Abstract

The creation of a sustainable living farm is the solution proposed in this paper for the urgent need to fight global warming and the depletion of environmental resources. It is crucial to educate and involve people in environmental protection since urbanization and irresponsible consumption drive widespread resource depletion. The circular economy-inspired design of the planned farm intends to increase public awareness, impart knowledge, and act as a test site for innovative technology. The farm's sustainable method provides self-sufficiency with a low reliance on outside resources while preserving the balance of the social, economic, and environmental systems. The primary beneficiaries of the farm's establishment in the Bayern region are the universities and businesses there. The project aims to build a sustainable farm that promotes education, raises awareness about nature conservation, and utilizes new technologies and innovations. The scope of the project focuses on the Bayern area, aiming to contribute to universities and companies in the region. The report provides an analysis of stakeholders, cost, market, and competitive factors with all the necessary policy requirements and future possibilities of the farm. Farm covers different sectors like food, water, building materials, energy and heating. Overall, this study emphasizes the significance of creating a farm that fosters environmental education, raises awareness, and enables individuals to develop basic skills while connecting with nature and animals. Sustainable farming practices reduce their negative effects on the environment, increase resource efficiency, and promote local economies, ecosystems, and human well-being. For a sustainable farm, the challenges are to choose fertile land near water, renovate existing structures, optimize solar energy, balance sustainability with practicality and aesthetics, and address challenges during winter seasons.

Keywords: Social start-up, sustainable farm, circular economy approach, innovation, permaculture farming, self-sustaining, socially sustainable, economically sustainable, environmentally sustainable, agriculture, education, awareness

TABLE OF CONTENT

1. Introduction

Nowadays, it has reached a visible level where global warming is increasing day by day and environmental resources are decreasing. With the decrease in green areas, the gradual decrease in wildlife and the current 1.5 °C, every step that needs to be taken to educate people about the environment and to reduce the use of environmental resources has become a necessity. In this farm, which will be established with the circular economy approach of the sustainable living farm, which will be built to educate and raise awareness of people on this issue. Sustainable keyword means that the farm is self-sustaining and needs very little external resources and is socially, economically and environmentally sustainable. Living keyword means that it will adapt to the needs and new innovations every year in an evolving and changing world and that it will act as a pilot to test some new technologies. Circular approach means that it will be a closed system and that every new resource used will be sourced from a waste on the farm or, for example, from rainwater to meet water needs, and that all waste generated will be included in the system in a circular way, such as using waste as fertilizer.

First of all, when it comes to the SDGs, it is thought that the 6th SDG, clean water and sanitation, has been achieved by using rain water and circular collection of water in the sustainable farm. The 7th SDG, Affordable and clean energy, can also be added to the goals achieved by the use of solar panels on the farm and the fact that it is only renewable. Next is the 9th SDG, industry innovation and infrastructure, which is also achieved by acting as a pilot area for all innovations and changes and new technologies with the concept of a future living farm. 11st SDG, Sustainable Cities and Communities, with the establishment of a living space and this living space will be a sustainable area that will be home to 2-3 families, then 35 people and up to 50 animals. Therefore, we also provide this. 12nd SDG, Responsible consumption and production, with this farm, which will be in a completely closed cycle and will reduce waste to almost 0, it will be ensured that all the resources used and consumed in this farm will be done consciously. 13th SDG, With Climate Action, it will be a project that will lead people to take action on climate change in both education and awareness. 15th SDG, Life on Land, with the agriculture to be done, steps will be taken by recognizing the importance of the soil with the diversity in the soil and the diversity that will be continuous. 17th SDG, Partnerships for the goals, the most important aspect that will be the most important in the projects is that the institutions and organizations that provide the same purpose and are good at different subjects and can help each other come together and contribute and help each other for the same purpose and share their experiences, which is very important and valuable for all parties.

i. Problem Statement

With today's conditions, industrialization and unconscious consumption has led to a very widespread and unconscious use of a lot of resources. Therefore, in the future we have a high possibility of losing everything we have now and what do you think is the main problem? Actually there can be many reasons for this but if we start with the simplest ones. it's either people don't know how to help to help nature or they don't care or even they don't realize the

problem. A very large part of the world and 77% of Germany's population live in urban centers. Although Germany has an advantage in terms of green space compared to other countries, unfortunately, the lack of spaces in city centers where people can really connect with nature is becoming a big problem. Connecting with nature should not be perceived as hiking or walking around a lake. What is meant is more of a hands-on experience with nature and animals, which unfortunately cannot be found either in zoos or in a natural fruit and vegetable market. This can only be found in farms that offer options such as workshops. Also, the proportion of such farms and nature and greenery is constantly decreasing. So it will be harder and harder to find this opportunity. As research has shown, people are growing away from simple natural skills, and the surprising thing is that there are people who study nature. It is seen that people studying in these departments also lack basic skills such as milking cows and making fire.

ii. Aim and Scope

First of all, the aim of the project is to build a sustainable and living farm where people can unite with nature and animals and learn basic skills, that is, a farm that makes education the main focus and aims to raise awareness about nature conservation, which can be developed with new technologies, innovations and new research contributions from universities and individual people. As for the scope of the project, since the farm is intended to be established in the Bayern area, it is planned to contribute primarily to universities and companies in the Bayern area. This can be found in detail in the market analysis section.

2. Main Findings

i. General Information

Circular Classroom is a sustainable circular farm, which can also be called a regenerative farm or a self-sustaining farm. In self-sustaining farming, food is produced by using all the produce from one's own farm, or by using other things' by-products or waste as raw material for other things. A circular classroom is based on closed-loop systems that leverage the concept of recycling and reusing resources within the farm. In circular classrooms, the animal waste is used as fertilizer for the plants and crops, and the crop residue is used as fodder for the livestock. Solar energy is also used to generate energy and heat the farm. The waste is used for the insulation of the building and scrap wood is also used for the structure of the buildings.

