POLITÉCNICO DE LEIRIA | ESCOLA SUPERIOR DE ARTES E DESIGN

Design for Oceanic Health & Wellbeing Through Sustainable Practices.

An Online Platform for Educational Content Creation and Incentivising Innovation, Driven by Open Science and Blockchain Technology.

OZEAON

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Master in Design for Health and Wellbeing

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Caldas da Rainha, December 2023

Disclaimer

This is an original dissertation, purposefully made for the completion of my master's degree, and all authors whose studies and publications were used to complete it are duly acknowledged.

It represents research in progress along the completion of this dissertation, and hence some of its content is an extraction and expansion of the following published paper, which briefly outlines the idea to design educational resources for developing much needed solutions to climate change coupled with the health benefits that can be derived from the oceans:

ehSemi 2022 - 2nd students' seminar on Ehealth and Wellbeing

Flynn, J., Mouga, T. & Pernencar, C. (2022). Designing new resources for health and sustainability. In Almeida, A. M. P. (coord), Oliveira, R. (coord), & Santos, R. (coord). (2022). ehSemi 2022: 2o Seminário de Estudantes em Tecnologias Digitais e Saúde/Bem-Estar: livro de resumos. pp. 48-49. UA Editora. https://doi.org/10.48528/ewzj-k395

Acknowledgements

I would like to thank all the participants in the surveys and user research especially, it is of great generosity and kindness to help with this study by answering time consuming surveys, testing prototypes and giving interesting and honest answers for consideration. Thank you to all of the staff and professors, as well as fellow students and friends at ESAD, IPLEIRIA. Many thanks to the wonderful country of Portugal for having me during my study as well, a wonderous place of adventure, full of delicious food and incredible, lovely and friendly people for whom the currents of the ocean run deep in the veins of history, science, exploration and culture.

For my supervisors, Cláudia Pernencar and Teresa Mouga, thank you both so much for your patience, never ending support and guidance during this project. Without your combined expertise and knowledge in ocean science and design I would have had a much more difficult time trying to complete this.

I would also like to thank my family (especially) and friends for the support and encouragement I received from them throughout the study.

All of your combined assistance and support has made this possible and is enormously appreciated!

Thank you.

Abstract and Keywords

The health of our oceans is under threat from climate change, ecosystem degradation, and pollution, posing significant risks to global human health and well-being. The COVID-19 pandemic has highlighted the consequences of environmental mismanagement, underscoring the urgency of sustainable practices. This study explores the potential for building environmentally sustainable and regenerative foundations for society, fostering green growth.

New ocean farming technologies and algae research hold immense promise across various domains, including health, biomaterials, medicine, ecosystem services, food production, circular economies, global industries, and design applications to name a few. By sequestering carbon dioxide from the atmosphere, the oceans mitigate climate change, supply food, and support vital economic sectors like tourism and fishing, while nurturing diverse ecosystems.

In the pursuit of environmental sustainability, the world needs eco-friendly and sustainable industries like regenerative ocean farming and land-based sustainable agriculture. Additionally, the oceans' economic value, stemming from their rich biodiversity, underscores their importance.

This thesis addresses a critical need for an accessible online platform that consolidates information on ocean-related innovations. The platform aims to inspire individuals to develop solutions, fostering innovation in environmental recovery, healthcare, design, food production, industry, and the ocean economy. By providing an Open Educational Resource (OER) integrated with crowdfunding capabilities, users can learn, share, fund, and innovate, thereby advancing sustainable economic and environmental solutions. Blockchain technology and cryptocurrencies offer the potential for decentralized governance, increasing user engagement and trust within the platform. The envisioned platform seeks to empower individuals to drive sustainable change and contribute to a healthier planet.

Keywords: **sustainability; UX design; blockchain; health; ocean; education**

Resumo e Palavras-chave

A saúde dos nossos oceanos está ameaçada pelas alterações climáticas, pela degradação dos ecossistemas e pela poluição, colocando riscos significativos para a saúde e o bem-estar humanos a nível mundial. A pandemia de COVID-19 pôs em evidência as consequências da má gestão ambiental, sublinhando a urgência de práticas sustentáveis. Este estudo explora o potencial de construção de bases ambientalmente sustentáveis e regenerativas para a sociedade, promovendo o crescimento verde.

As novas tecnologias de agricultura oceânica e a investigação sobre algas são extremamente promissoras em vários domínios, incluindo a saúde, os biomateriais, a medicina, os serviços ecossistémicos, a produção alimentar, as economias circulares, as indústrias globais e as aplicações de design, para citar apenas alguns. Ao sequestrarem o dióxido de carbono da atmosfera, os oceanos atenuam as alterações climáticas, fornecem alimentos e apoiam sectores económicos vitais, como o turismo e a pesca, ao mesmo tempo que alimentam diversos ecossistemas.

Na procura da sustentabilidade ambiental, o mundo precisa de indústrias sustentáveis e amigas do ambiente, como a agricultura regenerativa dos oceanos e a agricultura sustentável em terra. Além disso, o valor económico dos oceanos, resultante da sua rica biodiversidade, sublinha a sua importância.

Esta tese responde a uma necessidade crítica de uma plataforma em linha acessível que consolide informações sobre inovações relacionadas com os oceanos. A plataforma tem como objetivo inspirar os indivíduos a desenvolver soluções, promovendo a inovação na recuperação ambiental, nos cuidados de saúde, no design, na produção alimentar, na indústria e na economia dos oceanos. Ao fornecer um Open Educational Resources (OER) integrado com capacidades de financiamento coletivo, os utilizadores podem aprender, partilhar, financiar e inovar, promovendo assim soluções económicas e ambientais sustentáveis. A tecnologia Blockchain e as criptomoedas oferecem o potencial para uma governação descentralizada, aumentando o envolvimento dos utilizadores e a confiança na plataforma. A plataforma pretendida procura capacitar os indivíduos para impulsionar a mudança sustentável e contribuir para um planeta mais saudável.

Palavras-chave: **sustentabilidade; design UX; blockchain; saúde; oceano; educação**

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List of Acronyms and Abbreviations

AI	Artificial Intelligence
ADGM	Abu Dhabi Global Market
AML	Anti Money Laundering
App	Application
API	Application Programming Interface
ASIC	Australian Securities and Investments Commission
BFT	Byzantine Fault Tolerance
CEO	Chief Executive Officer
CIS	Cooperative Investment in Stewardship
CLI	Command Line Interface
CLR	Common Language Runtime
CMS	Content Management System
$C0_2$	Carbon Dioxide
CSS	Cascading Style Sheet
CTO	Chief Technology Officer
dApps	Decentralized Applications
DAO	Decentralized Autonomous Organization
DB	Database
DBFT	Delegated Byzantine Fault Tolerance
DDOs	Deliberately developmental Organizations
DeFi	Decentralized Finance
DeSci	Decentralized Science
DIY	Do-It-Yourself
DOM	Document Object Model
DPoS	Delegated Proof-of-Stake
DRY	Don't Repeat Yourself
EA	Effective Altruism
Eco	Ecologically
Etc	Et Cetera
EU	European Union
FinCEN	Financial Crimes Enforcement Network
FTX	Futures Exchange
GFC	Global Financial Crisis
GPL	General Public License
GUIs	Graphical User Interfaces
HABs	Harmful Algae Blooms
HTTP	Hyper Text Transfer Protocol
HTML	Hyper Text Markup Langauge
IBM	International Business Machines
ICO	Initial Coin Offering
IDE	Integrated Development Environment
IGP	Institue for Global Prosperity
IIS	Internet Information Services
IP	Intellectual Property
IPFS	InterPlanetary File System
IT	Information Technology
JIT	Just-In-Time
JS	JavaScript
JSON-RCP	JavaScript Object Notation Remote Procedure Call
JSX	JavaScript XML
KSFs	Key Success Factors

KYC	Know Your Customer
LAN	Local Area Networks
MiCA	Markets in Crypto Assets Regulation
MOOCs	Massive Open Online Courses
MVC	Model View Controller
MVP	Minimum Viable Product
NCSA	National Center for Super Computer Applications
NFT	Non-Fungible Token
NPS	Net Promoter Score
OERs	Open Educational Resources
OOP	Object-Oriented Programming
ORM	Object-Relational Mapping
OS	Operating System
P2P	Peer-to-Peer
PBFT	Practical Byzantine Fault Tolerance
PC	Personal Computer
PES	Payment for Ecosystem Services
PHP	Hypertext Preprocessor
PL/SQL	Proceedural Language Extension to Structured Query Language
POJOs	Plain Old Java Objects
PoS	Proof-of-Stake
PoW	Proof-of-Work
RDBMS	Relational Database Management System
ReFi	Regenerative Finance
RoR	Ruby on Rails
SCSS	Sassy Cascading Style Sheet
SDGs	Sustainable Development Goals
SDK	Software Development Kit
SEC	U.S. Securities and Exchange Commission
SEPA	Single Euro Payments Area
SQL	Structured Query Language
STEAM	Science Technology Engineering Art and Math
SUS	System Usability Scale
SWIFT	Society for Worldwide Interbank Financial Telecommunication
T-SQL	Transact-SQL
TQM	Total Quality Management
UCL	University College London
UI	User Interface
UN	United Nations
UNSDG	United Nations Sustainable Development Goals
URL	Uniform Resource Locator
USD	United States Dollar
UX	User Experience
VRF	Verifiable Random Function
WAN	Wide Area Networks
WEF	World Economic Forum
WFP	World Food Programme
WHO	World Health Organisation
XML	eXtensible Markup Language
XP	Experience Points
XR	Extinction Rebellion

1

INTRODUCTION

MOTIVATION

PROBLEM

BACKGROUND

RESEARCH QUESTIONS

1.1. Motivation

The health of our oceans is at threat with the consequences of climate change, ecosystem abuse and pollution thereby increasing the dangers to the health and wellbeing of humanity around the world. The recent COVID-19 pandemic has highlighted the negative impact that mismanagement of our fragile relationship with nature can have and exposing the weaknesses both in health and economic instability created by constant over-exploitation of the planet's natural resources through unsustainable practices that have damaged the Earth's ecosystems (Vincent, A., 2020).

The ocean plays a vital role in regulating our planet's temperature and maintaining a global balance for health and wellbeing (Richardson, F., 2022). There exists opportunity to develop further sustainable and adaptable foundations for society through creating economic growth that is environmentally sustainable and regenerative with green growth.

The benefits from new ocean farming technologies and algae research are starting to become clear and abundant in many aspects of life from health, biomaterials and medicine to ecosystem services, food, the circular economy, global industry, and design applications.

By absorbing and sequestering carbon dioxide from the atmosphere, the global oceans play a critical role in modulating climate change. Oceans and seas cover more than 70% of the Earth, supplying us with food, regulating our climate, and producing at least 50% of the oxygen we breathe (Regaudie-de-Gioux et al., 2014). Oceans are critical to key economic sectors such as tourism and fishing, as well as providing habitats for organisms from whales to bacteria and viruses, with all the other forms of biodiversity.

The last decade has seen an increasing number of biomaterials produced from marine organisms, with the science behind new biomaterials developing rapidly and ranging from coralline bone grafts to polysaccharide-based biomaterials. Several stages of discovery and development have taken place in the field of marine biopharmaceuticals. These include the discovery and development of chitin and chitosan, marine collagen, and composite materials comprised of marine organisms. These materials are simple to get and are excellent in terms of biocompatibility, biodegradation, and bioactive characteristics because they are abundantly available and reasonably priced and biologically compatible with us humans and other land-based species. They possess a wide range of potential in medical applications, including

antibiotics, drug delivery agents, anticoagulants, and metabolic diseases like diabetes and cardiovascular disease. These materials are being used for comestible, cosmetic, and industrial purposes as well as for medical treatments in specialised fields (Wan et al., 2021).

Marine derived substances have frequently been used as ingredients, preservatives, and packaging materials in the food industry. Due to the surge in interest from consumers seeking health promotion from food items in the last decade, marine-derived ingredients have been highlighted for their health-promoting effects. The use of marine-derived biomaterials in cosmeceuticals is gaining popularity.

The number of people who suffer from hunger had been declining for decades as measured by the pervasiveness of malnutrition, although this started to slowly increase again in 2015. Up to 690 million people are hungry, consisting 8.9% of the global population. This is an increase of nearly 60 million in five years. The world is not on track to achieve Zero Hunger by 2030. If recent trends continue, the amount of people affected by hunger could increase to 840 million by 2030. Improving agricultural productivity and sustainable food production are crucial steps towards reducing world hunger. With better management of wild marine fisheries and marine aquaculture (mariculture), production from the ocean could increase sixfold, providing more than two-thirds of the protein needed to feed a population of almost 10 billion people in 2050 (United Nations, 2017).

The world has reached a stage in which everything needs to be eco-friendly and sustainable. This is the need of the hour, as our planet is grappling with several environmental issues such as climate change, deforestation, sustainability and so on. To tackle these problems effectively, there is a surge in the demand for industries that are eco-friendly and sustainable like regenerative ocean farms and sustainable farming practices on land. Introducing algae into the world of agriculture such as regenerating soil for healthy food production in carbon neutral, regenerative organic and zero waste ways can help to solve soil degradation and adding seaweed supplements to cattle feed can reduce emissions from livestock by up to 80% (Roque et al., 2021).

In addition to being an irreplaceable part of the earth's ecosystem, oceans have an underestimated economic value as a result of their unique biodiversity. There has been much talk recently about how design will play a crucial role in the future by inspiring the development of bio-based materials. The partnership

between design and the research and development of bio-alternatives to synthetic materials suggests a promising future for biomaterials derived from the ocean (Bell et al., 2022).

Around 50% of all oxygen in the air and ocean is produced by algae as a biproduct of photosynthesis (Yee et al., 2023). It is a preeminent regenerative material requiring neither fertiliser nor cleared land space to grow as external inputs making it both environmentally and economically sustainable. A strong and increasingly sustainable algae industry can generate new economic growth by directing investment into coastal communities or creating new employment opportunities, although these potential benefits have so far been under appreciated, especially in European and Western countries (Vincent, A., 2020).

1.2. Problem

Oceans hold tremendous opportunities for boosting jobs and the economy whilst providing numerous opportunities for innovation and development in health and wellbeing. Access to information that is easily digestible for the general public can be cumbersome and hard to find with potential curiosity of people coming to a standstill once information becomes difficult to navigate through given the variety of information spread across numerous different websites and articles all over the Internet.

The benefits of new ocean technologies, knowledge and algae research are clear and abundant although not easily found. In order for these benefits to be fully explored on a larger scale within society an online platform is needed where people can easily learn about them. People who might like to be further involved in developing solutions or even to be aware of some of the innovations and research that are continuously happening. Inspiring people with possibilities and ideas that can be easily understood and encouraging them to take part in the conversation, learning more and hopefully developing their own projects. Whether it be that someone wants to design a new bioplastic bottle, make some clothing from naturally sourced ocean materials, find a sustainable health food supplement, create a new drug for an illness, start a regenerative ocean farm or even organise a volunteer group for cleaning waste from beaches and waterways. There is no unified place online where information, learning, content sharing and funding coincide to inspire people to develop the important solutions to some of the global problems we all face. With the effects of environmental concerns, health problems and economic issues ever rising in an increasingly unstable world, the need for sustainable innovation in the fields of environmental recovery, health care, design, food, industry and economy in relation to the ocean are ever more important.

1.3. Background

The first idea I was concerned with in my studies was to design an easily accessible and affordable way to create ocean farms that could be scalable from the singular individual to a larger operation. The idea was to innovate the development of farming seaweeds, shellfish and corals etc. for the purpose of carbon sequestration, ecosystem recovery, biomaterials, food and health resources. I soon realised that I was unaware of how to achieve this goal, and it seemed that I would have to complete numerous degrees in order to figure it out. I also realised that it could be a good idea to inspire people who may be wanting to understand these concepts to develop their own ideas and create sustainable solutions. From there it seemed better to develop an online resource for the general public among numerous others to activate interest and innovation in this field in the near future, thereby generating more knowledge and real-world innovation than I would be able to develop myself as a singular being in my lifetime. This thesis is an outline of that journey and the discovery of how this idea might be achieved with the design of an online platform.

Knowledge about advancements in research and innovations for the benefits derived from the oceans can be difficult to find and are spread across many different locations over the internet. If someone wants to have an introduction to these concepts, begin to learn about them and potentially want to develop their own solutions, it can be difficult to consolidate the broad range of information and find a way to come up with their own ideas for sustainable development and access funding for their research or to start new projects.

Open Educational Resources (OERs) are learning, research and teaching materials that provide open and free information and knowledge to the public, published in the public domain or under open licences. There are 5 key points to consider within the bounds of Creative Commons licencing to consider when using OERs, being Reuse (Content can be reused in its unaltered original format), Retain (Copies of content can be retained for personal archives or reference), Revise (Content can be altered or modified to suit specific needs), Remix (Content can be adapted with other similar content to create something new), and Redistribute (Content can be shared with anyone else in its original or altered format) (Wiley et al., 2014).

There are also Massive Open Online Courses (MOOCs) that provide free learning materials and courses, although most the materials found in MOOCs cannot be legally copied, allowing users only fair use rights,

or rights stated in specific licences issued by the publisher and users have no control over the content and also may not edit or update the content themselves (Wesley, C., & Ivy, W., 2021).

I am mainly focusing on websites and webapps in my design. Some existing websites include OER Commons[1], Wikipedia[2], edX[3], Coursera[4], Domestika[5], and so on. Also there are many educational tutorial videos to be found on Youtube6, as well as a website dedicated to DIY tutorials for regenerative materials called Materiom[7].

Access to this knowledge and creating an online platform in the form of a webapp that is designed as an Open Educational Resource for it to become mainstream and popular throughout society would hopefully inspire people to develop more solutions and innovations for the health, food supply and ecosystem problems we are all facing, whilst creating new and sustainable opportunities. In conjunction with an OER, a platform where people can share their own innovations with each other through writing accessible articles, "Do It Yourself" tutorials, share or trade designs and ideas, scientific discoveries and video content like educational documentaries would help to generate innovation in the field.

Combining this with an integrated crowdfunding platform like Kickstarter[8], or Go Fund Me[9], would be beneficial for real world sustainable innovation and green growth in the ocean for the world. An online platform that can assist in the sharing of information along with generating financial incentive opportunities for people seeking to create sustainable economic and environmental innovations in the real world is lacking in this field. Some problems that exist with crowdfunding applications are that people may not be eligible to access them for funding opportunities due to location or currency restrictions implemented by governments.

In order to overcome these barriers to entry for some people there exists a relatively new way of recording information and utilising digital currency with blockchain technology and cryptocurrencies. Also with many online tech companies there may be a limited amount of control that the user of the technology has over the content on the website, and the decisions that can be made for the betterment of the users of the

1 https://www.oercommons.org/
2 https://www.wikipedia.org/
3 https://www.edx.org/
4 https://www.coursera.org/
5 https://www.domestika.org/
6 https://www.youtube.com/
7 https://www.materiom.org/
8 https://www.kickstarter.com/
9 https://gofundme.com/

platform. Simply put many companies are structured within a hierarchical system of power over decision making from CEOs to Executives and Shareholders with users or even employees having little say, but with blockchain technology the user can become the owner of the organisation itself as a Decentralized Autonomous Organization (DAO). The operational structure of a DAO is democratic and allows its users the ability to vote on decisions made within the platform. This organisational structure could help to provide people with an increased sense of engagement and trust with the platform and be more personally interested in its success, thereby further benefiting the community of its users. Furthermore, the DAO would operate for Decentralized Science (DeSci) and Regenerative Financing (ReFi), which are new terms for using blockchain and web3 technologies to advance traditional science, generate and fund scientific research along with positive environmental action in the real world.

These things are currently unavailable for the ocean sector as a singular go-to place online and for the benefits in sustainable economic, environmental, industrial, design, health and wellbeing led innovations to be realised, a website application that features these abilities may be able to help inspire people to help make these improvements in the world possible.

1.4. Research Questions

What is the most appropriate form that an Open Educational Resource should take according to the design research in consideration of speculative and circular design theories, and would this be helpful for society in developing sustainable innovation?

What information will be most useful in summarising key scientific research in the specified categories, and will the platform be able to inspire users to create further innovations, add their own knowledge to the educational resources and create funding opportunities for real world solutions in this field?

Is it appropriate for the platform to become a Decentralized Autonomous Organization, with the use of Web3, blockchain technology and a cryptocurrency for Regenerative Finance and Decentralized Science, and will this be something that the users would want or even trust?

2

STATE-OF-THE-ART

DESIGN FOR HEALTH & WELLBEING

DESIGN RESEARCH METHODOLOGIES

UNITED NATIONS
SUSTAINABLE DEVELOPMENT GOALS

BLOCKCHAIN TECHNOLOGIES

2.1. Design For Health & Wellbeing

Designing for health and wellbeing is concerned with identifying existing problems to develop new solutions and present proposals towards supporting, optimizing and promoting the health and wellbeing of individuals and societies in a sustainable and responsible way. There is a very broad range of issues and topics to work with in this field, such as medicine, disease prevention, nutrition, psychology, physiology, sustainability and so much more. This requires an open mentality to the possibilities of how complex problems can be solved through human centred design along with a creative mindset, considering empathy, codesign and social determinants with questioning, visualising, prototyping and storytelling (Ku & Lupton, 2020.).

When considering design for health and wellbeing in my chosen project titled OZEAON, the main concern was identifying some of the larger scale problems which effect the health of society and natural world from their roots. The health and wellbeing of a society can be largely put down to the ability to manage several different variables including but not limited to their surrounding environment, social determinants, food availability, quality of medicine and healthcare, economic sustainability and education.

Whilst trying to understand the wellbeing of individuals, we must also consider the relationship humans have with ecosystem services. The relationship to environmental change and human wellbeing was assessed in a critical review from the perspective of people in developing nations whose wellbeing is most dependent on ecosystem services where the frameworks analysed drew upon environmental sciences, economics, psychology, sociology and anthropology with their occurrence in real world applications. The study renews “emphasis on the importance of interdisciplinary or even trans-disciplinary collaboration among social anthropologists, economists, psychologists, and political scientists has broadened the scope of the human condition” with the relational dimension capturing the psychological need for rewarding connections to others in the conceptualisation and understanding of changes in wellbeing. A hybrid approach between micro and macro scales may be most useful for understanding relationships between wellbeing and ecosystem services and identifying the importance of the natural environment to the wellbeing of individuals (Agarwala et al., 2014).

True development and growth in the world can be understood by what the American/Australian ecological economist and Professor at the Institute for Global Prosperity (IGP) at University College London (UCL),

Robert Costanza defines as Sustainable Wellbeing; requiring a healthy balance among thriving natural, human, and cultural assets and sufficient and well-functioning produced or built assets. "We need a new model of the economy based on the worldview and principles of ecological economies starting by recognising that our material economy is embedded in society, which is embedded in our ecological life-support system and that we cannot understand or manage our economy without understanding the whole interconnected system." (Constanza, R., 2013, 39-40). Pursuing conventional economic growth as society has done since the end of World War II needs to not only to be more considerate for 'green growth' as an environmentally sensitive version of economic models. Rather to do away with the constant economic need for growth as the most important goal in place of understanding, creating and sustaining wellbeing as the main economic model for peace and positive development for a healthier world.

Constanza's description for the main dimensions of this new economy (Constanza, R., 2013, 40-41) include, but are not limited to:

A) Sustainable Scale – respecting ecological limits

- Establish effective governance for natural commons.
- Implement cap-and-auction systems based on planetary boundaries.
- Balance consumption of non-renewables with renewable development.
- Invest in sustainable infrastructure.
- Dismantle incentives for materialistic consumption.
- Linked policies to address population and consumption.

The project's goals aim to assist in the development of sustainable innovation for renewable and regenerative infrastructure, biodegradable and recyclable materials and consumption, with governance abilities for the direction of the platform itself available to the users.

B) Fair Distribution – protecting capabilities for flourishing

- Share work for balanced leisure-income trade-offs.
- Reduce global and national inequalities.
- Establish equitable governance for social commons.

Incentivising and inspiring educational resources and content creation through featuring user made articles for open science, videos and DIY tutorials can help people to learn about

sustainable innovations and grow their interest in education and learning new skills thereby reducing national and global inequalities by increasing access to easily digestible knowledge.

C) Efficient Allocation – building a sustainable macro economy

- Use full-cost accounting to internalize externalities.
- Implement fiscal reforms promoting sustainability.
- Establish cooperative investment in stewardship.
- Promote financial and fiscal prudence.
- Ensure information availability for a sustainable economy.

Incorporating the use of blockchain technology allows for transparent transactions within the distributed ledger that anyone can freely access and account for ensuring prices reflect social and environmental costs with the various abilities to invest in, fund and donate to projects for sustainable development and innovation. Promoting education and accessable informaiton for a sustainable economy is at the core of the project.

The environmental problems we are all currently facing with climate change can cause a long list of problems for the health and wellbeing of societies around the world, a recent event that made this issue immediately clear for me personally were the bushfires of Australia in 2019/2020, causing a serious health emergency that was proven to be triggered by the effects of climate change (Yu et al., 2020). The concerns for climate change are also evident here in Portugal where temperatures have increased in the past decade and are projected to do so, with precipitation decreasing by 30% in the southern portion of the country and around 15% in the northern portion of the country by 2100. With climate change affecting sea levels calculated to rise mor than 0.4m increasing coastal erosoion and flooding. Sever heat waves, storms and droughts are already affecting the country, and with climate change are expected to increase in frequency and intensity (Schleussner et al., 2020).

Environmental issues and climate change became an obvious topic to address in the development of my proposal at which point I grew an interest in ocean and algae science. My informed choice to study in Portugal and in particular focus on the ocean was due to the great history of Portuguese exploration and relationship with the oceans coupled with scientific discovery and research, development and innovation evident in the country. Refelecting the exploration of my own ancestors from the United Kingdom,

Ireland, Spain, Portugal and more into Australia with concerns primarily being in healthcare, sceince, engineering, arts, food and sustainable resources and development. With Portugal having the duty to and interest in being at the forefront of European countries that carry out oceanic research where 97% is ocean, its importance in regulating the climate, in food and other resources makes scientific advancement particularly necessary here. This was a good beginning but only scratched the surface to the benefits of ocean and algae sciences, which led me to structure my design proposal around the desire to develop solutions in health and wellbeing of not only individuals and society but the planet itself, with hopes for not only sustainability but ecological and environmental repair.

In my research I learnt that developments in health foods, cosmetics, medicines and biomaterials from the ocean and algae science industries have been progressing at a rapid rate with numerous recent discoveries from algae, and other species like fish and shellfish, sea snails, sponges and a plethora of other oceanic organisms. This would require a lot of secondary research trawling through hundreds if not thousands of academic and scientific research papers connecting them together to figure out how it makes sense as a complex system for optimizing and promoting the health and wellbeing of individuals and society. This helped me to understand as I was trying to educate myself on a broad range of topics that in order to fully realise and develop solutions for health and wellbeing, I would require numerous years of scientific research and study. It became my conviction that these benefits are the greatest and most sustainable solutions to many problems around the world. I realised that this needed to be recognised amongst more people and the proliferation of ocean and algae knowledge should become mainstream and popularised for the general public to easily access. To do this would require developing a way of making that possible.

2.2. Design Research Methodologies

2.2.1. Speculative Design

Speculative design is a design research method whereas opposed to taking the traditional approach of direct problem-solving, the designer rather uses imagination and broader problems as a platform to then create proposals of designing possible futures of a critical, discursive and fictional nature. The process is to design proposals that debate critical issues that may happen in the future for example, from the concern of ecosystem collapse and climate change to create open and freely available solutions that could alter the course of the future of the world itself for the benefit of environmental and human health and wellbeing.

Future consequences of what may happen in the world are considered with the implications of the existing relationship society has between science, technology, the environment and economy. Imagination for what could happen and how to best prepare for possible problematic scenarios are played out to present alternative products, systems or worlds. Proposed ideas are meant to trigger debate regarding future challenges and can seem disruptive or be irreverent towards existing systems or products in order to enact positive change rather than conforming to the status quo (Auger, 2013).

The A/B manifesto (table 1) introduced by Dunne & Raby in their book "Speculative Everything: Design, Fiction and Social Dreaming". Here the differences between affirmative design and speculative design are highlighted below (Dunne & Raby, 2013):

A	B
Affirmative	Critical
Problem solving	Problem finding
Provides answers	Asks questions
Design for production	Design for debate
Design as solution	Design as medium
In the service of industry	In the service of society
Fictional functions	Functional fictions
For how the world is	For how the world could be
Change the world to suit us	Change us to suit the world
Science fiction	Social fiction
Futures	Parallel worlds
The "real" real	The "unreal" real
Narratives of production	Narratives of consumption
Applications	Implications
Fun	Humour
Innovation	Provocation
Concept design	Conceptual design
Consumer	Citizen
Makes us buy	Makes us think
Ergonomics	Rhetoric
User-friendliness	Ethics
Process	Authorship

Table 1. *The A/B Manifesto, Dunne & Raby, 2013*

In speculating on a design, we can take our current position in time and what we currently know about, there here and now, and imagine what may occur in the future resulting in several different possibilities. Given that an idea of a preferable future is guided by the decisions of government and industry as opposed to the users of industrially produced consumer goods, speculative design proposes a way to address this and influence people to consider their own role as potential decision makers. Being that the future is not pre-determined, can be quite unpredictable, and can be influenced by present choices, through analysing past and present developments and/or problems, it is possible to envision probable futures. In this we can use the concept of 'future cones' (figure 1) to forecast possible outcomes and their level of probability, with an addition of the concept of a preferable future that can be placed anywhere within the cones. Logically if we can understand probable, plausible and possible futures, we can eventually create a preferable one (Jakobsone, 2017).

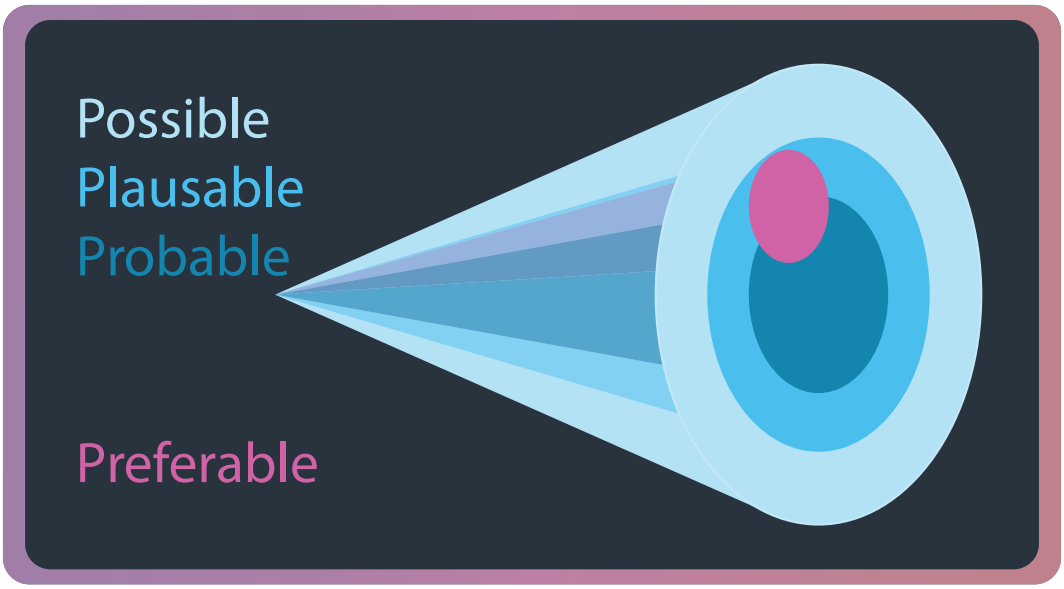

Figure 1. Future Cones, Jakobsone, 2017

2.2.2. Circular Design

A lot of design has been taught and practiced with a "take-make-dispose" model of resource use because following The Great Depression, a strategy for stimulating the economy was devised and implemented into the design of consumer goods by industry known as planned obsolescence. Planned obsolescence helped companies to increase their profits and continuously develop new and improved designs for products. These products could be easily replaced by consumers and were produced in large quantities, therefore the established and traditional habit of reusing, repairing and recycling old goods became unnecessary as replacements became cheaper and more accessible. Due to the amount of pollution and waste these discarded products created and their damaging effect on the environment, alternative design frameworks

needed to be developed by academics, designers and practitioners with a new understanding of how their work effects society (Moreno et al., 2016).

In consideration of this, new frameworks were developed towards the goal of creating more eco-friendly products from the inception of the design process. Green design came about in the 1970s focussing on recyclable materials, eco design in the 1980s with environmental considerations for each step of the design process, sustainable design in the 1990s by including social, economic and environmental factors, and design for sustainability in the 2000s in which designers strive for a sustainable future with radical designs. The most recent concept in the step towards sustainability is that of a circular economy, which is envisioned to stop waste being produced in the first place (Geissdoerfer et al., 2017). An industrial economy that is restorative or generative by intention and design as defined by the Ellen MacArthur Foundation with three principles, driven by design (What Is a Circular Economy?, n.d.):

Eliminate waste and pollution

- "The first principle of the circular economy is to eliminate waste and pollution. Currently, our economy works in a take-make-waste system. We take raw materials from the Earth, we make products from them, and eventually we throw them away as waste. Much of this waste ends up in landfills or incinerators and is lost. This system cannot work in the long term because the resources on our planet are finite" (Eliminate Waste and Pollution, n.d.).
- Through educational resources and Do-It-Yourself (DIY) tutorials, potential users of a platform can be inspired to organise activities like beach clean-up events and other projects like this. For example, where a group or individual can organise to collect plastic rubbish that has been accumulated in the oceans and ends up on beaches that can be recycled into new objects through a design workshop or simply an individual's design practice.
- In the design studio and ecological platform Space Available[10], artists, designers, scientists and environmentalists collaborate on education and design of new products from recycled materials like discarded plastic and clothing items. With their "Museum of Space Available" having both a physical and virtual presence they run workshops, exhibitions and events along with hosting a design library for local and global visitors.

[10] https://spaceavailable.tv/

Circulate products and materials (at their highest value)

• "The second principle of the circular economy is to circulate products and materials at their highest value. This means keeping materials in use, either as a product or, when that can no longer be used, as components or raw materials. This way, nothing becomes waste and the intrinsic value of products and materials are retained" (Circulate Products and Materials, n.d.).

• A company named Notpla[11] has developed new packaging solutions with algae and plant-based compounds that do not contain any plastic at all, are biodegradable and compostable. One of their products, Ooho is an edible bubble made from seaweed and designed for liquids, replacing single-use plastic bottles.

• Enabling people with easily accessible knowledge, sharing scientific research and collaboration possibilities in these innovative areas and many more can help to further develop the interest in them. Also helping to develop and innovate systems of best practices and efficient sustainable manufacturing methods by allowing the easy use of and access to existing patents can help to circulate products and materials at their highest value.

Regenerate nature

• "The third principle of the circular economy is to regenerate nature. By moving from a take-make-waste linear economy to a circular economy, we support natural processes and leave more room for nature to thrive" (Regenerate Nature, n.d.).

• GreenWave[12] is a non-profit organisation which provides training and tools to a network of regenerative ocean farmers founded by Bren Smith who started his own ocean farm after becoming concerned for the health of the planet's oceans as a former fisherman. They currently have over 8,000 people on their waiting list to enter their ocean farming programme, proving there is high demand for ideas and resources like this.

• Designing a user centred platform that shares the knowledge of these innovations and the research associated with them through open educational resources, open science, regenerative finance and decentralized science with a decentralized autonomous organization, I believe will help to increase innovation and development in these

[11] https://www.notpla.com/
[12] https://www.greenwave.org/

technologies. Creating sustainable opportunities for the benefit of humanity and great progress towards a circular economy for regenerating nature.

2.2.3. Double Diamond

The double diamond design process (figure 2) is a renowned design method for conceiving of an idea and processing it into a final concept ready for product development. It was developed by the Design Council and introduced in 2005 as a simplified graphical way of defining the design process in two stages, problem and solution and reiterating over them again until a clear design is formed (Kochanowska, Magda & Gagliardi, 2022). In discovering opportunities that can help to realise solutions for the problem the double diamond process is used to refine those solutions to deliver value to the end user and organisation.

