# An international innovation project - **Development of an IoT-driven solution in Zanzibar -**

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***Universities are encouraged to build partnerships and multidisciplinary projects based around real-life problems. Our project "Development of IoT-driven solutions for smart connected islands" is a multidisciplinary international project, executed by the students and lecturers of AP University of Applied Sciences and Arts and Karume Institute of Science and technology in Zanzibar.***

***International project, innovation, Internet of Things***

## I. Introduction

The purpose of this paper is to describe what the project is about and the students conceptions of an international and multidisciplinary learning experience. Besides 21st century skills, like communication, problem solving, critical thinking and creativity, we also make students look at the world in a different way. The need to see the world through different lenses, to respect different cultures.

With the AP-KIST Zanzibar project we focus on the development of real-life applications for internet of things to break away from the theory and give way to practical applications.

With wide-ranging technological progress taking place across the world, Zanzibar needs a healthy workforce with relevant skills and talents to serve the local labor market as well as to contribute and compete as global citizens. Therefore, Zanzibar Development Vision 2050 (ZDV2050) comes with these aspirations: commercialized technology-focused innovation in line with developments in ICT and emerging technologies for use in government, business and trade, including the development of e-commerce for domestic, regional and international markets; and solid support and training for human capital development in ICT at vocational institutes and universities.

The ambition to tackle these challenges are stipulated in the industrialization agenda of the Tanzanian Government. The project aims to fulfil the needs of an I(O)T engineer. These aims will be met by delivering short intensive courses, establishing technology laboratories and increase accessibility for students.

In March 2022 AP and KIST started the first collaboration with this project. With 6 students and 2 lectures of the Media Design and IT, we travelled to KIST for 1 month to develop together with local students and lecturers the IoT system to support ZDV2050.

## II. Preparation

First the students had to apply for a scholarship. The international coordinator in the study program (IT) at AP made the preselection and decided whether a student was allowed to do a traineeship abroad or not. Academic and personal competencies, language knowledge, attitude and motivation and other competences important for the study program were taken into account. The coordinator of AP international office supported the student in the preparation for the research project and with the application file.
Students had to write a 1 page motivation letter. The student had to explain his motivation to do this research in the south. In this document the student could explain more about his personal background and his project.

Furthermore, they had to fill in the application file. Students were evaluated on criteria about competencies of cosmopolitanism, as well as the surplus value the traineeship or research had for the local organization/country/people.

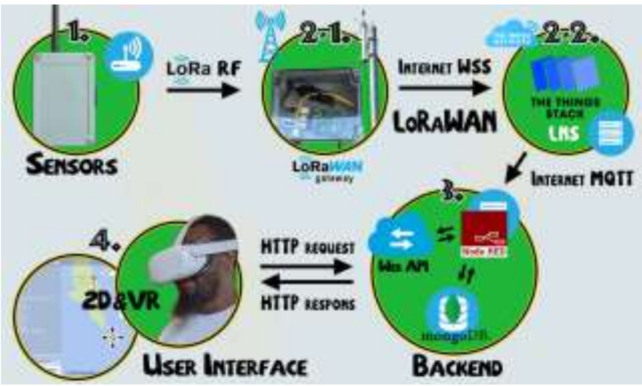
Also, a Memorandum of Understanding (MoU) has been written between AP and KIST. The purpose of this MoU is to promote academic exchange and cooperation of mutual interest in accordance with the respective needs and objectives of the parties.

## III. Development

The first concrete objective within this project was to develop an IoT system to monitor environmental parameters like temperature, pressure, salinity of the sea level.

The requirements were delivered by KIST institute and government, while the analysis was done by AP. The target was to make a proof of concept, which will be the start of introducing IoT technology at the Karume Institute of Technology and Science.

The KIST institute was in contact with different government institutions to identify valuable data needed monitoring. We installed a LoRaWAN gateway with an outdoor antenna on the top roof of the university and developed and installed different sensors and a virtual reality digital twin. AP provided material as a gateway, antenna and sensor nodes.
The architecture of this project exists of several subsystems. The subsystems are a LoRaWAN network, sensors, backend technology for data collection and a user interface to consult the data.