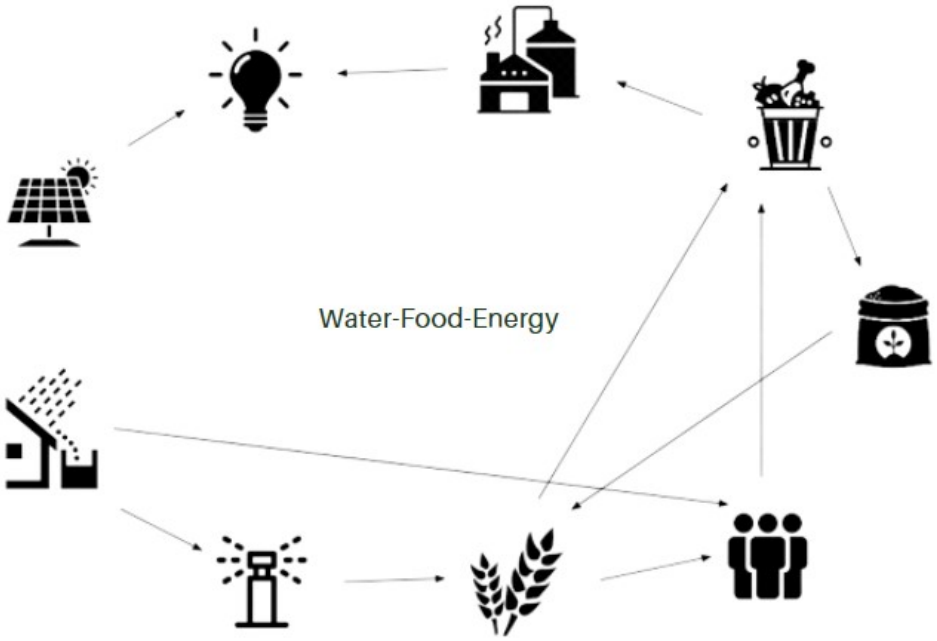

Fig 1: Circular Economic model of the Farm using Water Food Energy Nexus

All natural renewable resources are used to run the entire farm, making it more sustainable. The sunlight is used to generate energy, which is used on the farm for various operations. The rainwater is also collected and fed to the crops and plants. All organic waste is sent to a biogas plant for energy production

By using this concept, the company manages to reduce waste from the environment and thus not to produce any more waste. Regarding the building, reclaimed wood and glass bottles are used for the structure of the buildings.

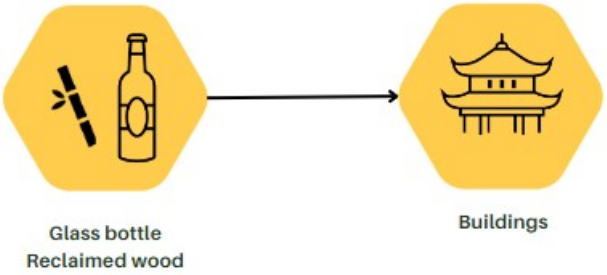

Fig 2: Waste bottles and reclaimed wood for building material

Likewise, the other waste products are used as fertilizer for the plants and in the end all the organic waste is sent to the biogas plant, as can be seen in the figure.

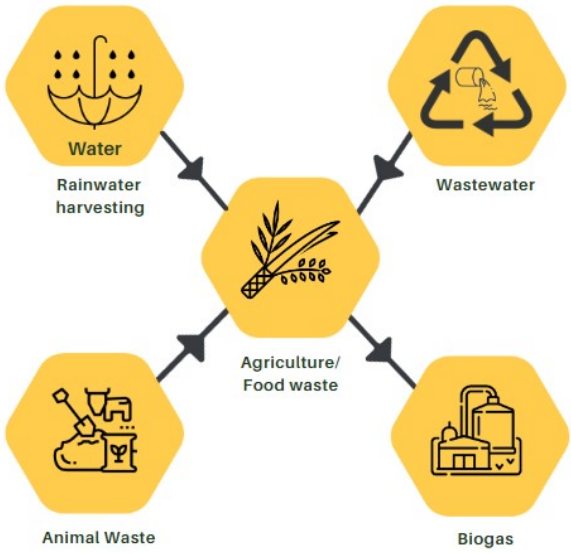

Fig 3: All the bio-waste is used to generate Bio gas

ii. Business Canvas

Business Canvas constitutes the complete working of our farm which is used to describe, analyze, and visualize the key components and elements of our business model.It offers a succinct summary of the processes the farm uses to produce, deliver, and capture value.These building blocks assist in identifying possibilities, difficulties, and potential areas for improvement while capturing the key components of a business model.

These following are the key components typically included in our business canvas:

1. Key Partners: The component of key partnerships lists the outside companies or organizations with which the farm works to improve its value proposition or streamline operations. These could be vendors, strategic partnerships, or joint ventures.
2. Key Activities: This section describes the fundamental procedures and actions that the farm performs to fulfill its value proposition. It includes tasks like manufacturing, advertising, shipping, providing customer service, or doing research and development.
3. Value Proposition: The value proposition outlines the special benefits that the farm provides to its clients. It describes the goods, services, or solutions that meet consumer needs, handle issues, or bring about advantages.
4. Customers Relationships: This section focuses on the kinds of relationships that the farm creates and keeps with its clients. Personalization, self-service, and personalized assistance are just a few examples of the strategies and methods used to build, maintain, and expand client relationships.
5. Customer Segments: The various customer segments or target markets that the farm seeks to service are described in this section. It entails comprehending the particular requirements, interests, and traits of each consumer segment.
6. Key Resources: This component highlights the crucial tools, resources, or capacities that the farm needs in order to function properly. Physical assets, intangible assets, human resources, and strategic alliances can all be included.

7. Channels: This building block describes the channels or means of distribution via which the farm connects with and engages with its clients. Physical storefronts, websites, mobile applications, and collaborations are just a few examples of traditional and digital channels that are included.
8. Cost Structure: The cost structure outlines the different costs and expenses a business incurs to run. It includes both fixed and variable costs, including those related to production, marketing, overhead, or employee compensation.
9. Revenue Streams: The section on revenue streams lists the sources of income for the farm. It describes the price strategies, revenue-generating plans, and payment procedures used to extract value from clients.

