Work Placement Report

Student Details

Name: Tadj Cazaubon
Email: tc222gf@student.lnu.se
Mobile: (+46) 707213048

1. Company details

Company: Växjö Linnæus Science Park AB

Address: Växjö Linnæus Science Park, Framtidsvägen 14, 352 22 Växjö

Description: Växjö Linnæus Science Park AB is owned by the municipality of Växjö and is run in collaboration with business, the regional innovation support system and academia. The aim is to build a supportive and inspiring community for entrepreneurs. The goal is for companies to become even more successful. Able to grow and take new market shares. Swedish Incubators & Science Parks (SISP) is the Swedish industry association for Sweden's incubators and science parks. SISP has 62 members all over Sweden who together run approx. 80 physical meeting places, offer operational business development, often run or collaborate with clusters and have triple helix anchoring. [1]

Historical: Since 1986, Växjö municipality has had a company that worked with both real estate and business development through science park operations: Videum AB / Videum Science Park. At the turn of the year 2021/2022, the science park operations were transferred to a completely new company - Växjö Linnæus Science Park. [1]. In 1989 SwedePark is formed as an association for research and technology parks. In 1999 SwedSpin is formed as an association for business incubators. In 2005 SwedSpin and SwedePark merge and form Swedish Incubators & Science Parks, and 2011 Swedish Incubators & Science Parks opens its officies [2].

2. Business Model

Växjö Linnæus Science Park has a number of key focus areas. The focus areas are selected based on the needs of business, the academy's strengths and Växjö Municipality's areas of interest.

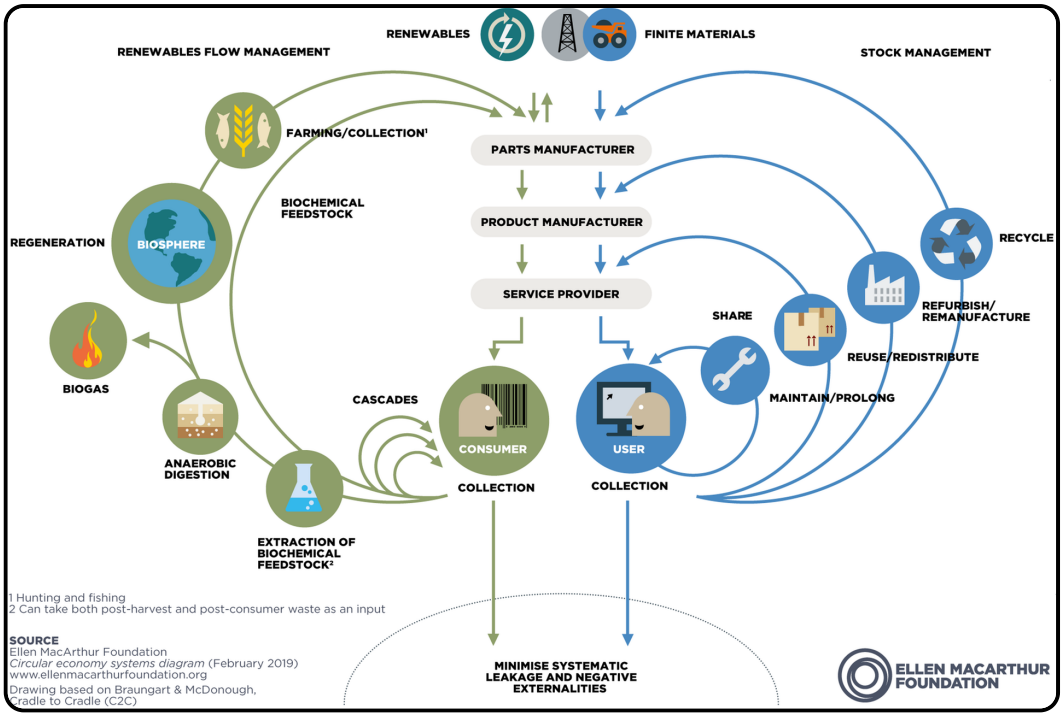
2.1. Circular Economy

VLSP puts an enormous emphasis on their goal for facilitating a circular economy. The Ellen MacArthur Foundation is referenced in their explainations on this topic, according to which, a circular economy is:

"a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting"[4].

VLSP believes that in order for to acheive Sweden's emisison reduction target of zero net emissions by 2045, a move from a linear to a circular economy is crucial. To illustrate this, they split the circulation of materials in the economy into two distinct 'flows'; *biological*, whereby materials are returned to the biospere and *technical*, whereby materials circulate in industrial processes.

An example of this is illustrated on the VLSP website in a diagram taken from the Ellen Macarthur Foundation [3][4]:



To accomplish this, the Science park has laid out a few key points:

- Extending the life of biological materials by designing them to be used in several different products one after the other, before returning to the biosphere
- Enabling upcycling, whereby materials circulate and maintain their quality and economic value regardless of the number of cycles.
- The closer you can get to the innermost circles of direct reuse, the greater the savings, as the need for new extraction of raw materials decreases and less energy is used for transport and material processing.