### A. LoRaWAN Network

(1)The LoRaWAN network is a Low Power, Wide Area (LPWA) networking protocol designed to wirelessly connect battery operated ‘things’ to the internet in regional, national or global networks, and targets key Internet of Things (IoT) requirements such as bi-directional communication, end-to-end security, mobility and localization services.

To setup the LoRaWAN network with The Things Network we configured a gateway. A LoRaWAN gateway is the device that connects a LoRa device to a Wide Area Network through a LoRaWAN Network Server (LNS). When an end device node, in this case a sensor, transmits its data in the form of radio waves, the gateway can receive the data. Once received, the data is sent to the LNS. The data is sent over internet to the cloud. This way the data is accessible everywhere through internet given the right authentication.

To enable the staff and students at KIST in the further development of IoT applications for environmental monitoring an embedded development board is developed. This board was built around a LoRaWAN module and a Cortex M0 microcontroller. The board is a flexible prototyping device because it can hook up multiple sensors over different serial protocols with a standard JST connector. The whole board can be powered with a battery.


### B. Salinity Sensor

For the monitoring of the salinity of the sea a sensor is developed. This sensor reports the relative change in salinity (conductivity) of water. It uses a probe, an OPAMP and an ATtiny. The salinity sensor probe exists out of two electrodes that are positioned within a certain distance of each other. When there is more salt, the resistance of the water will be lower so more current will be able to flow. Our students used a wheatstone bridge. The two sides of the wheatstone bridge are voltage dividers, on one side the voltage will change depending on the amount of salt, the other one is calibrated and will give a fixed voltage. The two outputs from the Wheatstone bridge are connected to a differential amplifier which will output a voltage proportional to the voltage difference on the inputs. An ATtiny will, on request, read the output voltage of the differential amplifier and send it over I2C. The current prototype of this sensor is made on a perfboard. This is a more stable way of testing than using a breadboard. There are also three working prototype boards made by the students of KIST in our workshop.

*C. Backend technology for data collection*

Node-RED is a programming tool for wiring together hardware devices, APIs and online services in new and exciting ways. At the back of our Node server,a MongoDB database is developed. IOT is not only about connecting things to the internet, but also about collecting data. MongoDB is perfectly suitable for collecting things data, because it can handle large volumes of data, and easily supports time series data, which is typical for IoT networks.

*D. User Interface*

Students developed two types of user interfaces. The first was a web application to visualize the data. The interface shows a map with all sensors installed. The sensor in the UI are clickable to show the data. They also designed a digital twin of the island in virtual reality. Wearing a headset gives you an overview of the island with all sensors installed showing the latest data value of the sensor.

## IV. FINDINGS

Students succeeded in the development of this proof of concept. Besides the technological challenges, students also experienced intercultural collaboration and communication. They immediately experienced that separately, they don't get anywhere, but as a team they are taking bigger steps to understand the technology and its capacity. Students understood the learning experience in relation to unusual situations during the project. The competences students used and developed were content knowledge, different personal characteristics, social skills, emerging leadership skills, creativity, future orientation, social skills, technical and testing skills and innovation skills.

*A. Student perception of the project*

Besides learning technology in a practical manner they also had to learn how to troubleshoot with limited resources and how to work together with people from a different culture. They constantly had to solve problems and be creative, e.g. dealing with power outages, testing electronics against Zanzibar climate, etc. The success of this project has been made possible by very motivated and curious students and lecturers. This is wat innovative teaching and innovative practice is about.

Our students formulated their experience as follows : "I have learned so much about the culture in Zanzibar, I have learned about the way people think, I have learned to be more relaxed and think about things with a calm mind, I have become more creative and my own way of thinking has changed a lot.

I am very grateful for this opportunity to go to Zanzibar. I am convinced that I have grown as a person and as an IT professional during the month in Zanzibar."

## V. CONCLUSION

The international innovation project described in this paper provides a way to connect higher education to the practices of society. It promotes the dissemination of innovation development programs in between education and the global South. This way, we build together on the future. Setting-up a sustainable relationship between KIST and AP, so we can learn from each other and prepare our next generation students for jobs in the industry 4.0.

[1] https://lora-alliance.org/about-lorawan/