<table>
<tr>
<td rowspan="2">Key Partners
•Sustainable Companies (Advertisement/collaborations)
•Student Councils?
•Universities and Hochshule.
•Plant a seed TUM.</td>
<td>Key Activities
• Develop & Implement sustainable farming practices
• Create & manage educational programming
• Waste Management
• Marketing
• Operating Airbnb
• Operating the restaurant</td>
<td rowspan="2">Value Proposition
• Educating about a self sufficient farm based on the circular economy principle while promoting sustainable eating habits</td>
<td>Customer Relationship
• Website
• Engagement between users in a chat function/ via emails.
• Telephone services will also be installed</td>
<td rowspan="2">Customer Segments
•Students
• Professors/assistants
•University staff
•Guest visitors</td>
</tr>
<tr>
<td>Key Resources
• Land
• Animals
• Staff</td>
<td>Channels
•Website
•Social media
•Advertising at Universities
•Billboards (if possible)</td>
</tr>
<tr>
<td colspan="3">Cost Structure
• Development cost, Material cost, Maintenance cost and Land</td>
<td colspan="2">Revenue Streams
• Café, Workshops, Social platform (YouTube), BnB, Sponsorship, Funding</td>
</tr>
</table>

Table 1: Business Canva

iii. Agriculture & Food

Circular classrooms mainly focus on permaculture farming. Permaculture farming is an agricultural technique that strives to produce self-sufficient, sustainable ecosystems by mimicking the patterns and linkages seen in natural ecosystems. It integrates elements from permaculture design, ecological principles, and traditional agricultural techniques to produce a regenerative and comprehensive system.

Permaculture farms include plants, animals, water systems, and microorganisms to mimic the structure and function of natural ecosystems. This design technique produces more resilient and diverse agricultural systems that require less external inputs and are more resistant to pests, diseases, and climate variability. This method highlights the significance of healthy soil as the foundation of sustainable farming. Composting, mulching, cover cropping, and crop rotation are all methods for improving soil fertility, structure, and water retention capacity. By

nourishing the soil ecosystem, permaculture farming reduces the demand for synthetic fertilizers and pesticides. Permaculture emphasizes the concept of "waste as a resource." It aims to cut waste and improve resource efficiency.

By adopting strategies such as composting, vermicomposting, and recycling organic waste, permaculture farms may close nutrient loops, minimize reliance on external inputs, and reduce pollution. Permaculture farming usually emphasizes local and community-based food production strategies. It promotes information sharing, collaborative activities, and the development of resilient local food networks. By promoting community engagement and local food security, permaculture farming contributes to social sustainability and resilience. By embracing these concepts and approaches, permaculture farming tries to construct long-term sustainable, regenerative, and self-sufficient agricultural systems that are ecologically sound, socially ethical, and commercially viable.

Along with permaculture methods, we would like to introduce vertical farming. Vertical farming is a cutting-edge agricultural practice that involves growing crops in vertically stacked layers or vertically inclined surfaces, typically in controlled indoor environments like greenhouses or warehouses. Vertical farming utilizes vertical space to maximize available land. It enables for many layers of crops, increasing production capacity per square meter as compared to traditional farming methods. This is especially useful in urban areas where available land is limited or expensive. Pesticides and herbicides can be reduced or eliminated in vertical farms grown under controlled indoor circumstances. Pest and disease pressures are reduced in a managed environment, minimizing the demand for chemical inputs.

The food we grow on the farm is then used for local market supply as well as for the cafe we aim to open in the near future. A seven-day menu is also designed to help understand how many people can be fed on the farm every day. We were able to develop a three-dish per day meal plan that includes salad and juice with each meal. For breakfast, we provide a variety of vegan pancakes, and for lunch, we offer smoked veggies and soups in a variety of flavors. We have baked cauliflowers, Italian potatoes, pumpkin vegetable curry, and many other alternatives for dinner. Some dishes may alter or be added to the menu as specials based on the harvest of seasonal plants. A detailed 7 day menu card is shown below.

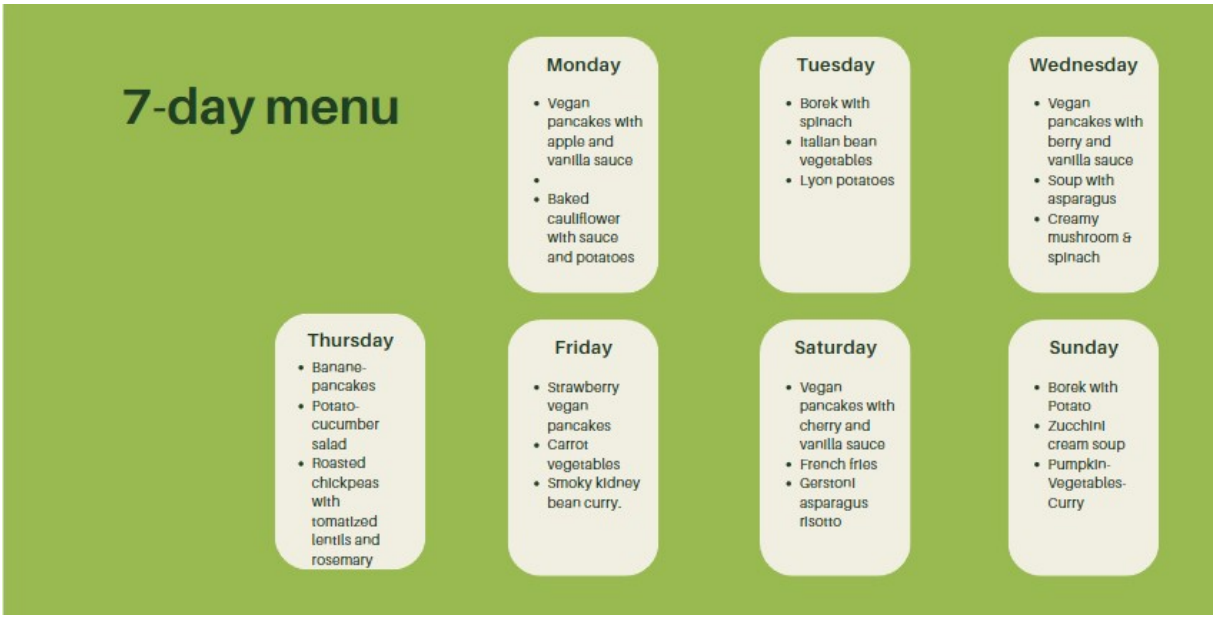

Fig 4: 7 Day Menu of the farm

iv. Water

Rainwater harvesting, groundwater and gray water treatment plants are our primary sources of water. Rainwater harvesting is a sustainable strategy that involves collecting and storing rainwater for various agricultural applications on an organic farm. Rainwater is collected via gutters and downspouts from various surfaces such as rooftops, greenhouses, and other structures. Water flows via these canals and into storage tanks or reservoirs. Rainwater is collected and stored in tanks, cisterns, or ponds. It is critical to utilize non-toxic storage containers that do not contaminate the water. Filtration systems can be added to remove dirt and sediment, ensuring that the water is pure and safe to drink. Irrigation is one of the most important uses of gathered rainwater on an organic farm. Drip irrigation, sprinklers, or other effective watering technologies can be used to transfer the stored rainwater to crops. This reduces the requirement for freshwater supplies and reduces the need for energy-intensive pumping equipment. It decreases dependency on traditional water sources, conserves freshwater resources, reduces energy consumption related with water pumping and treatment, and eliminates possibly contaminated water discharge into natural rivers. It adheres to organic farming ideals by supporting ecologically friendly and sustainable techniques. Rainwater harvesting at an organic farm is feasible and successful depending on factors such as rainfall patterns, farm size, water consumption, accessible infrastructure, and local regulations. Rainwater harvesting systems must be properly designed, maintained, and monitored to ensure water purity and long-term performance.

