTs developed for their city. In Kristiansund, a DT simulator will be available at Campus, and our hope is that the versatile DT developed through CREST could be used actively to revolutionize decision-making processes. Lastly, we urge all involved stakeholders to do their utmost to maximize the sustainability and replicability of CREST results at a larger geographical scale, in accordance with the project objectives, so that more urban areas can benefit from the lessons learned.

Literature

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United Nations Environment Programme. (n.d.). Cities and climate change. https://www.unep.org/explore-topics/resource-efficiency/what-we-do/cities-and-climate-change