2.2. Smart City

The smart city objective according to VLSP, is a set of projects with the goal of streamlining the city's functions while improving the quality of life for residents, with a focus on acccessibility. [5]

An example of this would be the **DigIT Hub** project aimed at small to medium-size oublic sector companies in southern Sweden to help them digitize, and become part of an established network of 'hubs'. The project includes members such as: Växjö municipality, Lund Municipality, Malmö City, City of Helsingborg and RISE - Research Institutes of Sweden. Information of the project can be found on their website digithub.se

2.3. Forest and Wood

VLSP pays close attention to the current climate crisis, factoring in the potential climate impact into their goals and methods of achievement. With nearly two-thrids of Sweden's area being forest, VLSP has stressed establishing incentives to build out of the abundant resource of timber.[7]

VLSP therefore works very closely with the Municipality to facilitate common goals associated with wood building.
This therefore reflects in the projects it chooses to sponsor and carry out, or in research carried out by

contributors. An example of this would be the CEO, Fredrick Lindblad, who has personally done much work on this topic. The most often referenced in discussions being Fredrick's 2020 Article: *Växjö Municipality's Planning Strategy to Increase the Construction of Wooden Multi-Family Buildings*[8], and his 2022 Article: *A Case Study of Växjö Municipality's Actions to Increase the Construction of Wooden Multi-family Buildings* [9].

2.4. Digitization

Digitization for VLSP involves working with businesses to update, automate and therefore digitize their existing processes and information. THis may be as simple as moving from a system to physical file-keeping, to hosting files on some electronic platform, all the way to making sweeping changes to processes to automate large parts in bid for efficiency.

3. Task

My task was to to implment the IOT Weather Station Mesh Network Monitoring System proof of concept laid out in my initial proposal document. This entails not only building the core mesh network, but also accompanying systems for statistical analysis and eventually classification.

The network consists of 4 ESP32 microcontrollers with DVP OV5640 cameras (previously OV2640), equipped with a BMP390 altimeter, and SHT31-D hygrometer. These weather stations send periodic images and readings to a central server housed in the Science park. This data is then used to obtain the size, type, height and approximate velocity of the cloud, as well as host generally useful temperature readings.

Initially I was tasked to complete this between June 5th and August 11th, 2023, but since then my internship has been extended by a further 2 months.

3.1. Problems

The most prevelant issue was my schedule at the time. Though I was able to work remotely, I was travelling at the time and unable to access my main computer at home. This meant things like compiling code, or creating graphs of my data so far would take much longer each time as my laptop is very under-powered. In some cases, I simply couldn't run the needed tests because my laptop didn't have enough RAM. This easily set my my development schedule back over a month.

My next problem admittedly was my own fault. In ordering the ESP32 boards, I opted for newer ESP32-S3 models due to their increased flash storage, more robust vector instruction set and lower power usage. Documentation and software support for these is limited due to them being so new however, especially in my chosen language of MicroPython. The existing firmware and libraries I was using would not be compatible with the new boards. This meant I would not only have to rewrite my existing code for the Esp, but I would have to do it in the Arduino programming language, of which I was not familiar. Support within the Arduino ecosystem was of course also lacking for these boards, which set me back further.

Developement in the ArduinoIDE is also a much slower process. Whereas Micropython allows a user to upload and run pytohn files onto a board, Arduino files must be compiled first and upoloaded to the board, taking much longer during the development cycle.

The level of mathematics I needed to fully understand the systems I was attempting to analyze was above my level by miles. It took weeks of revision to have enough of a grasp just to read the requisite research papers for the topics I needed.

3.2. Result

The goal for this large of a project was for rapid development of small but scalable components. The stations would send the data to a server running in the Science Park, with the data being saved to a simple MYSQL database. This database would be open to a separate computer to access to train a simple classififcation model. As of September 8th, 2023, I have built the system by which these boards can take their pictures and environmental readings, and send them to a central server to be logged. I have also made the tools for undistorting the images received as to map them onto a 3D space. I'm currently constructing the database manager and capturing image data from the OV5640 cameras to analyze in comparison with the old OV2640s. Any further in that pipeline however, I have not reached. I have, however, created the tools for analyzing the image data for classification, such as simple histograms, Principle Component Analysis and Quadratic Discriminant Analysis.

3.3. Development process

Within the Innovation Lab, I am the only developer assigned to my project. I am able to ask developers of other comoanies within the Science Park for assistance, including my superviser, David Avery. However, I ultimately choose the timeline, style and speed of development. While this does allow me to weave my schedule around my current UNiversity studies, I find the lack of structure leaves me feeling demotivated at times.

Deliverables however, are the main goal. Every monday, there is a staff meeting, at which there is a presentation of the previous week's results and a discussion on the plan for the week ahead.

3.4.1 Tools

4. Lessons learned

References

- [1] 'Mer om science parks', https://vaxjolinnaeussciencepark.se/om-oss
- [2] 'Historic', https://www.sisp.se/om-sisp
- [3] https://vaxjolinnaeussciencepark.se/fokusomraden/cirkular-ekonomi
- [4] https://ellenmacarthurfoundation.org/topics/circular-economy-introduction/overview
- [5] https://vaxjolinnaeussciencepark.se/fokusomraden/smarta-staden
- [6] https://vaxjolinnaeussciencepark.se/samverkansprojekt/digit-hub-sweden
- [7] https://vaxjolinnaeussciencepark.se/fokusomraden/skog-och-tra
- [8] Lindblad, Fredrik. (2020). Växjö Municipality’s Planning Strategy to Increase the Construction of Wooden Multi-Family Buildings. Sustainability. 12. 10.3390/su12124915. Available: https://www.researchgate.net/publication/342211480_Vaxjo_Municipality%27s_Planning_Strategy_to_Increase_the_Construction_of_Wooden_Multi-Family_Buildings
- [9] F. Lindblad, “A case study of Växjö Municipality’s actions to increase the construction of wooden multi-family buildings,” Journal of Civil Engineering and Architecture, vol. 16, no. 5, 2022.

doi:10.17265/1934-7359/2022.05.002 Available: https://www.researchgate.net/publication/361796022_A_Case_Study_of_Vaxjo_Municipality's_Actions_to_Increase_the_Construction_of_Wooden_Multi-family_Buildings