Given the region's temperature and rainfall patterns, rainwater harvesting in Munich, Bavaria, can be a profitable and sustainable technique. Munich has a temperate climate with modest precipitation year round. The city receives approximately 950 millimeters (37 inches) of rain each year on average. Rainwater harvesting can help maximize rainfall consumption and give multiple benefits to both urban and rural regions, including organic farms.

Groundwater is a vital resource throughout Germany, particularly the Munich area, and its management is governed by legislation to ensure its protection and long-term use. Germany has a comprehensive system of water resource laws and regulations, including groundwater. The Federal Water Act (Wasserhaushaltsgesetz) and various state water laws (Bundesländer) establish the legal framework for groundwater management, addressing issues such as extraction, usage, and protection. Water extraction from groundwater in Germany normally requires a permit, especially for greater quantities. Permits are often provided by local water authorities or boards (Wasserbehörden) and may include conditions regarding extraction rates, monitoring, and reporting.

Implementing a greywater treatment plan on an organic farm can be a long-term practice for reusing water and reducing waste. Greywater is wastewater generated by activities such as dishwashing, laundry, or bathing, but does not include toilet waste. Identify greywater sources on the farm, such as sinks, showers, and washing machines. Determine the quantity and quality of generated greywater to determine its appropriateness for reuse. There are several greywater treatment options available, ranging from simple to complex systems. The treatment method used is determined by factors such as local restrictions, available space, and the desired level of water quality. Filtration, biological treatment through artificial wetlands, and the use of greywater-specific treatment devices are all common treatment methods. Filtration is frequently used in greywater treatment to remove sediments, trash, and bigger particles. To remove bigger particles, simple filtration technologies such as mesh screens or settling tanks can be employed as a first step. Biological treatment technologies can help to improve greywater quality even more. Wetlands and soil-based treatment systems can be used to filter and cleanse greywater naturally through the activity of microorganisms, plants, and soil. Disinfection may be required to assure the safety of treated greywater, depending on local rules and individual requirements. Disinfection procedures include UV treatment, chlorination, and other appropriate ways for removing germs and bacteria. Greywater might be held in separate tanks or reservoirs once it has been treated. It is critical to utilize greywater-compatible storage containers that are free of pollution. Create a distribution system to supply treated greywater to designated locations for irrigation or other permitted purposes. It is critical to follow local legislation and guidelines when building a greywater treatment strategy in your area. Consult with your local water authority or environmental agency to ensure that your greywater treatment system fulfills the necessary standards and complies with any applicable licenses or restrictions.

v. Building Materials

The Circular Classroom is a sustainable farm that focuses on all sustainable aspects of life. Therefore, the same aspects were taken into account when selecting the building materials.

Building materials play a crucial role in creating sustainable farms. Several factors should be considered when selecting materials for farm buildings, including environmental impact, durability, energy efficiency and resource conservation.When considering sustainable building materials for a farm, it is important to assess their suitability for the specific climate, local availability and long-term maintenance requirements.

For our farm we have followed the 3 dimensions of sustainable materials for selection procedure.

- Highly sustainable materials
- Moderately sustainable materials
- Conventional materials with sustainable attributes

These criteria include natural materials, recyclable materials, locally sourced materials,less carbon footprint, energy efficient materials and water efficient materials.

Sugarcane bagasse, glass bottles, reclaimed wood are the main components which constitute the sustainable materials of our farm. Where sugarcane bagasse is used as a very good source of insulation to the walls of the farm. Glass bottles are used as finishing elements as well as provide a better structure to the farm. Reclaimed wood which are sourced locally are the main component for every building structure which provides strength and support.

When building a sustainable farm with sustainable building materials, several factors should be considered such as:

1. Material selection: Choose building materials that comply with sustainability principles, recycled or reclaimed materials, sustainably sourced wood, natural materials such as clay or straw bales and low-emission products. Look for certifications or eco-labels that validate their sustainability credentials.
2. Energy efficiency: Use materials that contribute to energy efficiency, e.g. B. High R-value insulation, energy-efficient windows and doors, and reflective roofing materials. These decisions can help reduce heating and cooling needs and minimize energy consumption. Water
3. Management: Consider materials and strategies that support efficient water management. These include water efficient fixtures, rainwater harvesting systems, permeable surfaces to encourage groundwater recharge and the use of materials that withstand water exposure without degrading.
4. Renewable Energy Integration: Integrate renewable energy systems such as solar panels or wind turbines into the design of commercial buildings. Using sustainable energy sources can reduce dependency on fossil fuels and reduce the carbon footprint of operations.
5. Durability and Maintenance: Opt for durable materials that require minimal maintenance and will last a long time. High-quality, durable materials reduce the need for replacement and repairs, thus saving resources and costs in the long term.
6. Consideration of site and climate: Adjust the choice of building materials to the specific site conditions and climate. For example, choose materials with good thermal insulation properties in colder regions or use shading materials in hotter climates.
7. Life Cycle Assessment: Conduct a Life Cycle Assessment to assess the environmental impact of different materials. Consider factors such as embodied energy, carbon footprint and end-of-life disposal. Choose materials with a lower overall environmental impact.

vi. Energy

Since the farm is a self-sufficient farm, it will produce its own electricity through renewable resources. Electricity production will be done in two phases:

1. Initial phase: This is the initial phase of the farm in which there are 3-4 buildings and 5-10 people. For this, we are using solar panels and a Lithium Iron Phosphate (LiFePO4) battery.

    - The amount of solar electricity required to power four rooms will depend on several factors, including the size of the rooms, the number of occupants, the type and number of appliances and electronics used in the rooms, and the amount of sunlight available in the location where the solar panels will be installed.