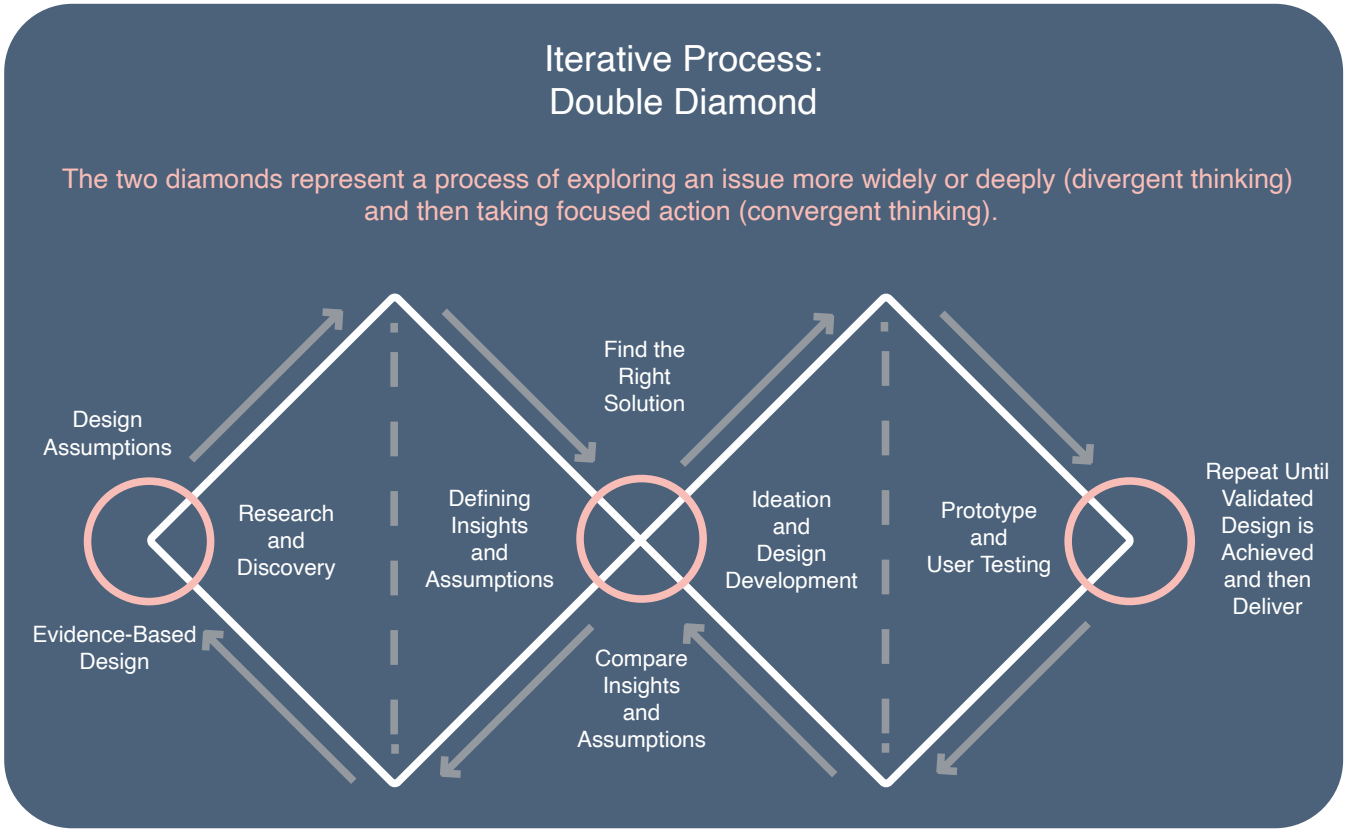

Figure 2. *Iterative Process: Double Diamond. Based on - The Design Process: What is the Double Diamond? Design Council, 2005.*

In this process one must understand the problem that one wants to solve, the first diamond. It is the stage of exploring, synthesizing and defining the problem. The problem that I am trying to solve is that of limited awareness and accessibility of innovative research and education, funding and collaboration towards a healthier and sustainable future where the benefits derived of the ocean play a major role. In the solution stage (the second diamond), visualizing, iterating and experimenting with various designs is repeated until something close to what might resonate with a particular audience, both visually and functionally.

2.2.4. Surveys

Surveys serve as a prominent method for gathering self-reported data on various aspects such as characteristics, thoughts, feelings, behaviors, or attitudes. Widely employed for efficiently collecting substantial data within short timeframes and at minimal cost, surveys offer versatility in information gathering. Two primary techniques within survey data collection include questionnaires, whether self-completed or administered by researchers, and structured interviews conducted through different means. Despite their efficiency, surveys, being self-report instruments, may not always accurately reflect true sentiments or behaviors, emphasizing the importance of careful design and administration. Complementary methods, like observations or participatory design, are often used alongside surveys for a more comprehensive understanding. Survey questions vary, encompassing closed or open formats, general or specific focuses, factual or hypothetical inquiries, and various others, with the choice depending on the inquiry, time constraints, and desired response format (Martin & Hanington, 2012).

2.2.5. Benchmarking

Benchmarking is a strategic management technique aimed at improving organizational performance through the systematic comparison of processes, functions, and key success factors (KSFs). The process involves seven main stages: identifying functions to benchmark, evaluating the importance of each subject area, determining benchmarking partners, gathering information, comparing performance with "best-in-class" entities, deriving implications for improvement, and implementing changes (benchaction). The approach is versatile, encompassing various types such as internal, industry, competitive, and process benchmarking. The key to successful benchmarking lies in understanding the unique competitive position of the organization, choosing appropriate benchmarking partners, and utilizing the results for continuous improvement. Despite its effectiveness, benchmarking has limitations, including potential focus on quantitative data, challenges in obtaining information about competitors, and the need for ongoing commitment rather than treating it as a one-time project.

Industry (functional) benchmarking involves assessing a company's functional operations by comparing them to similar measurements from other companies within the same industry group. This strategic approach focuses on specific functions, including technological and market characteristics. Unlike competitive benchmarking, the partners in industry benchmarking are not direct competitors, promoting a cooperative atmosphere for sharing insights. Challenges may arise in scheduling, as some companies

may be overwhelmed and reluctant to participate. Nonetheless, industry benchmarking provides valuable insights into leading practices within the industry, supporting improvements in functional operations.

Benchmarking is not merely a static tool but a continuous improvement strategy within the Total Quality Management (TQM) framework. Its application requires a careful selection of subject areas, benchmarking partners, and a strategic understanding of the organization's competitive position. As an ongoing process, benchmarking contributes to organizational learning, innovation, and adaptation to changing market dynamics, making it a valuable element in strategic management and organizational development (Freytag & Hollensen, 2001).

2.3. United Nations Sustainable Development Goals

The 2030 Agenda for Sustainable Development was adopted in 2015 by all United Nations Member States, in which provides a blueprint for peace and prosperity for people and the planet, now and into the future. The 17 Sustainable Development Goals outlined in the agenda are made as an urgent call to action by all countries whether they are developing or developed, in a global partnership. Recognising that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests (United Nations, 2017).

Goal 1: No Poverty

End Poverty in all its forms everywhere.

Supporting the development of sustainable ocean research, development, projects and innovation increases the financial opportunities for individuals. Since the poorest countries of the world are most effected by climate change, regenerating nature through educational resources about regenerative ocean farming and ecosystem services will help to reduce impacted peoples as well as providing open and free resources for education can help them to create local solutions.

Goal 2: Zero Hunger

End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Regenerative ocean farming will create new food sources whilst helping to increase fish

populations that can be fished sustainably and developing best practices for sustainable fish farming all has the potential to produce enough food for the population of the world. Using an algae supplement to regenerate overused and degraded agricultural soils can help to sustain farming lands without toxic chemicals.

Goal 3: Good Health and Well-Being

Ensure healthy lives and promote well-being for all at all ages.

The health benefits from ocean organisms like algae, shellfish, crustaceans and fish are diverse and rich, from biomaterials to biopharmaceuticals, health food supplements and cosmetics. Marine derived materials produce anti-cancer activities, benefits for cardiovascular diseases, diabetes and bone diseases in the human body along with fantastic developments in tissue engineering and regenerative medicine among others.

Goal 4: Quality Education

Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Open educational resources with DIY tutorials and video content will be specifically designed to be inclusive and accessible for all learning stages and create inspiration for people to develop further research, adding to and improving the resources and generating opportunities for innovation.

Goal 5: Gender Equality

Achieve gender equality and empower all women and girls.

Inclusivity and respect for all genders is promoted in the accessibility for designing a platform without barriers to access, amplifying the equality for opportunities for all genders.

Goal 6: Clean Water and Sanitation

Ensure availability and sustainable management of water and sanitation for all.

Desalination provides clean drinking water for millions of people, improving sanitation and recycling of waste with circular methods through awareness and education increasing the water quality of oceans and local environments.

Goal 7: Affordable and Clean Energy

Ensure access to affordable, reliable, sustainable and modern energy for all.

The renewable energy potential of the ocean is almost unlimited from wind farms to wave energy and creating algae-based biofuels among others. There are many sustainable options

to work with in creating affordable and clean energy.

Goal 8: Decent Work and Economic Growth

Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Increasing education through free and open resources, science and funding options creates increased economic opportunities for all. A platform designed to inspire innovation through education that can also provide funding options for projects to be developed thereby creating more opportunities for decent work and economic growth in society.

Goal 9: Industry, Innovation and Infrastructure

Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Inspiring people to innovate and grow through accessible learning platforms will help to develop more regenerative ocean farms, sustainable ocean energy and circular economic models for sustainable wellbeing. The infrastructure of an educational platform can develop sustainable and regenerative industry through innovations it helps to bring about.

Goal 10: Reduced Inequalities

Reduce inequality within and among countries.

Open and free accessibility to educational resources and DIY tutorials, collaboration with a community of like-minded people and access to funding options for sustainable and regenerative projects, whilst helping to develop ecosystem services could reduce inequalities in society.

Goal 11: Sustainable Cities and Communities

Make cities and human settlements inclusive, safe, resilient and sustainable.

Sustainable innovations can be developed for creating biofuels with algae, together with recycling practices, biomaterials for designing new products that can be composted easily can help to develop sustainable cities and communities.

Goal 12: Responsible Consumption and Production

Ensure sustainable consumption and production patterns.

Solving ocean plastic pollution with recycling and creating new compostable and biodegradable bioplastics from algae reduces waste and creates a more circular economy.

Goal 13: Climate Action

Take urgent action to combat climate change and its impacts.

Increasing the knowledge of society about the ecosystem services and benefits of algae through regenerative ocean farming such as carbon sequestration and ocean de-acidification can reduce the impacts of climate change.

Goal 14: Life Below Water

Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Designing an online platform focussing on the benefits of a circular ocean economy with appropriate protections, as an educational resource where people can also collaborate and develop new projects and apply for funding options will help to increase new sustainable innovations for the benefits of new ocean and algae research and technology.

Goal 15: Life on Land

Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Algae supplements can be used to regenerate overused agricultural soils, reducing the use of harmful chemicals that cause biodiversity loss. Reducing ocean dead zones catalyses land-based reforms towards regenerative precision agriculture.

Goal 16: Peace, Justice & Strong Institutions

Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

The integration of blockchain technology and a governance mechanism such as a DAO will give everyone who uses the platform autonomy, authority and transparency over the fair use and allocation of resources within the platform.

Goal 17: Partnerships for the Goals

Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

The ocean is a platform for collaboration and strengthens global partnerships for sustainable development. An online platform allowing easy collaboration between people will help to increase partnerships for the goals.

2.4. Blockchain Technologies

Since the Global Financial Crisis of 2008, trust in financial systems like banks has been tarnished, not to mention the damage that was done to global economies in this time. This created a desire for a different, autonomous, completely transparent and reliable system of accounting for what exactly goes in and what exactly goes out of a thing of value, and an unchanging amount of something to store value with, based on something tangible rather than continuously inventing fiat money as debt that used to be based on written agreements from the safe keepers for the amount of gold one had in their bank (of which is no longer required).

The trust in the political and financial systems of the world to safeguard a certain value of wealth was clearly compromised when the Global Financial Crisis (GFC) occurred. It caused a group of computer scientist or one under the pseudonym of "Satoshi Nakamoto" to create a new value with computational science and a new software technology that cannot be altered once written on the so called "blockchain" outlined in the white-paper "Bitcoin: A Peer-to-Peer Electronic Cash System". This was the first cryptographically stored amount of data packages or "blocks" on a blockchain to account for value as a cryptocurrency. It was named Bitcoin in 2008 and has since generated mass interest from almost everyone familiar with a computer from all around the world (Nakamoto, S., 2008).

Blockchain technology is made up of data sets that are composed of a chain of data packages (blocks) and each block itself is comprised of multiple transactions. The blockchain is extended by each supplementary block and therefore represents a complete ledger of the transaction history. Each block is validated cryptographically, contains a timestamp, the hash value of the previous block and a nonce (a random number for verifying the hash) thereby ensuring the hash value of the entire blockchain all the way to the very first block. Fraud can be effectively prevented due to the cryptography of the nonce to verify each unique hash and changes to a block would immediately change the corresponding hash value. A block can only be added to the chain if the majority of nodes in the network agrees by a consensus mechanism that a transaction is valid. After a transaction is validated and transferred to the ledger the information in the blockchain cannot be changed and each block has access to the exact same ledger for further transactions and validations. Data security and trust in the system is achieved by this system having no requirement for an intermediary or other participants like banks in the network (Nofer et al., 2017).

2.4.1. Cryptocurrencies & Sustainability

Cryptocurrencies are networks and mediums of exchange using cryptography to secure transactions in a blockchain. They are worldwide digital and online payment systems, which can be processed in a matter of hours or even seconds as opposed to the conventional systems of transferring money over country borders using the Society for Worldwide Interbank Financial Telecommunication (SWIFT) system for transactions around the world or the Single Euro Payments Area (SEPA) system within the European Union that can take days and require a third party to verify transactions. Some examples of cryptocurrencies are Bitcoin, Ethereum, Dogecoin, Cardano and so on (Hashemi Joo et al., 2020). Fast transaction systems and processes are available in traditional financial systems through a number of processes such as credit and debit cards with companies such as Mastercard and VISA, as well as online payment methods to asssist in the transfer of money like Paypal, although these methods are private being unavailable to public record and are not autonomous in nature like blockchain's mediums of exchange.

The way in which cryptocurrencies are "mined" through the use of a consensus mechanism has been a topic of debate regarding sustainability and environmental concern. This is due to the high electricity usage and cost of computational hardware required to mine bitcoin and other cryptocurrencies that use "proof-of-work" as a method to ensure the validity of transactions in a blockchain. This involves solving exponentially complex cryptographic mathematical equations with computer processing power, requiring ever increasing amounts of electricity to run. For each block newly minted, the person using a computer to do the complex computational work receives a new block as a reward making it financially attractive but is also environmentally unsustainable. The electricity consumption of Bitcoin mining has been estimated to be similar to that of a medium-sized country "such as Denmark, Ireland or Bangladesh [in the range of 3-6GW]" per year by 2017 (Vranken, 2017).

The cryptocurrency Ethereum switched its consensus mechanism from mining by "proof-of-work" to "proof-of-stake" in 2022 as the collective energy consumption of miners came to "about the same as the Czech Republic" which is around 70 TWh/yr (Paul, W., 2022). Proof-of-stake mining does not require large amounts of computational power, specialised hardware and electricity usage in order to mine new blocks in a blockchain, but rather users have to prove that they own their amount of coins. Users or coin owners create "coinstake" transactions where they send the coins to themselves and add a percentage as a reward. This percentage is determined by the "coin age", being the amount of time by a time-stamp that changes

every second multiplied by the number of coin(s) they have staked (as opposed to a nonce value that can be changed by the miner in proof-of-work). When a block is mined which includes a coinstake by proof-of-stake, the time-stamp resets. This consensus mechanism is far less energy consuming, and environmentally sustainable by switching out the importance of computational power for staked coins (Vranken, 2017).

2.4.2. Consensus Mechanisms

There are many more than just two consensus mechanisms and these vary with different blockchain networks, some of which include the following types summarised below (Xie et al., 2023).

Proving-based - This consensus mechanism, employing Proof of Work (PoW) and Proof of Stake (PoS) and their variations, operates on decentralized peer-to-peer networks. PoW allocates currency and accounting rights based on computational workload, while PoS privileges nodes with more stake, influencing block generation and rewards.

Voting-based - Voting-based consensus algorithms, exemplified by Paxos[13] and Raft[14], rely on nodes broadcasting requests for votes during leader elections. The candidate winning the majority becomes the leader. These traditional systems employ leader-based consensus mechanisms to ensure distributed system consistency.

Alternating-based - In the DPoS (Delegated Proof of Stake) consensus mechanism, authorized delegates rotate to produce blocks at scheduled intervals, packaging transactions. If a delegate misses its turn to generate a block, the authority passes to the delegate scheduled for the next period. Meanwhile, in PBFT (Practical Byzantine Fault Tolerance) and its variants, the primary node is determined based on both the view number and node number.

VRF-based - Consensus mechanisms employing Verifiable Random Function (VRF) aim to address the drawbacks of partial centralization in traditional consensus methods. In these mechanisms, a subset of nodes, determined by the VRF algorithm, engages in the consensus process for a set duration. Following this, either PoS or PBFT consensus mechanisms are applied by these selected nodes. This approach seeks

[13] hhttps://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/tr-2005-33.pdf
[14] https://raft.github.io/

to balance efficiency and performance advantages while considering both decentralization and system performance. However, challenges arise in constructing a fair and resilient committee through random selection, requiring a substantial number of nodes, often exceeding 2,000. Practical implementation proves challenging, as seen in the case of Algorand[15], which assumes a strongly synchronous network not reflective of real-world conditions. Additionally, the absence of effective incentive and penalty mechanisms exposes the network to potential malicious attacks.

Hybrid based - Hybrid consensus mechanisms combine two or more consensus methods to address limitations and optimize blockchain performance: PoW and PoS Integration (Decred[16]): Decred's hybrid approach merges PoW for block creation with PoS for voting on block acceptance, enhancing security against attacks like the 51% power attack. PoW and PBFT Blend (Truechain[17]): Truechain balances security and speed by combining PoW for ledger maintenance and PBFT for efficient transaction recording. PoW nodes handle elections and oversight, ensuring network security. PoS and PBFT Fusion (DBFT): The Delegated BFT (DBFT) mechanism combines DPoS and PBFT, with common nodes voting for accounting nodes based on equity stake. This integration ensures efficient block generation and complete transaction confirmation with enhanced security.

2.4.3. Regenerative Finance

The term Decentralized Finance (DeFi) was coined with the creation of cryptocurrencies and has been quite powerful in disrupting the financial sector to great financial benefit of many and loss for some as well. It is subject to the market and many projects fail or are deemed scams or are simply "ponzicoins", this is where many lessons need to be learnt from traditional finance. One of the big questions in the space has really been, what are the real-word uses for Web3? Many ideas for uses have been for health data, insurance and supply chain monitoring with the Internet of Things for blockchain technology, but none have gained much application in the real world.

Regenerative Finance (ReFi) is a way of using cryptocurrencies and blockchain technologies that create economic incentives towards common goals for developing environmental benefit, climate change solutions and other positive real-world objectives. It is based on "Regenerative Capitalism", a term coined

[15] https://www.algorand.foundation/
[16] https://decred.org/
[17] https://www.truechain.network/

by economist John Fullerton in 2015 for an economic system that delivers shared prosperity on a thriving planet (Fullerton, J., 2015). This creates a more equitable and sustainable system for driving innovation using Web3, blockchain technologies and cryptocurrencies in order to create value for the natural world.

A functioning use case for this is Cardano Forest[18], a ReFi project that aims to plant one million trees in the real world powered by the Cardano Foundation in partnership with VeriTree. They incentivise people to donate one million Cardano coins (ADA) to plant one million trees, having currently planted 35% of their goal. A record of the planting of each tree is stored on the Cardano blockchain and donors receive a certificate for the exact location of their donation, along with the type of tree planted. There is also a founder-led startup community called ReFi DAO that brings "together founders, investors and key contributors to accelerate impact for people and planet" with 371 Web3 ReFi projects listed on their website at the time of writing this.

Recently, the World Economic Forum (WEF) produced a white paper about ReFi titled "Blockchain for Scaling Climate Action" (World Economic Forum, 2023). The white paper identifies the technological advantages of using blockchain technology, not only for its wide availability to the public, but its decentralised structure and strong tamperproof and trust-less processing features. The WEF highlights that the utilisation of blockchain for ReFi "would provide a path to solve the fundamental accountability and incentive problems endemic to global climate negotiations". This new technological ecosystem presents new and unique challenges around education with the need to expand initiatives to build public awareness and trust with organisations needing to stay focused on solving real-world problems by playing a value additive role in the fight against climate change. These are some of the core reasons as to why I am wanting to design a platform for developing sustainable and effective innovations from the benefits of the ocean through education and funding opportunities with an online platform that is blockchain enhanced for ReFi and DeSci.

2.4.4. Decentralized Science

Like ReFi, Decentralized Science (DeSci) is a movement using Web3, blockchain and cryptocurrencies to revolutionise the way people do and support scientific research. Its aim is to create an open alternative to the current scientific system, built on the open science movement whose principles are that science should

[18] https://ito.veritree.com/

be transparent, rigorous, shared, collaborative, communicated, reproducible, and accessible (Vicente-Saez & Martinez-Fuentes, 2018).

DeSci uses technology to enable scientists to raise funding, run experiments, distribute insights, share data and more. An interesting new project called SCINET[19] is currently being developed to allow "institutional investors to invest directly in life sciences research and technology with security and authenticity" (Decentralized Scientific Research, n.d.).

"To realize the full benefits of these efficiencies and increased market participation, closer collaboration is needed among registries, carbon standards, verification bodies, scientific communities and blockchain entrepreneurs to construct a mutually beneficial end-to-end digital ecosystem." (World Economic Forum, 2023).

2.4.5. Non-Fungible Tokens

Non-Fungible Tokens (NFTs) are unique digital assets that exist on a blockchain, similar to a cryptocurrency in that they can be traded, bought or sold. Fungible assets are interchangeable with other goods or assets of the same kind implying equal value between them, such as a unit of Ethereum or Bitcoin, where there is equal value between each of the same kind of token. Tokens being a digital representation of a good, service or other form of value or utility. Although an NFT is not interchangeable and cannot be replaced, copied or exchanged for another similar NFT for the same value, each being individually unique. Any kind of easily reproducible digital file can be stored as an NFT to identify the original, this could be a digital artwork, a song, a video, design or e-book etc. that can be created digitally and stored as a file on a blockchain (Q. Wang et al., 2021).

Essentially an NFT is a digital certificate of authenticity that cannot be duplicated that is stored on a blockchain within a smart contract where the record of ownership and history of transactions is available and transparent. This means that that authenticity of an NFT can be checked and verified by any of the participants of the blockchain network it is stored on, such as Ethereum. The main characteristics of an NFT have been outlined as being in limited supply, non-interoperable, indivisible, indestructible, and verifiable (Popescu, n.d.).

[18] https://www.scinet.one/

NFT uses can range from authentic digital artworks to patents and intellectual property assets. A recent paper proposes an NFT-based patent framework that uses the advantages of decentralized networks for storage, authentication, verification, blockchain and application layers. This allows for patent holders to monetize their patents with smart contracts and sell their patents instantly to a buyer without them ever having to interact directly if they are both satisfied with the conditions. Hopeful inventors can then fast-track their process of innovation by building upon others patented inventions through licences that could be as easy as using a search query tool. The blockchain can be used to keep track of patent owners with an example being the companies IBM[19] and IPwe[20] teaming up to use the IBM blockchain to build the infrastructure for an NFT-based patent marketplace (Bamakan et al., 2022).

Tracking the provenance of intellectual property, research, design or artistic work etc. to prove that an individual or organisation actually created the asset before it has been "minted" as an NFT is a complicated issue. NFTs serve as a platform for consumers to showcase and validate digital artifacts with a transparent record of sale and ownership. The exponential growth of NFTs is driven by their unique ability to provide a certification of authenticity, represented by the NFT token. Consumers are attracted to NFTs for the assurance of possessing something genuinely rare, fostering a strong sense of ownership and value.

Some of the main chellenges inherent in NFTs inlude intellectual property rights, therefore ensuring the genuine ownership of NFTs is vital. While price volatility is less concerning, the primary value lies in verifying authenticity and ownership. Prices are currently significant, potentially influenced by a misunderstanding of NFTs. Mitigating transaction misunderstandings is crucial for regulatory approaches, initially relying on general laws, but adapting as the market evolves. If NFTs become speculative investments with minimal rights and high prices, financial market-like regulations may be necessary to ensure buyer protections (Ali et al., 2023).

The availability and acceptance of NFTs can vary by country and region. Generally, NFTs have gained global popularity, and many people from different parts of the world participate in buying, selling, and trading NFTs. However, there may be legal and regulatory variations that affect the use and trading of NFTs in specific locations. Some countries may have imposed restrictions on cryptocurrencies, including NFTs, due to concerns about fraud, money laundering, or other regulatory issues. It's also worth noting that access

[19] https://www.ibm.com/

[20] https://ipwe.com/

to NFT platforms and marketplaces might be subject to restrictions based on local regulations or platform policies. Users in certain regions may encounter limitations when using specific platforms to buy or trade NFTs. Some regulations that currently exist in different jurisdictions include (Kumar, S. J., 2023):

Australia:

No prescriptive regulation for NFTs, but if meeting criteria of a financial product, ASIC regulations apply.

An Australian Financial Services Licence is required for digital asset trading.

China:

Cryptocurrencies are banned.

No specific laws on NFTs, but an initiative discourages financial product issuance through NFTs.

European Union:

No specific regulation or legal definition of NFTs.

Markets in Crypto-assets Regulation (MiCA) excludes NFTs but may apply if they grant specific rights.

France:

No specific regulatory framework for NFTs.

Digital assets fall under the 5th Directive; marketing and advertising regulations may apply.

Germany:

NFTs may fall under existing legislation based on their characteristics.

Anti-money laundering requirements may apply, and financial instrument NFTs require licensing.

Italy:

No specific laws for NFTs, but they might qualify as investment products, triggering additional requirements.

Japan:

No specific laws, but a task force suggests potential future regulation.

NFTs may fall under securities definition if they involve profit sharing.

Portugal:

No specific regulation; anti-money laundering obligations triggered if NFTs qualify as virtual assets.

Spain:

NFTs may be subject to anti-money laundering regulations.

[21] https://aragon.org/

[22] https://daomaker.com/

Regulation depends on the underlying asset and potential future crypto-game regulation.

Singapore:

The NFT market is not regulated.

If an NFT resembles a capital markets product or digital payment token, specific regulations may apply.

United Arab Emirates:

ADGM proposes licensing for companies facilitating NFT trading.

Compliance with anti-money laundering rules and crypto asset regulations considered.

United Kingdom:

NFTs are considered cryptoassets.

If categorized as security or e-money tokens, they fall under specific regulations.

Anti-money laundering rules may apply to NFTs with art as their underlying asset.

United States:

NFTs are not specifically regulated.

Classification depends on associated rights and attributes.

Potential regulation by the SEC, FinCEN, and state laws.

Tax obligations for creators and investors.

2.4.6. Decentralized Autonomous Organizations

A Decentralized Autonomous Organization (DAO) is an online community of like-minded people self-governing an organisation with blockchain technology, and that jointly controls a cryptocurrency to pursue common goals, such as running a business or charity. People from anyone with a general interest to an investor, developer, scientist or founder can become a part of a DAO if they own some of the DOA's associated "token", coin or cryptocurrency. This specifically determines membership of the DAO and can give members access to content, group conversations and decision making within the organisation by way of a voting system. A DAO runs on its own without any central authority or management hierarchy, but rather organised by its members, relying on smart contracts and rules written on the blockchain itself (S. Wang et al., 2019).

Traditional companies or organisations are managed by a formalised hierarchical structure based on authority, with decisions being made by a small group of influential people from CEOs to executives, managers and shareholders who can have a disproportionate amount of control over the directions that

the organisation might go. The slow pace of bureaucracy in the structure of some hierarchical organisations can be highly inefficient and create too much control or "red tape" over decision making processes and limits to the abilities of the members of the organisation to only exactly what their job description may be as well as creating a culture of ignoring consumer complaints and unnecessarily increased and often biased oversight (Prendergast, 2003). The best way to create innovation and entrepreneurial motivation within an organisation is to break down the hierarchical structures and recognise the contributions of individuals in an organisation that can add their own self driven value without the complexities of hierarchical bureaucracies (Bartlett & Goshal, 1996).

The difference of a DAO is that they reduce the need for managers and traditional hierarchy systems because they can create a unique set of rules regarding their purpose, membership and objectives etc, that are embedded into the code in the blockchain through smart contracts and distributed consensus protocols which allows decisions to be made autonomously through a process of decentralised governance. Ideas can originate from anywhere within the organisation rather than them being largely implemented by the people with decision-making power in a traditional hierarchy. This gives opportunity for any member of the DAO to propose an idea that everyone could democratically vote on, thereby fostering an "idea meritocracy" which is usually associated with Deliberately Developmental Organizations (DDOs) that encourages the learning, creativity and innovations of the members of the organisation by spreading the decision-making power in favour for the "wisdom of the crowd" (Kegan et al., n.d.).

The world's first DAO project was created in 2016 and simply named "The DAO" also known as Genesis DAO. It was developed by members of the Ethereum community and purpose built to operate like a venture capital fund secured by Ethereum, controlled entirely by smart contracts without a conventional management structure or board of directors. The Initial Coin Offering (ICO) was the largest crowdfunding campaign at the time, being more than $150 million worth of Ethereum with each member receiving an amount of corresponding DAO tokens or coins as a cryptocurrency according to how much they invested. Members of The DAO were able to propose and review investment projects, then vote on which they would like to see happen. Upon approval of a project, tokens were automatically transferred to that project and earnings returned to the token holders according to their share. Although a vulnerability in the code was identified by a hacker who was able to siphon off a third of The DAO's funds soon after it was created. Eventually the funds were able to be restored through a controversial decision to hard fork the Ethereum

blockchain (Wang et al., 2019).

There are also platforms that provide the infrastructure needed to create and manage various types of DAOs such as Aragon[21] DAO and DAO Maker[22] amongst others. Aragon empowers users to easily create their own DAOs as global organisations without the restrictions of borders or intermediaries that are defined by their self-defined smart contracts, free of bureaucracy. They are built on its unique online system "aragonOS" that became "Aragon Client" which is currently updating to become "Aragon App" with better functionality and user-friendly design in each iteration. Users can create and run their own DAO through the platform with ability to manage their tokens, finances, governance, voting system, dispute resolution and even design, learning, and exploration of other DAOs built on the ecosystem. This platform allows people to create any kind of DAO they want without the need for knowing how to write the code behind it.

In the WEF white paper "Blockchain for Scaling Climate Action" it notes that "Web3 companies should continue to embrace and promote the democratic benefits of blockchain technology by developing more public, open-source products with community governance features built-in." (World Economic Forum, 2023, 18).

2.4.7. Decentralized Applications

Decentralized Apps (dApps) are online digital applications that exist and run on blockchain technology, a peer-to-peer (P2P) network of computers instead of relying on a single computer. Usually a standard web app, such as TikTok or Uber is run on a centralised computer system owned and operated by a company or organisation that maintains full authority over the application and its functions. The front-end or User Interface (UI) can have many different users with customisable layouts, but the backend is completely controlled by a single organisation. In contrast to this, dApps run on a blockchain network in an open-source, decentralised and public environment, free from total control and intervention by a single authority. As dApps run on blockchain networks, they can be used to secure data, which cannot be altered once written into the blockchain.

They can be developed to create decentralised social media platforms, financial services, identity verification, supply-chain management, real estate, healthcare, educational resources, predictive markets, multi-user games, and facilitate secure, blockchain-based voting and governance among other things.

They use smart contracts to complete transactions between two anonymous parties without relying on a central authority, therefore maintaining the privacy of users which can be useful for supporters of free speech.

Many decentralized applications (dApps) currently in existence are still in the experimental phase of development. One significant challenge they face is the struggle to match the level of User Experience (UX) design that users have come to expect from popular applications and traditional software programs. Achieving a seamless and intuitive user experience is crucial for the widespread adoption of any application. However, dApps often encounter obstacles in delivering this level of user-friendly design. Part of the difficulty lies in the decentralized nature of blockchain technology. Traditional applications have the luxury of centralized servers that can quickly process and update data, allowing for smoother user interactions and dynamic user interfaces. In contrast, blockchain-based dApps operate on decentralized networks, which can introduce latency and other technical challenges that impact the user experience. Moreover, modifying code that has been published to the blockchain is not as straightforward as updating traditional software. Blockchain, by design, emphasizes immutability, meaning that once code is deployed, it is challenging to make changes. This poses a unique set of challenges for developers who want to improve or upgrade their dApps after they've been released (Frankenfield, J. et al, 2023).

2.4.8. Trust in Blockchain Technologies

With the use of these technologies, it could be beneficial to design and develop a platform that incorporates the organisational structure of a DAO with a cryptocurrency for ReFi and DeSci in order to accelerate innovation in this field. Allowing for people to easily access funding for their various innovative projects and scientific research or organise volunteer groups or even to secure and trade their intellectual property as NFTs. If there is some financial incentive for people that they can attain in a positive and sustainable way, it will hopefully help to inspire people to develop some of the solutions the world so clearly needs for the health and wellbeing of not just humanity but the planet itself.

In my opinion the technology is sound and could make a big difference for simplifying, accelerating and unifying a lot of these already existing processes, although whether the potential user feels they can trust a system built with blockchain technology is another thing due to the recent problems that have arisen with some cryptocurrencies and exchanges around the world. Many cryptocurrency projects claiming to be

good investments have been scams or Ponzi schemes and recently with the collapse of a large, centralised cryptocurrency exchange called "FTX Exchange" many people are very cautious to trust such novelties.

FTX specialised in derivatives and leverage products which supported the most commonly traded cryptocurrencies, that was once valued at $32 billion USD but filed for Chapter 11 bankruptcy on November 11, 2022, resulting in $8 billion USD of liabilities it can't pay to around 1 million creditors. The CEO Sam Bankman-Fried resigned and is facing criminal charges of fraud, conspiracy, campaign finance law violations and money laundering in a New York federal court in the US where he could face up to 115 years in jail (Smith, 2023).

As cryptocurrencies can be bought and traded on many public cryptocurrency exchanges, they are open to market manipulation such as "pump-and-dump" schemes that can boost the price of a stock or security through false, misleading or greatly exaggerated statements. The perpetrators of a pump-and-dump scheme already have an established position in a company's stock and then sell their positions after the hype has led to a higher share price. This scheme is illegal, and people found guilty of such activity are punished with heavy fines. Cryptocurrencies are particularly vulnerable to pump-and-dump schemes due to the lack of regulation in the market. Researchers of a study in 2018 identified more than 3,400 such schemes over the course of just 6 months proliferated over group messaging platforms popular with cryptocurrency investors (Li et al., 2022).

Due to the great advantages of blockchain technologies, I believe that it is worthwhile to be implemented in a platform for allowing users to develop research, attain funding, self-organise and trade ideas. Allowing people to spend more time doing the research, science, design and engineering rather than time spent applying for funding or grants. Giving the average person the opportunity to partake in a whole new realm of finance and quest for knowledge, opening a new world of opportunities for people that come from many different backgrounds, cultures or countries to participate in the advancements for innovation, health, sustainability and more. Trust in the platform would be able to be achieved as long as the technology is implemented well with ethical objectives that can be verified and largely agreed upon by the users. At the end of the day, the technology is not at fault when something goes wrong, but how it is being used.

3

DESIGN PROCESS

RESEARCH & DISCOVERY

DEFINING INSIGHTS & ASSUMPTIONS

WIREFRAMES & LOW FIDELITY PROTOTYPING

USER INTERFACE DESIGN - PROTOTYPING & USER TESTING

3.1. Research & Discovery

3.1.1. Surveys

A survey is a list of questions asked to individuals with the aim of collecting useful information and feedback. They are an efficient tool for collecting a lot of information and data in a short time frame with little cost. Results can be analyzed statistically with structured and limited options or can also be broad with generalized questions to receive more personalized answers from participants. Surveys may not be an accurate reflection of true thoughts, feelings perceptions or even behaviors, as participants may or may not be interested in providing honest information (Martin & Hanington, 2012). Conversely, I did receive a few brutally honest answers in my user research.

Survey #1 - Main Results

The first section was relating to questions about demographics and general questions relating to everyone that took the survey. The full survey results can be found in appendice 2.