      To get a rough estimate, we can assume that each room will have an average size of 12' x 12' (144 sq. ft.) and will require an average of 1,000-1,500 watts of power. This would give a total power requirement of 4,000-6,000 watts for four rooms. Assuming an average of 5 peak sunlight hours per day, a 4 kW solar panel system could generate about 20 kWh of electricity per day. This should be enough to power most of the electrical appliances and lighting in four rooms, depending on their energy efficiency and usage.

    - When it comes to choosing environment-friendly batteries to work with solar panels, the best option is Lithium Iron Phosphate (LiFePO4) battery because it can be used particularly for off-grid and backup power systems. LiFePO4 batteries are a type of lithium-ion battery that offer several advantages over other types of batteries. They have a longer lifespan, can be discharged more deeply, and are more temperature stable than other lithium-ion batteries. They are also non-toxic and environmentally friendly, making them a popular choice for renewable energy systems.Overall, LiFePO4 batteries are a reliable and efficient choice for homes looking to use renewable energy and reduce their carbon footprint.

2. Final phase: This will be the stage when the farm will start to run at its full capacity. More buildings, more animals and 35-40 people will reside in the farm. With this many people and animals, we will generate a lot of solid organic waste. We will use this biowaste to generate biogas. This will be our primary source of energy, especially in winters. We will also have a backup battery system like the initial phase but with more batteries. We plan to install a few more solar panels to make a small-scale solar power plant during summers. Surplus electricity can be sent back to the grid.

vii. Heating

The Circular Classroom is a self-sustaining farm and is based on the concept of making the environment greener and also reducing environmental waste. Sustainable heating plays an important role in farms to maintain the optimal temperature in various farms such as greenhouses, cattle sheds, water heating and also in the processing plants. For this purpose, the following sustainable methods are used in the company:

- Solar water heating system: This system actually uses the sun's energy to heat the water and then this water is transported to different casings for daily use and also an additional casing is placed inside the walls so that it is used when the room temperature is high is the heat from water using the concept of convention. The wall temperature is increased to maintain the temperature in the room. The total costs for this are 7,000 to 8,000 euros(Energy, 2023).
- Air source heat pump: ASHP extracts heat from the ambient air and uses it for heating purposes. The operating cycle is similar to that of the refrigerator, but in reverse. ASHP absorbs heat from the outside air, increases the temperature and distributes it to the farm's heating system. Energy is still required to operate, but it is still a sustainable form of heating as it can easily run on renewable energy. The total cost of this method is from 6000 to 7000 euros (Gallizi, 2023).
- Energy Screens: The third option is to use the energy screens. Many materials are used for insulation for this purpose, but in circular classrooms, sugar bagasse is used for wall insulation. The price varies, but this project uses the waste product for insulation, so the cost is negligible (Schulz, 2022).

viii. Future of the Farm

This means the visualization of the farm approximately 20 years into the future. The following things can be expected in the future.

- Expansion of the farm: The farm will grow in all aspects with time. The overall growth comprises approximately 40 people, multiple buildings and a restaurant, more and more species of animals, more variety of crop production. The total land area of the farm will also increase with time and with the introduction of a biogas plant.
- Bread and Breakfast: Since the farm has multiple buildings, few of them will be used as accommodation. Visitors can come and stay in the farm overnight. The farm will also have a presence on some accommodation platforms like AirBnB.
- Presence of social media: The farm will have its own YouTube channel where the experts in the farm can demonstrate various activities that run this farm. Presence on multiple social media platforms can be used to spread awareness and be used for marketing of the farm. However, the main purpose will be to act as an educational platform.
- Retreat: Farm can also be looked at as a retreat. People can come to this farm to take time off from their city-life and spend time with nature. An outdoor gym or people doing yoga and meditation are also in the vision of the farm developers.
- Advisors/Consultants: This farm will become an example of a self-sustaining sustainable farm. New farms in Bavaria or even in Germany can take inspiration from it and create similar projects. The developers of this farm can become advisors for the new farm owners and share their knowledge and challenges that came across over the course of 20 years.

3. Analysis

i. Stakeholder analysis

Circular Classroom is a social start-up with the basic model to use all the income generated for the development of the farm and the welfare of the animals, and also to offer the learners an excellent workshop in a real-time situation. Since the main focus is on learning and the lab is a self-sufficient lab, the key players are:

- Municipality of Munich
- Agtech: Munich Startup in agriculture
- Green office TUM

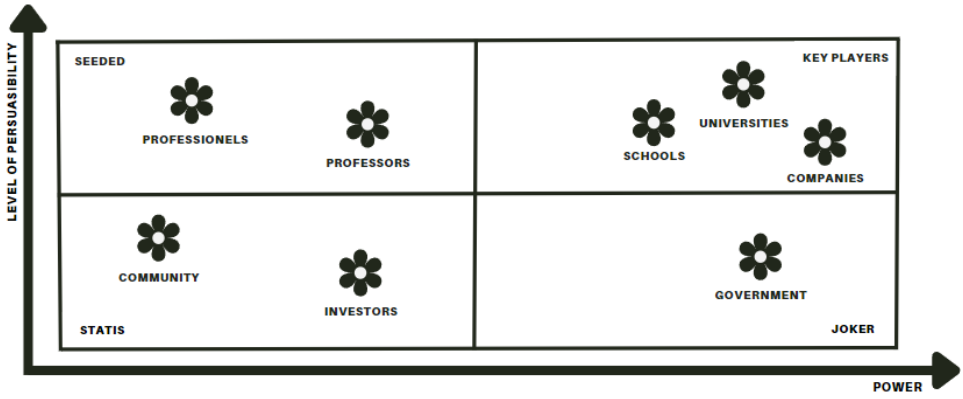

Fig 5: Stakeholder Analysis Chart

The circular classroom is the learning laboratory, therefore the main actors are the schools, universities and companies interested in learning in Bavaria. The government is the most important body and all initial investments depend on it. The university professors and professionals will also play a leading role as they will give lectures on farming and agriculture in the organized workshops. The community and investors are aware that their contribution is really needed for the complete success of the project. The community supported the project by adopting the sustainable farming method learned in the workshops. Likewise, the investors are expected to support and support the farm through their contacts and also their credibility and support is required for the success of the project.

ii. Cost Analysis

Our farm's cost analysis is separated into five sectors. Water, energy, heating, construction, and agriculture are all sectors. The total cost is anticipated to be €66,000. Water (€15,000), energy (€15,000), heating (€11,000), building (€15,000), and agricultural (€10,000) are the expected costs for each industry.

The cost of each sector is calculated by calculating the expenses associated with each sector and its consumption. The infrastructural costs are initially considered. Determine the costs of creating and maintaining water infrastructure, such as wells, pumps, pipes, irrigation systems,

storage tanks, and filtration systems, and include expenses for installation, repairs, maintenance, and upgrades. Not only do we consider water, but also energy, heating, and building materials. Irrigation costs are considered in the agriculture sector. We calculated the costs of irrigation methods such as drip irrigation systems, sprinklers, and other irrigation technologies. Then, take into account the price of irrigation equipment, such as drip lines, sprinkler heads, valves, and controllers, as well as the energy consumption (electricity or fuel) connected with pumping water for irrigation. The energy consumption analysis is completed first in the energy sector. Identify the many farm energy sources, such as electricity, fossil fuels (e.g., diesel, gasoline), biomass, solar energy, wind energy, or biogas. Examine energy consumption trends and calculate the amount of energy consumed by various farm operations such as irrigation, mechanical operation, heating, cooling, lighting, and processing. Determine the expenses connected with each energy source, such as utility bills, fuel prices, maintenance costs, and delivery charges, and then distinguish between variable costs (such as electricity rates) and fixed costs (such as monthly connection fees).
Consider the costs and benefits of investing in renewable energy systems like solar panels, wind turbines, or methane digesters and calculate the initial capital outlay, installation costs, ongoing maintenance costs, and potential returns on investment from energy savings or incentives. Determine the costs and benefits of implementing energy-saving measures to minimize energy usage. Identify potential areas for improvement, such as replacing inefficient machinery and equipment with more energy-efficient models, optimizing lighting systems, enhancing insulation, or installing smart energy management systems.

For building materials, firstly determine the expenses of developing farm structures such as barns, storage facilities, greenhouses, processing areas, or livestock housing. A proper estimation of the costs of materials, labor, permits, architectural and engineering services, site preparation, and any specific infrastructure that will be required. Continuous examination of expenditures of farm building upkeep, such as repairs, painting, roof maintenance, plumbing, electrical systems, or structural renovations which include costs for routine inspections, cleaning, pest control, and general upkeep.
Costs related with heating systems used in farm buildings, such as boilers, furnaces, radiant heating, heat pumps, or biomass heating systems, should be evaluated. For this, Take into account the initial capital investment, installation costs, ongoing maintenance costs, and fuel or energy costs connected with heating the buildings.

Also, calculate the expenses of the fuel or energy sources used to heat farm buildings, such as propane, natural gas, electricity, biomass, or renewable energy sources and determine the costs using fuel usage rates, fuel prices, or utility bills. Then, determine the expenditures associated with meeting local or national construction codes, permits, and inspections.
Fees for inspections, certifications, or compliance with environmental and safety laws should be included. Consider the costs of building monitoring and control systems, such as programmable thermostats, energy management systems, and smart building technologies.

iii. Market Analysis

The purpose of the market analysis is to determine the human capacity that the farm can reach and to establish a farm that will be sufficient for this many people. The numerical data of universities and companies that are important for this area are used in this section.

First of all, since the research was based on the Bayern area, the market research was also based on this situation. Our primary target group will expand with schools, universities and then companies and individuals who want to raise awareness about the environment. In the research conducted for this, Germany is available in the largest target group. If the general figure in Germany is taken into consideration, the number of students reaches 3.3 million in Germany. In the next step, about 15% of all students in Germany are in the Bayern area, so the figure to be reached is 480,000. In the next steps, the number of people working in all universities and companies in Munich was taken into consideration in order to narrow down the target values and make them more realistic. In this case, the number reached 220,000. However, in order to narrow this down even further, the students of the top 5 universities were taken as our main target group. These universities are TUM, LMU, HSM, Macromedia University, Munich Business School. If we add the number of students studying at these universities and the number of people working in companies, the number of target people we can reach together with the sustainable living farm in the first 5 years reaches 170 thousand and the number that constitutes the main target audience for the farm.

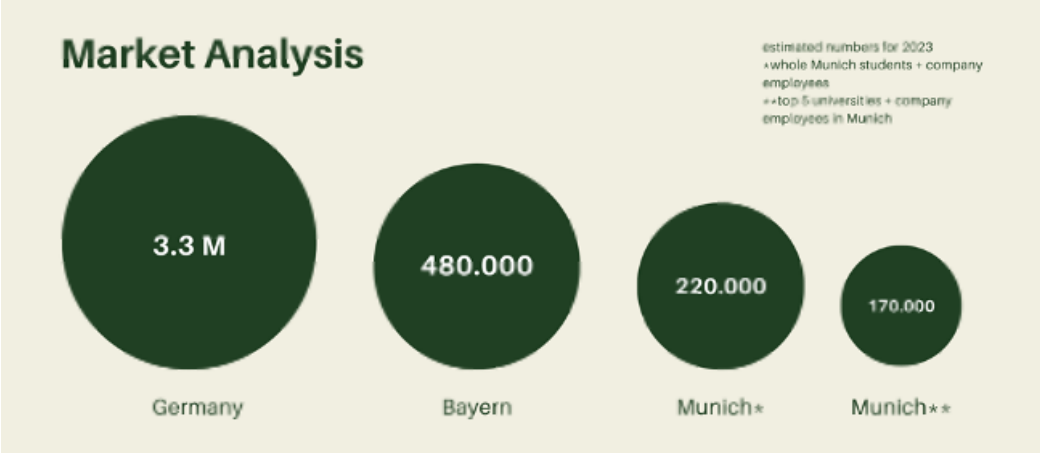

Fig 6: Market Analysis based on whole Germany

In addition, when calculated according to the increase in the number of students and employees in the previous years, it has been reached that the increase rate is more than 10%. Therefore, the target audience will reach 190 thousand within 5 years. With the TAM, SAM, SOM analysis, the growth potential that the farm can reach is also determined. In addition, with the market analysis, it will be much easier to understand the cost and income ratio, and while determining the characteristics of the farm, how much square meter area is needed and how much growth is required in the farm every year will be determined by the addressable market value. Also, identifying the target market will help to identify competitors in this area and identify other farms that cater to the same target market. This can be found in detail in the next chapter.

iv. Competitive analysis

We should be able to understand our opponents in order to grasp our competition in this field. Our main competitors with similar points of view are WWOOF (World Wide Opportunities on Organic Farms) and organic garden.