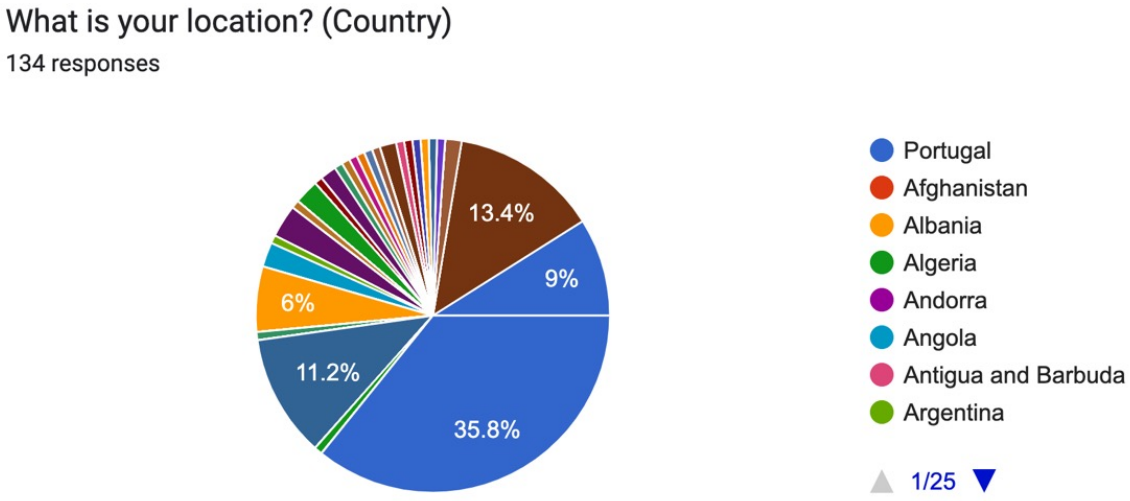

Figure 3. Demographics of participants by Country

The answers I received were from people around the world with a total of 134 participants (figure 3), the majority of which were from Portugal at 35.8%, the United Kingdom 13.4%, Australia 11.2%, the United States of America 9% and Canada 6%. I also received answers from Turkey, Sweden, Spain, Slovakia, Russia, Philippines, Norway, Netherlands, Morocco, Mexico, Malta, Italy, Ireland, Indonesia, India, Iceland, Germany, Ecuador, Denmark, Columbia, Chile, Belgium and Algeria. Most of the participants were researchers or the general public with designers and people in related industries to the premise also taking part in the survey. Most people (45.5%) were in the 30 - 45 years of age bracket a majority (57.3%) of which identified as

female, noting that I did include category for "other" to which no one identified as. The professions of the participants Environmental Advisor to CEO with many students, teachers, architects, artists, designers and more in between. This gives a broad range for the demographic of this survey.

I asked participants to rate on a scale from 1 to 5, how important they considered the health of the ocean to be in relation to their own health and wellbeing. 78.4% answered with a 5, and 17.9% answered 4 with one answering 3 and four answering 2.

84.3% agreed that an educational resource would be helpful for spreading knowledge and awareness about this topic. The majority of people would like to see a documentary film for digesting educational content, whilst 18.7% and 24.6% prefer a smartphone app or website, this helped me to understand that video content would be important to include in the design of the platform. Most people regard the health of the oceans as of high importance to their personal health and wellbeing with their awareness of it being mainly concerned with food and health supplements.

97.7% of participants thought that it is worthwhile to design an educational resource around this topic, and 75.7% agreed that summarizing research articles and academic knowledge would be beneficial for the public whilst 22.3% said maybe. 91.9% said that research in this field requires design intervention and most people (76.7%) gave a score of 3 or lower from 1 to 5 regarding how much awareness they felt there was surrounding this topic. 84% of people believed that a DAO would be worthwhile to develop (it is important to note that this survey was produced before the financial collapse of FTX and subsequent associated bank failures).

I asked an open question for any research or ideas that I might be unaware of in this survey, with some interesting answers from participants that helped me to form a better understanding of what would be appropriate to focus on. When it came to blockchain, a respondent was fully aware that Proof-of-Work mining process involves "environmental impact and long-term consequences" that are "diametrically opposed to the project's own initial goals."

Another participant was concerned about summarising research being that the "issue with research summary is that it is often loosely done and in complete layman terms, leading to complete misinterpretation

that is often completely wilful and even for nefarious purposes, such as claiming the climate is cooling, fuelling many "fake news" outlets. People who consume such outlets will take everything for granted and spread such disinformation to their circle which is detrimental. Summaries must be done right."

When targeting industry related participants, 96.1% agreed that an educational resource would help to benefit the development of new economies in this field and 91.8% gave a score of 3 or lower on a scale of 1 to 5 regarding how much awareness they felt there was surrounding this topic.

I asked what the best way was to communicate complex research, to which I received some inspiring answers such as, "the same as Leonardo Da Vinci did through a holistic art/science interface" and "make it popularly understandable", which are the real ideological cornerstones of the project itself.

61.7% of participants were interested in developing new solutions in this field, with 27.8% of them saying maybe. 80.3% were interested in knowing more about this topic and 75.8% preferred to learn about something new through summarised research with designed visualisations. The majority (80.5%) of participants gave a score of 3 or lower on a scale of 1 to 5 about their understanding of blockchain technology, with 60.3% of them saying they would like to see the platform integrated into a DAO and 34.4% being undecided.

This survey helped me to understand that my assumptions for the design were going in the right direction, but also required some further understanding. There is still limited understanding of blockchain technology with the human faults giving premise to the criticism it has gained recently.

Survey #2 - Main Results

After the first survey was successfully conducted among a broad range of individuals, I did have some difficulty for the second survey. This survey was sent to a similar amount of people as the previous one, although only 18 people responded as opposed to the 134 from the first one. The purpose of this survey was to refine the categories of interest in the educational resources along with some questions about the aesthetic design of the platform. The full survey results can be found in appendice 3.

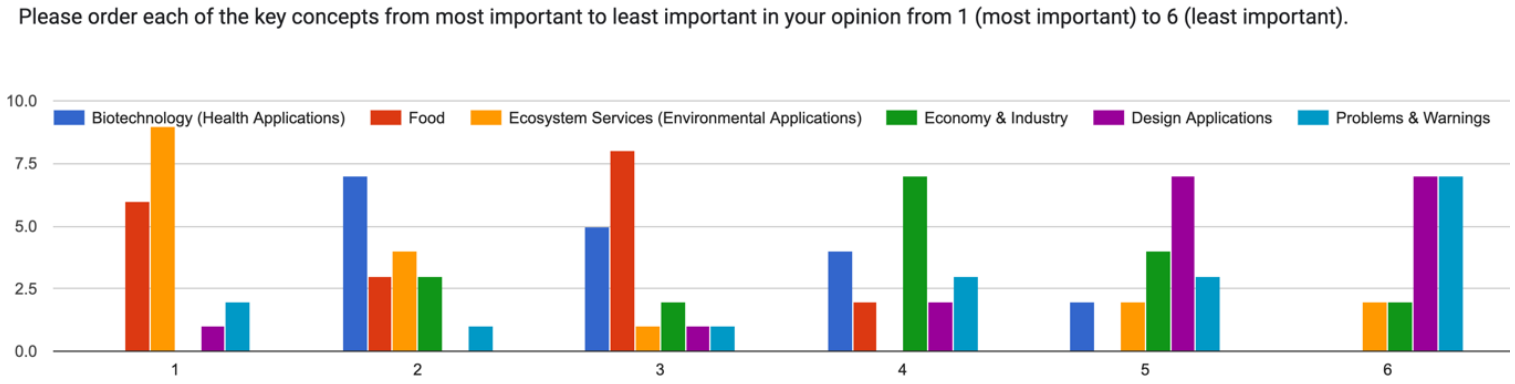

Figure 4. Key categories rated from most important to least important.

This question above (figure 4) was quite important to the designing of the platform's educational resources as the relatable structure of categories is imperative to the user's functionality and experience flow for learning outcomes with online information (Rossin et al., 2009). The answers tell me that Ecosystem Services are most important, followed by Biotechnology, Food, Economy & Industry, Design Applications, and Problems & Warnings being of least concern.

The importance of the topics for the articles to be featured within the main categories were then rated by participants in this survey as follows.

Biotechnology (Health Applications):

Here Health Supplements were the most important topic, although I did not specifically disassociate Bio-Materials being design terminology from Biomaterials being scientific and medical terminology so I decided on placing Biomaterials as the most important given that some participants may have not been aware of this topic. Health Supplements came in third behind Biopharmaceuticals, both of which can help to prevent diseases. Cosmetics were clearly the least important topic to focus on.

Ecosystem Services:

Climate change was the most important topic for the participants in the heading of Ecosystem Services, with Ecosystem Recovery being followed closely behind by Carbon Sequestration and Pollution.

Economy & Industry:

Sustainability was clearly the most important, followed by Carbon Economy & Biofuel. Blue Economy and Farming Techniques were relatively equal while Novel Companies and Markets were seen to be least important.

Food:

World hunger was the most important topic for Food, with Sustainable Produce & Fertilisers, Edible Algae, Health Food Supplements and Recipes following in that order.

Design Applications:

Bio-Materials was most important followed by Bioplastics and then Circular Design.

Problems & Warnings:

Algae Bloom was most important followed by Harmful Farming Techniques and then Inedible Algae.

From these two surveys I could begin to structure my designs for the platform with quantifiable research from a number of people around the world with different backgrounds, nationalities and levels of expertise in the premise. The next questions were regarding the functional design the platform might take.

I asked participants what the most immediately attractive feature is when considering an Open Educational Resource. The importance of Functionality ranked highest with 33.3% when considering an online educational resource, with Quality of Content (27.8%) following closely behind and then Relatable Content and Range of Content regarded equally important (11.1%).

From untrustworthy being 1 to trustworthy being 5. I asked what level of trust the participants put into blockchain projects. Nine participants answered with a 3 (50%), 22.2% answered with a 4, 11.1% answered with a 2 and 16.7% answered with a 1. No one answered with blockchain projects being trustworthy at a 5 but there is a level of trust.

Most of the participants (55.6%) were unsure as to whether the structure of a DAO would be a good way of organizing new additions to the educational resource, with 38.9% saying yes and the rest rejecting the idea. In reference to an existing DAO platform, DAO Maker which is used for funding and helping to launch projects on its ecosystem, 50% of the participants answered maybe that this kind of structure would be a good way of providing support for new and interesting projects in the blue economy. 44.4% said yes to this and the remaining few (5.6%) rejected the idea. Readiness to trust in blockchain technology is still quite limited based on the answers from both surveys, although I still included it in the design because there are some interesting real-world uses that can be developed with it in the scope of this design and for scaling climate action.

3.1.2. Benchmarking

Within my process of forming a design, I needed to perform industry benchmarking to measure the various facets of the application I am intending to design, those which share some common technological and market characteristics as to the project I will design. An OER, combined with funding options both fiat and cryptocurrency enabled, IP protection with NFTs and smart contracts, videos and DIY tutorials, with its content contributed to and largely controlled by its users, structured as a DAO for ReFi and DeSci. A platform for inspiring innovation and helping to develop real world solutions by providing the digital infrastructure for innovation. With the design method of Benchmarking (Freytag & Hollensen, 2001), I have identified several organisations or websites that offer a part of what I imagine a great design for my project would look like by searching through and comparing a number of OER, crowdfunding, ocean science resources, DeSci and Refi online platforms and websites that fit my vision for OZEAON.

Open Educational Resources

OER Commons [https://www.oercommons.org/]

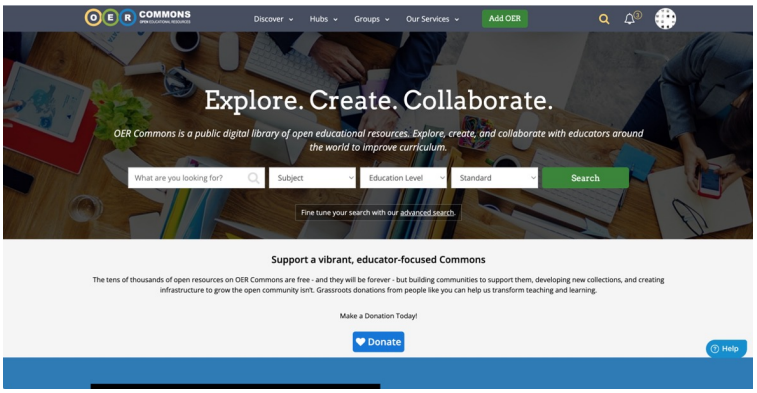

Figure 5. OER Commons Landing Page

OER Commons (figure 5) is a public digital library of open educational resources. It is a website that provides access to tens of thousands of free open resources. The website offers not only open resources in a multitude of subjects and materials but curated collections of similar types of resources for ease of access to the user.

By categorising resources not only by subject but collections for similar types of resources under a system like this, users are able to access as much of the information they might need surrounding a particular topic, whether it be Adult Education or STEAM (Science, Technology, Engineering, Art and Math) or Garden-Based Learning etc. When a user joins OER Commons, they can submit their own Open Educational Resource, being their own website, to the website for becoming a part of OER Common's library of resources that is then reviewed for acceptance and listing on OER Commons. They can also create or join a group of users for developing resources or use the website's Open Author editor to create and submit their own open educational resource on the website itself, thereby becoming a contributor. The in-built editor for

developing a user's own educational resources is quite important and unique along with the ability to create or become a member of groups allowing for sharing of resources and discussion for potential collaboration in their respective fields.

The ability for a user to not only search and use educational resources on the website but to easily create their own resources, connect with other creators and communities on the website are very interesting and useful features that I will take into consideration for the design of my own project.

Materials Recipes and DIY Tutorials

Materiom [https://materiom.org/]

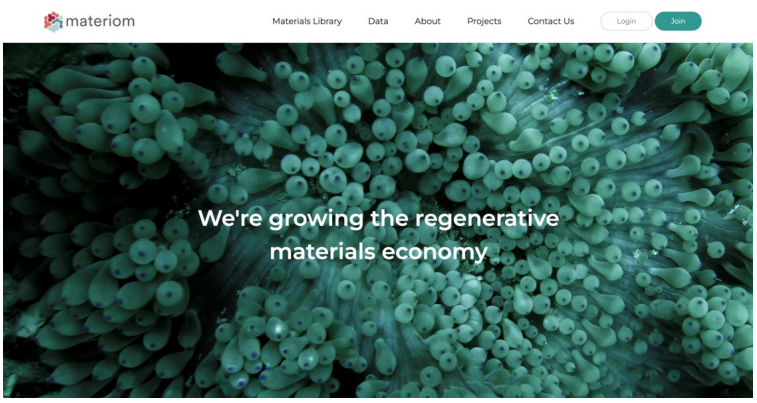

Figure 6. Materiom Landing Page

Materiom (figure 6) is a platform for DIY tutorials and recipes on how to create regenerative materials to help users in the development of their own sustainable products. The website offers a materials library as well as an AI powered machine learning database of materials that a user can submit their own formulation of materials to and receive performance data in return, including mechanical, thermal and barrier properties.

The ease at which users can search for and find regenerative material recipes and the ability to add their own contributions to this website is something I am interested in considering for my own project. Tutorials were on the website at the time of writing this.

The website was still in development at the time of this research, but the promise of using AI to assist in the research and development of sustainable products with regenerative materials is very interesting and indeed could speed up the R&D for creators to analyse, optimise and commercialise regenerative materials.

Crowdfunding Platforms

Kickstarter [https://www.kickstarter.com/]

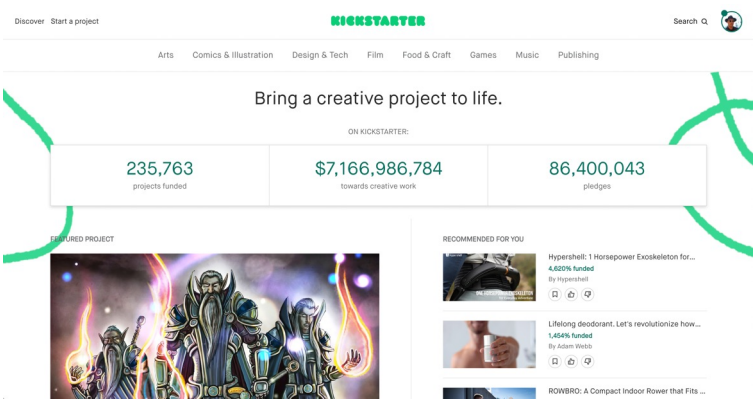

Figure 7. Kickstarter Landing Page

Kickstarter (figure 7) is a crowdfunding platform for creators to launch new products and business ideas with. Essentially creators can use the platform to find funding for their project(s). The website offers a large catalogue of projects that a user as a funder can search through and find an interesting project to support. Creators can offer several different packages or rewards for funding their project, which may include the product that is being developed or a gift or token of appreciation from the creator themselves. Projects that are developed can be anything from funding needed for the creation of a film to an electronic exoskeleton for example.

Users can also easily create a project for funding on the platform, with an easy-to-follow step-by-step system for creating and launching campaign for funding. The only problem is that there are specific countries that have access to this platform with many being unable to use it to fund their projects at all due to government restrictions etc. Also being only able to fund through a fiat currency can be limiting for many people with this platform, if they were able to provide a cryptocurrency system for funding it may be more user friendly.

The ability for this platform to help facilitate innovation by allowing people to access funding, which they can attract from their friends or family, or anyone interested in their work is something I find quite important for the development of innovation in ocean and algae research and development. If I included the use of a cryptocurrency in the funding options for people, it would be more user friendly and accessible for people around the world.

Ocean and Algae Resources

World Register of Marine Species [https://www.marinespecies.org/]

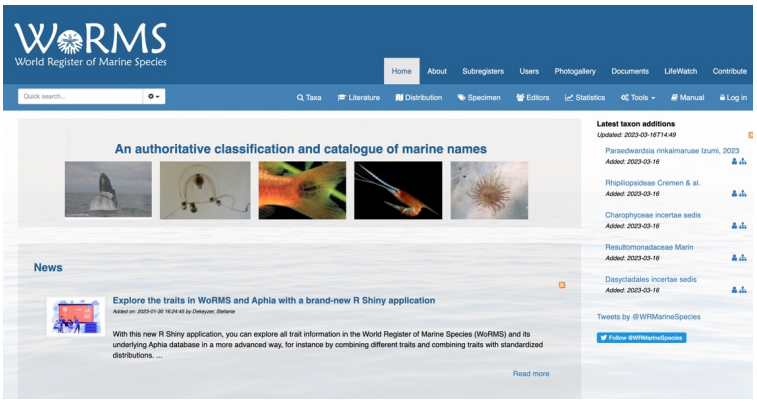

Figure 8. WORMS Landing Page

The World Register of Marine Species (WORMS) (figure 8) is an authoritative classification and catalogue of marine names. It is a combination of several other species registers and makes use of the Aphia platform which combines numerous databases from all over the world into a uniform registry of species names.

The website is not very well designed and does not seem user friendly, but it has a detailed search function and of course fantastic databases of information. This website is mainly for researchers, biologists and scientists being a great resource, although is not designed for use by the general public and is not very attractive or easy to use. There is a section for contributing to the resources, although this only provides information to contribute through other websites and provides no easy way to do much.

This is a great resource for scientists and professionals in the field, although it is difficult to use if you are not already trained on how to use it and it seems that the information would be quite hard to find unless you already know exactly what you are looking for. I would like to be able to access this information, possibly being able to connect to the database in my own project, for providing accurate and valuable definitions for terms and names of species.

Although it is an educational resource, it is not exactly good at providing useful information unless you already have a good understanding of it. Using the database system they have built could be quite useful for creating an Open Educational Resource for the general public within my own project.

Popularising Ocean Science and Education

Parley for the Oceans [https://www.parley.tv/#fortheoceans]

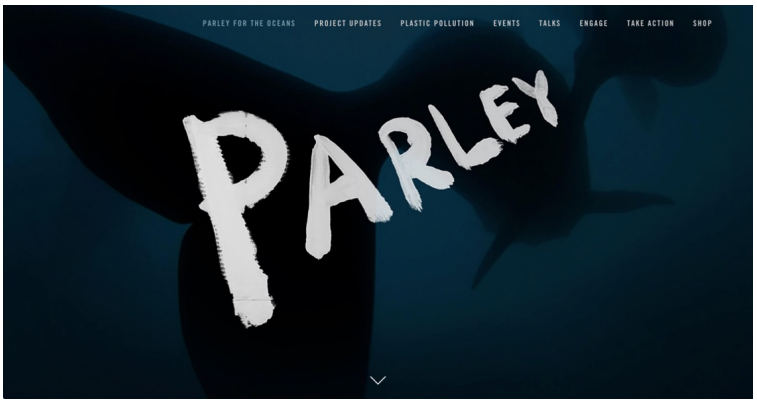

Figure 9. *Parley for the Oceans Landing Page*

Parley for the Oceans (figure 9) is a space that combines information, projects, and education often in collaboration with artists to raise awareness of the ocean. Educational workshops, volunteering initiatives, product launches, artist exhibitions etc. help to increase the public's knowledge about the importance of the ocean.

The website provides information on project updates, plastic pollution, events and talks. Users can engage through signing up to newsletters and taking action by signing petitions that are featured on the site, along with participating in volunteering programs. They also have an educational section of the website, with online courses in several subjects from plastic recycling to general knowledge about the oceans. The courses Parley for the Oceans provide are very interesting, providing people with accessible information on topics related to the ocean and plastic pollution. There are nine courses to choose from with levels of difficulty including beginner, intermediate and advanced. There is not much possibility for users to create their own volunteering programs or courses by contributing to the platform here though, which would create more user engagement and potentially help to develop solutions faster with a bigger reach.

The website is well laid out, with attractive imagery and beautiful videos helping to gain attention from a broad audience. The past, ongoing and upcoming projects they create are a great way of activating real world change, their courses are educational for general public digestion and the platform has a strong social media presence. The idea of creating collaborations with a number of different stakeholders, including artists, designers, sailors, scientists, athletes and volunteers gives the platform a great reach.

I would like to include some of these capabilities into my own project, and some kind of gamified quiz into the articles of educational resources, where the user's knowledge can be quickly tested on what they have just learnt in each article.

Blockchain-Based Organisations

SCINET [https://www.scinet.one/]

Figure 10. SCINET Landing Page

SCINET (figure 10) is not yet up and running but is an exciting new platform for doing and supporting scientific research and development with blockchain technology. It promises to allow users to fund others as well as find funding and profit from their own research with investor funding options, provides decentralised publishing and peer review with documentation of intellectual property on a blockchain with smart contracts. It also promises to facilitate collaboration with its own digital laboratory similar to virtual lab notebooks or Google Docs.

Even though the platform is still in development, the active use of a Decentralized Autonomous Organizational structure is very interesting, using blockchain technology and Decentralized Science to protect intellectual property and access funding for innovation is something I am considering for my project.

Spirals [https://www.spirals.so/]

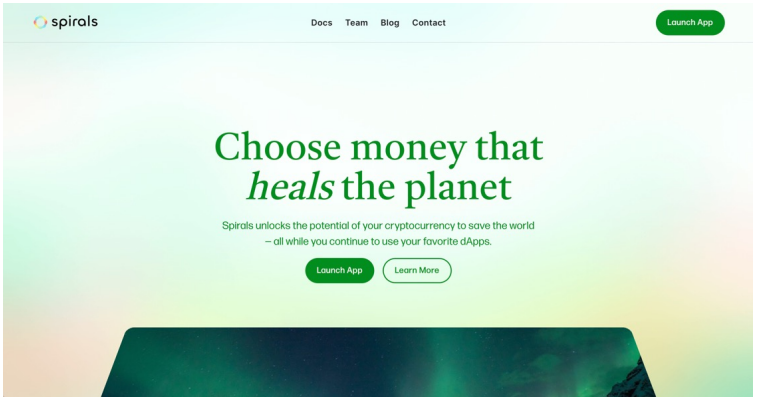

Figure 11. Spirals Landing Page

Spirals (figure 11) is a decentralized app that uses blockchain and cryptocurrency to fund and support projects that fight climate change. Through proof-of-stake mining, a user can stake their cryptocurrency with the platform's dApp so that the yield of the staking is used to invest into verified projects that tackle environmental issues around the world.

In this way, according to the website, "Staking 4426 $cUSD will contribute the equivalent to offsetting your personal footprint without you having to spend anything. Any amount, however, makes an impact! Carbon Footprint Estimation: The cost of offsetting your carbon footprint depends on how much you emit, which

is highly dependent on your lifestyle. The average annual carbon dioxide emissions per American is ~18 metric tons. We will assume ~$15/ton sequestered. To be carbon neutral, you'd need $270/year/person (or $22.5/month). With cUSD's 6.1% APY, this comes out to 4426 $cUSD staked." (Spirals - Climate Impact Staking, n.d.).

This is quite interesting to me because if my project is to become a DAO and utilise blockchain technologies, it seems possible to use the proof-of-stake mining process for donating to charities or organisations or scientists or any projects on the platform that a user might be aligned with.

3.1.3. UX Benchmarking Analysis

Features	OER COMMONS	materiom	KICKSTARTER	WoRMS World Register of Marine Species	PARLEY	SCINET	spirals
Free to Access	✓	✓	✓	✓	✓		
Public User Contributions	✓	✓	✓			✓	
Funding Ability			✓			✓	✓
User-Friendly Interface	✓	✓	✓		✓		✓
Educational Content	✓	✓		✓	✓	✓	
Tutorials or Courses	✓	✓			✓		
Social Interactivity	✓		✓				
Collaborative Community	✓				✓	✓	✓
Data-Base Powered	✓	✓		✓		✓	
Blockchain Technology						✓	✓
Environment Action		✓	✓		✓		✓

Table 2. UX Benchmarking Analysis

Here in Table 2, I identify the different traits that I would like to have in my design and weigh them against the websites and online resources I looked at in the benchmarking. The most amount of features that a single platform had was OER Commons, although none had every feature.

3.2. Defining Insights & Assumptions

3.2.1. Speculative Design

Within my own designs for the project OZEAON, I have positioned an understanding of current technologies, along with some of the larger problems within society and the natural world to conceive of probable, plausible, possible and preferable futures:

Step 1 – Define a context for debate

- How can we sustainably develop innovations for health and wellbeing with the abundant resources from the ocean whilst regenerating the ecosystems of the world and generating new innovations and economic opportunities for society?
- In the present situation, we are faced with human-made climate change problems from sea level rise to ocean acidification and pollution etc. which all have negative flow on effects for health and wellbeing of society. It is possible that these problems become catastrophic, or remain at a worsening constant, or we could try to make a great change in the world for the benefit of all.

Step 2 – Ideate, find problems and create a scenario

- There is a possibility that in the worst-case scenario, we could see regular environmental catastrophes, causing overwhelming diseases and pandemics causing the eventual economic and social collapse of civilisation as we know it.
- The most probable scenario if we continue as we currently are, technology continues to rapidly advance, along with the worsening of the effects of climate change. Continuing to merely manage environmental catastrophes will lead to the poorest people of the world being affected the most, whilst the divide between rich and poor increases along with the instances of pandemics, only the ones who can afford the highly advanced cures for diseases will have access to them.
- The preferable scenario is one in which open education, science and innovation are shared by all, leading to a circular economy and social equality with sustainability and environmental regeneration at its core, disease prevention is widespread, and cures are available for everyone in the world.
- There is a plausible scenario where education, science and innovations increase sustainably within society, increasing equality, disease prevention and cures.

Step 3 – Materialise the scenario to provoke an audience

• Here I designed a flow chart mapping out Step 2 in four segments, Possible, Preferable, Plausable and Probable as seen below in figure 12.

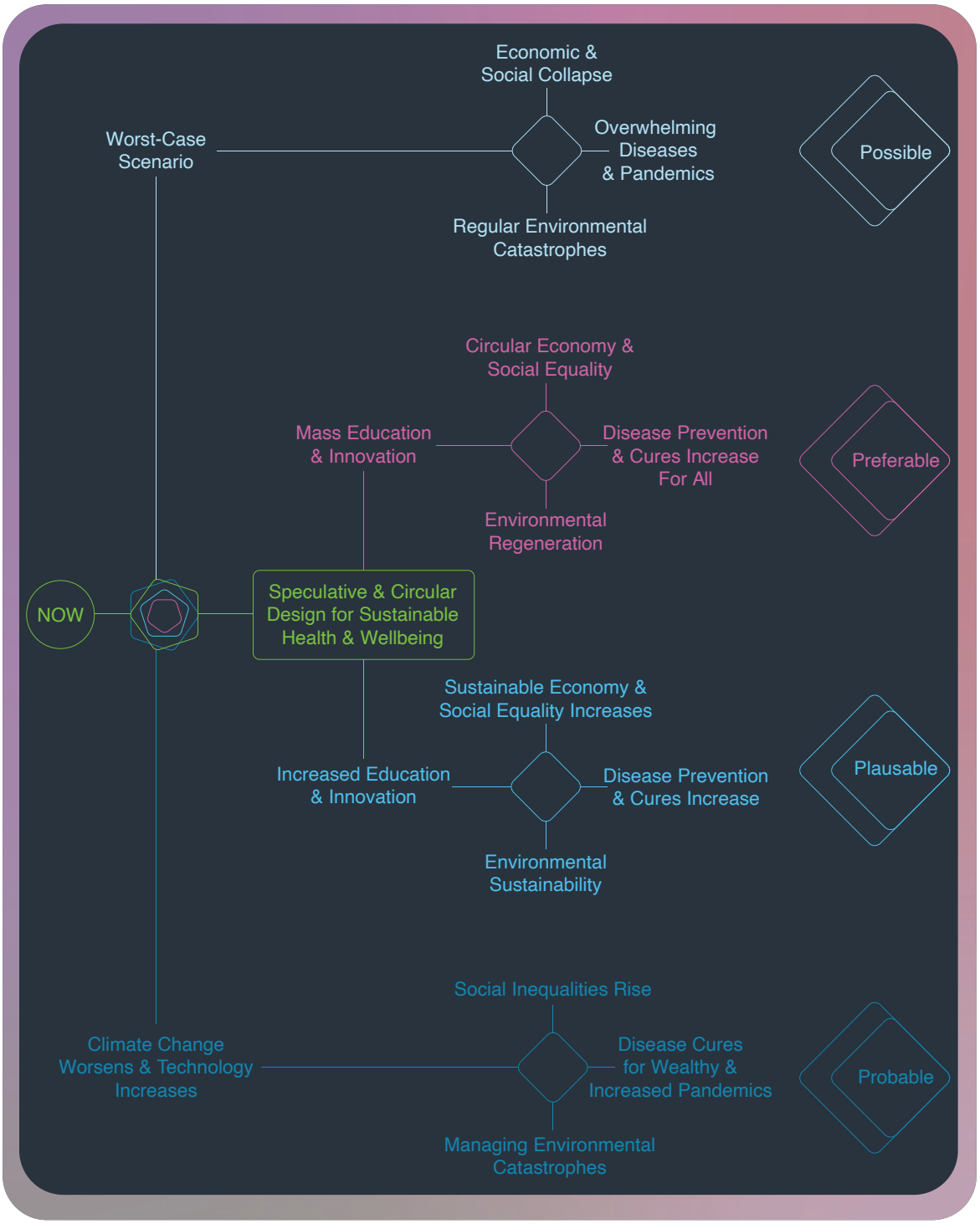

Figure 12. Materialise the scenario to provoke an audience

The next step is to figure out how my speculations regarding potential futures, with the hope of reaching the preferable outcome, might be achieved. The most immediately possible thing to do is to design an online platform that is possible to develop in the here and now that can help people to realise solutions to be achieved.

3.2.2. Visualising the Ideas - Brainstorming

What are the benefits of Ocean and Algae Research and Technologies?

In the process of ideating what exactly to design, I wanted to visualise some of the main categories could be for exploring in what benefits are already being realised from ocean and algae research and technologies. The most obvious categories according to my initial assumptions were Health-Care, Ecosystem Services, Food, Economy and Design. Some of the sub-categories that could be identified from Health-Care include biomaterials, bioprinting, medicine, supplements and cosmetics. Subcategories in Ecosystem Services include climate change, pollution, CO_2 sequestration and ecosystem recovery. Subcategories under Food include health foods, world hunger, sustainable produce, edible algae and new recipes. Subcategories in Economy include production industry, blue economy, sustainability and new markets. Subcategories under Design include circular economy, bio-materials, arts-based initiatives and collaboration.

Through the design research in the surveys these became and were organised into the categories I finally decided on as outlined in figure 13 below:

Figure 13. Visualising the categories for summarised articles

What do I want the platform to be able to do?

I wanted to design an open educational resource, that also offers funding options for users, along with collaboration on projects, with DIY tutorials, video and written content such as scientific articles to be able to be uploaded and shared by the users (figure 14).

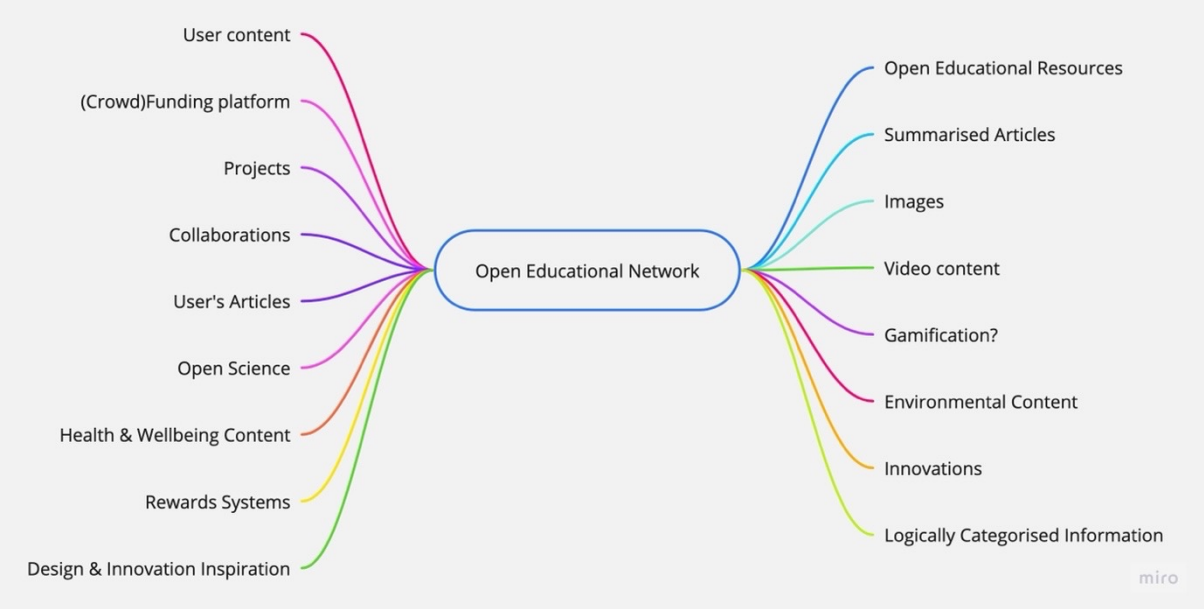

Figure 14. Brainstorming abilities of the platform

It could be called an open educational network, as the platform is not going to be designed to just display educational information but have some functionality for users to connect with each other to share research and ideas along with other kinds of content. This brainstorm includes a number of ideas for what could be included in the final design of the online platform.

Why a Web App?

In realising the idea to create an online open educational resource, I needed to realise what the best way of doing this would be, there were a few options such as a website, a mobile phone app or designing standalone application software. Finally, I decided on a web app based upon the survey results, which is an online application that runs on the internet through a web browser without needing to be downloaded or installed onto a user's device and can be accessed from anywhere if they have access to the internet and a way to browse the internet.

A website is a group of publicly accessible interlinked web page documents, that share a single domain name and can be accessed over the Internet (Rouse, 2020). A website can host any kind of information from photos of cats to information about bus schedules. A website is a good way of presenting an open

educational resource because it can be accessed from anywhere. The only problem is that a simple website does not allow for users to contribute or collaborate or have much functionality, a website merely displays information or content that a user can digest (figure 15).

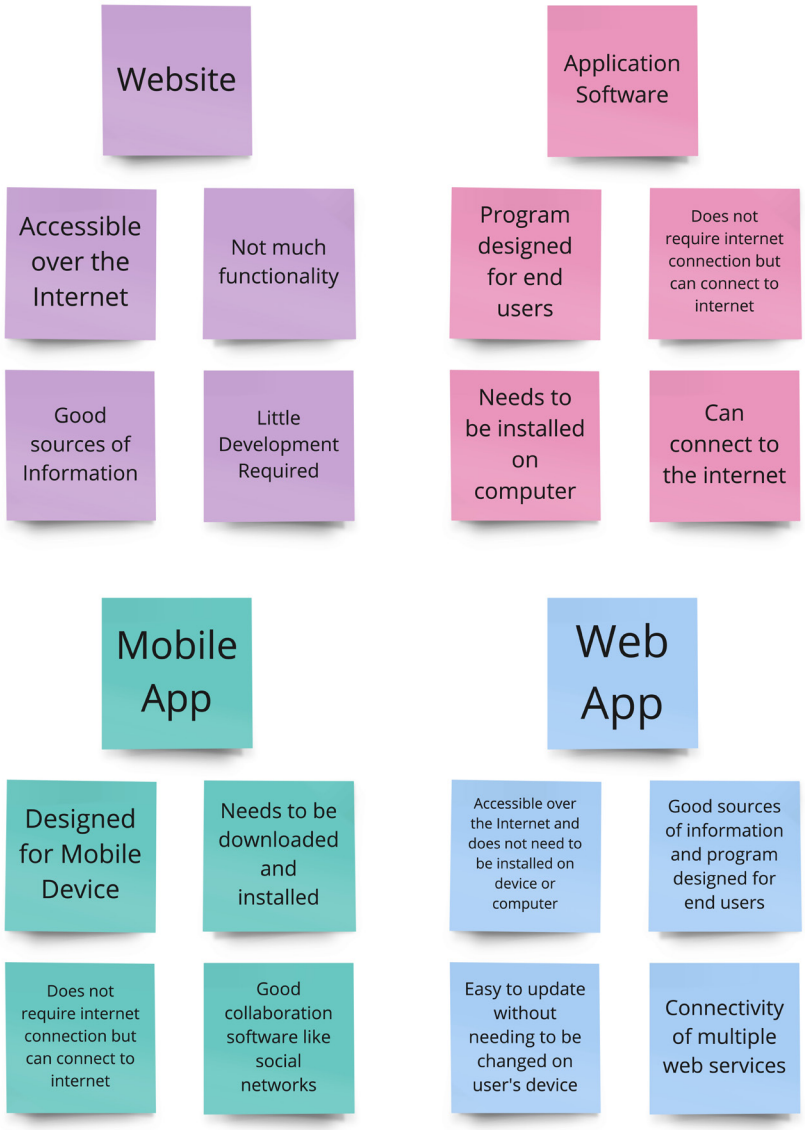

***Figure 15.** Comparison between a website, application software, a mobile app and a web app.*

A mobile application is software that is made to run on a mobile device such as a smart phone or tablet, commonly referred to as an app. Apps are generally small software units with limited capabilities which run on the device itself (Rouse, 2020).They can access the internet and can either be designed for a specific task like an alarm clock or a photo editor, or they can be a social network like Instagram or Facebook where users interact with each other and create content to share with other users of the app. An app needs to be downloaded and installed on the device itself, taking up memory space. A mobile application is a good

way for the users of a platform to collaborate and create content for sharing with each other, increasing the potential usability of an educational resource to provide a more dynamic learning environment where people can also share their own research and development.

Standalone application software is any program or number of programs designed for end users (Rouse, 2020). It is quite a broad term and includes any kind of program that runs on a computer system, like Microsoft Word or Adobe Photoshop. They don't require an internet connection to function and can also connect to the internet, whilst are designed to do a certain thing, like creating a written document or editing video. Application software could be a good way to create an educational platform but would need to be downloaded and installed on a computer, therefore may not be so accessible.

A web app is an application software that is not stored on a user's computer, but a remote server that can be accessed over the Internet through a web browser interface. Web services are defined as web apps but not all websites contain web apps (What Is Web Application?, n.d.). It became clear that designing a web app can provide the best functionality and accessibility due to the fact that it can be used on any device connected to the internet through a browser, and can be designed for best display on different screen sizes with break points for responsive design to fit easily onto a larger computer screen, a mobile or tablet device. The functionality of application software and a mobile application for users to be able to fully interact, create and share content with the accessibility of a website through a web browser, a web app is the best choice for designing the platform.

Together with a web app, using blockchain technology such as decentralized apps (dApps) along with the platform's own cryptocurrency, the funding abilities and financial incentives for using the platform can be enhanced along with the abilities of NFTs for people to share and trade research, designs, patents, artworks, designs and ideas etc. Focusing on Regenerative Finance and Decentralized Science, utilising the technology of dApps and running the platform as a Decentralized Autonomous Organization where users can decide and vote on what they want to see happening on the platform as described in a previous chapter.

The initial brainstorm for the website includes a quick layout for the concept of the webapp, being a website with application software that can work on both mobile and desktop browsers. With the main focus in the

middle for increasing sustainable development of ocean and algae research and technology, the webapp has two sides to it, the standard application software side with the Open Educational Resources, Projects, Articles, Videos and DIY Tutorials and the Decentralized App (dApp) side, with the DAO, ReFi and DeSci components (figure 16). The idea to incorporate NFTs into the system came later.

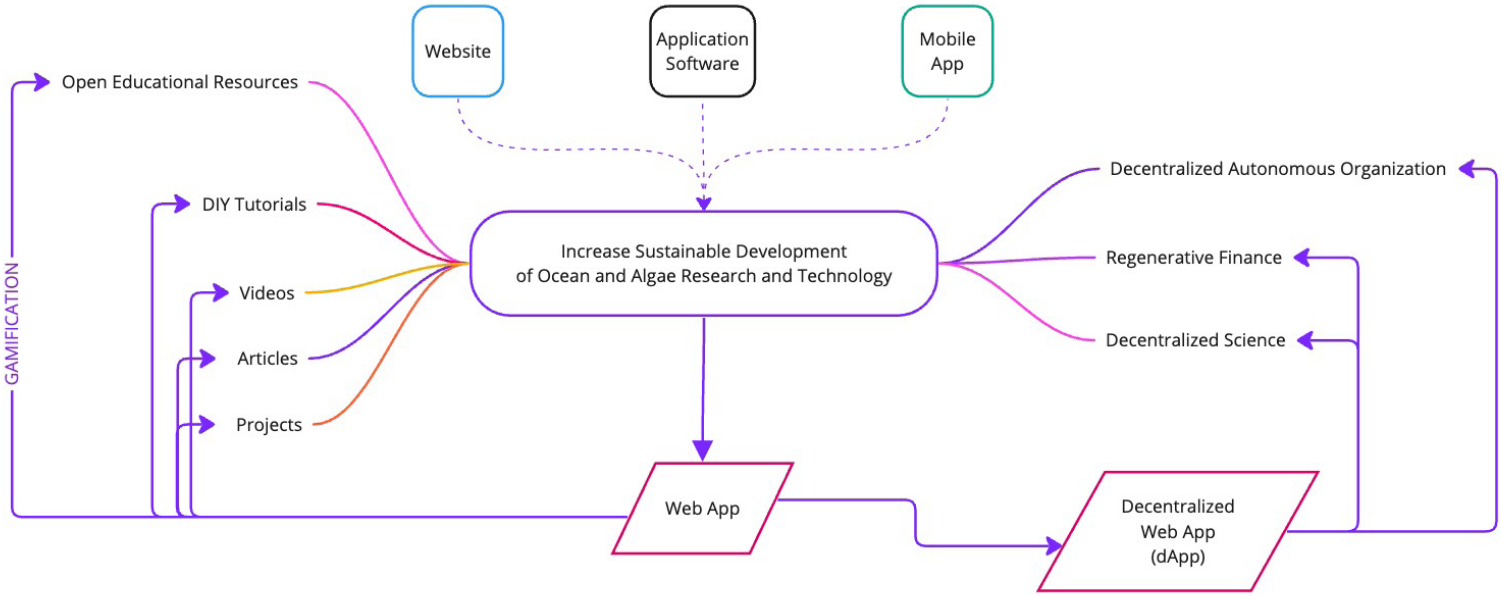

Figure 16. Brainstorm of the project as a Web App

3.2.3. Ideation & Design Development

Visual Identity

The name OZEAON is a mix of three words, Ocean, Ozone and Aeon. Ozone is a word correlated with the atmosphere thereby connected with climate change and environmental issues, and aeon is with the intention for a sustainable circular economic model that can last for literally an aeon, OZEAON was the name for the platform I decided on (figure 17).

Figure 17. OZEAON platform visual identity

Figure 18. Initial sketch of the logo (visual identity)

Figure 19. OZEAON as a mixture of Ocean, Ozone and Aeon

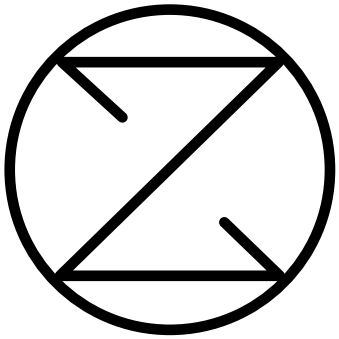

Figure 20. Spherical Logo (Letters O & Z)

This was my first sketch of what I imagined the design of the logo to look like. The name below and a Z in a circle, surrounded by Kelp seaweed (figure 18).

I then developed the Typography to be a bit more technological and simplistic. I wanted the letters to be more symbolic, with circles, triangles, infinity symbols and equal signs to suggest a blance between nature and humanity (figure 19).

And then, including the three words that make up the name with Ocean, Ozone, and Aeon (figure 19). The concept of this is to incorporate the idea of supporting civilisation for aeons to come through sustainability.

This logo also has the symbol of the hourglass (figure 20) as the sperical logo for the project. Interpreting that it is time to behave in accordance with nature. Also that if this is not understood and sustainable living is not achieved, then there is only some time before we have to fix it before the world fixes us.

I later realised that the spherical logo with a simpler Z inside an O could be confused with the Russian pro-war propaganda motif "Z" that first appeared on Russian tanks and military trucks amassing on Ukraine's border on the 19th of February, 2022 (Sauer, P., 2022, March 7). This was obviously no longer an appropriate form for the platform's logo and visual identity to be associated with, so I decided to change the form slightly.

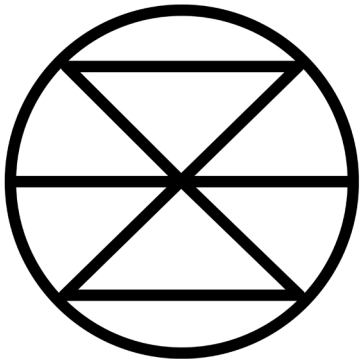

Figure 21. Sperical Logo Revised (visual identity)

Here in figure 21 I included the use of the E, which added a central line in the design and I also connected the end lines of the Z to make the hour glass more visible within the design. This form has some similarities to the Extinction Symbol (figure 22), created in 2011 by East London artist known as 'ESP', which is now the offical logo of the Extinction Rebellion (XR), a global social movement for climate action (Webster, C., 2019). This association with XR is a lot more appropriate for the platform, with the new design (figure 23) having 8 sections that are the same amount of categories the Open Educational Resourcess will finally have on the platform itself.

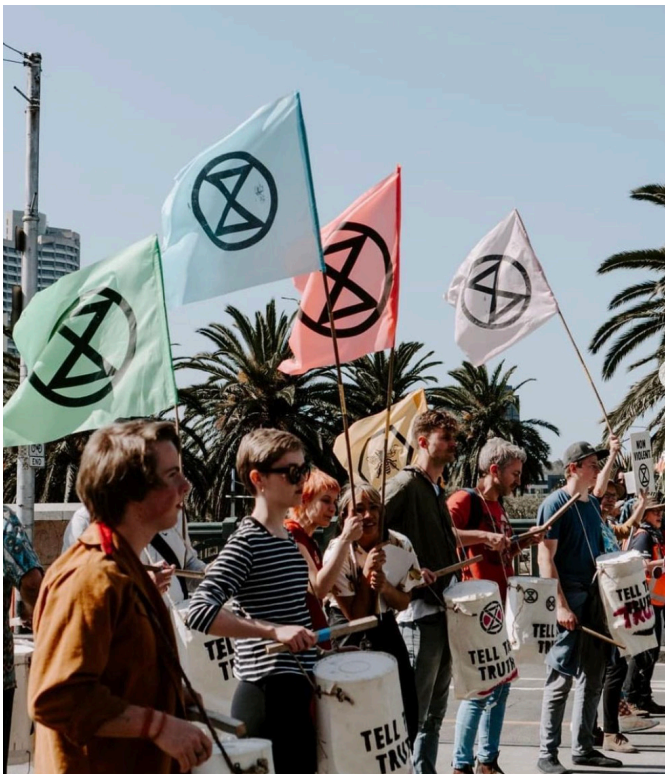

Figure 22. Extinction Rebellion Flags. Extinction Rebellion (XR), Photo by @gemmadawn

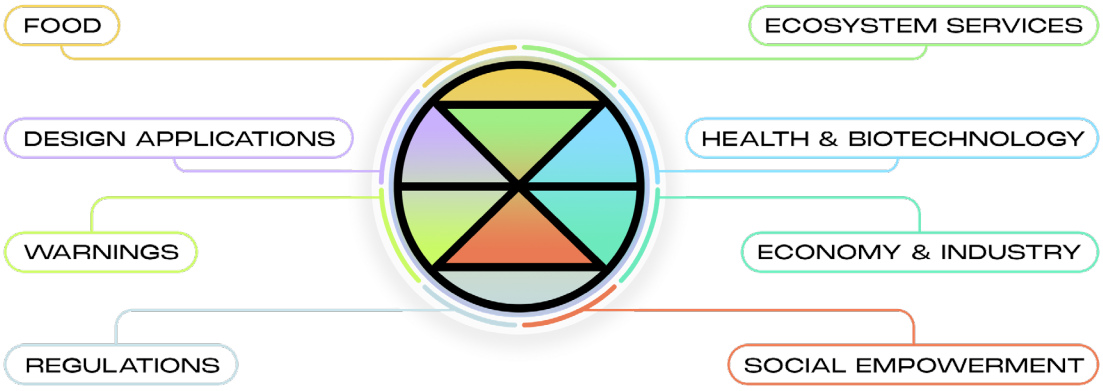

Figure 23. Sperical Logo Revised with OERs

Industry Hack

What inspirations can be taken from other industries and applied here?

- Creating a platform that can effectively act as an Open Educational Resource, with simplified summarised knowledge based on topics related to ocean and algae research, is a main component of the design concept. Organising the information into categories with simplified research will help to provide an easier understanding of the topics.
- Creating a Library of tutorials and recipes for people to use and contribute to in order to make it easy for people to learn how to develop sustainable products with regenerative materials. Not only using this for materials but health supplements and food recipes as well.
- Including crowdfunding abilities incorporated into the platform will allow users to be fully inspired to create new and beneficial projects, whether it be a volunteer group or research and development of a new scientific study or to launch a new sustainable product made from regenerative materials.
- Users should also be able to interact with each other on the platform, by forming groups and posting information on a notice board like a Facebook home screen.
- The ability for people to add video content to website would be greatly beneficial for not only the DIY tutorials, but also for sharing educational content or updates on their research and development.
- Contributing to the educational resources should be easily done with the use of a File uploader and a text editor as is used on OER Commons.
- Using the benefits similar to SCINET of a DAO can help to make funding, IP protection and collaboration easier for people around the world.
- Using blockchain and dApps with staking to develop no expense fundraising options for donations to volunteer groups or the recipient of the user's choice would make the platform a lot more effective for helping to develop real world outcomes.

Site Mapping

I further expanded the standard application side of the webapp in another site map as seen below in figure 24. Here we can see that idea is that the Open Educational Resources with each category and sub-categories feed into the user's ability to create Projects, Articles and DIY Tutorials, Videos and their Community News Feed, which then feed back into updating the OERs themselves, with the addition of Quizes and DAO.

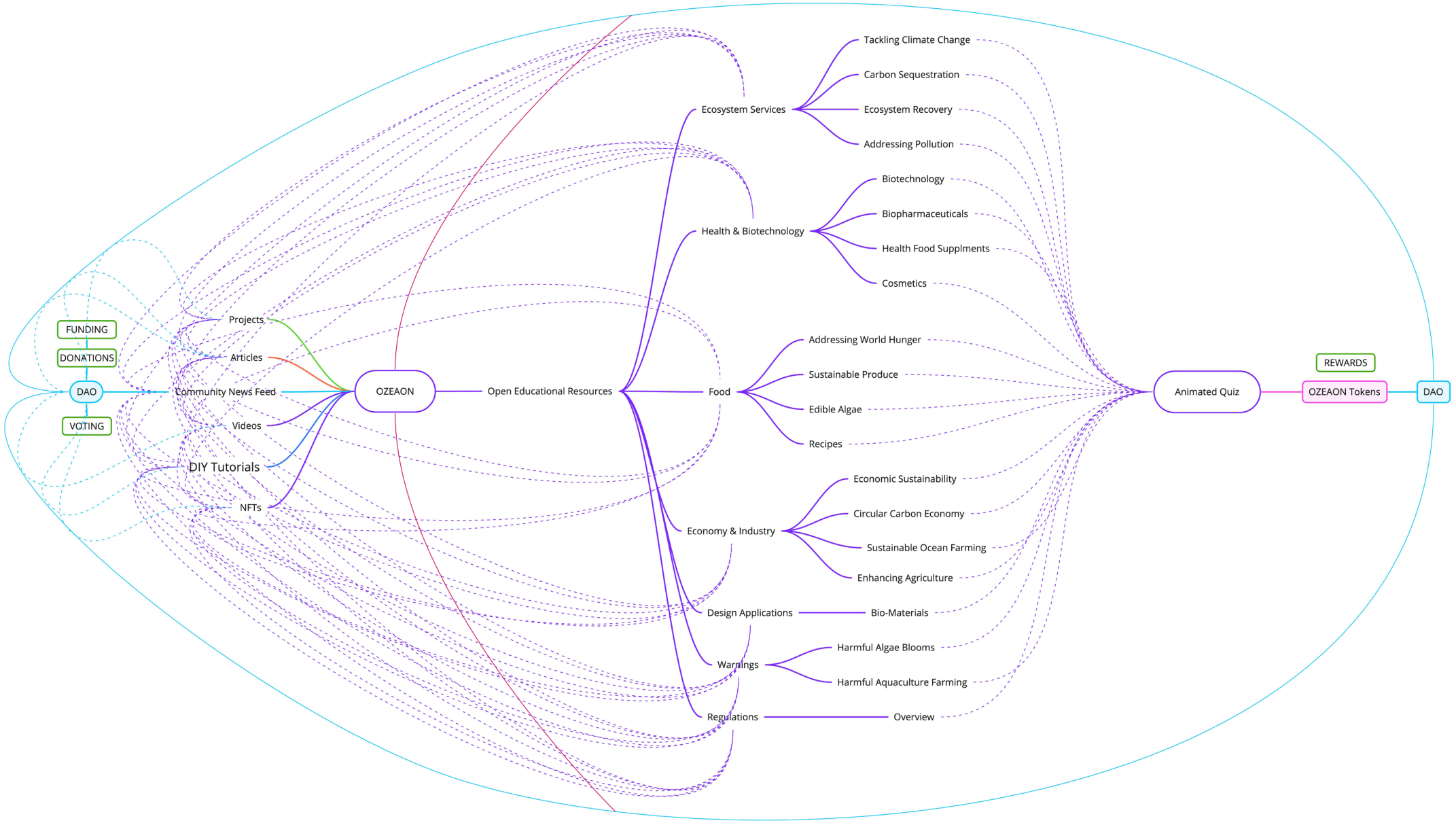

Figure 24. *Site Map of OZEAON Platform*

3.3. Wireframes & Low Fidelity Prototyping

My initial wireframing for the project was quite simple. It included a main landing page and pages for each of the main topics that I wanted to address in the Open Educational Resources such as Environmental Services, Health & Biotechnology, Food, Economy & Industry, Design Applications, Warnings and Regulations. These topics were ordered from most important to least important according to the answers from the surveys in a stylized list. Each category had their associated sub-category identified in a list beneath it as a drop-down menu. I went with a minimal approach for this design and began to map out the individual pages necessary for the application to function. A profile page for the individual user to keep track of their own work, and a home page listing all users' work. I identified three initial forms of interaction the user might take with the platform: Projects, Articles and at this stage I decided to add NFTs as they allow the ability to trade ideas, IP, patents, designs and artworks (etc.) with other users and track their origins in an immutable way. Along with a cryptocurrency wallet to monitor their funds and ability to incorporate the blockchain component with an explanation of the concept of the DAO in an about page.

Figure 25. Landing Page for the OERs

Here in figure 25 is the wireframing of the landing page for the OERs, with a list of the main categories that drop down on click to reveal a list of sub-categories under each main category. When a user clicks on the categories, they are taken to the page associated with each category.

Each main category here (figure 26) has its individual page for displaying their sub-categories as a basic set of cards that would link to that specific article. Below the cards are links to the other categories to select from.

In figure 27 we can see a landing page for the user side of the webapp, where a brief explanation of OZEAON is outlined, along with some examples of projects, how to connect to the DAO through cryptocurrency and some NFTs. Then there is a user's Profile page (figure 28), displaying their Projects, their Articles and their NFTs. A Home page was included where users

can see other user's Projects, NFTs and Articles. A settings page and a Wallet page (figure 30) for accounting their $OZEAON tokens. Also pages for users to be able to 'Create New' Projects, Articles and NFTs.

Figure 26. Environmental Services page

Figure 27. Landing Page for the DAO

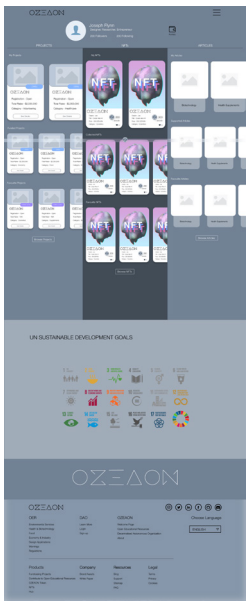

Figure 28. User Profile page

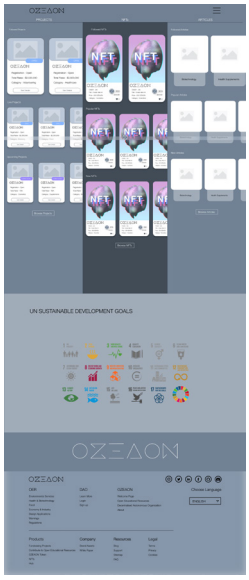

Figure 29. Home page

Figure 30. Wallet page

In my opinion this initial wireframe was somewhat unorganised and does not include everything I eventually wanted to include in the scope of the project like DIY Tutorials and Video content, but it gave a basic idea to work from and something I could share with potential users to get some feedback[23].

3.3.1. First Prototype User Testing

This initial wireframing was shared with many people, although I received minimal answers. I invited people by email to participate in the user testing who had previously agreed to further contact and user testing in the first two surveys. I personally believe it was not aesthetically pleasing enough to hold concentration or interest. Because the website itself is just some simple wireframes, the feedback was quite basic. I did also build a mobile version of this first prototype, although no one provided any feedback for that version.

The feedback I received from the user testing of this first prototype was minimal as the design was obviously more of a wireframe. There were no comments on the concept of the project itself but almost all were about too much repitition such as "I don't think the sections need to be repeated on each page for Environmental Services, Health and Biotechnology, Food, Economy & Industry, Design Applications, etc. It could cause the user to load the website slow trying to load in all the additional data." All comments made by participants can be found in appendice 4. The next prototype needed to be a lot more functionally sound with better design, that much was clear.

3.3.2. Informal Feedback & Lack There-of

It was concerning to receive so little feedback from the initial wireframing, so I decided to create personalized email questionnaires to get a more specific idea of what people are thinking about the project, it's concept and ideas. After extensively contacting thousands of people to help with the design research I received few willing participants and this was my main limitation in the study. It may also be quite possible that due to the continual controversies surrounding cryptocurrencies, potential feedback was withheld due to the possibility of respondent's opinions being negative towards blockchain technologies with the assumption that it is a merely an operator for greed. I cannot have fully known this as at this time, although there was some feedback indicative of this which I will further explore.

[23] https://xd.adobe.com/view/e13b7704-5210-45ef-85ec-6c03426409d6-b468/

In the questionnaire emails which were sent to people I knew personally each email was specific to the individual and what I knew of their understanding and skills. Most people did not actually respond again, which is likely because there is no reward or personal incentive for providing me with feedback and it takes time out of people's already busy schedules to do so.

I did receive two detailed answers which in which my concerns are addressed with answers provided at generous length. All emails I received for informal feedback can be found in appendice 5.

I found the answer from an American Software Developer whose main goal is to help "Effective Altruism (EA) Organizations and/or EA aligned organizations improve their ability to have positive impact on the world" to be quite insightful. He recognizes and likes that the platform is designed to "help grow the technologies, research and products produced with the technologies to help people". At the same time, he advises that there needs to be a lot more clarity surrounding the blockchain component and is "not sure that people will trust crypto enough to want to integrate with it due to the regular occurrence of crypto crashes and scams".

The answer I received from an Irish/Canadian United Nations (UN) Civil Servant of the World Health Organisation (WHO) describes in his motivations that "we need to change our behaviour as a species. That means adopting new ways of living to lessen the negative impact we are having on the planet. Our current way of living is destroying the planet." In asking what a sustainable world looks like he answered by referencing a story in The Bible about the sons who inherit talents, "Talents were money, back in those days, one talent was a 25-70kg ingot of metal. They had gold talents, silver talents, copper talents etc etc. One son got 100 talents and when he died he had none left. Another son got 100 talents and when he died he still had 100 talents. The other son got 100 talents and when he died he had 1,000 talents. The moral of the story is that people might manage resources responsibly but they might also squander what they have. Our goal should be to manage our limited resources in a responsible way. That is the essence of the SDGs of the UN."

When I asked him about his thoughts on blockchain technology he gave another answer being that "blockchain technology is like any other technology: the way you apply it determines success or failure. We know the technology is good and it works." In asking about his thoughts on DAOs and integrating it

into the platform as a way users can self-govern and manage the platform itself, he responded with "voting is an ancient way to manage our affairs. We run countries with the majority view. Minorities have to accept the will of the majority. That makes sense. It is the basis of democracy. If the majority of users within an ecosystem decide to turn left, and not turn right, then it would be arbitrary to turn right. The single force of higher voting power is "x" and "x" is the majority of the users, not one individual, or narrow group of individuals. However, when you look at the world today, you see that many individuals or small groups have seized power in order to benefit themselves, and not to benefit the majority of people."

It was clear from these answers that there is a keen interest in sustainability and being able to manage resources of the planet in a responsible way. The main concern is whether this can be achieved with blockchain technology coupled with a web application and if so, it needs to be very clear and applied in an ethical and sustainable way.

3.4. User Interface Design - Prototyping & Testing

3.4.1. Secondary Research

I wanted to develop the initial summarized articles for the Open Educational Resources to have in the next prototype of OZEAON. I did a lot of secondary research into the summarized articles that I wrote for the OERs based on the different categories identified in the user research from the second survey.

The following are introductory paragraphs to each summarized article I created through secondary research for each category and sub-category that I found relevant to include in the Open Educational Resources.

The following pages include the graphic design elements for the headers of the webpages to each summarised article (figures 28 - 33) along with a short extract from each of the topics I wrote summarised articles on, with some advice from my supervisor Teresa Mouga for the second prototype. In these articles I aimed for scientific accuracy whilst simplifying the information into easily digestable and fast reading. The full texts can be read in the second prototype[24].

[24] https:// xd.adobe.com/view/ae6f6b69-f726-4047-88f7-cd7a0e9353f3-fb3c/

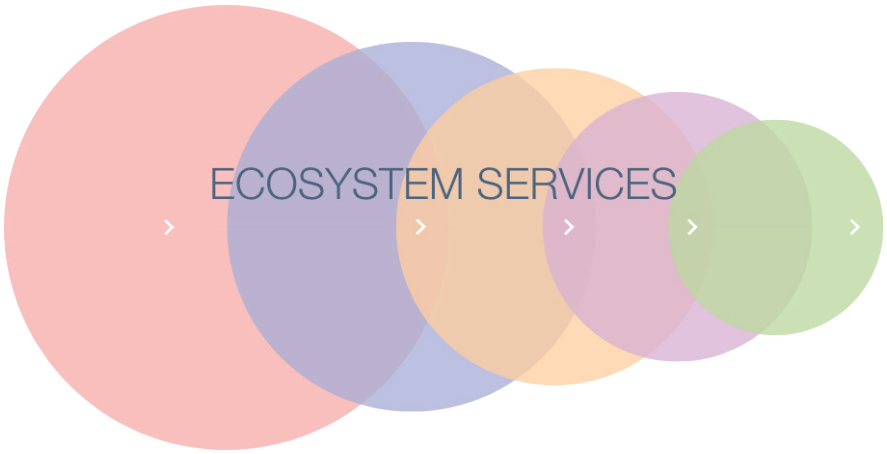

Figure 31. Ecosystem Services heading (Credits: Joseph Flynn)

Tackling Climate Change

With the projected effects of climate change on the rise, the future of our planet is looking bleak. The ocean plays a vital role in regulating our planet's temperature and maintaining balance. However, with the increasing impact of carbon and other emissions that already has a significant impact on most forms of life on the planet, including humans, we can try to find new ways to manage the delicate balance of life on Earth (Poloczanska et al., 2013).

Carbon Sequestration

By absorbing and sequestering carbon dioxide from the atmosphere, the global oceans play a critical role in modulating climate change (Regaudie-de-Gioux et al., 2014). The scientific community has been awakening to the idea of "carbon neutral" or "net-zero" societies, also known as a carbon neutral world for some time now (Chen et al., 2022). After all, carbon dioxide is an invisible yet extremely potent greenhouse gas with the potential to warm our planet in lasting and damaging ways.

Ecosystem Recovery

Oceans and seas cover more than 70% of the Earth, supplying us with food, regulating our climate, and producing the oxygen we breathe. Oceans are critical to key economic sectors such as tourism and fishing, as well as providing habitats from whales to bacteria and viruses, with all the other forms of biodiversity (Gentry et al., 2020).

Addressing Pollution

Pollution of the oceans is widespread, worsening, and poorly controlled in most countries. It consists of toxic metals, plastics, manufactured chemicals, petroleum, urban and industrial waste, pesticides, antibiotics, fertilizers, agricultural runoff, ballast water, along with pharmaceutical chemicals and sewage (Bennett et al., 2023).

Figure 32. Health & Biotechnology heading (Credits: Joseph Flynn)

Biomaterials

The last decade has seen an increasing number of biomaterials produced from marine organisms, with the science behind new biomaterials developing rapidly and ranging from coralline bone grafts to polysaccharide-based biomaterials. Algae have garnered significant attention as they can be used to produce biomaterials with unique properties and numerous applications because of their substantial yields, fast development times, and flexible growing conditions (Wan et al., 2021).

Biopharmaceuticals

Several stages of discovery and development have taken place in the field of marine biopharmaceuticals (Anjum et al., 2017). These include the discovery and development of chitin and chitosan, marine collagen, and composite materials composed of marine organisms (Wan et al., 2021).

Health Food Supplements

Marine derived substances have frequently been used as ingredients, preservatives, and packaging materials in the food industry. Due to the surge in interest from consumers seeking health promotion food items in the last decade, marine-derived ingredients have been highlighted for their health-promoting effects (Ku et al., 2013).

Cosmetics

The use of marine-derived biomaterials in cosmeceuticals is gaining popularity. Cosmetic companies have recently focused on combining cosmeceuticals with marine-derived bioactive ingredients. These materials are simple to get and are excellent in terms of biocompatibility, biodegradation, and bioactive characteristics because they are abundantly available and reasonably priced (Sotelo et al., 2021).

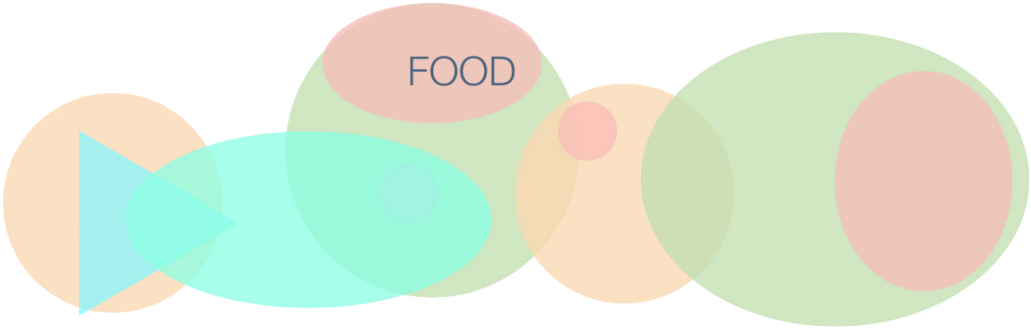

Figure 33. Food heading (Credits: Joseph Flynn)

Addressing World Hunger

The number of people who suffer from hunger had been declining for decades as measured by the pervasiveness of malnutrition, although started to slowly increase again in 2015. Up to 783 million people are hungry, consisting almost 10% of the global population (World Food Programme, n.d.). This is an increase of nearly 60 million in five years. The world is not on track to achieve Zero Hunger by 2030. If recent trends continue, the amount of people affected by hunger could increase to 840 million by 2030. Increasing sustainable food production and agricultural activity is necessary to lessen the perils of hunger (The State of Food Security and Nutrition in the World, 2021).

Sustainable Produce

Improving agricultural productivity and sustainable food production are crucial steps towards reducing world hunger. With better management of wild marine fisheries and marine aquaculture (mariculture), production from the ocean could increase sixfold, providing more than two-thirds of the protein needed to feed a population of almost 10 billion people in 2050. It can also be done in conjunction with efforts to restore ocean ecosystems (Packer et al., 2016).

Edible Algae

Edible algae is a great source of nutrients and vitamins. It's also full of healthy fats, amino acids, minerals, and more. There are many health benefits to eating edible algae, including reducing the risk of heart disease and improving skin conditions like acne, eczema, and psoriasis. Edible algae is found in almost every corner of the world. It grows in lakes, rivers, streams, and even oceans. Many people might think that algae is something unappealing that grows on stagnant water or rotting logs. However, there are many types of edible algae that can be incorporated into your diet as a superfood (Pereira, 2016).

Algae Recipes

I included several cooking recipes in the prototype for incorporating algae into the user's diet.

Figure 34. Economy & Industry heading (Credits: Joseph Flynn)

Economic Sustainability

The oceans play a vital role in sustaining the environment and economy in the face of rising demand for resources, as the link between food, water, and energy consumption grows. In addition to being an irreplaceable part of the earth's ecosystem, oceans have an undervalued economic value as a result of their unique biodiversity. To sustain economic development, the oceans must be managed sustainably through initiatives in shipping, transit, manufacturing, fisheries, tourism, and marine biotechnology, among other things. Despite the fact that the blue economy has been identified as a new economic opportunity, investment from existing industries is limited and emerging industries are little known, more scientific research and understanding is required for development (Stuchtey et al., 2020).

Circular Carbon Economy

Climate objectives, such as those outlined in the Paris Agreement, will almost certainly be impossible to achieve unless all options to reduce Green House Gasses are pursued, and experts concur. In the ensuing century, hydrocarbons will be a major source of energy that helps the world achieve carbon balance, net-zero emissions, or carbon neutrality. However, the resulting carbon emissions must be controlled. The circular carbon economy, a variation on the circular economy concept, is a helpful framework for comprehending how alternative carbon management options interact to achieve climate objectives (Shehri et al., 2023).

Sustainable Ocean Farming

The world has reached a stage in which everything needs to be eco-friendly and sustainable. This is the need of the hour, as our planet is grappling with several environmental issues such as climate change, deforestation, water scarcity and so on. To tackle these problems effectively, there is a surge in the demand for industries that are eco-friendly and sustainable (Costello et al., 2020).

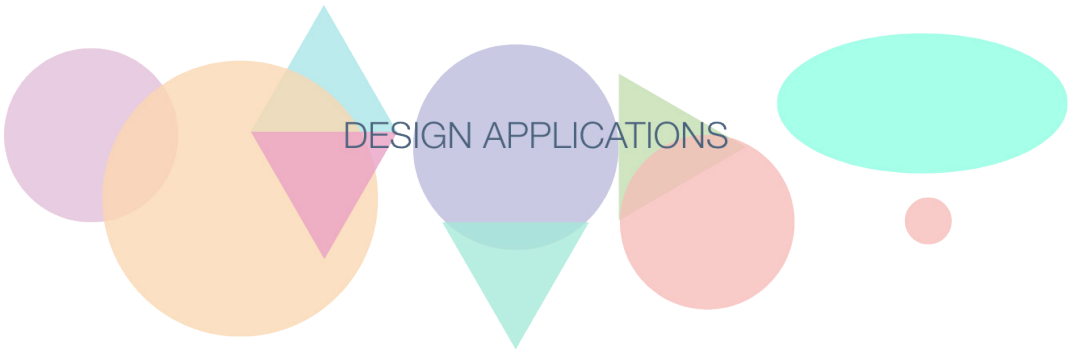

Figure 35. Design Applications heading (Credits: Joseph Flynn)

Bio-Materials

There has been much talk recently about how design will play a crucial role in the future by inspiring the development of sustainable bio-based materials (Tardy, 2023). The partnership between design and the research and development of bio-alternatives to synthetic materials, which is evident in the world of design, suggests a promising future for biomaterials (Bell et al., 2022).

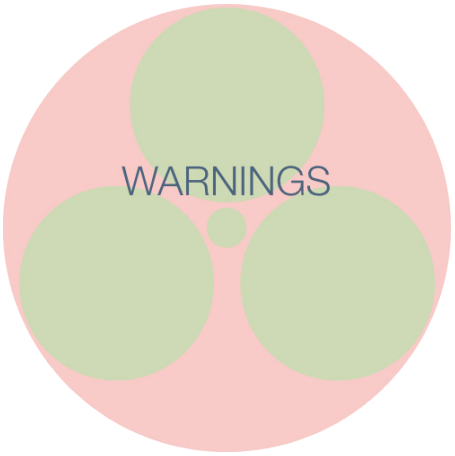

Figure 36. Warnings heading (Credits: Joseph Flynn)

Harmful Algae Blooms

Harmful algal blooms or HABs, happen when colonies of microalgae or macroalgae grow out of control, thereby creating toxic or harmful effects on people, marine animals, birds, shellfish and fish. Illness in humans can range from debilitating to even fatal, although this is rare (Gobler, 2020).

Harmful Aquaculture Farming

Historically, certain issues impeded the aquaculture industry from producing fish in a sustainable manner. The aim of fish farming was never to harm the environment, but to increase food security. However, environmental problems did occur. There was no lack of damaging press, and it has stayed with the public ever since (Barreto et al., 2022).