Firstly, WWOOF stands for "Willing Workers on Organic Farms" or "World Wide Opportunities on Organic Farms." It is a global initiative that connects volunteers with organic farmers and growers. Individuals interested in organic farming, sustainable agriculture, and ecological living can work and study on organic farms in exchange for food, lodging, and education through WWOOF. Secondly, Organic Garden's nutritional philosophy is "from the farm to the consumer's plate." In the near future, the company plans to map the entire value chain itself, beginning with regional food production on its own farm and progressing through additional processing to the sale of the food produced. There are numerous differences between Circular Classroom and other similar systems. When we dig deep into our mission and slogan, we find several differences. Initially, a circular classroom is a platform for learning. We provide an educational platform for people of all ages. Our primary target groups are school and university students, who are the future generations. So that we can make them better in the future. There are numerous differences between Circular Classroom and other similar systems. When we dig deep into our mission and slogan, we find several differences. Initially, a circular classroom is a platform for learning. We provide an educational platform for people of all ages. Our primary target groups are school and university students, who are the future generations. So that we can make them better in the future. For our visitors, we offer internships, master thesis projects, and volunteer opportunities. Another big difference comes under the category of Animal rights. The other two platforms don't give their focus on animals while we would love to protect them. In a farm context, animal rights refer to the ethical treatment and well-being of animals kept for agricultural reasons. Animal rights approaches on farms might differ depending on farming practices and beliefs. Our farm follows particular animal welfare standards or certifications that prioritize the animals' well-being. Guidelines for housing conditions, space requirements, access to clean water and healthy food, competent veterinary care, and humane handling techniques are examples of these criteria. Farm animals should be fed a balanced, healthy diet that suits their individual nutritional needs. Regular animal health monitoring, disease prevention, and access to veterinary care are critical components of competent farm animal management. Animal rights in farming frequently entail avoiding inhumane methods that give animals unnecessary suffering or harm. Avoiding practices like confinement in excessively small places, overcrowding, the use of growth hormones or antibiotics without medical necessity, and other forms of physical or psychological abuse are all examples of this. We also attempt to reduce animal stress during the handling, transportation, and slaughter operations. Low-stress livestock handling techniques, as well as providing calm and peaceful environments during these activities, can assist minimize stress and increase animal well-being. It is crucial to remember that animal rights policies on farms can vary greatly, from traditional farming methods to alternative models such as organic farming, regenerative agriculture, or permaculture, where animal care may be a primary concern. Individuals can choose to support farms that value animal rights by purchasing products from certified organic or humane farming operations, therefore consumer demand and awareness are

important in influencing farm practices. Certifications and labeling systems such as "Organic," "Animal Welfare Approved," or "Certified Humane" can assist consumers in making informed decisions while also supporting farms that value animal welfare. Furthermore, advocacy groups, industry organizations, and governmental legislation can all help to establish norms and standards for animal care in farm settings.

Another significant distinction emerges when we examine our farm's energy sources. We are heavily invested in alternative energy sources such as solar and biogas. Renewable energy such as solar, wind, hydro, geothermal, and biomass are important now and in the future for a variety of reasons. The use of fossil fuels for energy generation contributes significantly to greenhouse gas emissions, which contribute to climate change. Renewable energies emit minimal to no greenhouse gas emissions while in use, assisting in the mitigation of climate change and the reduction of carbon footprints. Renewable energies have a lower environmental impact than traditional energy sources. They aid in the reduction of air and water pollution, the preservation of habitats, the preservation of biodiversity, and the conservation of natural resources. The use of renewable energies encourages a more sustainable and balanced approach to energy production. Renewable energies offer prospects for diversifying energy sources and lowering reliance on imported fossil fuels. Countries can improve their energy security and lessen their vulnerability to geopolitical conflicts or price volatility linked with fossil fuels by utilizing indigenous renewable resources. Adoption of renewable energies is consistent with numerous United Nations Sustainable Development Goals (SDGs), including affordable and clean energy (SDG 7), climate action (SDG 13), sustainable cities and communities (SDG 11), and decent jobs and economic growth (SDG 8).

Societies can address major environmental concerns, reduce greenhouse gas emissions, promote sustainable development, create economic opportunities, and provide a more secure and sustainable energy future for future generations by embracing renewable energies now and in the future.

Lastly, reduction of carbon footprint. While comparing with other platforms, the carbon footprint is very much lower than the other facilities. CO2 and other greenhouse gas emissions are significant contributors to climate change. We can reduce the concentration of greenhouse gases in the atmosphere and delay the rate of global warming by minimizing our carbon footprint. This is critical for mitigating climate change's negative effects, such as rising temperatures, sea-level rise, extreme weather events, and changes to ecosystems and biodiversity. The use of fossil fuels for energy, transportation, and industrial processes is frequently connected with a high carbon footprint. These activities lead to air and water pollution, as well as habitat damage. We can lessen the negative environmental impacts of resource extraction, processing, and combustion by reducing carbon emissions. High carbon footprints are frequently associated by air pollution, particularly in countries that rely heavily on fossil fuels. Pollutants including sulfur dioxide, nitrogen oxides, and particulate matter are harmful to human health, causing respiratory disorders, cardiovascular illness, and other problems. We can improve air quality and promote healthier living conditions by reducing carbon emissions. Reducing one's carbon footprint is inextricably linked to sustainable development, which attempts to meet current demands without jeopardizing future generations' ability to meet their own. We create economic possibilities, inspire innovation,

and foster resilient and inclusive communities by shifting to low-carbon and sustainable practices. This contributes to the creation of a more sustainable and equitable future for all.