Figure 37. Regulations heading (Credits: Joseph Flynn)

Overview

In the seventeenth century, the notion of freedom of the seas was first advanced, which limited nations' rights and jurisdiction over the seas to a narrow belt of sea near their coastlines. Outside of these waters, the seas were considered open to all and owned by none. This situation lasted into the twentieth century, but by the middle of the century, there was an urge to extend national claims over offshore resources (Oceans and the Law of the Sea, n.d.).

3.4.2. Second Prototype

The second prototype for the project was a lot more resolved and I tried to include everything I possibly could into it for the platform to function, apart from the DAO tools for governance. Included were the written OERs, with a cleaner and brighter design, a resolved landing page with descriptions for what the application can do, an about page with brief descriptions for the platform, and user pages such as Profile, Home and associated News Feed, Projects, Articles, Watch (for videos), DIY and NFTs. I also created a wallet page, settings and content creation tools for each category of action the user can choose to make in interacting with the webapp. In total there were 82 screens for this prototype[25].

I included two menu options for this design, with one being on the left with the OZEAON logo as clickable revealing quick navigational links to the OERs, the DAO, About, Seach and an option to change

[25] https:// xd.adobe.com/view/ae6f6b69-f726-4047-88f7-cd7a0e9353f3-fb3c/

the language. On the right were navigational links to quickly access the Home, Profile, Projects, Articles, Videos, DIY Tutorials, NFTs pages and a Log in / Log out option. The footer included shortcut links to the OERs, the DAO, informational pages about OZEAN, and social media links along with an option to change the language. I tried to make each page have easily accessible options to get to any page of the webapp quickly without the user getting lost.

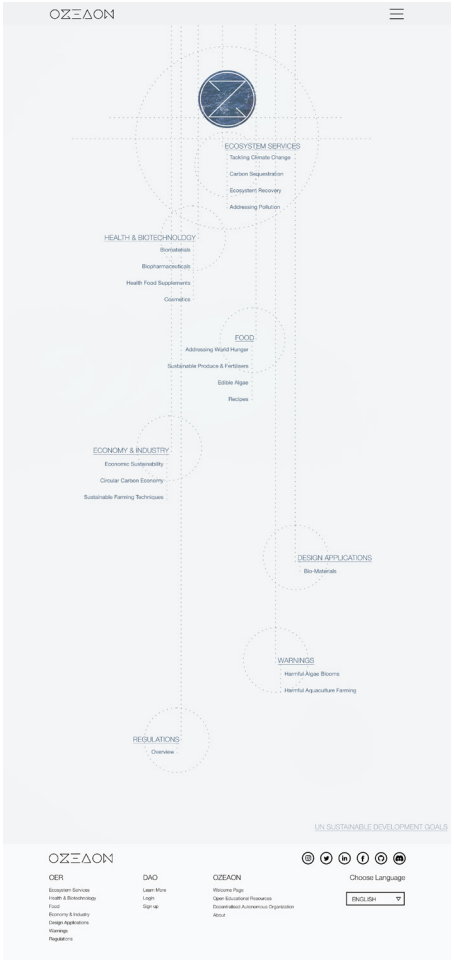

Figure 38. Landing page for the OERs

Figure 39. UNSDG page

Here the design and layout of the landing page for the OERs (figure 38) are quite similar to the previous design, with an added page for the United Nations Sustainable Development Goals (figure 39) and an About page (figure 40).

The layout of the user's platform, where they can sign in, access their Profile and Home pages along with the My Feed, Projects, Articles, Watch, DIY and NFT pages along with basic examples of how they can create content for the website in each category. In the Create New pages (figure 41), a user can include the necessary components of what is needed for each type of content they want to create along with associated category tags in line with the categories and sub-categories of the OERs.

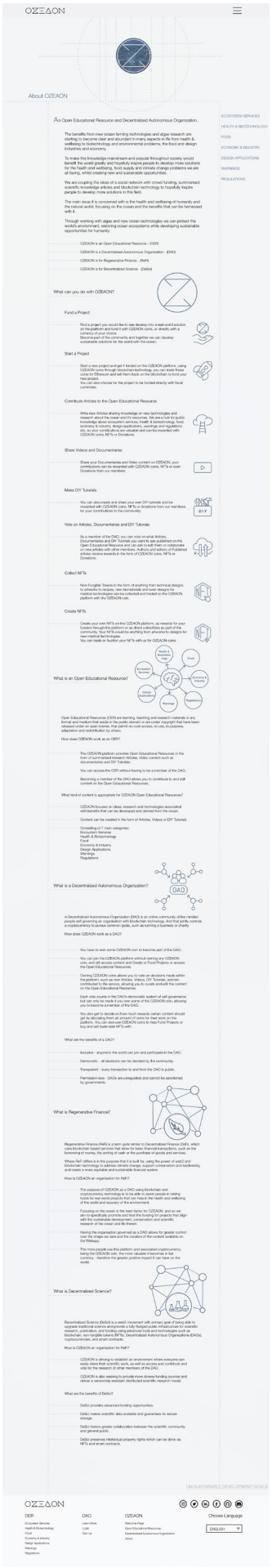

Figure 40. About page

I also created example pages for a Project, an Article, a Video and a DIY Tutorial to show how it would look to the end user after creation on the platform. These included options for funding or donations, voting for the content, favourite and share buttons. I included an option to “create new” on as many pages I thought I could fit it, to always have the option for the user to produce new content on the platform. There are also Settings and Wallet pages where the user can edit their profile and manage their $OZEAON tokens for the DAO, receive funding & donations, and check their balance. To me it felt like this design was a lot more resolved and had some interesting example content for potential users to be able to test.

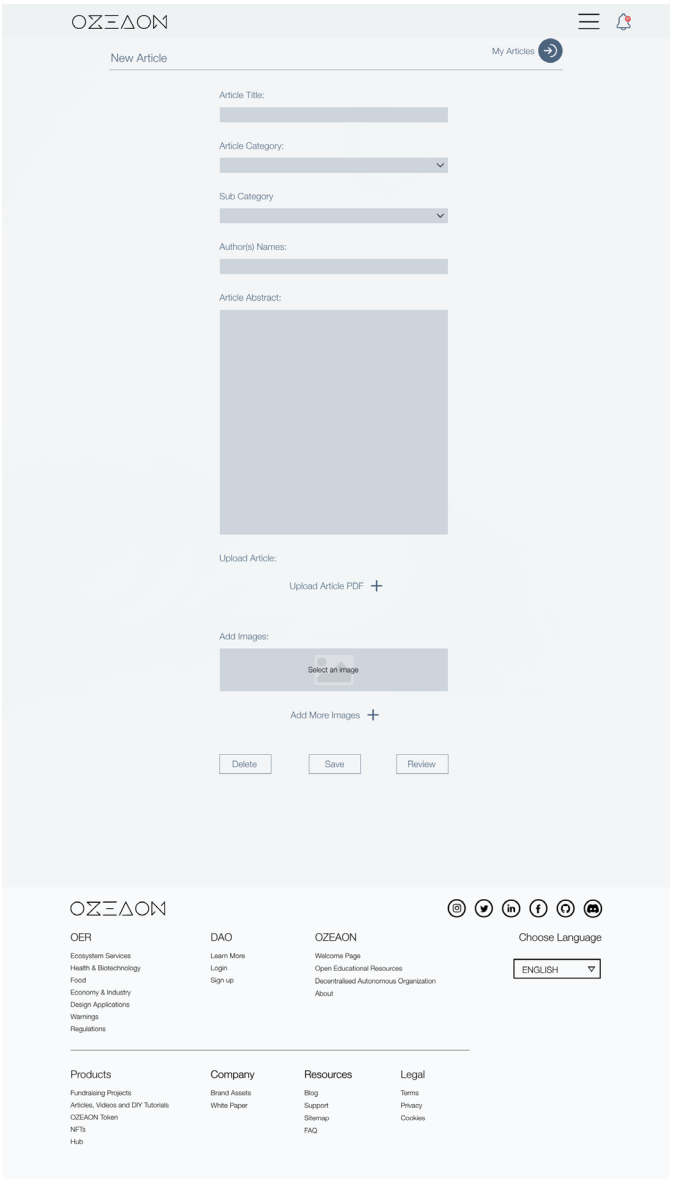

Figure 41. Create New Article page

3.4.3. Usability tests & Feedback

For the user testing of the second prototype I created a three part questionnaire along with a short video of how to use the Adobe XD user testing application to navigate through the webapp design easily. I also conducted usability testing employing the System Usability Scale (SUS). The SUS is a tool for measuring the usability of an application by a 10-item questionnaire that each have 5 answer options from Strongly agree to Strongly disagree (Brooke, n.d.). In this scale it is only necessary to have 5 participants. This was distributed in the form of a survey to as many people as I could and received this time 17, which is an improvement from the previous user testing. The full results can be found in appendice 6.

Main Results

The demographic of participants were 58.8% female between the ages of 21 and 64 whose occupations ranged from students to professors, researchers, investors, marine biologists, industrial and software engineers, a retailer along with a United Nations civil servant. Their nationalities were geographically broad from Russian, Indian Chinese, North American and Irish, Brazilian to New Zealand and Australian, but most were from Portugal. With various hobbies like sailing and diving, effective altruism, music, art, science, sports, volunteering, gardening, learning, reading, film and travel.

I asked the participants to list their goals and frustrations, to which some of the replies I found relevant were "excellence in scientific teaching and learning", "research, conservation and cultivation of macroalgae and their properties", "to help spearhead great engineering solutions to issues that exist both inside and outside green revolution" and "invest in impactful organizations". Some frustrations include "the lack of interest and trust of people in the science", "tragedy of the commons. Overfishing, excessive use of fossil fuels, lack of international cohesion and monitoring" and "limited progress, minimal collaboration from all regions of the world, constant degradation of oceanic environment" among others. So these are people who have real interest in the research and the design of the project itself.

3x Scenarios

- **1** I had the participants follow three scenarios, the first one being "Layout of Welcome Page to the Educational Resource" where I asked them to start from the landing page and explore the different options for the educational resource and navigate through them. Questions were posed on a scale from 1 (not at all) to 5 (very much so). 35.3% found it easy to navigate through the information

and find what topics they were interested in at a 5, with equal 29.4% marking a 3 and 4, followed by a 5.9% marking 2. 47.1% of participants found the information relevant and useful marking a 5, 23.5% at 4 and 29.4% marking 3. So most people answered that it was easy to navigate and thought the information was relevant and useful to them.

There were mixed but mainly positive answers regarding the aesthetic of the design and structure of the pages, with the most significant answer being "The website is visually very pleasing, and once one is familiar with the site it becomes easier to navigate, however there is a significant learning curve. The concept of a decentralised crowd funding website running on blockchain tech is innovative, futuristic and begs the question - could this be applied to broader areas of business and research other than the ocean algae?".

• **2** In the second scenario, "Layout of the Home Page of the DAO and Navigation" I asked them to find their way to the DAO home page and explore the different options, menus, options and pages. 35.3% said that the menus and layout were easy to find and access, marked by a 5 on the scale. 23.5% marked a 4, and 41.2% marked this with a 3. 41.1% found it simple and easy to navigate to the different main pages, being Home, Profile, Portfolio, Projects, Articles, DIY Tutorials etc. by marking a 5. 17.6% marked this with a 4, and 35.5% marked 3. Most participants found the menus and layout a bit more confusing than I had anticipated, whilst navigating to different pages was found to be simple and easy.

This prototype was still functionally and aesthetically unresolved so some of the recommendations were "I am not a visual artist however the design of the pages is clean and uncluttered and makes it easier to concentrate on the message instead of a lot of distracting images", "Needs to work on iPhones" and "one page clearly states whats going on thats good". There was some confusion over the layout for some users, which is very important to know for working on a better design next.

• **3** The third scenario, "Navigating the Usability of the DAO" is where I asked participants to try to create a project, an article and an NFT as laid out in the prototype, and to read the about page for the DAO to see if they could gain a clear understanding of its purpose. In understanding the purpose of the DAO, 35.3% marked this with a 5, an equal 29.4% marked 4 and 3, with 5.9% marking

a 1. Finding and accessing options for creating a new project, article or video etc. was found to be simple and clear by 52.9% of participants, answering with a 5, 17.6% were equally marked for 4 and 3, with 5.9% equally marking 2 and 1. The participants found it easy to understand the DAO and access options for using the app as intended.

Recommendations from participants

I asked for the participants' further recommendations regarding the DAO component, to which I received mixed answers with a lot of questions over the need for utilising blockchain technology, what actually is DeSci & ReFi. Such as "DeSci also faces the problem of having a proper Peer-Review System" and how these can these "projects be protected against cryptocurrency speculators that are often associated with leading to crypto crashes?" Questions about having the structure of a DAO integrated into the platform, with concerns over user adoption hurdles for onboarding with cryptocurrency assets were also quite valid and interesting, suggestions that more understanding will be needed.

There was one particularly damning answer that I received regarding the project where the respondent's "issues lie primarily with not how this information is presented, but with the premise of the project itself and the incentives provided by the use of cryptocurrencies and NFTs, among others." He described the project as "remarkably vague and obtuse" and "primarily self-serving, interested in attracting investment not because of its scientific goals, but for maximum profitability within the system", ending with "the project's description is a deceptive lie."

Of course, it is good to receive such passionate feedback, although I don't think this respondent was referring to this project in particular, but opinions he has formed from recent scandals and fraud of other cryptocurrency projects. Because OZEAON does not exist as a business so there is no evidence for these concerns and in no way is there any intention for these problems to be a part of the design.

System Usability Scale

The scores from the answers from the SUS are calculated to reach up to a score in a range of 0 to 100 in accordance with yielding a single number indicating a combined measure of the overall usability of the platform being tested. Each individual answer is calculated then an average of all user's scores is calculated together to reach the final SUS score (Brooke, n.d.).

The total average of the scores being the final SUS score came to 72.2 from 17 individual answers, with a standard deviation of 21.23. This should not be considered as a percentile although can be communicated as such through the method Jeff Sauro recommends for interpreting the score and understanding the Net Promoter Score (NPS) which designates three classes based on their answers, Passives, and Detractors. (Sauro, J., 2018).

Grade	SUS	Percentile Range	Adjective	Acceptable	NPS
A+	84.1 - 100	96 - 100	Best Imaginable	Acceptable	Promoter
A	80.8 - 84.0	90 - 95	Excellent	Acceptable	Promoter
A-	78.9 - 80.7	85 - 89		Acceptable	Promoter
B+	77.2 - 77.8	80 - 84		Acceptable	Passive
B	74.1 - 77.1	70 - 79		Acceptable	Passive
B-	72.6 - 74.0	65 - 69		Acceptable	Passive
C+	71.1 - 72.5	60 - 64	Good	Acceptable	Passive
C	65.0 - 71.0	41 - 59		Marginal	Passive
C-	62.7 - 64.9	35 - 40		Marginal	Passive
D	51.7 - 62.6	15 - 34	OK	Marginal	Detractor

Table 3. *Percentiles, grades, adjectives, and NPS categories to describe raw SUS scores.*

Using this method, the score of 72.2 comes in at close to 64% on the percentile range with a grade of C+, an adjective of Good, and an Acceptable score with a NPS of Passive. From this I can understand that this prototype is not yet fully resolved and requires further work, considering the recommendations made by the participants, such as being optimised for mobile.

4

HIGH FIDELITY PROTOTYPING

MOBILE APPLICATION DESIGN

DEVELOPMENT ANALYSIS

4.1. Mobile Application Design

Following this second prototype, I did recognise that there should be more importance focused on the webapp being aligned to a mobile application. I then decided to study web development at this time so I can understand how to develop the webapp and find better ways in which to design it that are more aligned with the logic of computer science itself. The aesthetic was further refined in line with best practices for mobile application design, gaining inspiration from some of the most popular platforms such as Facebook and Instagram mobile applications.

I then created a new refreshed style based on what I had learnt from the first two prototypes and user testing, focusing on the platform being a mobile application[26]. I organised this into three main areas. The Open Educational Resources and ability for users to browse through all publicly viewable content and use the application without having signed up (figure 42). I changed the layout of the list of categories and summarised articles for the purpose of easier navigation through the OERs as well and created an area for organisations, so that already existing organisations and companies can use the platform not only as individuals but to create organisational content for individual users to be able to easily collaborate.

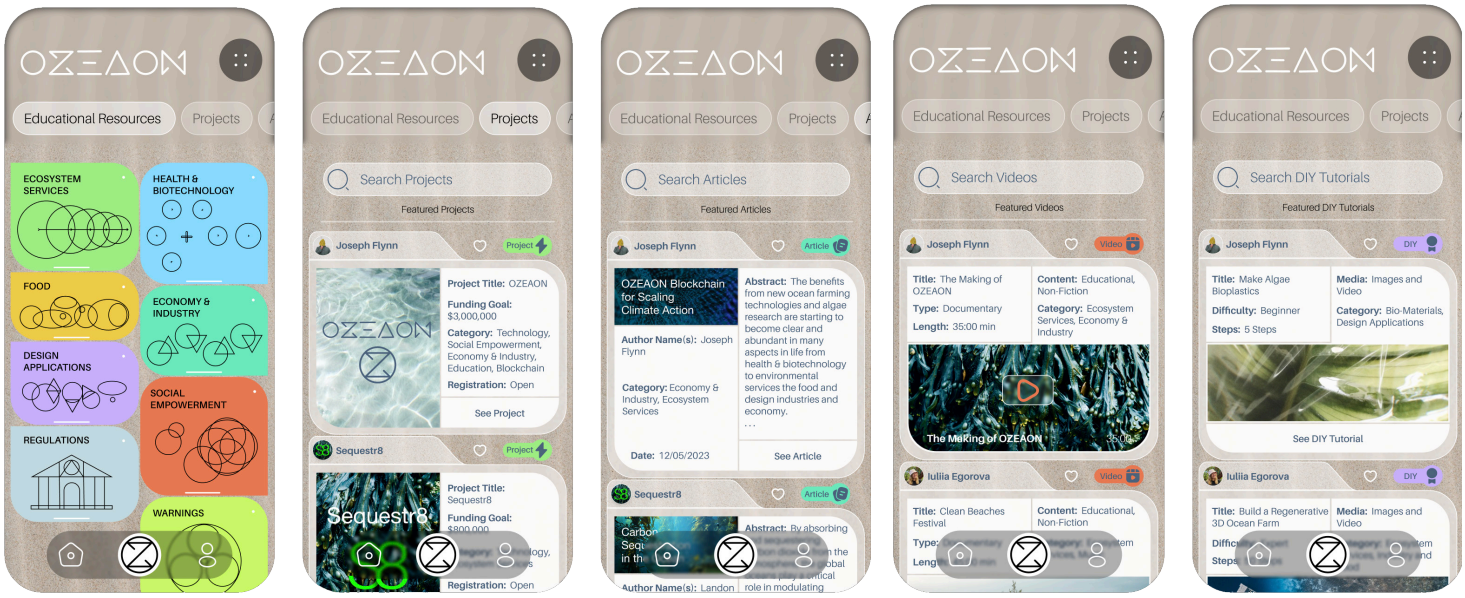

Figure 42. Mobile Application - Public's view of OERs and User Created Content

A Profile area where users can view the posts they make for the Home news feed and they can create new post updates on their work and create new content for the platform including Projects, Articles, Videos, DIY Tutorials, NFTs, and access the Organisations they are members of (figure 43). A Wallet area featuring their $OZEAON balance along with what Projects they have funded and donations they have given and received.

[26] https://www.figma.com/file/CR8Vvnprk38VpCU1vzsA7l/OZEAON-App-Light-Final?type=design&node-id=0%3A1&-mode=design&t=evD299wC5UrqodsT-1

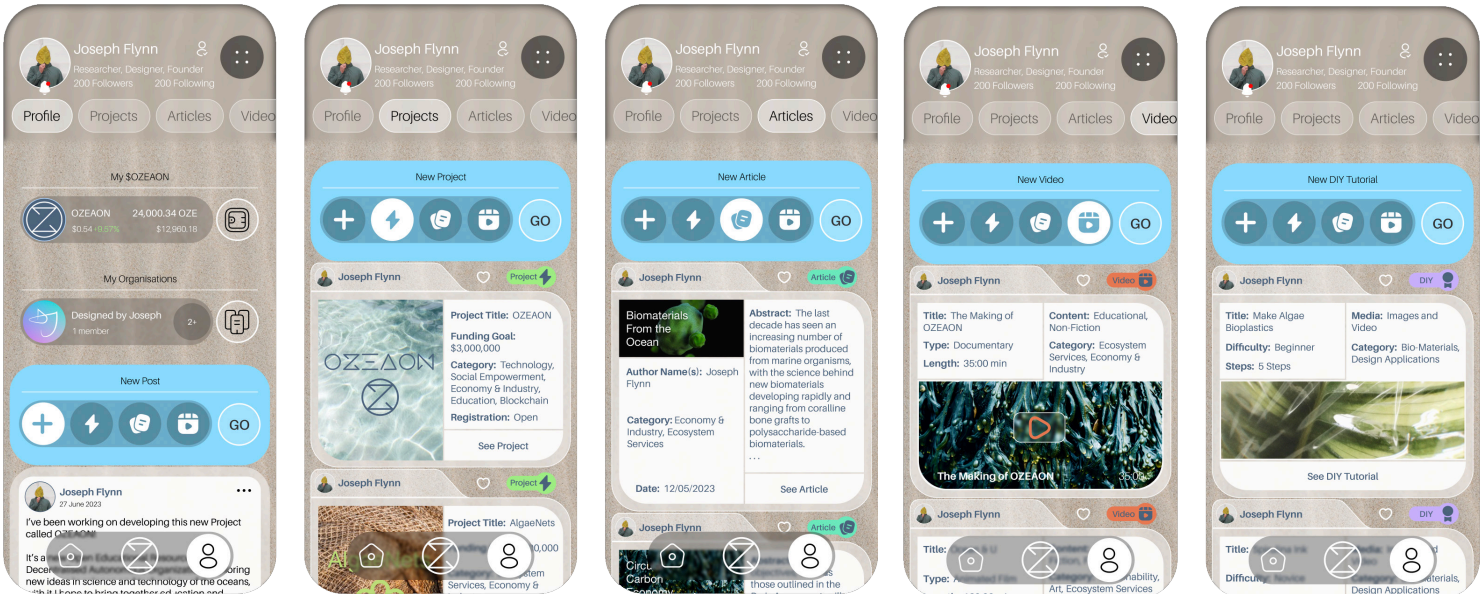

Figure 43. Mobile Application - User's Profile view

The Home area where only the other users that one specifically follows can be viewed and commented on, as well as organised lists of saved through favouriting of other user's Projects, Articles, Videos, DIY Tutorials and NFTs (figure 44).

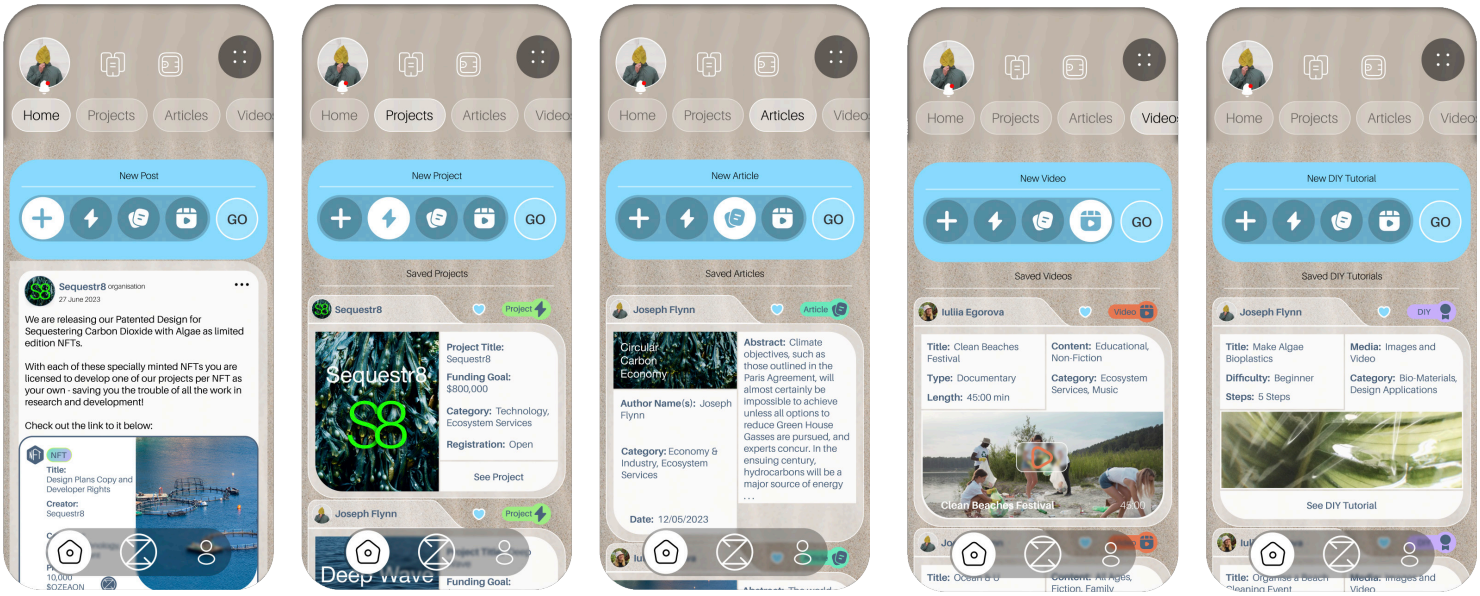

Figure 44. Mobile Application - User's Home Feed view

This design is very well resolved in my opinion for a mobile application, and I will need to also re-design the desktop application to aesthetically mimic the mobile version. This will require some final user testing before going into development and further experimentation with the graphic design along with a desktop version, but I personally feel as though it is quite a good point from which to begin development.

4.2. Development Analysis

With an understanding of Object-Oriented Programming (OOP) and the Model View Controller (MVC) framework in web development that I gained from learning to code helped to better identify and organise each different ways in which the platform should function for best performance. Therefore, separating the application into three main areas such as the OERs, which is open use for users to browse through content without having to sign up, a Profile area for users that have signed into the application for creating content and interacting with the DAO and blockchain components of the platform, as well as a home page area for users to interact with each other and collaborate through Organisations.

Further research into cross platform languages for developing the web app to be able to function seamlessly on both mobile devices and desktop computers, Apple, Windows, Linux and Android will be required in deciding on a programming language to build the platform with. A functioning minimum viable product (MVP) can then be developed, which will initially focus on the ability to browse through the OERs, create and fund Projects, and for users to be able to upload their own scientific research as Articles and to collaborate through Organisations and in the three main areas outlined above. If this is done well and positively received then the blockchain component can be developed along with the rest of the designed functionality of the platform such as Videos, DIY Tutorials and NFTs.

4.2.1. Web & Mobile App Development

For a web development project to function, I need to understand what kind of web stack will be involved in the programming of the web and mobile application to be most efficient and effective. A web stack is a collection of software used for web development that involves an operating system (OS), programming language(s) and framworks, database software and a web server (Awati, R., & Wigmore, I., 2023).

Operating System (OS)

Some popular opertating systems (OS), being the central interface between hardware and software components of a web application to consider using in developing the platform are:

Windows[27] **-** Windows, introduced in 1985, stands as Microsoft's leading operating system, serving as a

[27] https://www.microsoft.com/

standard for both home and business computing. Originating from the collaborative efforts of Bill Gates and Paul Allen in 1975, Microsoft has evolved its software offerings, including Windows iterations and gaming systems like the Xbox Series X. The company's impact extends to diverse personal computing devices, such as the well-received Surface Pro line, showcasing Microsoft's enduring influence across software, hardware, and gaming (Gillis, A. S., & Hanna, K. T., 2022).

UNIX[28] **-** Developed in the 1970s and written in C programming language, is a multiuser, multitasking operating system known for its adaptability and impact on the computer industry. With a focus on portability and stability, UNIX and its derivatives have played a pivotal role in fostering interoperability across diverse environments and devices (Sheldon, R., & Mixon, E., 2022).

Linux[29] **-** GNU/Linux is a Unix-like operating system with the Linux kernel at its core, originally created by the GNU Project. The term "GNU" is a recursive acronym emphasizing its non-Unix origin. Developed collaboratively, it allows access to source code for copying and modification. The OS is flexible, branching into different distributions that alter its appearance and functionality (Gillis, A. S., 2022).

MacOS[30] **-** Apple's proprietary operating system for Mac desktops and laptops, known for its optimized performance on Apple hardware. Released annually since 1984, macOS played a significant role in popularizing graphical user interfaces (GUIs) and influencing the direction of Windows OSes (Gillis, A. S., 2022).

Web Server

The web server is required to deliver documents to the clients that request them from their web browser via a Hyper Text Transfer Protocol (HTTP), the web server then processes the requests for static content or refers to a database and script module for dynamic content. Some web servers include:

Apache[31] **-** The Apache HTTP Server, an open-source cross-platform web server, is fast, secure, and cost-effective. Developed in 1995 as an extension to the NCSA web server, it gained popularity quickly.

[28] https://unix.org/
[29] https://www.linux.org/
[30] https://www.apple.com/macos/
[31] https://httpd.apache.org/

The Apache Software Foundation, founded in 1999, supports and enhances the project, positioning it as a robust alternative to proprietary servers like Microsoft Internet Information Services. Its versatility allows for easy extension with modules and add-ons to meet various website needs (Sheldon, R., 2023).

Microsoft Internet Information Services[32] - IIS (Internet Information Services) is a versatile web server developed by Microsoft for Windows systems. It efficiently handles requests for HTML pages or files, facilitating the sharing and delivery of information across networks, including local area networks (LAN) and wide area networks (WAN) like the Internet (Rosencrance, L., & Bigelow, S. J., 2019).

Nginx[33] - Pronounced "engine x," an open-source web server software designed by Igor Sysoev to address the challenge of handling 10,000 concurrent user connections, known as the C10k problem. Apart from serving as a high-performance web server, Nginx excels in reverse proxy, load balancing, email proxy, and HTTP cache services. It is renowned for its ability to run at high speeds under heavy loads, thanks to a master and worker process structure that enhances efficiency compared to traditional Apache builds. Many major companies, including Facebook, LinkedIn, Apple, Microsoft, and Google, leverage Nginx to manage high-traffic pages. Notably, it is the second-most popular web server software globally, following Apache (What is Nginx?: Definition from TechTarget, 2019).

Database Software

The database is where the data of the application or web project is stored to make it available to the web server as required by the end user. Data is generated through server extensions that output from the database in a suitable format like HTML. Some popular databases for web projects include:

SQL Server[34] - Microsoft SQL Server is a prominent relational database management system (RDBMS) supporting transaction processing, business intelligence, and analytics in corporate IT. Built on SQL, it incorporates Microsoft's proprietary Transact-SQL (T-SQL) extensions, providing database administrators and IT professionals with a powerful platform for managing databases and querying data (Hughes, A., & Stedman, C., 2019).

[32] https://www.iis.net/
[33] https://www.nginx.com/
[34] https://www.microsoft.com/en-us/sql-server/

MySQL[35] - An open source RDBMS backed by Oracle, and operates on various platforms. Widely used for web applications and online publishing, MySQL is integral to the LAMP stack—Linux, Apache, MySQL, and PHP or other scripting languages. Originally developed by MySQL AB and later acquired by Sun Microsystems and then Oracle, it can be used under the GNU General Public License (GPL) for developers, while enterprises require a commercial license from Oracle. MySQL is a key database system for leading websites and numerous web-based applications worldwide, including Facebook, Twitter, and YouTube (Moore, L., 2018).

Oracle[36] - The Oracle Database is a robust RDBMS. Positioned at the core of many corporate IT ecosystems, it facilitates transaction processing, business intelligence, and analytics. Utilizing SQL as its foundation, the software integrates PL/SQL, Oracle's proprietary programming extensions. This RDBMS supports Java programming, allowing interoperability between PL/SQL and Java. Oracle Database plays a pivotal role in managing databases and extracting valuable insights for businesses (Stedman et al., 2017).

MongoDB[37] - An open-source NoSQL database management program, provides an alternative to traditional relational databases, particularly effective for large sets of distributed data. It excels in high-volume data storage, allowing organizations to manage extensive data while maintaining rapid performance. MongoDB supports ad-hoc queries, indexing, load balancing, aggregation, and server-side JavaScript execution, making it versatile for various data management needs (Gillis, A. S., & Botelho, B., 2023).

Programming Frameworks

The two main types of programming frameworks that I will be using for developing the platform are front-end and back-end. Web development frameworks employ different architectures, with many adopting the MVC model. In MVC, the Model layer manages back-end business logic and data, the View layer handles the user interface and interactivity, and the Controller layer serves as an intermediary processing requests between the model and view layers (Sheldon, R., 2023). Some of these programming framworks to consider in the development of the platform include but are not limited to the following:

[35] https://www.mysql.com/
[36] https://www.oracle.com/
[37] https://www.mongodb.com/

1. Front-End Frameworks

Front-end frameworks, also known as user-side or client-side frameworks, concentrate on the user-facing aspects of a web application. These frameworks offer components and templates essential for rendering both static and interactive webpages directly in a browser. User experience (UX) professionals play a crucial role in designing these features to ensure accessibility, aesthetic appeal, and user-friendly functionality. Common front-end frameworks include:

HTML[38] **-** (Hyper Text Markup Language) documents consists of plaintext elements enclosed in matching tags, defining its structure. Tags, enclosed in angle brackets, surround text or other elements, with optional attributes for additional information. For example, a webpage may have a <blockquote> element with an embedded <p> element. HTML5, goes beyond traditional versioning, adopting the term "HTML Living Standard." This dynamic approach continually integrates new features based on ongoing feedback. Unlike static version numbers, HTML5's development involves GitHub commits, creating frozen snapshots for historical reference. Despite its official name lacking the "5," the industry still commonly refers to it as HTML5, recognizing its crucial role in shaping the modern web (Sheldon, R. 2023).

CSS[39] **-** (Cascading Style Sheets) adhere to the separation of concerns design pattern, offering a centralized location for styling HTML elements on a webpage. It efficiently manages fonts, colors, emphasis, and layout for different parts of the page, adapting to various devices like desktops, tablets, and smartphones. CSS ensures consistent and tailored presentation, aligning with best practices in web design (McKenzie, C., 2021). SCSS, or Sassy Cascading Style Sheets, is a CSS superset that empowers web designers with added features like variables and nesting. Developed by Hampton Catlin, the concept was implemented by Chris Eppstein and Natalie Weizenbaum. SCSS offers enhanced capabilities, making it potentially faster and easier to write than regular CSS (Verma, R., 2023).

JavaScript[40] **-** (JS) is a versatile scripting language, empowers web pages to deliver dynamic and interactive features beyond static content. It plays a pivotal role in creating engaging elements like timely content updates, interactive maps, and animated graphics, making it the third layer in the

[38] https://html.com/
[39] https://css-tricks.com/
[40] https://www.javascript.com/

standard web technologies stack, alongside HTML and CSS (MozDevNet., n.d.).

TypeScript[41] **-** TypeScript is an object-oriented, compiled language, enhancing JavaScript by providing strong typing and improved tooling at any scale. Serving as a superset of JavaScript, it was created by Anders Hejlsberg, the architect of C# at Microsoft. Open source and supported by Microsoft, TypeScript is often described as "JavaScript with syntax for types," incorporating additional features while maintaining compatibility with JavaScript (Shubel, M., 2023).

jQuery[42] **-** jQuery is a popular open-source JavaScript library that simplifies web application development. It streamlines DOM manipulation, Ajax for data exchange, and event handling. jQuery's selector engine, Sizzle, efficiently identifies elements, making it widely used and supported by user-created plug-ins (Gillis, A. S., 2019).

ReactJS[43] **-** ReactJS is an open-source JavaScript library for creating declarative and efficient user interfaces. It adopts a component-based approach within a MVC architecture, allowing the development of modular and reusable UI elements. By utilizing a declarative paradigm, React simplifies dynamic data handling, ensuring efficient updates and rendering. Components can be nested to build complex applications, enhancing predictability and ease of debugging. React is widely used for its ability to create modern and interactive web interfaces (ReactJS Introduction, 2023).

2. Back-End Frameworks

Back-end frameworks, alternatively known as server-side frameworks, focus on the server and the back-end components that underpin a web application. Their responsibilities include URL mapping, handling HTTP requests, interacting with data sources, and supporting various back-end operations. Back-end development may be particularly appealing to individuals with a background in mathematics or engineering. Common back-end frameworks include:

Ruby on Rails[44] **-** (RoR) is an open-source framework for web development in Ruby, an OOP language similar to Perl and Python. What sets Rails apart is its emphasis on speed and ease of use, allowing

41 https://www.typescriptlang.org/
42 https://jquery.com/
43 https://react.dev/
44 https://rubyonrails.org/

developers to see immediate changes without typical web development cycle delays. Notably faster than Java-based frameworks, Rails includes components like Active Record for object-relational mapping, Action Pack for managing controller and view functions, and more. It supports various databases, runs on most web servers, and follows the MVC architecture, providing all layers within Rails itself. Invented by David Heinemeier Hansson, Ruby on Rails is distributed as an open-source project available through rubyonrails.org (Howard, A., 2006).

Go[45] **-** Go, also known as Golang, is an open-source programming language developed by Google. Widely used for web applications, cloud services, and software development, Go is statically typed and modeled after C, offering fast startup time and low runtime overhead. It excels in microservices development due to its efficiency, ability to run without a virtual machine, and support for concurrent programming using goroutines. Inspired by Python's simplicity, Go addresses issues like slow build time, uncontrolled dependencies, and cross-language development through lightweight processes (goroutines) and efficient dependency management packages (Barney, N., & Gillis, A. S., 2023).

Django[46] **-** Django is a widely used Python web framework for building large-scale applications and websites, closely adhering to the MVC architecture. Its popularity stems from being an open-source, full-stack Python framework with built-in features, emphasizing the 'Don't Repeat Yourself (DRY)' and 'Explicit over Implicit' principles. Django utilizes its Object Relational Mapping (ORM) for mapping objects to multiple databases, supporting MySQL, SQLite, PostgreSQL, Oracle, and more. The framework provides extensive libraries, third-party adapters, and content management systems for flexibility. Django's support for localization, user authentication, sessions, cookies, web server, and compatibility across browsers makes it stand out among other Python frameworks (Patel, J., 2023).

Lavarel[47] **-** Laravel is a versatile PHP framework designed for cross-platform web application development. It provides developers with an extensive library of pre-programmed features, including authentication, routing, and HTML templating, streamlining the development process. Laravel boasts a functional development environment, intuitive command-line interfaces, and utilizes ORM for simplified data access and manipulation. Its applications are highly scalable, maintaining easily

[45] https://go.dev/
[46] https://www.djangoproject.com/
[47] https://laravel.com/

manageable codebases. With a modular packaging system and robust dependency management, Laravel facilitates seamless addition of functionalities to web applications (The Laravel PHP Framework – Web App Construction for Everyone, 2023).

.NET[48] **-** The .NET Framework, developed by Microsoft, is a versatile software development platform for creating applications on Windows. It supports multiple languages like C#, F#, and Visual Basic, offering a range of libraries and tools for desktop, web, mobile, and gaming applications. Key components include the Common Language Runtime (CLR) and the .NET Framework Class Library. With features like language diversity, broad application support, and integration with Microsoft technologies, it provides a robust foundation for developers, enhancing security, reliability, and performance (Introduction to .NET Framework, 2023).

Spring[49] **-** The Spring Framework is a popular open-source Java framework, established in 2003, designed to simplify and enhance the development of Java-based applications. Focused on plain old Java objects (POJOs), Spring aids developers in creating high-performing applications, eliminating tedious configuration work and allowing a focus on business logic. It provides infrastructure support, improving coding efficiency and reducing development time by efficiently utilizing system resources. With features like security, cost-effectiveness, and flexibility, Spring has become a widely adopted framework in the Java development landscape (What is Spring Framework?: Definition from TechTarget, 2023).

Node.js[50] **-** Node, is an open-source and cross-platform JavaScript runtime environment designed for executing JavaScript code. Widely used for server-side programming, Node enables developers to utilize JavaScript for both client-side and server-side tasks without learning an additional language. Although sometimes labeled as a programming language or software development framework, Node is more accurately described as a JavaScript runtime. It incorporates the V8 JavaScript engine, also found in browsers like Google Chrome, and operates independently of a browser environment. Node, written in C++, supports macOS, Linux, Windows, and other systems, offering efficient execution through its just-in-time (JIT) compilation processes (Sheldon, R., & Denman, J., 2022).

[48] https://dotnet.microsoft.com/
[49] https://spring.io/
[50] https://nodejs.org/

Mobile Application Development Frameworks

Mobile application development involves the processes and procedures of creating software for small, wireless computing devices like smartphones. While rooted in traditional software development, mobile apps are distinct as they are often tailored to leverage specific features of a particular device. For instance, a gaming app might utilize an iPhone's accelerometer, and a health app could utilize a smartwatch's temperature sensor. The primary mobile platforms are iOS (Apple) and Android (Google), each with its own app store—Apple App Store and Google Play Store, respectively (David et al., 2021).

React Native[51] **-** React is an open-source JavaScript framework that leverages Facebook's React UI library for cross-platform mobile app development. It allows the creation of apps for web, iOS, and Android, emphasizing native code over HTML. Originating in 2015, React Native gained traction with applications like the Facebook Group and Ads Manager. React Native uses JavaScript XML (JSX) to create applications that bridge native APIs for both iOS and Android, enabling code to be written once for both platforms. By directly utilizing host platform APIs instead of webviews, React Native ensures a consistent appearance and high-performance applications, with the separation of React from the main UI thread preserving functionality without compromising speed (Lewis, S., 2019).

Flutter[52] **-** Flutter is Google's versatile UI toolkit for building native applications across mobile, web, and desktop platforms from a single codebase. It streamlines app development, reduces costs, and provides a canvas for high-end user experiences. Flutter unifies app development for Android, iOS, web, and desktop, allowing a single codebase for branded apps. It supports a wide range of hardware and services, using its high-performance rendering engine to draw widgets. Flutter's framework is layered, customizable, and written primarily in Dart, providing control and flexibility for developers (FAQ, n.d.).

Xamarin[53] **-** Xamarin is an open-source platform for building cross-platform applications for iOS, Android, and Windows using .NET. It allows developers to share around 90% of their application code across platforms, providing native performance and appearance. Xamarin runs in a managed environment, facilitating memory allocation and garbage collection. Applications written on PC or

[51] https://reactnative.dev/
[52] https://flutter.dev/
[53] https://dotnet.microsoft.com/en-us/apps/xamarin

Mac can compile into native packages for specific platforms (What is Xamarin? - Xamarin, n.d.).

Ionic[54] **-** Ionic is an open-source UI toolkit for building mobile, desktop, and web apps using web technologies. Launched in 2013, it enables developers to create cross-platform applications with a focus on front-end user experience. Integrated with Angular, and supporting Vue.js and React.js, Ionic allows efficient and cost-effective development, enabling deployment across various devices and operating systems (What is Ionic Framework - javatpoint., n.d.)

Due to the clear and strong advantages of developing a cross platform application with a single code base, Flutter seems to be the best option for the development of the platform. I have a good background in front-end frameworks and languages, as well as some back-end experience mainly being with Ruby on Rails and MySQL with Apple mac OS for web development. So I will be testing out a few of these different options before finally deciding on the specific web stack to develop with as well as getting some advice from professional developers with more experience than me during the stages of the development process. As well as considering options for the implementation of the blockchain development, web3 end of the platform.

4.2.2. Blockchain Development

Choosing the best programming language for blockchain development depends on various factors, including the specific requirements of the project, the blockchain platform, and developer expertise. Here I will look at some language specific frameworks then some popular frameworks and platforms that offer solutions across a number of different languages.

Language Specific

Some of the programming languages commonly used to develop blockchain technologies, smart contracts and dApps include:

Solidity[55] **-** Solidity was proposed in 2014, as a high-level programming language for Ethereum smart contracts. It draws inspiration from C++ and JavaScript, aiming to provide a Turing-complete language for decentralized applications. Originating from Ethereum's need for smart contract functionality, Solidity

[54] https://ionicframework.com/
[55] https://soliditylang.org/

was introduced in 2014 by CTO Gavin Wood and Ethereum founder Vitalik Buterin. The language team, led by Christian Reitwiessner, succeeded in creating a Turing-complete, object-oriented language (What is Solidity?, n.d.). In the realm of Solidity development, the demand for efficient tools is on the rise. Online editors are convenient for experimentation, but development frameworks offer more control over the environment. Smart contracts being a relatively new technology, the optimal features within these frameworks are still evolving (Helms, C., & McGahon, C., 2023):

Remix[56] **-** A browser-based Integrated Development Environemnt (IDE). Requiring minimal setup, it provides a basic workspace, compiler, debugger, and deployment configuration. Remix's simplicity makes it accessible to those with basic blockchain and Solidity experience. It offers a desktop IDE and Visual Studio Code plugin for enhanced functionality and secure file storage.

Truffle[57] **-** A Node-based framework by ConsenSys, offers tools for developing, compiling, JavaScript-based testing, and deploying Ethereum smart contracts. It mandates project definition with a specific structure and configuration. Truffle uses migrations to manage contract versions, streamlining deployment after code changes. The ecosystem includes Ganache, a proprietary development network, providing speed, debugging benefits, and additional contract insight. Support for Truffle and Ganache are ending but both are being integrated into Hardhat.

Hardhat[58] **-** Another Node-based framework by the Nomic Foundation, offers development support, JavaScript testing, and contract deployment. Gaining popularity, it boasts open-source plugins for gas analysis and unit test coverage reports. Unlike Truffle, developers manage deployed contract versions, giving more control over deployments through a JavaScript file. Highly configurable, Hardhat projects enable customization of various aspects.

Foundry[59] **-** A Rust-based framework, is gaining traction for its growing toolset and speed. Accessed through a CLI, it comprises Forge for contract compilation, Cast for transaction creation, and Anvil for a local network. Foundry's unique Rust-based approach prioritizes speed, offering notably shorter compilation and testing times compared to competitors.

[56] https://remix.ethereum.org/
[57] https://trufflesuite.com/
[58] https://hardhat.org/
[59] https://book.getfoundry.sh/

JavaScript - JavaScript can be used for developing decentralized applications and server-side scripting. It is versatile, being used for both front-end and back-end development, with extensive library support. Various JavaScript libraries and frameworks cater to blockchain implementation (Implementing a Blockchain with JavaScript, n.d.):

Node.js - A JavaScript runtime for server-side applications, commonly used for decentralized app development on Ethereum.

Web3.js[60] - This JavaScript library facilitates interaction with the Ethereum blockchain, enabling tasks like smart contract deployment and transaction management.

Crypto-js[61] - This library offers cryptographic functions, including hashing and encryption, ensuring data security on the blockchain, although active development has been discontinued.

IOTA[62] - Leveraging a unique data structure called Tangle, IOTA is a distributed ledger technology written in JavaScript, suitable for building distributed systems and designed for the Internet of Things (IoT).

Golang - Go stands out as a robust choice for blockchain development due to its efficiency, concurrency support, strong standard library, and emphasis on safety. Here are key frameworks and libraries in the Golang ecosystem tailored for blockchain development (Oke-Samuel, J., 2023):

Go-ethereum[63] (Geth) - The official Go implementation of the Ethereum protocol, offering tools for Ethereum network interaction, smart contract creation, and decentralized application (dApp) development.

Tendermint[64] - A Byzantine Fault Tolerant (BFT) consensus engine used in projects like Cosmos and Binance Chain. It provides a Golang library and consensus algorithm for building blockchain networks.

Cosmos[65] SDK - Designed for simplifying the development of interoperable custom blockchains. Built

[60] https://web3js.org/
[61] https://cryptojs.gitbook.io/
[62] https://www.iota.org/
[63] https://geth.ethereum.org/
[64] https://tendermint.com/
[65] https://docs.cosmos.network/

in Go, it enables the creation of application-specific blockchains within the Cosmos ecosystem.

go-ipfs[66] - The Go implementation of the InterPlanetary File System (IPFS), offering decentralized storage for building dApps with content-addressable storage.

go-libp2p[67] - A networking framework facilitating peer-to-peer application development, used as the networking layer in IPFS. Simplifies the creation of peer-to-peer networks with secure communication. Hyperledger Fabric SDK for Go - Enables interaction with Hyperledger Fabric networks, creation of smart contracts (chaincode), and development of enterprise-grade blockchain applications.

NATS Streaming[68] - A messaging system, written in Go, that supports real-time data streams. While not exclusive to blockchain, it can be valuable for creating scalable and efficient blockchain architectures.

Java[69] - Java is a versatile and widely used programming language, making it a robust platform for developing blockchain applications. Java's object-oriented nature aligns well with the complex requirements of blockchain development, making it a preferred choice in enterprise settings. The language boasts a mature ecosystem with robust tools and libraries, enhancing its suitability for building secure and scalable blockchain applications (Stackarr, 2023):

Web3j[70] - A lightweight Java and Android library known for extensive documentation. It serves as a valuable blockchain connectivity layer, offering flexibility through its CLI and plugins. Mainly used for Ethereum client integration.

Python[71] - Python's widespread popularity in software development has given rise to a plethora of libraries and frameworks tailored for blockchain development. Python's strengths in agility and flexibility align well with the demands of blockchain development. Python's ease of integration with other languages and technologies further simplifies the creation of complex decentralized applications that interact seamlessly with external systems. Developers often leverage the following frameworks for building blockchain networks and smart contracts (Logik Labs, 2023):

66 https://docs.ipfs.tech/reference/go/api/
67 https://pkg.go.dev/github.com/libp2p/go-libp2p
68 https://nats.io/
69 https://www.java.com/
70 https://www.web3labs.com/web3j-sdk
71 https://www.python.org/

Web3.py[72] **-** Facilitates the connection of dApps to the Ethereum blockchain. Developed with a focus on Python developers, it enables tasks such as sending transactions, interacting with smart contracts, and retrieving block data indDApps (Web3.py - Web3 Libraries, n.d.).

PyCoin[73] **-** A Python blockchain framework demonstrating basic functionalities. It establishes nodes, mines blocks, and supports token transfers with automatic error checks for transaction data and node balances. While not an industrial-grade cryptocurrency, it serves as an educational framework for blockchain experimentation (Richardkiss, n.d.).

Pyethapp[74] **-** A Python-based client, implements the Ethereum cryptoeconomic state machine, fostering the development of innovative ideas through blockchain technology. Designed for easy hacking and extension, it leverages two core Ethereum components: pyethereum, encompassing the blockchain, Ethereum virtual machine, and mining, and pydevp2p, a peer-to-peer networking library for encrypted connections and node discovery.

Ruby - Ruby on Rails excels in blockchain development, offering a quick start for dApps through Web3 integration. Its flexibility ensures robust and secure platforms, leveraging distributed features for heightened availability. With the ability to build private blockchain networks, it enhances security through encryption layers and innovative hashing methods. The framework's open-source nature and strong community support make it an ideal choice for blockchain projects, particularly when integrated with widely used blockchains like Ethereum (Ng, N., 2023).

Peatio[75] **-** An open-source cryptocurrency exchange platform developed using RoR. It accommodates various cryptocurrencies and encompasses essential features like trading, deposits, withdrawals, and KYC/AML verification. Peatio's capabilities span accounting, buying and selling, as well as interaction with different blockchains.

Chain[76] **-** A blockchain technology platform offering APIs and SDKs for creating and organizing applications. Sequence provides an immutable ledger for business transactions, while NFT Chaining

[72] https://github.com/ethereum/web3.py
[73] https://pycoin.readthedocs.io/
[74] https://pyethapp.readthedocs.io/
[75] https://www.peatio.tech/
[76] https://www.chain.com/

offers a customizable service for NFT projects. Through collaboration with industry leaders, Enterprise Chain supports the development of blockchain networks, from prototypes to production systems. This makes Chain a versatile toolset for diverse blockchain applications.

Blockstack[77] - A decentralized computing platform, constructed with RoR, empowering users to develop decentralized applications. Users obtain digital keys for identity creation on the Blockstack network, benefiting from blockchain-driven decentralized security. User data can be stored locally or linked to storage hosting providers, ensuring user control over their data.

Gem[78] - A blockchain development platform constructed with RoR, equips developers with tools to build and deploy blockchain-based applications. Among its offerings, "Onramp" facilitates users in buying cryptocurrency within an app using fiat payment methods or by transferring funds from their exchange accounts. The platform's robust API supports over 2,000 cryptocurrencies across 20+ exchanges, providing comprehensive connectivity for transactions.

Cross-Language Frameworks & Platforms:

Some of the popular frameworks and platforms that support different programming languages commonly used to develop blockchain technologies, smart contracts and dApps include:

Hyperledger[79] - Founded in 2015 and overseen by the Linux Foundation, is a collaborative initiative among companies to develop modular and extensible blockchain frameworks. The focus is on creating reusable building blocks, allowing developers to experiment and tailor distributed ledger solutions to specific needs. The Architecture Working Group defines modules and interfaces, covering various aspects like communication, consensus, cryptography, identity, ledger storage, smart contracts, and policy. Hyperledger projects provide accessible APIs, encouraging interoperability and supporting a diverse developer ecosystem. Their goal is to offer a flexible collection of tools with modularity and interoperability, enabling individuals to build customized distributed ledgers (The Hyperledger White Paper Working Group et al., 2018).

77 https://blockstack.tech/
78 https://pycoin.readthedocs.io/
79 https://www.hyperledger.org/

Exonum[80] **-** An open-source blockchain framework by Bitfury Group, is designed for enterprise projects. Exonum is a framework for creating custom blockchains, emphasizing permissioned setups for enhanced security. It ensures transparency, using Rust for robust memory safety and achieving peak throughput of 7,000 transactions per second. The framework employs a custom Byzantine fault-tolerant consensus algorithm and supports application development in Java or Rust (Exonum, n.d.).

Openchain[81] **-** Launched by Coinprism, is a distributed ledger framework tailored for issuing and managing digital assets. Primarily targeting banking establishments and financial institutions, Openchain enhances financial processes, anti-fraud, and anti-money laundering systems. It employs a partitioned consensus algorithm, establishing a client-server architecture for added reliability. Unique features include the ability to link tokens with Bitcoin via sidechains, smart contract modules, and a unified API for interaction with various Openchain instances. The framework supports the creation of multiple synchronized blockchains (Frequently Asked Questions, 2023).

Graphene[82] **-** A platform, initially developed for Bitshares, a cryptocurrency exchange. Primarily written in C++, Graphene features a modular structure for adaptability, widely adopted for its transparency and reliability. It stands out with the capacity to process up to 3,000 transactions per second, potentially reaching 100,000. Graphene forms a new block in three seconds, supporting zero-commission payments and enabling concurrent handling of multiple tokens within a single system. Managed by Cryptonomex, it is open source and available on GitHub, notable for its modular structure and adaptability (Graphene – An Open Source Blockchain, n.d.).

Corda[83] **-** R3's Corda is a scalable, permissioned blockchain platform designed for regulated markets, facilitating the development of multi-party applications with digital trust. Operating on private P2P networks, Corda offers built-in tools, SDKs, and APIs for efficient development, ensuring privacy and synchronization. The platform supports frictionless negotiation, creation, and exchange of high-value data, assets, and smart contracts, streamlining automation and orchestrating complex workflows across business networks. Corda accelerates the development of applications for regulated digital asset issuance, trading, and settlement (Corda, 2023).

[80] https://exonum.com/
[81] https://www.openchainproject.org/
[82] https://github.com/cryptonomex/graphene
[83] https://r3.com/products/corda/

MultiChain[84] **-** MultiChain, by Coin Sciences, is a turnkey framework for private blockchain deployment, catering to financial sector needs. With a user-friendly API, it simplifies building and managing private blockchains across multiple entities. MultiChain offers participant autonomy, decentralized blockchains, private key management, system reliability, and high configurability for easy deployment, even by non-developers. MultiChain also provides a range of features and resources for developers, including online tutorials covering permissions consensus, asset reissuance, atomic exchanges, and more. Production guides offer insights into deploying MultiChain in real-world scenarios, covering parameters, performance optimization, upgrading nodes, and backups. Official tools, like API libraries and explorers, aid development, and various language-specific libraries, including for C#, Go, Java, JavaScript, PHP, Python, and Ruby, offer convenient wrappers for the MultiChain JSON-RPC API (MultiChain for Developers, n.d.).

All of the options outlined above for developing the blockchain component for the platform have their own strengths and weaknesses, and in consideration of my own skill level in computer science and web development I would most likely gravitate towards the MultiChain platform. For its ease of deployment even for non-developers and range of API libraries with different programming languages. Ruby on Rails for blockchain, Python and JavaScript would be also quite useful in the development of the platform, but learning to use the Solidity language with the Hardhat framework does seem quite attractive as Solidity was primarily created for developing dApps. Given the problems associated with developing the project as a dApp such as the difficulty in modifying code and a unifying UX design, the initial development of the platform may not be appropriate to be fully implemented as a dApp, but have dApp components.

[84] https://www.multichain.com/

5

CONCLUSIONS & RECOMMENDATIONS

RESEARCH ANSWERS

GAMIFIED QUIZ BASED LEARNING & USER CREATED EDUCATIONAL CONTENT

A NEW BLOCKCHAIN CONSENSUS MECHANISM

It is very clear to me from this study that an Open Educational Resource for inspiring sustainable research and development into the benefits that can be gained from the ocean for both society and the natural environment is something that can be of value to society. Developing a platform around this that can inspire people to create new research, receive funding and collaborate with each other is a good idea and has been suggested that it should not be specifically restricted to the ocean through the design research. An online platform for educational content creation, driven by open science and blockchain technology can function to the benefit of society and the environment through incorporating circular design theories and developing sustainable innovation.

The development of the concept in conjunction with blockchain technology will need to be explicitly clear and understandable in order to build trust in the platform and built very carefully so that it cannot be exploited by bad players. The actual function of the cryptocurrency associated with the platform will need to be used only to specifically operate for the benefit of the users to inspire people to generate new research and innovations in an ethical way. Trust in blockchain technology is particularly low, although in order to inspire people to learn and create new ideas, innovations and content, I still believe there needs to be a functional system of incentivisation and blockchain technology can help to develop this as a transparent ledger system.

The biggest limitation of the study was the lack of participation I received in the user testing and surveys. Feedback was slow where it was existent and in comparison to the amount of emails, messages, calls and personal conversations I instigated, very few people participated. I can only assume that this is due to the negative news coverage that blockchain was receiving at the time due to the events connected to some cryptocurrencies and exchanges like FTX. Although there were clear indications towards this in some of the feedback, which also felt somewhat like a personal attack on me and the project itself as though the project's intention was to replicate the negative events happening in the blockchain world at the time.

In the development of this, it is important to advance in cohesion and collaboration with trusted existing authorities in the financial fields and government organisations to ensure non-disruptive but rather evolutional or additional innovations for the benefit of humanity in the natural world as it comes to the health and wellbeing of life by maximising the ability to come out of the computer and into the real world.

5.1. Research Answers

I found that a combined web app and mobile application that could be built with Flutter providing multi-platform functionality for an Open Educational Resource would be most effective, and according to the research this would be helpful for society in developing sustinable innovation.

The information that will be most useful in summarising scientific research were narrowed down into the following categories in order of importance: Ecosystem Services (Tackling Climate Change, Carbon Sequestration, Ecosystem Recovery, Addressing Pollution), Health & Biotechnology (Biomaterials, Biopharmaceuticals, Health Food Supplements, Cosmetics), Food (Addressing World Hunger, Sustainable Produce, Edible Algae, Recipes), Economy & Industry (Economic Sustainability, Circular Carbon Economy, Sustainable Ocean Farming, Enhancing Agriculture), Design Applications (Bio-Materials, Circular Design), Regulations (Overview), and Warnings (Harmful Algae Blooms, Harmful Aquaculture Farming). I later added Social Empowerment (Addressing Poverty, Gender Equality, Peace & Justice, Reducing Inequalities), and to Design Applications added sub-categories of (Sustainable Architecture, Sustainable Product Design), to Regulations I added (Regulations by Region, Ocean Regulations, Land Regulations) and to Warnings added (Climate Change - What to Expect, Harmful Agriculture & Cattle Farming). Participants in the research preferred to consume new information as summarised articles with design visualisations that are easy to digest but are also accurate.

The platform's ability to inspire users to create further innovations, add their own knowledge to the educational resources and create funding opportunities for real world solutions in this field will be known only when the platform is functional, although the research I have done in regards to whether it is believed that this is possible indicates that it would. It has been designed specifially to do this, but it needs to be built and tested in the real world for this to be truly known. Further modifications and user testing will be required and are expected to shape the platform, determining its success into the future.

Even though the participants understanding of blockchain technology was low, more than half wanted to see the platform integrated into a Decentralized Autonomous Organization. Participants do not trust cryptocurrencies to be used for funding scientific research due to the volatility of cryptocurrency markets. Applying blockchain technolgy for scaling climate action is certainly promising, and there are many use cases for blockchain technology within this including Regenerative Finance and Decentralized Science.

5.2. Gamified Quiz Based Learning & User Created Educational Content

Incorporating a gamified experience into the Open Educational Resources would be beneficial for increasing the enjoyment of users in learning new knowledge that will assist in the ability to retain new scientific concepts. Developing animated quizzes for each of the summarised articles in which the user can earn $OZEAON coins (cryptocurrency) for correct answers like "Diamonds" and "XP" in Duolingo would assist in the onboarding process for new users to the platform interested in further learning.

The application TikTok rewards users for creating content on its platform, which in western society is usually some kind of useless entertainment content, although in China TikTok is being used to propagate educational moral values content, rewarding users for their ability to learn new knowledge and successfully educate other users (Schlott, R., 2023). Incorporating into the platform, specifically user generated educational content, by which they can be rewarded. This could be of great benefit to society as young people who have been brought up with the Internet and technology can become easily influenced and are psychologically more likely to consume new information presented in this format (Su et al., 2021).

5.3. A New Blockchain Consensus Mechanism

It would be ideal to develop a new blockchain with a new consensus mechanism for a unique cryptocurrency used on the platform to instead of using proof-of-work or proof-of-stake methods, develop a method where one can mine the cryptocurrency by funding projects as an investor, along wth being able to mine the cryptocurrency by contributing research articles and content to the educational resources as well as by donating to other users in appreciation for their contributions. It is indicated that using a cryptocurrency would not be appropriate for funding research, although the use of a blockchain to implement smart contracts and potentially using a stable coin that does not fluctuate in price so much like USDT (Tether) could be appropriate for implementing in the consensus mechanism for incentivising innovation, education and investment (funding) into sustainable development.

I would call this method Proof-of-Progress and it would behave similar to proof-of-stake, but instead of proof of how much one has saved over time, it would require proof of how much one has contributed or invested into funding new innovative sustainable projects and donations to creators through the platform or creating new research and content itself. $OZEAON coins could also be rewarded to new members of the

DAO by completing quizzes on the educational resource and educational games or organising successful volunteer programs etc. Several ways to incentivise the use of the platform, contributing to it and educating users can be developed with the use of blockchain technology but must be done ethically and carefully. I will begin writing a White Paper for the "Proof-of-Progress" (PoP), with a draft of the consensus mechanism outlined below in fugure 45:

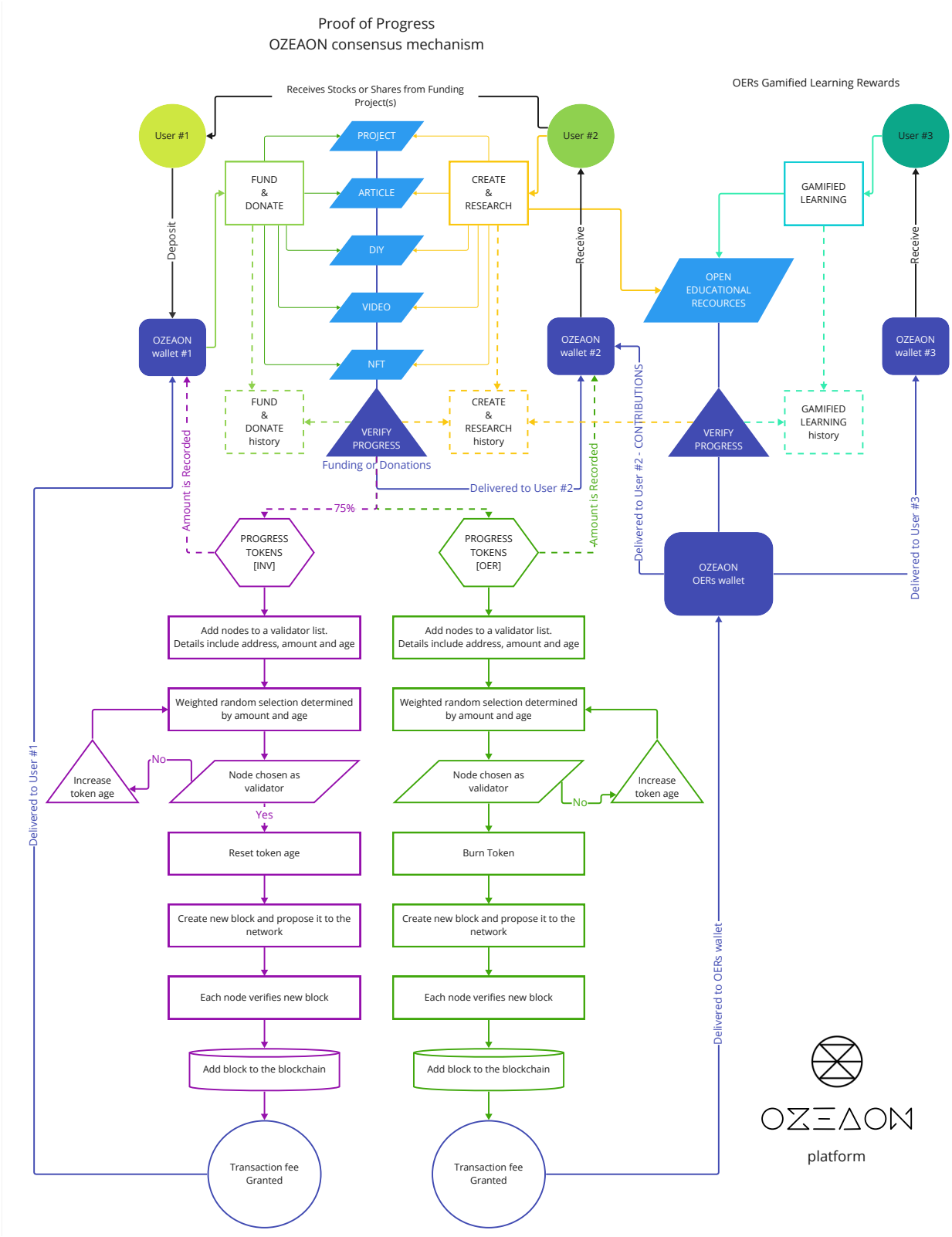

Figure 45. OZEAON Consensus Mechanism Draft

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GLOSSARY

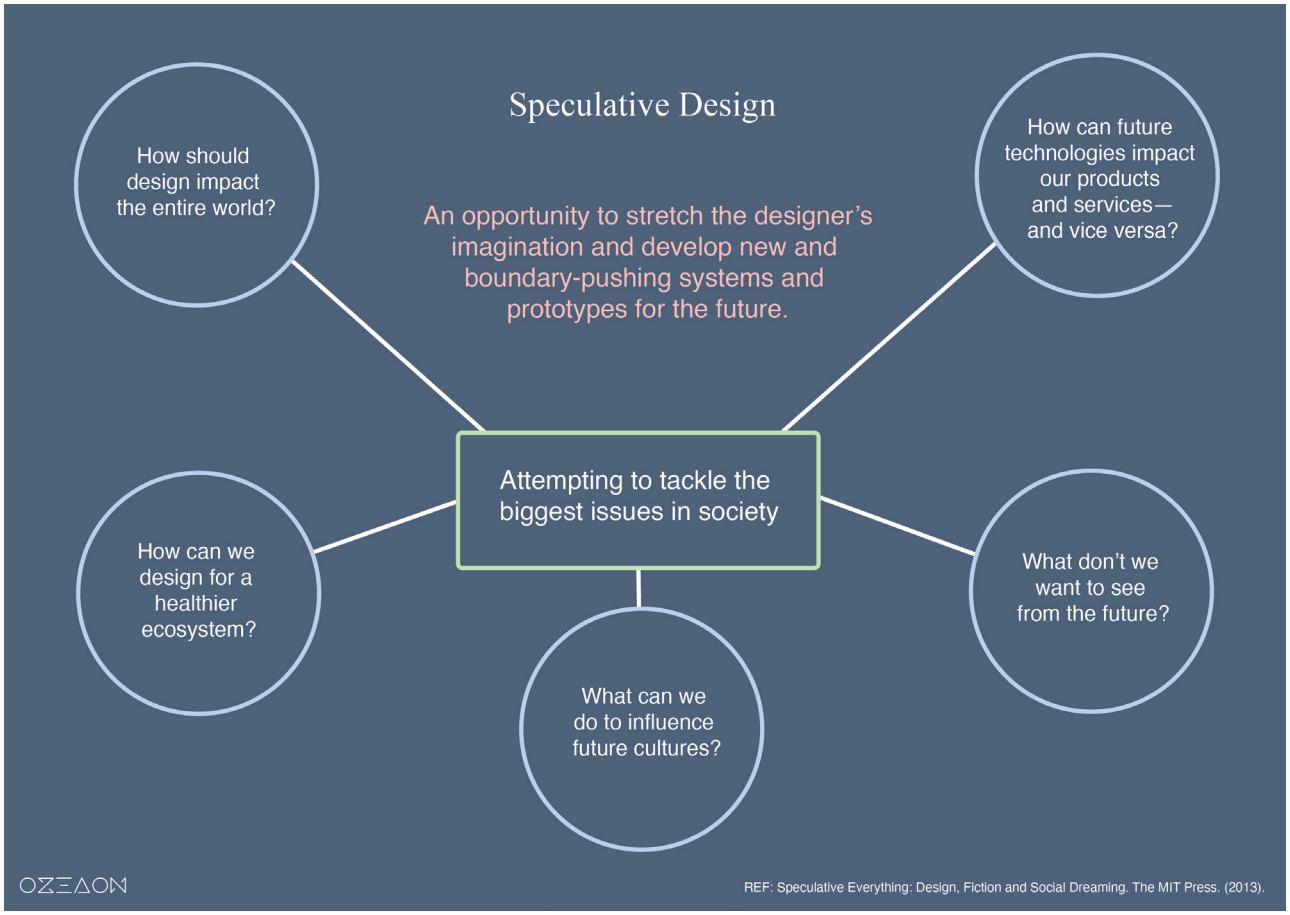
Algorithm	A step-by-step set of instructions or a sequence of well-defined rules designed to perform a specific task or solve a particular problem.
Application Programming Interface	A set of rules and tools that allows different software applications to communicate with each other.
Aquaculture	Also known as aquafarming or mariculture, is the controlled cultivation of aquatic organisms such as fish, crustaceans, mollusks, algae and other organisms of value such as aquatic plants.
Bitcoin	A decentralized digital currency.
Biofuel	Any fuel that is derived from biomass; that is, plant or algae material or animal waste.
Biomaterial	A substance that has been engineered to interact with biological systems for a medical purpose, either a therapeutic or a diagnostic one.
Biopharmaceutical	Also known as a biological medical product, or biologic, it is any pharmaceutical drug product manufactured in, extracted from, or semisynthesized from biological sources.
Bioplastic	Plastic materials produced from renewable biomass sources, such as vegetable fats and oils, corn starch, straw, woodchips, sawdust, recycled food waste, etc.
Biotechnology	A multidisciplinary field that involves the integration of natural sciences and engineering sciences in order to achieve the application of organisms, cells, parts thereof and molecular analogues for products and services.
Byzantine Fault Tolerance	A property of distributed systems that enables them to remain secure and operational even when some of their components fail or behave maliciously, nodes can reach a consensus on a particular value or decision, even if some nodes provide incorrect or conflicting information.
Carbon Neutral	When the same amount of CO_2 is released into the atmosphere as is removed by various means, leaving a zero balance, also known as a zero carbon footprint.
Climate Change	The significant variation of average weather conditions becoming, for example, warmer, wetter, or drier over several decades or longer.
Codesign	A process of involving all 'stakeholders' which includes consumers, communities, and end-users in the planning and design, implementation and evaluation of products, services and research to combine lived experiences and professional expertise.
Command Line Interface	A text-based interface used to interact with a computer or software by entering commands into a terminal instead of a GUI.
Content Management System	A software application or a set of related programs that allow users to create, manage, and modify digital content on the web.