4. Policy requirements

In Germany, sustainable farms which help to promote sustainable living conditions are strongly supported through various policies and regulations.Some of the policies adopted by the government in building a sustainable farm are:

- Rural Development Program (RDP): The European Agricultural Fund for Rural Development (EAFRD) provides funding for the RDP, which is a national initiative. It advocates for environmentally friendly farming methods, rural diversification, and financial support for agricultural infrastructure. distinct German federal states may have distinct policies and funding options.
- Common Agricultural Policy (CAP): An EU strategy known as the Common Agricultural strategy (CAP) offers financial assistance and establishes rules for agriculture. It consists of a number of initiatives to encourage organic farming, agri-environmental programs, and funding for rural development initiatives.
- Federal Organic Farming Scheme: Germany supports organic farming with special policies and programs. These regulations seek to advance organic farming practices, help organic producers financially, and streamline organic certification.
- Renewable Energy Sources Act (EEG): The EEG encourages the production of renewable energy, including the use of biogas plants, wind turbines, solar panels, and other on-farm renewable energy systems. To promote the use of renewable energy technologies in agriculture, the program offers feed-in tariffs and financial incentives.
- Animal Welfare Act: The extensive Animal Welfare Act in Germany establishes guidelines for the compassionate care of all animals, including farm animals. This law promotes ethical and sustainable animal husbandry methods by ensuring that animals receive the proper shelter, care, and handling.
- Water Framework Directive (WFD): An EU directive called the WFD seeks to safeguard and enhance water quality. It establishes guidelines and rules for water management, as well as steps to conserve farmland water resources and lessen pollution from agricultural practices.
- For the agricultural part the regulations are divided into 2, direct and indirect. For the direct regulations; Landwirtschaftsgesetz (LwG), Lebensmittel, Bedarfsgegenstände und Futtermittelgesetz, Produkthaftungsgesetz. For the indirect regulations; Düngegesetz, Düngemittelverordnung und Saatgutverordnung, Grundstücksverkehrsgesetz, Flurbereinigungsgesetz (FlurbG) und Flurneuordnungsverfahren, Pflanzenschutzgesetz

- For the food part of the farm we have the regulations as follows;-Gaststättengesetz, Lebensmittelhygiene Verordnung

5. Conclusion

Building a sustainable farm is vital to promoting environmental protection, economic viability and social responsibility. By implementing sustainable practices and using sustainable building materials, farms can minimize their environmental footprint, improve resource efficiency, and contribute to a more resilient and regenerative agricultural system. In this report, we have examined various factors to consider when building a sustainable farm. This includes prioritizing soil health, water conservation, biodiversity, energy efficiency, waste reduction, animal welfare, social responsibility and economic viability. By incorporating these factors into farm design and operation, people can strike a harmonious balance between productivity and sustainability. In addition, the selection of sustainable building materials plays a crucial role in the construction of farms. The use of recycled and reclaimed materials, sustainable wood, natural materials, energy-efficient and low-emission products, and the integration of renewable energy systems contribute to a reduced environmental impact and improved energy efficiency. A sustainable farm not only benefits the environment, but also improves health. composed of farm workers, local communities and consumers. It promotes healthier ecosystems, promotes food security and supports local economies. In addition, sustainable agricultural practices have the potential to mitigate climate change, conserve natural resources and protect biodiversity.However, the transition to a sustainable farm requires a holistic approach that integrates sustainable practices into various aspects of the farm. It requires continuous education, research and collaboration with stakeholders to continuously improve and innovate sustainable farming techniques. Ultimately, building a sustainable farm is an investment in a brighter future, where agriculture can coexist in harmony with the environment while meeting the needs of a growing population. By implementing sustainable principles and practices, farms can become role models for sustainable spaces, inspiring others and contributing to a more sustainable and resilient global food system.

6. Limitations

- Land requirements: The farm will be built on an existing old farm. The building crew will renovate the old farm according to the requirements. This will save costs.
- The farm, ideally, should be built near a water body (lake or a river) to provide consistent water supply.
- The land chosen for the farm needs to have fertile soil.
- The farm must not be completely under shade since it is releasing solar energy.

- Only a moderate amount of rainfall is ideal for the farm and for rain water harvesting.
- The farm will begin its operation in the summer to exploit the solar energy during the initial stages.
- Using sustainable materials for buildings might occasionally be more expensive than using conventional ones.
- Using sustainable building materials may call for particular knowledge and abilities. The project's complexity may increase if farmers and construction workers need to take training courses or hire experienced professionals.
- A balance between sustainability and the desired aesthetic or practical criteria must be struck
- The season will play a crucial role in the operations and revenue of this farm. Since, majority of the activities in the farm are outdoors, it will be a challenge to maintain the farm and attract new customers during peak winters.

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Appendix

1. Soil Management

- Soil Testing Results: Provides a summary of the soil testing results conducted on the farm, including nutrient levels, pH balance, and organic matter content.
- Crop Rotation Plan: Outlines the crop rotation schedule implemented on the farm to maintain soil fertility, prevent pest and disease buildup, and reduce soil erosion.
- Composting Guidelines: Offers a step-by-step guide on composting methods used on the farm, including the ratio of green to brown materials, turning frequency, and compost application techniques.

2. Water Conservation

- Irrigation System Design: Presents a detailed description and schematic diagram of the farm's irrigation system, highlighting the use of drip irrigation, rainwater harvesting, or other water-efficient techniques.
- Water Usage Monitoring: Describes the methods employed to measure water consumption on the farm, including metering devices, data collection frequency, and monitoring practices.
- Water Recycling and Reuse: Outlines strategies for water recycling and reuse on the farm, such as capturing and treating runoff water, utilizing greywater for non-potable purposes, and implementing water-efficient cleaning practices.

3. Energy Efficiency

- Renewable Energy Sources: Details the utilization of renewable energy sources on the farm, such as solar panels, wind turbines, or biomass systems, and provides data on energy production and consumption.
- Energy Audits: Presents results from regular energy audits conducted on the farm, highlighting areas of improvement and energy-saving initiatives implemented.
- Equipment and Machinery Efficiency: Includes a list of energy-efficient equipment and machinery used on the farm, along with relevant specifications and energy-saving features.

4. Carbon Footprinting and reduce the emission:

- Use carbon footprint calculation tools to quantify emissions from each relevant source. Activities are converted into carbon dioxide equivalents (CO2e) based on emission factors obtained from scientific databases and regular measurements from all sources used on the farm.
- Introduce composting and anaerobic digestion systems to dispose of organic waste, thereby reducing methane emissions. Implement appropriate manure management techniques and monitor emission reduction.
- will set up a system for monitoring according to the set standards according to the SDGs and regularly monitor the progress. Set up metrics to evaluate the effectiveness of implemented actions and make adjustments as needed.

Declaration of Academic Integrity

I hereby declare that the thesis submitted is my own unaided work. All direct or indirect sources used are acknowledged as references.

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Munich, 30.06.2023