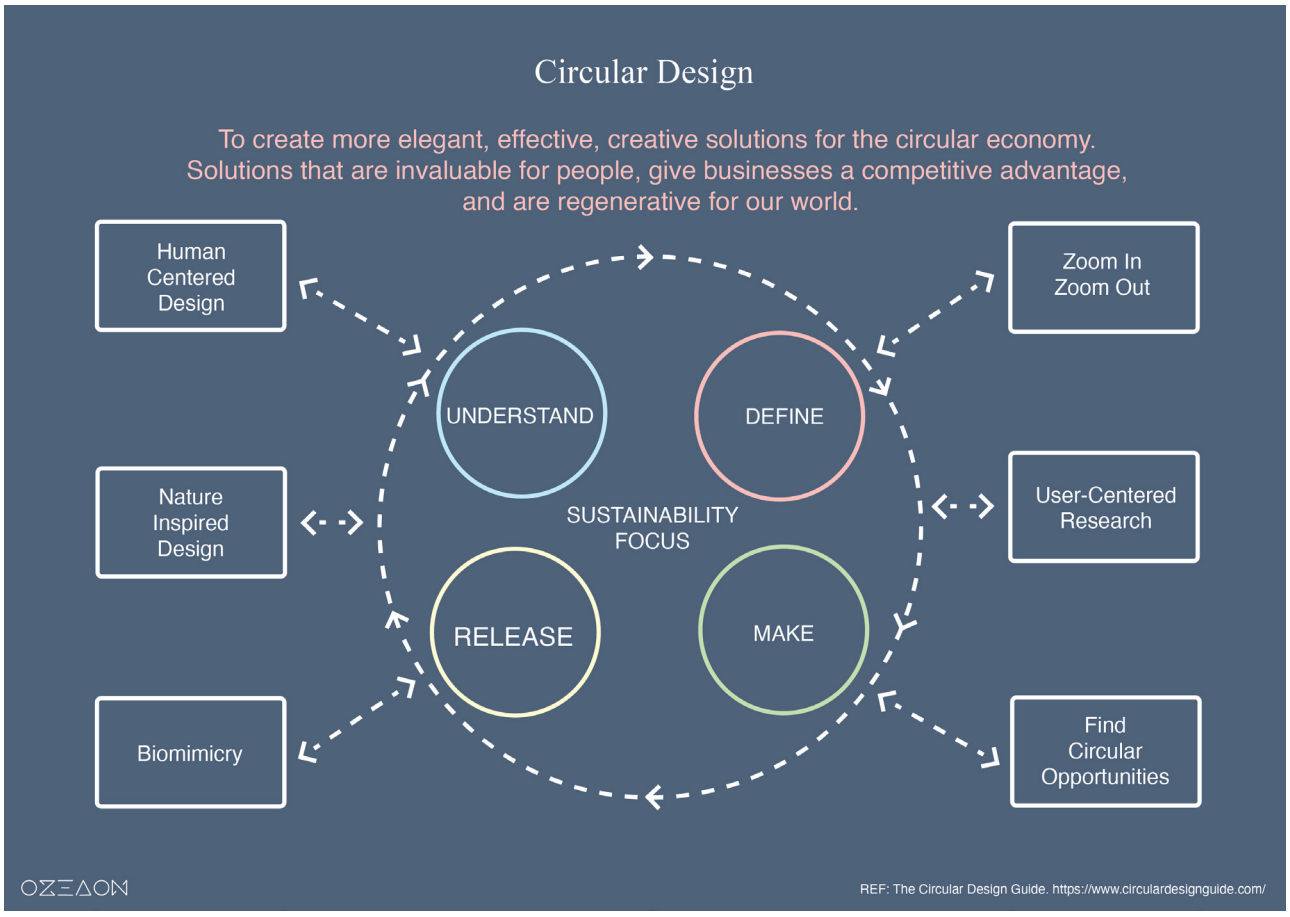
Cosmeceutical	Cosmetic products with bioactive ingredients purported to have medical benefits.
Crowdfunding	The practice of funding a project or venture by raising money from a large number of people, typically via the internet.
Cryptography	The process of hiding or coding information so that only the person a message was intended for can read it.
Don't Repeat Yourself	A software development principle aimed at reducing redundancy in code, the idea that each piece of knowledge or logic in a system should be represented in only one place.
Ecosystem Services	The direct and indirect contributions of ecosystems to human wellbeing, and have an im pact on our survival and quality of life.
Effective Altruism	A philosophy and a community focused on using evidence and careful reasoning to take actions that help others as much as possible.
Ethereum	A decentralized blockchain with smart contract functionality.
Explicit over Implicit	making code explicit and clear rather than relying on implicit or hidden behavior to favor transparency and readability in code, making it easier for developers to understand the logic and behavior of the program.
Green Growth	A concept in economic theory and policymaking used to describe paths of economic growth that are environmentally sustainable.
Graphical User Interface	Allows users to interact with electronic devices or software through graphical elements such as icons, buttons, and windows, rather than through text-based commands.
Idea Meritocracy	A system that brings together smart, independent thinkers and has them productively dis-agree to come up with the best possible collective thinking and resolve their disagreements in a believability-weighted way, which will outperform any other decision-making system.
Internet of Things	Devices with sensors, processing ability, software and other technologies that connect and exchange data with other devices and systems over the Internet or other communications networks.
Mining	The process of validating transactions and adding them to a blockchain.
Minting	The process of publishing an NFT on a blockchain.
Minumum Viable Product	A version of a product with just enough features to be usable by early customers who can then provide feedback for future product development.
Model View Controller	An architectural pattern that separates an application into three main logical components: the model, the view, and the controller. Each of these components are built to handle specific development aspects of an application.

Non-Interoperable	Where different systems, applications, or technologies are unable to work together or exchange information seamlessly.
Object-Oriented Programming	A computer programming model that organises software design around data, or objects, rather than functions and logic.
Object-Relational Mapping	A programming technique that allows developers to interact with relational databases using an OOP language, instead of SQL.
Onboarding	The process of helping users get started with your app in an automated way, so they begin engaging with high-value features quickly.
Online Platform	Any website that facilitates a service or interaction between itself and the visitor.
Open Science	The movement to make scientific research and its dissemination accessible to all levels of society, amateur or professional.
Open-source	Any program whose source code is made available for use or modification as users or other developers see fit.
Ponzi Scheme	An investment fraud that pays existing investors with funds collected from new investors.
Red Tape	Referring to regulations or conformity to formal rules or standards which are claimed to be excessive, rigid or redundant, or to bureaucracy claimed to hinder or prevent action or decision-making.
Securities	Tradable financial assets, representing ownership or a creditor relationship with a corporation or the government issuing the security.
The Great Depression	A worldwide economic downturn that began in 1929 and lasted until about 1939.
Turing-Complete	Indicates the ability to solve a wide range of problems and execute any algorithm that is computationally possible.
User Experience	How a user interacts with and experiences a product, system or service.
User Interface	The point of human-computer interaction and communication in a device.
Verifiable Random Function	A cryptographic primitive that generates a random output based on a secret key and an input.
White Paper	An authoritative and detailed report or guide that presents information about a complex issue, technology, policy, or problem.
Web3	An idea for a new iteration of the World Wide Web which incorporates concepts such as decentralization, blockchain technologies, and token-based economics.
Wisdom of the crowd	The collective opinion of a diverse independent group of individuals rather than that of a single expert.

APPENDICES

Appendice 1. Graphical Representations of Speculative Design and Circular Design





Appendice 2. Full Results of Survey #1

OZEAON - Research Survey

Hello and thank you for taking the time to answer these questions!

My name is Joseph Flynn and I am developing this survey for the Masters in Design for Health and Wellbeing at Politécnico de Leiria, Escola Superior de Artes e Design.

This survey is made to help inform my research for developing a public's Educational Resource for algae knowledge in order to make it easier and more accessible to understand the benefits of new ocean farming techniques and recent algae research in health care, ecosystem services, economy and food and design industries.

The concept of this research is to develop a science based communication tool to make knowledge easily digestible and for communicating the main methods and benefits without academic boundary so as to amplify the positive impact that the research can have on society as a whole.

There are sections relating to different groups of stakeholders so you may skip to the one(s) that relate to you, but please feel free to answer all of the questions.

Thank you :) !!

P.S. Please let me know if you would be interested in continuing to participate in the design process; co-design research following on from this survey!

(*This is an anonymous survey)

Time: 5 minutes
Sections: 5

(Feel free to share this survey with anyone you think might be interested in this topic)

Kind Regards,
Joseph Flynn
Mestrado em Design para a Saúde e Bem-Estar
Escola Superior de Artes e Design
Politécnico de Leiria

* Indicates required question

OZEAON - Research Survey

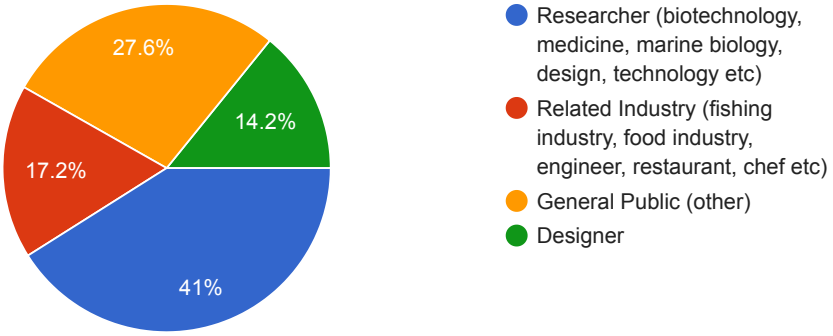
134 responses

Publish analytics

Which group would you best fit into?

Copy

134 responses



What is your occupation?

134 responses

Student

Researcher

Teacher

Professor

Student

Designer

Lecturer

PhD Student

Artist

Curator

Marketing

architect

Architect

administrative worker

PhD student

quality

PhD research fellow

Consultant and marine educator

Administrativa

Marine biologist and Sea food fishermen

superior technique

Community development officer

Environmental Advisor

unemployed

Phd scholar

Manager

Provide technical assitance to the various seaweed indutries

Master Student

Seaweed mariculture and seaweed food development

Retired teacher.

Marqee hire

Project scientist

University lecturer

Laboratories supervisor (Test Facility Manager)

Project Manager

Banker

ceo

Researcher and teacher

Senior Officer

Bolseiro Investigação

Marine Scientist

Student phd + designer

non profit CEO

Customer Service Representative

Artist/designer and researcher

Seaweed Artist

Science Communicator

CEO/ Founder

Industrial Design Student

Content Curation and Communications

Chef

Owner-Wild seaweed harvesting company

Founder and biodesigner

CEO

Sustainable ocean farming

Marine Ecologist

Community & Communications Manager

Full professor

Research Associate

research, climate action advocacy - on sustainable foods

Chef/Teacher

Social and environmental design

Teacher

Director /Engineer

various

Doctorate student

Researcher and lecturer

Start-up Founder

Seaweed Artist

Science Communicator

CEO/ Founder

Industrial Design Student

Content Curation and Communications

Chef

Owner-Wild seaweed harvesting company

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research, climate action advocacy - on sustainable foods

Chef/Teacher

Social and environmental design

Teacher

Director /Engineer

various

Doctorate student

Researcher and lecturer

Start-up Founder

Studying

Student at Eindhoven University of Technology

Masters Student

Energy

Event manager

Creative

Masters student

Software Developer

International Civil Servant

Technician/Assistant programmer

Industrial Designer

Artist, pre-service secondary teacher

Lawyer

Administration

Research

Home maker

Industrial designer

Architect

Training Specialist

Master student

sustainability

Microscopy hobbyist

Director of Operations, Business Founder

artist

Startup accelerator / ocean conservation non profit organisation

Operations Manager

Professora

Water Resource Specialist

Manager of Communications

Professora aecs

bio-artist and scholar

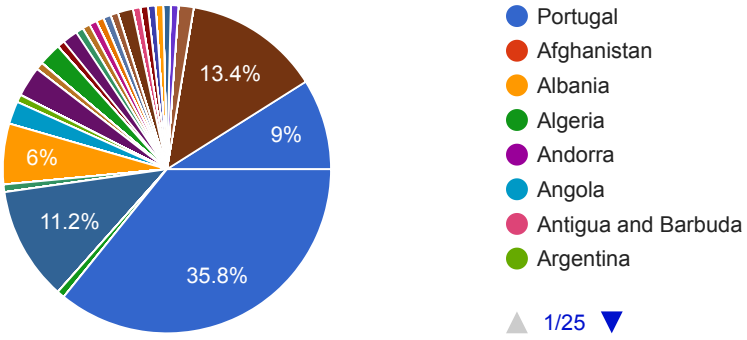
Production manager

5 more responses are hidden

What is your location? (Country)

Copy

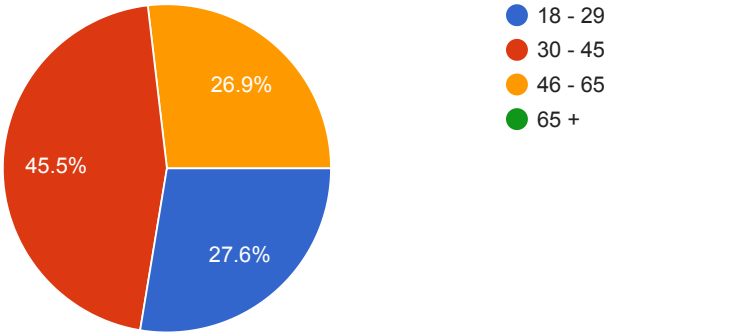
134 responses



What is your age group?

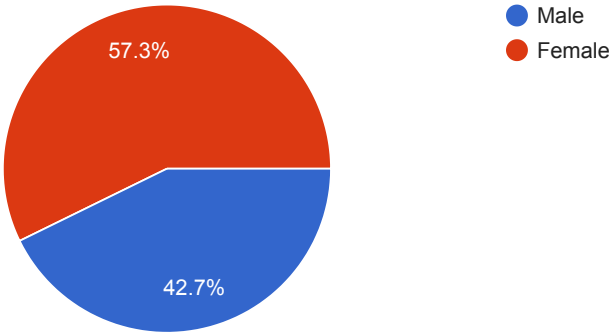
Copy

134 responses



What is your gender? Copy

131 responses

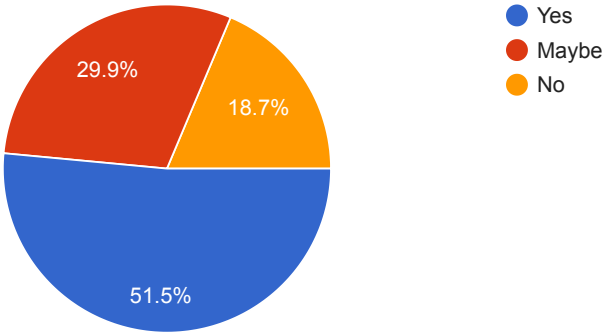


OZEAON Presentation

General Questions (Section I)

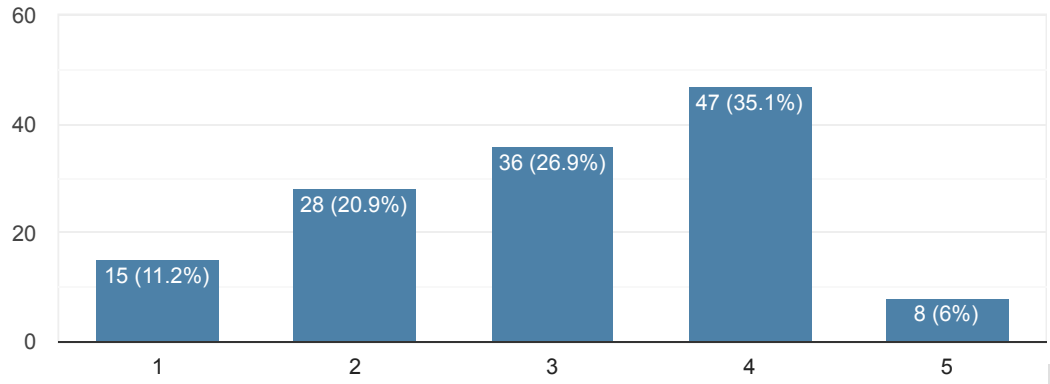
1. Would you consider yourself aware of the benefits of recent algae research and ocean farming techniques / technologies? Copy

134 responses



2. How aware of this new research and technology would you say that you are on a scale from 1 to 5? Copy

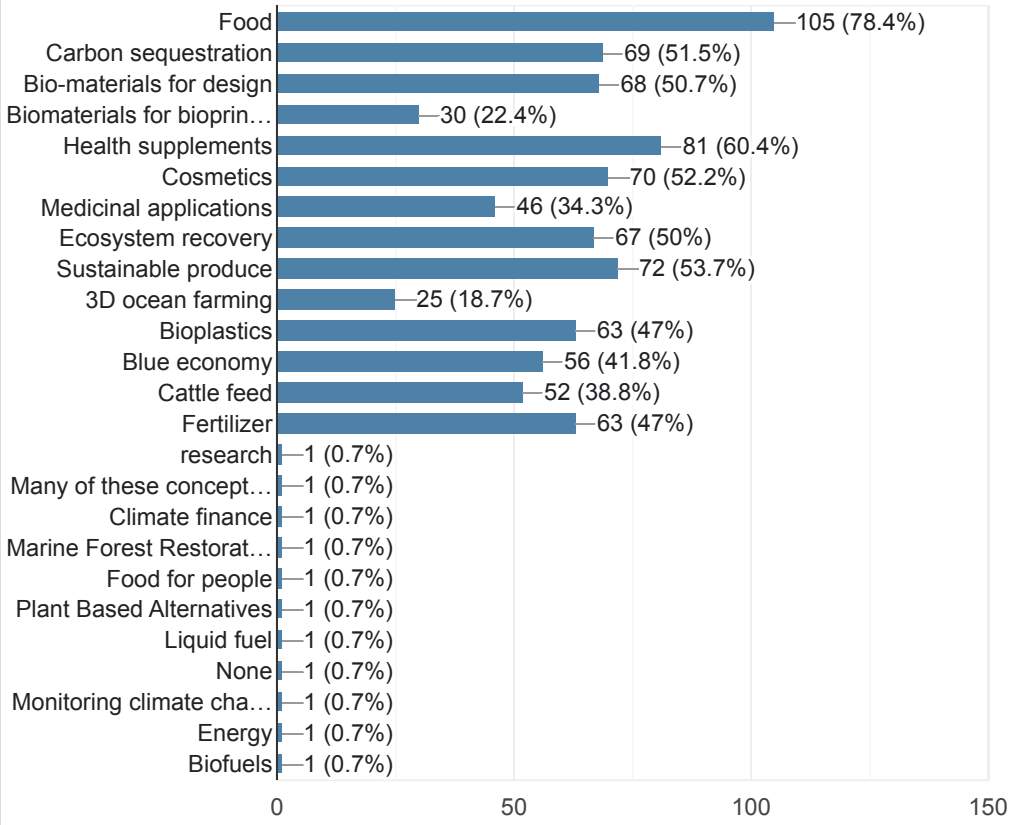
134 responses



3. Please select the areas that you are currently aware of...

Copy

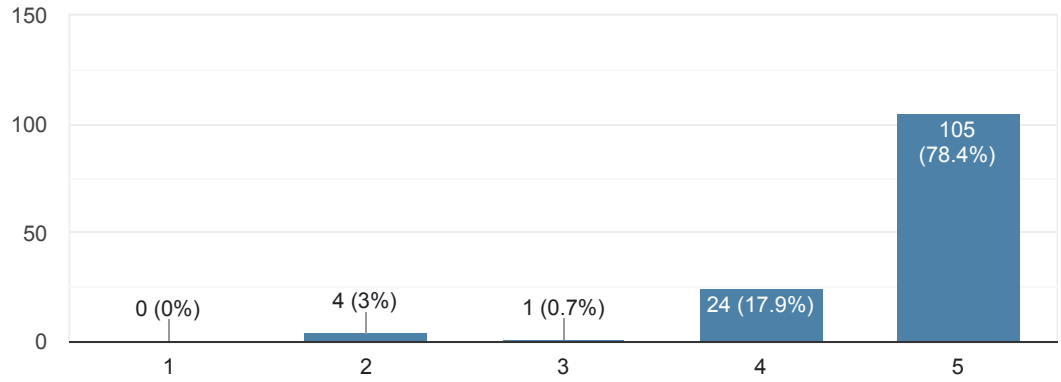
134 responses



4. On a scale of 1 to 5, how important would you consider the health of the ocean to be in relation to your own health and wellbeing?

Copy

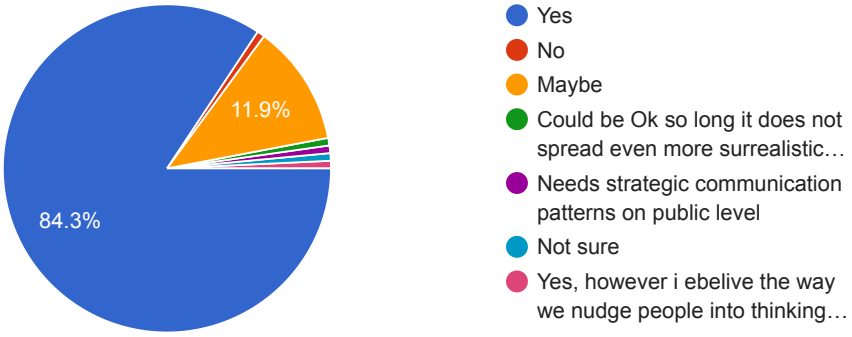
134 responses



5. In your opinion, would an Educational Resource be helpful for spreading knowledge and awareness about this topic?

Copy

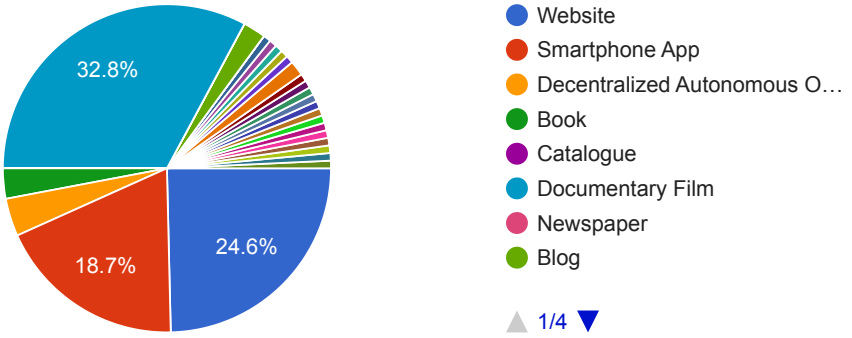
134 responses



6. If an Educational Resource were to be created, what would be the most effective form it could take?

Copy

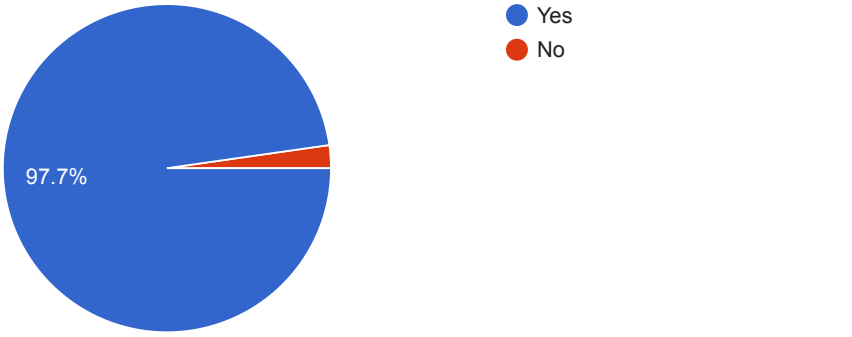
134 responses



7. In your opinion, do you think that it is worthwhile to design an Educational Resource about this topic?

Copy

133 responses



Researcher Questions (Section II)

1. What is your main field of research?

98 responses

Design

Biotechnology

Marine Biotechnology

Chemistry

Biomaterials

Seaweed biotechnology

Algae

Harvest and postharvest fruit technology

Aquaculture, molecular biology

Conservation and biotechnology

Linguistic, literature and foreign languages

Tudo, a essência de tudo

Materials and Technology

Aquaculture and Marine Biotechnology

Marine Biology

Seaweed bioactivities

Creativity and innovation

Ecology

Aquaculture development shellfish and marine plant

Climate change impact

Seaweed for healthcare

Land based seaweed seed production

1. What is your main field of research?

98 responses

Design

Biotechnology

Marine Biotechnology

Chemistry

Biomaterials

Seaweed biotechnology

Algae

Harvest and postharvest fruit technology

Aquaculture, molecular biology

Conservation and biotechnology

Linguistic, literature and foreign languages

Tudo, a essência de tudo

Materials and Technology

Aquaculture and Marine Biotechnology

Marine Biology

Seaweed bioactivities

Creativity and innovation

Ecology

Aquaculture development shellfish and marine plant

Climate change impact

Seaweed for healthcare

Land based seaweed seed production

Artificial reefs

Marine Ecology - sustainable aquaculture

Energy Engineering

food & biotech

Bioplastic

Seaweed aquaculture

Kelp ecology

Biotech

Plant Based

biomaterials and circular design

Aquaculture

Not yet established, but from my bachelor thesis I have some experience in biomaterials relating to packaging design / 3d printing

Algae based materials

None

architecture

Bio-Architecture

Recycled fabric

Biodesign

n.a.

Strategic communication

Law

Marine Toxicology

Stream ecology

Machine intelligence

Digital fabrication, bio material fabrication, computational design

Post harvest handling of fresh P. acanthophora

Marine biotechnology

sustainability

Fossil diatoms

Sugar kelp, aquaculture, sustainable fisheries

Ecosystem services assessment

Visual Art and Film

Not research. I am involved in supporting startup to commercialise and scale solutions to improve ocean health.

Cannabis

saúde e bem-estar

Physical Environment and Resource Management

Marine biology

biotechnology and art

Offshore construction

printing typography

Seaweed

sustainable materials & products

Architecture

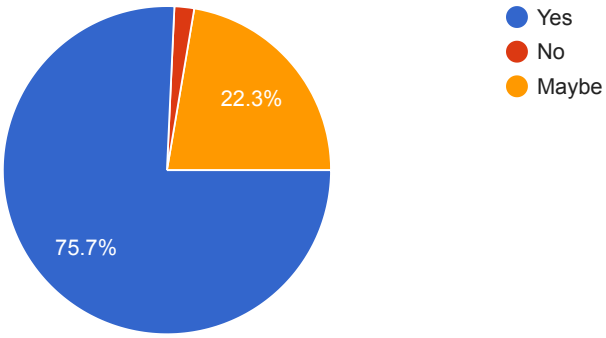
Traditional and Cultural uses of seaweed in the North Atlantic

IT

2. Would summarising research articles and academic knowledge for the public be beneficial for developing new science and or technology in this field?

Copy

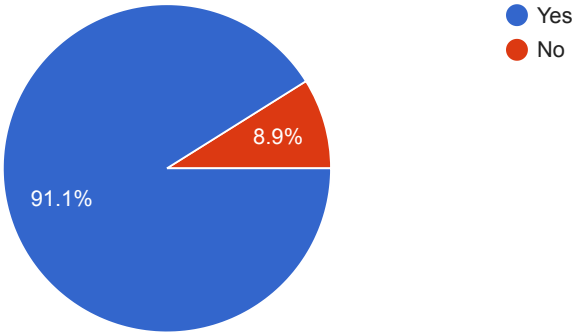
103 responses



3. Do you feel that the research in this field requires design intervention?

Copy

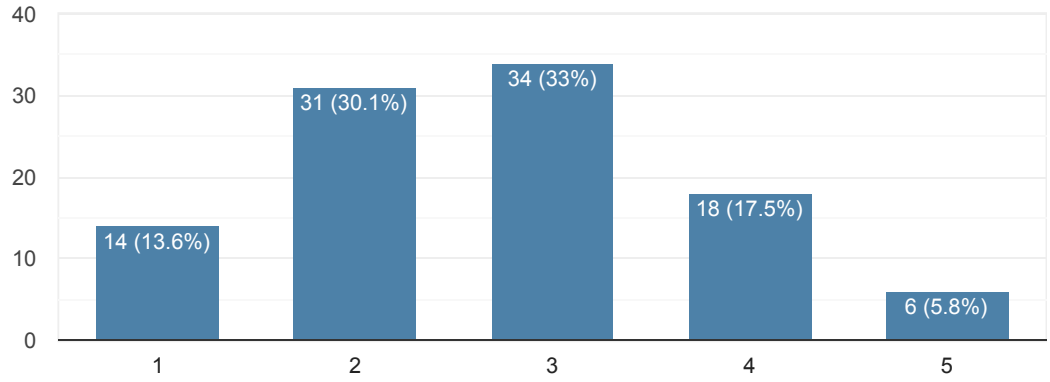
101 responses



4. How much awareness do you feel there is surrounding this topic from 1 to 5?

Copy

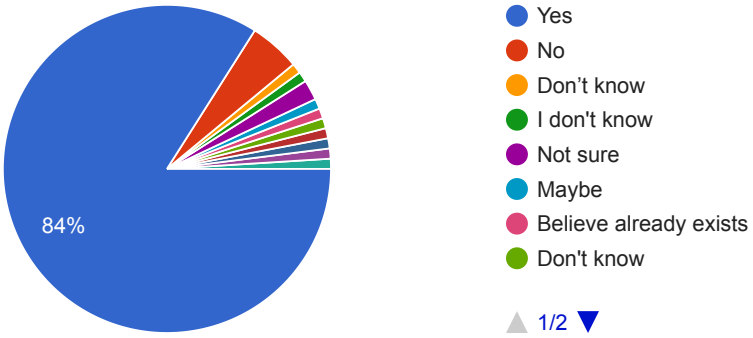
103 responses



5. As an educational resource is initially planned, would the development of a DAO (Decentralized Autonomous Organization) be worthwhile for ability to scale and develop real world incentives, applications and opportunities in this field?

Copy

100 responses



6. If there is any research or ideas that I might be unaware of, please let me know below.

19 responses

I think that research on algae and its application is still not well known because it only covers a very specific niche - people with more economic power, more education (maybe) that it is not surprising that we use algae for various purposes. It is necessary to create a language (and price) that takes into account all economic classes and sectors :)

None

Yes, tissue culture

can someone figure out who started all the present seaweed related propaganda?

To be effective, the need of the combination of different means of spreading knowledges is highly recommanded (special focus on social media's and contents spreaded within Internet service's users)

Contact the Scottish Association for Marine Scoence

Yes

There is still an immense amount of work that can be done in trying to increase the exposure and readability of scientific content without the involvement of tools with dubious reach, seccurity and long-term viability such as DAOs. No doubt the OZEAON team is aware of the environmental impact and long-term consequences of the proliferation of blockchain technolgoy, many of which are diametrically opposed to the project's own initial goals. Me and many other researchers working in fields closely related to environmental sciences will be skeptical (to say the least) in the use of blockchain-related technology, with which DAOs are intrinsically related. These concerns would need to be addressed with additional clarifications on the nature, role and impact of the DAO being developed.

Phyconomy is really useful

How do you finance your research at planet scale?

Please check Gilberto Esparza's work about microorganisms in plants or corals. His artistic work is a trigger to awareness on some ambiental issues.
https://gilbertoesparza.net/portfolio/plantas-autofotosinteticasautophotosynthetic-plants/

Nothing

Issue with research summary is that it is often loosely done and in complete layman terms, leading to complete misinterpretation that is often completely wilful and even for nefarious purposes, such as claiming the climate is cooling, fuelling many "fake news" outlets. People who consume such outlets will take everything for granted, and spread such disinformation to their circle which is detrimental. Summaries must be done right.

There are currently some researchers implementing methods to identify marine species and various algae, which is important for climate research.

Check Dr Bruce Damer https://astrobiology.nasa.gov/ask-an-astrobiologist/episodes/31/

Industry groups and collectives to advocate for enhancements and improvements in farming / production. Eg the Seaweed Institute of Australa.

https://biovip.pt/pt/chlorella trabalho com suplementação alimentar, representante nº 300241 http://www.biovip.pt/300241

Edutainment is the leading way to get knowledge to the people. Feel free to contact me for more ameenkunbargi@gmail.com

Algal oil-based biofuel development in Hawaii

Ocean growing in remote volcanic islands so you can carbon sequester without transport/transmission

Industry Related Questions (Section III)

1. Which industry do you work in?

65 responses

Aquaculture

Education

Events

Design

Academic/University

algae production

Alimentar

Mechanical Technology

Research and development

Educational and Offshore

I don't work in an Industry as research is not classed as Industrial.

No

working waterfront seaweed industry

University

Seaweed industry

Hospitality management

Biopharmaceuticals

Investigação

Science

Dedign

Sustainability

Art/design

Harvesting and manufacturing

Art

Food and beverage

Wild Seaweed harvesting

Biomaterials

Aquaculture and educational outreach

academia & SME

Private Chef/Teaching high school culinary Arts

Akasha design lab 100% biodegradables materials

Seaweed

Food

Builiding industry

Fashion

construction

Design + Education

IT

Public health

PR

Circular Design, manufacturing

Law

Sports equipment

Architecture

Fisheries sector

sustainability

Scientific equipment sales

Finance, aquaculture product development

Startup acceleration and ocean conservation

Industrial hemp

water

Student of marine biology

Arts

Offshore construction

Reusing materials

leading an association/Seaweed Cluster

I am a student

several

Architecture

Arts and Heritage

2. What is your main concern for the future of industry in the production of food and materials?

67 responses

Sustainability

is the future!

Sustainabity

Scarcity, pollution and low quality

The impact of waste residues on the ecosystems.

No food for all world population

Ocean health

Food production might be impacted with climate change depending on if there is more drought or rain in certain areas. Materials might become more scarce due to demand from a forever growing world wide population.

Carrageenan

Many of The New Seaweed Cowboys are dreaming impossible dreams.

Regulations

Too much processing, degrading nutritious qualities

Yes, green produtions

Corruption

Recovery of the ecosystems

Consequências ambientais

Not enough change will be made towards a circular economy that is truly sustainable. People HAVE to work WITH nature.

Resource access, extension, justice

To have sustainable and circular technological processes and not affect the enviromemt

Very promising

Industrial Ag

Natural resources and sustainability

Clean food with no loss of nutrients

its impact on the environment

Sustainability

That we keep doing the same mistakes we did in agriculture

Packaging

the change of mindset towards the circular economy model

The sheer amount of waste, water pollution, emissions, methane emissions, etc.

Descomposicion time- impact

Crop vulnerability to extreme weather

human trafficking

Climate change

Food security / sustainable supply chain / food waste reduction

Plastic

Carbon and job opportunities

Wokeness turning every facet of life to shit.

supply chains

Plastic + Genetically modified food

Lack of sustainability

Population growth, climate crisis, wars

resource scarcity, emissions from virgin material extraction, consumerism culture and the global acceptance of take make waste.

Climate chabge

Sustainability and resource depletion

Waste material

Sustainable source

sustainability

How will rapid industrialisation of developing countries, especially those of Africa impact the planet and their own environment. China did this and they ate up all the consequences, beginning to actually care (finally), other countries should not repeat this example.

Lack of awareness, misinformation, supply chain / accessibility

Ability to scale whilst ensuring a positive impact on the ocean.

A product that is not in symbiosis with humans, the environment and all other life.

If we do not scale, educate, and utilize algae or begin to within the next few years. the global community will suffer set backs when manufacturing and supply chains are constricted by government regulations.

The lack of goods

Local supply

Resíduos, desperdício, poluição, consumo excessivo água

Carbon reduction

Ending the decline of the natural environment, and the loss of biodiversity and any future for animals

shortage of raw materials, resource exploitation, poor system design, pollution

Market is not "ready", lack of information and facts about seaweed and benefits for the food industry. Materials: The alginate is expensive compare to other matierials used today.

I hope we will be able to make products that contribute to live with nature

Over consumption

to make it sustainable

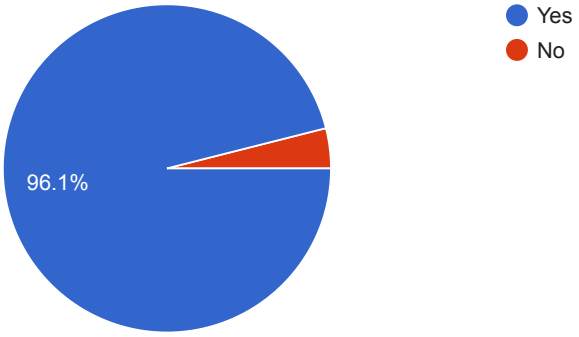
Production of food in a sustainable way

Sustainability, provenance, cultural and ecological relevance

3. Would an Educational Resource about ocean farming and algae help to benefit the development of new economies in the field?

Copy

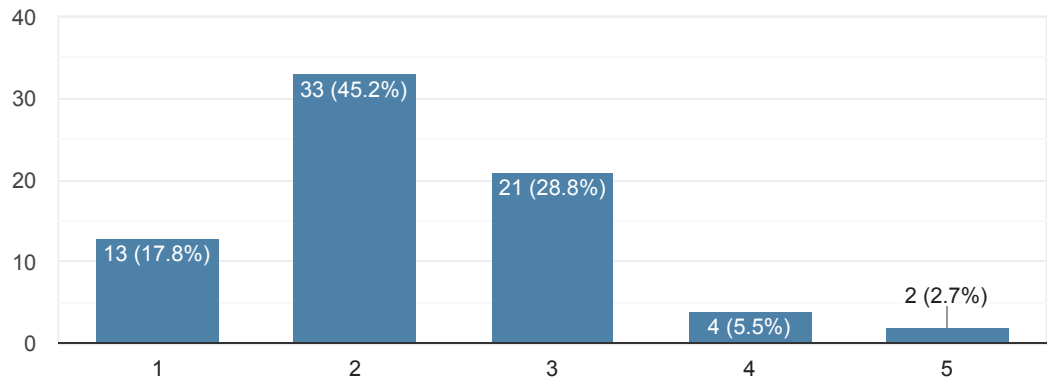
76 responses



4. In your opinion, how much awareness currently exists regarding the topics of this research survey from 1 to 5?

Copy

73 responses



5. What are the best ideas or concepts for developing new business solutions in this field? Please let me know below.

42 responses

inovation

I think that food can be a very interesting way to use this production , but I'm really hopeful about the plastic substitutes from algal compounds.

Treating the ocean with respect. No farmer would litter their fields with trash, yet those who use the ocean the most disrespect it. They do not understand that the tide does not sweep away the issues. It will affect their livelihoods.

Research, Education, Advertising and funding

Biorefinary

Just drop the hype and let real experts develop the markets

Maybe to relate it to an ethical view (environmental; C footprint...). How the service represents a positive citizen's action value! In another manner, how it can provide a wiser way of consumption...

Developing more food applications including seaweed

Promotion of a safer future

Knowledge and effective dissemination is really important. People need to know how to translate their innovative ideas into businesses and important social change.

Getting comfortable with how money actually works in climate finance and business development. You need to capitalize at levels much bigger than you are probably planning.

First of all i think its hard to know that since i do not personally know how much the public is aware of what is red algae or ocean farming. I think spreading the awareness through the resource etc is great but for providing and developing new business solutions you have a different target audience which is more lets say either training other autonomous groups

Intervention

Value added products and research.

Continue to share the importance and impact of kelp and algae for the environment and for food sustainability

Education about the ocean and the resources in it.

Fashion and single-use products

Small scale community businesses

sustainable aquaculture connecting fish farming and the production of algae (macro and/or micro) with minimal waste and energy consumption

I love the red algae research on the reduction of methane production on cattle

Experimentation

To create local and global communities with ecological preservation goals and techniques conservation

Mariculture of seaweeds

Encourage startups and employability in this sector, the government should readily give more coverage for the betterment of the nation.

economic awareness

I am going to use the word "people" to refer to individual people and groups of people including governments, orgs, businesses, etc.

Getting people the general information is a good start but people also need to be able to practically utilize the information which may require additional resources (access, money, skills, time, etc). Even if they have the above they need to care in the first place. Out of the people above that care and act, some people within that subset will have a significant higher impact than others. I think fastest way is by incentivizing those with higher potential impact to participate in developing these new solutions and funding existing ones. These incentives can be created by many groups.

Governments tend to have the most influence though through direct spending and incentivizing people in ways that can more easily lead to systemic change. Governments can give tax breaks for spending on sustainable products (as helped with electric cars in the USA, solar, etc to help offset some of the cost with the more environmentally friendly options). Governments could also be influenced to spend on and use the existing solutions themselves. Governments can also fund research, issue research grants, shape education, etc.

The Government of Norway is probably interested in investing in a commercial project in this area.

I don't have a huge amount of experience in ocean farming, but there are existing products and opportunities for new materials made from algae that are fully biodegradable.

Don't know

Material development and science

Explore anything under the sun.

Unfortunately, people will not just scout a beach and look at algae and think "yummy". Even vegan food wants to imitate meat products which obviously means people care about the taste. I have (foolishly) tasted some marine algae, fished out fresh, they taste fishy and slimey, eek. Cooked, they might taste better? Ideally, the food product will taste good and be healthy. Fake vegan meat might taste good, but they are usually as healthy as greasy bacon (Impossible burger, for example). I think a balance can be made.

I am developing a seaweed snack that is approachable and tasty to introduce benefits of the ocean to new consumers.

Increasing support structures to provide more opportunities to startups, researchers and businesses. Investment and Gov support. Good science to ensure balanced environmental and social impacts.

Sorry I wish I knew.

incubator, reduce market entry cost, develop research grants for universitas.

Carbon sequestration

accept that product design, information design and sustainable design have to go hand in hand with the industry in the present and future

Technology. Too much manuel work in the industry today, cause high prices. Need to streamline the production.
The market need more information about seaweed. And the high iodine content needs to be adressed.

Start a seaweed farm, so you can make it grow

packaging, content for food and cosmetics

Looking at commonalities across island and coastal communities

Designer Questions (Section IV)

Designer Assumptions Research

What is the best way to communicate complex research?

57 responses

infographyc

Videos

Graphical, schematic and concise

Documentaries

Study

-Organizing contents creation/apps competitions and finding sponsors to finance and launch the initiative

Television and through social platforms

It really depends on the audience - multiple streams is best.

I dont know

Immersion

Visuals, that are eye catching and pleasing to the eye. Information avoiding “jargon” and being easy to understand.

With schematic illustrations, visually

Simple slide decks

It depends on which audience you're targeting. You could have similar content but different platforms to target different populations. (i.e. age group, level of investment already in the idea, schools, industry?)

For my current project as a design student, I am in the early stages of exploring Lichen as a co-designer and learning a lot about the biology and ecological processes that take place. As someone without a true scientific background, I’ve found that taking a narrative based approach helps me digest complex ideas and information and thus share them more easily. Such as taking the complex mutualistic relationship between funghi, algae, Cyanobacteria and others in Lichen and looking at it as a household has helped me understand what the biological terms mean. My name is Eden Zinchik and my email address is eden.zinchik@gmail.com Hope this helped :)

To synthesize the research as Emotion [in a variety of formats: film, book, theater, etc.

I would say this largely depends on your audience. However making information digestible can be accomplished througg videos and written content and infographics. As longbas you keep in mind who your communicating with you can cater your language and form appropriately.

Make it popularly understandable

visualizations

Simplified for public use

In the simplest way possible, with numbers that support the benefits and impacts of its development.

Newsletter or publication with links to peer reviewed documents

Film and interactive experiences

Seminars. If the research is genuinely complex, and the audience needs a full understanding, then seminars in which the researcher unfolds the research in detail and allows questions, is the best way.

some blend of science (the core concepts must be understood) and art (creating emotions to facilitate the understanding of the necessary background (oversimplifications may not bring any added value)

Trough examples, short impact videos

(Bio) art makes it possible to visualize complex information while reflecting the work of various disciplines such as researchers, scientists, engineers, biologists, civil associations, artisans, artists, etc. In another response, I commented on the work of Gilberto Esparza, who, from my point of view, initiates the conversation on various topics of ecological restoration. His artistic pieces are widely published by both, scientific and non scientific media. It also allows us to speculate on future possibilities in response to the problems it poses

In person workshops

Visually, with clear contents

storyboards & visual presentations. If it is possible, I think the best thing is to produce prototypes - in order to provide the user experience.

Infographics or documentary

Initially I would say, indeed make a platform or an organization that manages all the input relating to this field of research and try to get some structure in it. However I read that you also want to make something physical, which I believe is very interesting as you could show the complexity in one object rather than many tabs on a website page. But it depends on how many people you are trying to reach.

Infographics, simulations, animations, gif and most importantly prototypes in exhibition.

Concise video and a deep dive (no pun intended) podcast

By implanting the research in the urban built environment. The more this research-output is experienced first hand, the more convincing it is going to be.

Documentary + Blog

Communicate the tip of the iceberg that is of interest to the receiver

Articles, podcasts... hard one in design

Who is the audience? For general public, social media.

Visual graphics to help explain

Infographics

Include photography

Orthodox and complete rigorous summaries, with graphs and lots of disclaimers, making it hard to near impossible to create disinformation.

Visual aids together with a verbal explanation

através de mestrado ou doutoramento

with an analogy that the student can relate to.

Social network

Through games and entertainment strategies

Web app and summarised research

Infograficos; transformar parte do conteúdo escrito em conteúdo visual

Through action

A multi-levelled and accessible format that does not detach from it's valid sources

depends on many factors, this is a very big question. but it depends on your source of research, which is the public that you want to exhaust and that you are looking to generate.

I'm not a designer, but I think you have to simplify the message, short videos, animations, vide interviews, don't make it to complicated. A website with long articles and text would not work

(I think).

case studies aand how to guides

Visually through diagrams

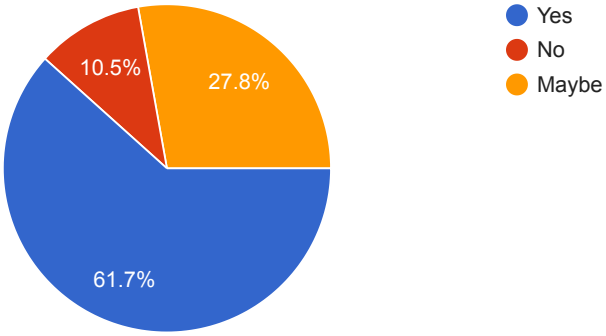
The same as Leonardo Da Vinci did through an holistic art/science interface

General Public Questions (Section V)

1. Are you personally interested in developing new solutions in this field?

Copy

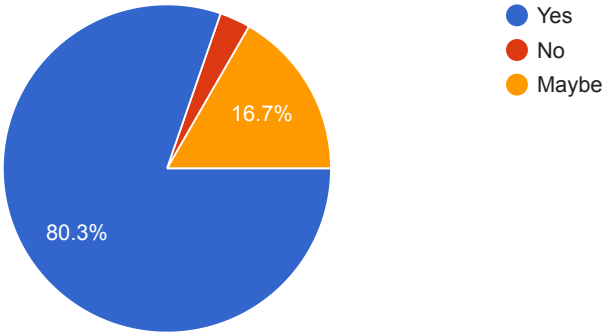
133 responses



2. Do you want to know more about this topic?

Copy

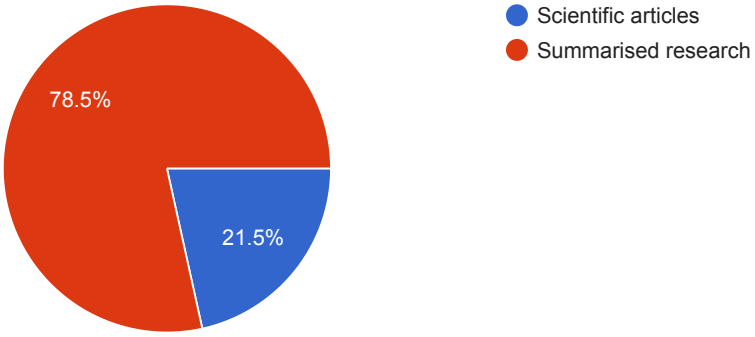
132 responses



3. Would you prefer to learn about something new through scientific articles or summarised research with designed visualisations?

Copy

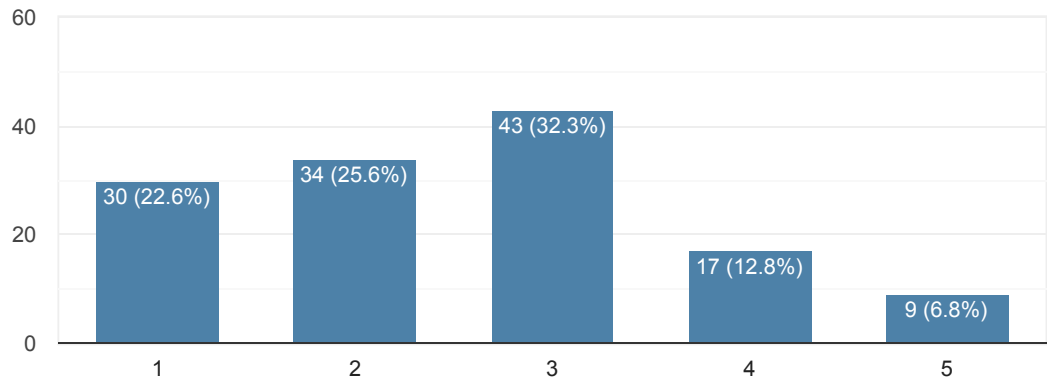
130 responses



4. On a scale of 1 to 5, what is your understanding of decentralized networks, such as blockchain?

Copy

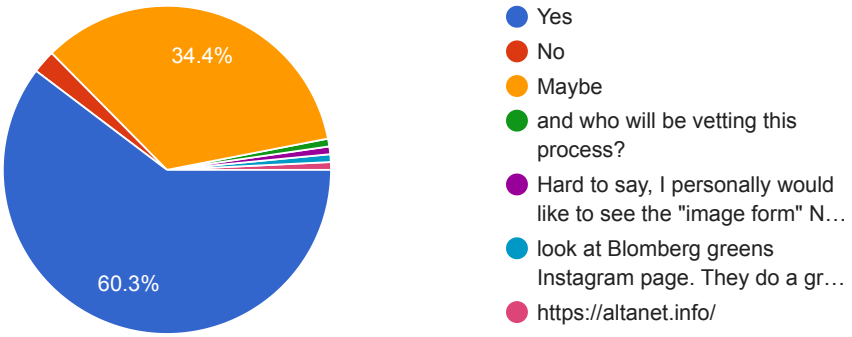
133 responses



5. Would you like to see scientific research summarised and developed into an educational resource that can potentially become a decentralized autonomous organization?

Copy

131 responses



Appendice 3. Full Results of Survey #2

OZEAON - 2nd Phase Research Survey

My name is Joseph Flynn and I am a developing this survey within my thesis for the Masters in Design for Health and Wellbeing at Politécnico de Leiria, Escola Superior de Artes e Design.

This survey is made to help inform my research for developing a public's Educational Resource for algae knowledge in order to make it easier and more accessible to understand the benefits of new ocean farming techniques and recent algae research in health care, ecosystem services, economy and food and design industries.

The concept of this research is to develop a science communication tool to make knowledge easily digestible and for communicating the main methods and benefits without academic boundary so as to amplify the positive impact that the research can have on society as a whole.

This is the second research survey in my study, with more specific questions about the design research.

I am focusing on 3 main areas in the research:
- The Beta version of the Educational Resource and its Content
- The Design of how this should look and feel to users, the UX and UI design
- The Design and functionality of a DAO

For the first survey if you have not completed it, can be found here:
https://docs.google.com/forms/d/e/1FAIpQLSfPH-3ymm1emwsAQXVptcWvCfPGRwp-vWeB69gfE3keXcdYNA/viewform?usp=sf_link

(*This is an anonymous survey)

Time: 5 minutes
Sections: 4

(Feel free to share this survey with anyone you think might be interested in this topic)

Kind Regards,
Joseph Flynn
Mestrado em Design para a Saúde e Bem-Estar
Escola Superior de Artes e Design
Politécnico de Leiria

* Indicates required question

OZEAON - 2nd Phase Research Survey

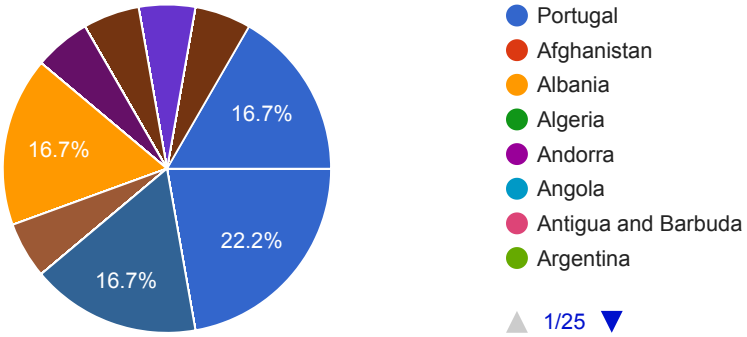
18 responses

Publish analytics

What is your location? (Country)

Copy

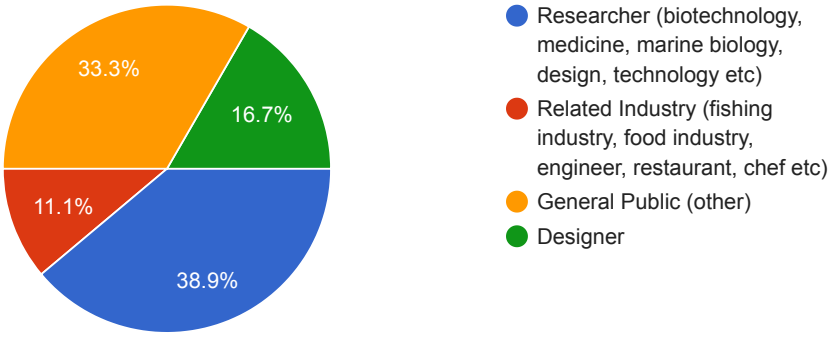
18 responses



Which group would you best fit into?

Copy

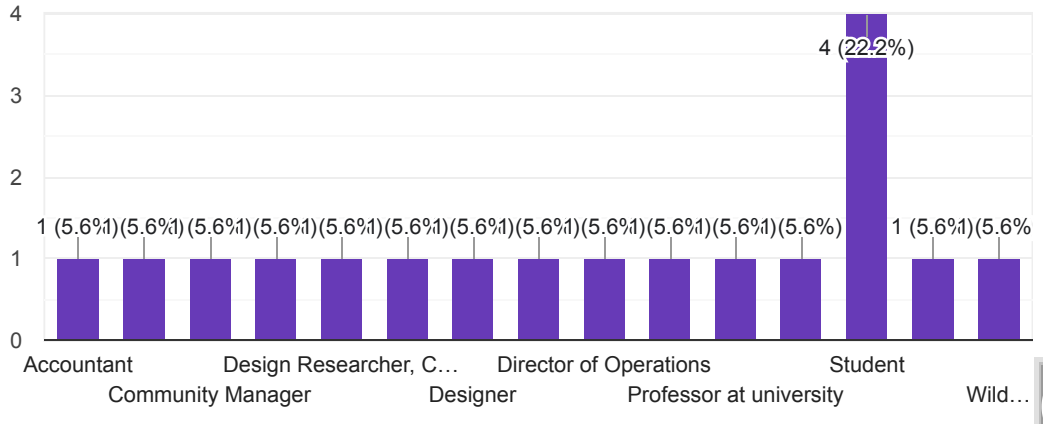
18 responses



What is your occupation?

Copy

18 responses



What is your age group?

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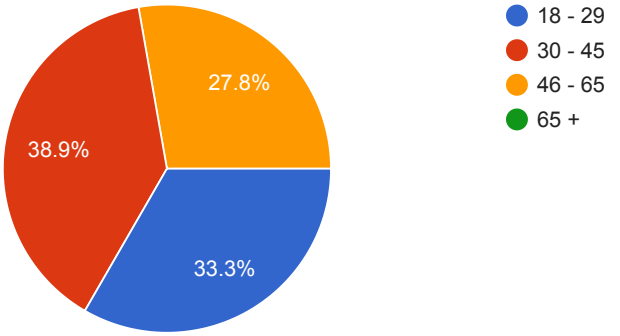
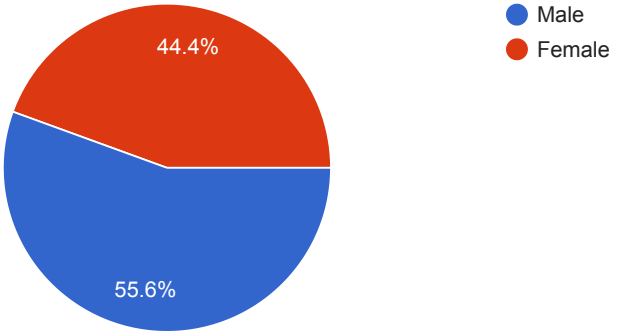
18 responses



What is your gender?

Copy

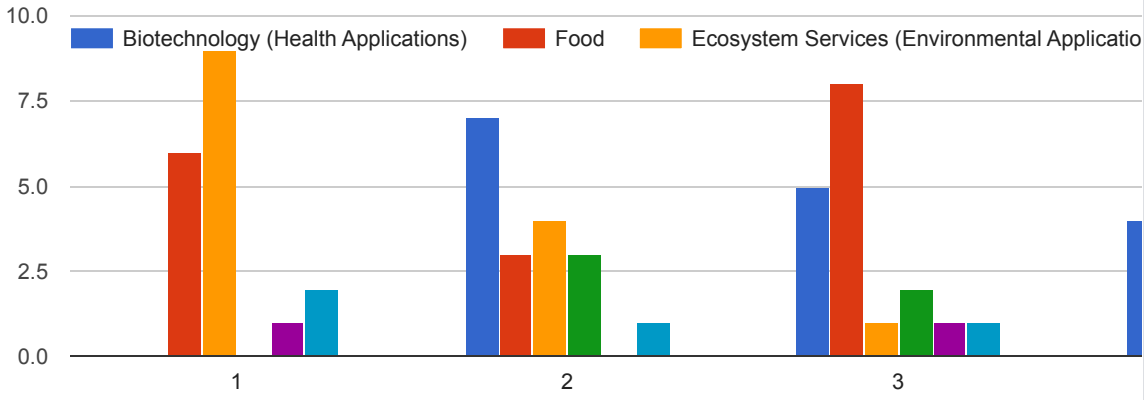
18 responses



Key Content

Please order each of the key concepts from most important to least important in your opinion from 1 (most important) to 6 (least important).

Copy



Is there a Heading I may have missed that you would like to see featured?

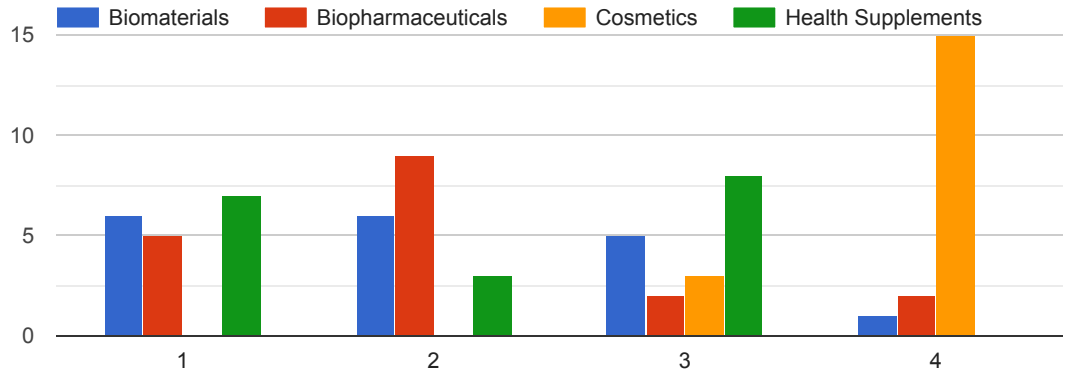
2 responses

I think environmental application and ecosystem services should be separated. As it covers such a wide range.

Energy? Food, water & energy are the essential basics 🙏 https://youtu.be/ohGa1DcA6BI

Within the Heading of Biotechnology (Health Applications), I have identified sub-headings to focus on. Please order these from most to least important.

Copy



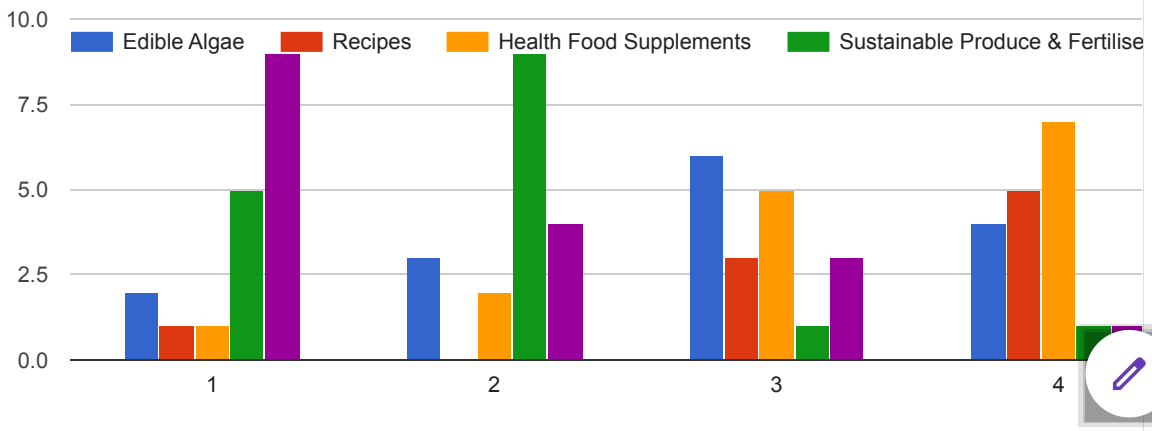
Is there a Sub-Heading I may have missed that you would like to see within this heading of Biotechnology?

1 response

Unsure

Within the Heading of Food, I have identified sub-headings to focus on. Please order these from most to least important.

Copy



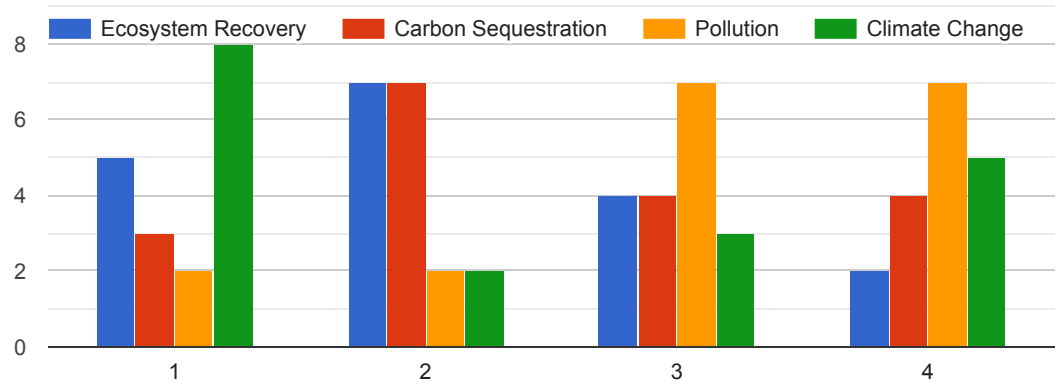
Is there a Sub-Heading I may have missed that you would like to see within this heading of Food?

0 responses

No responses yet for this question.

Within the Heading of Ecosystem Services (Environmental Applications), I have identified sub-headings to focus on. Please order these from most to least important.

Copy



Is there a Sub-Heading I may have missed that you would like to see within this heading of Ecosystem Services?

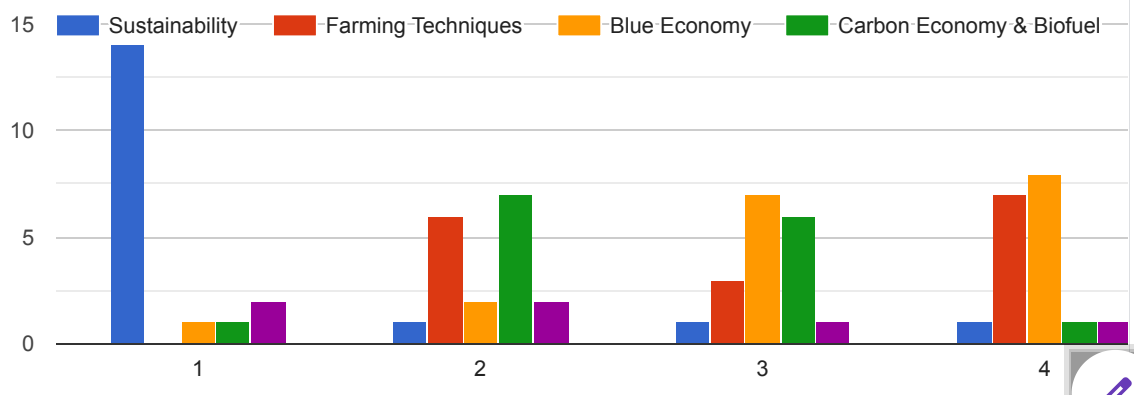
2 responses

Fish habitat

Honestly I would have put all on 1 most important

Within the Heading of Economy & Industry, I have identified sub-headings to focus on. Please order these from most to least important.

Copy



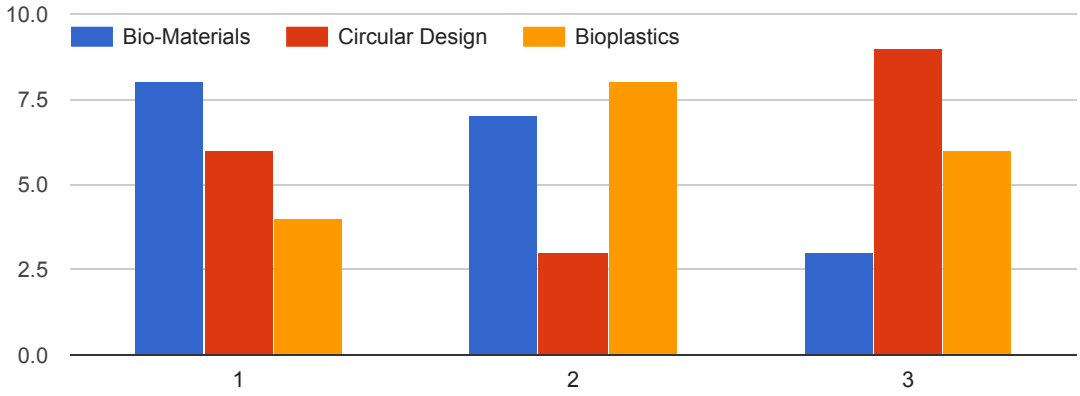
Is there a Sub-Heading I may have missed that you would like to see within this heading of Economy & Industry?

1 response

Finance. We have to figure out money at scale to address the solutions at scale. Finance is about speculation when it should be about stewardship. bankofnature.eco Also consumerism, income inequality, resource management

Within the Heading of Design Applications, I have identified sub-headings to focus on. Please order these from most to least important.

Copy



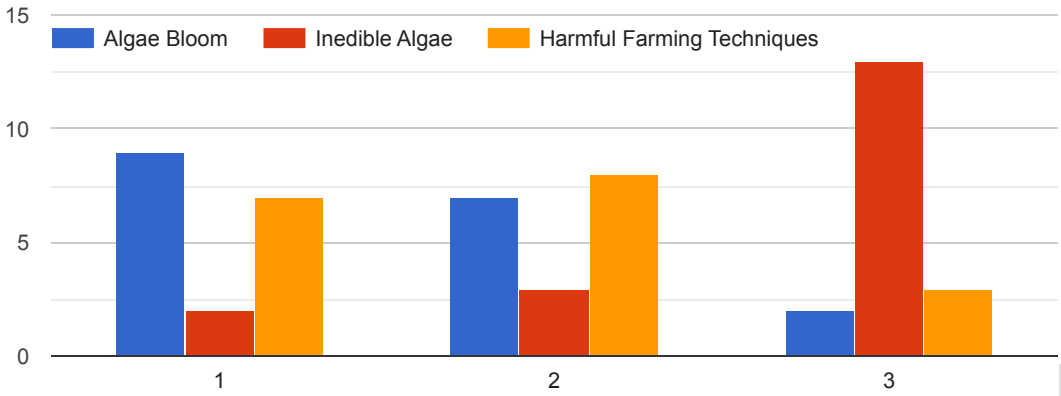
Is there a Sub-Heading I may have missed that you would like to see within this heading of Design Applications?

1 response

Regenerative Design

Within the Heading of Problems & Warnings, I have identified sub-headings to focus on. Please order these from most to least important.

Copy



Is there a Sub-Heading I may have missed that you would like to see within this heading of Problems & Warnings?

2 responses

The problems that come with the release of bromine on ozone.

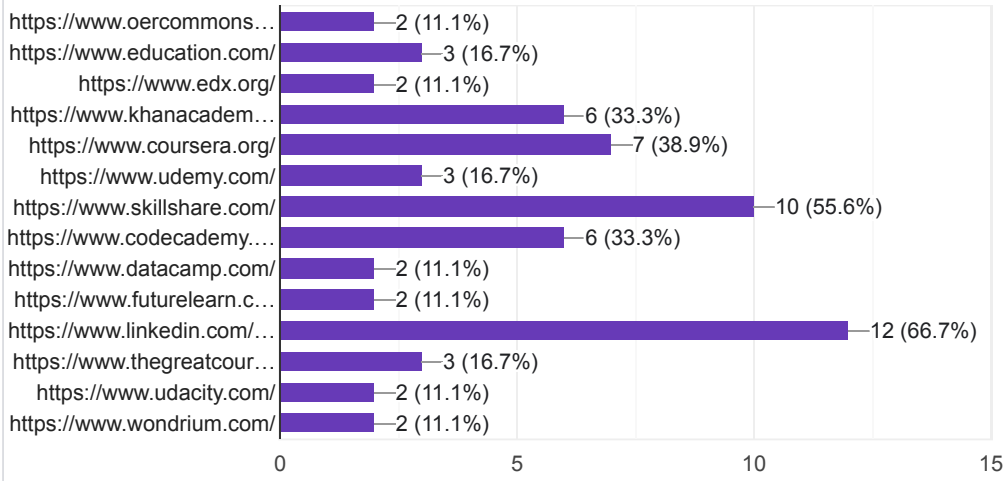
IPCC reports, SDGs, extreme weather

Web App Design - An Educational Resource

Please let me know which Educational Resource websites or applications you are aware of from the list below.

Copy

18 responses



Which website or app from above (or other) has the better User Experience Design in your opinion?

18 responses

skill share

I don’t know

dsrny.com

Coursera

Khanacadrmy

LinkedIn

I don't know

Skillshare

-

I’ve never heard of any of them

Don't know

Wikipedia

Skillshare.com

Domestika

edX

EdX

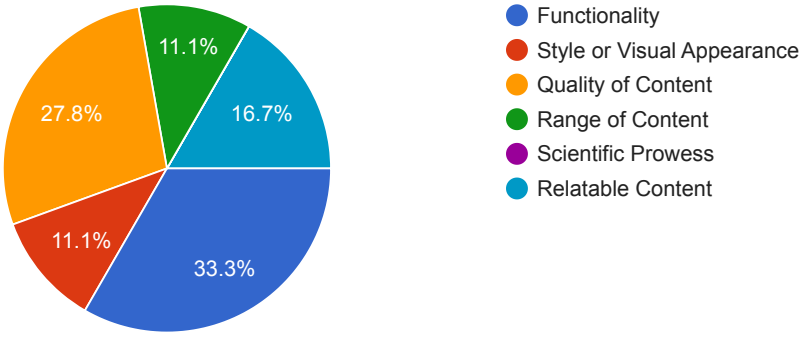
Code Academy

Can't answer

What is the most immediately attractive feature for you when considering an Open Educational Resource?

Copy

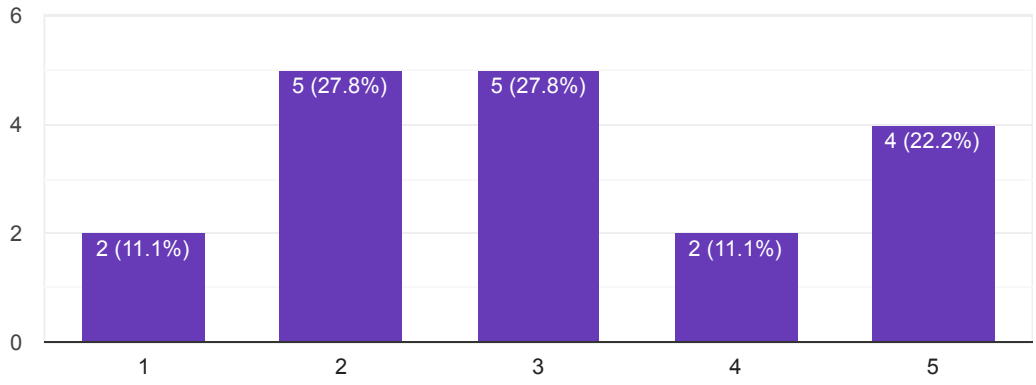
18 responses



How would you rate this artistic concept below for a User Interface of an overview of structure of the articles and subjects in the Educational Resource. (Imagine you could zoom in and out of this image to find appropriate and related articles)

Copy

18 responses

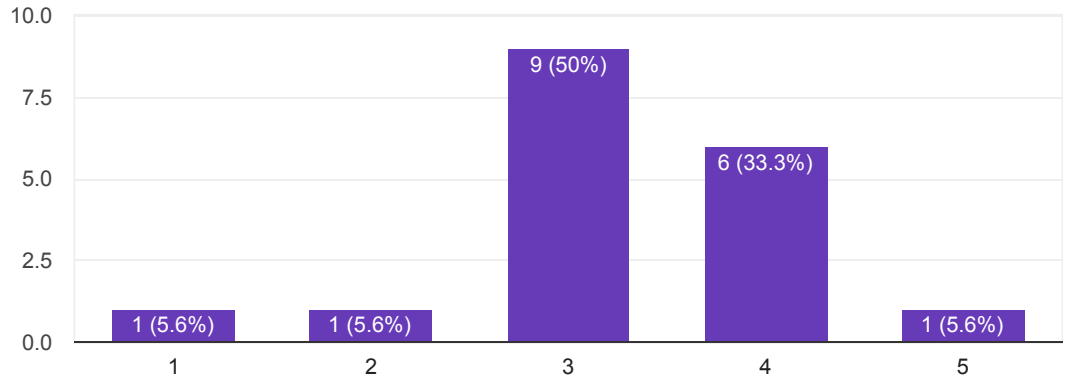


Decentralized Autonomous Organization (DAO)

How do you feel about blockchain projects, specifically DAOs?

Copy

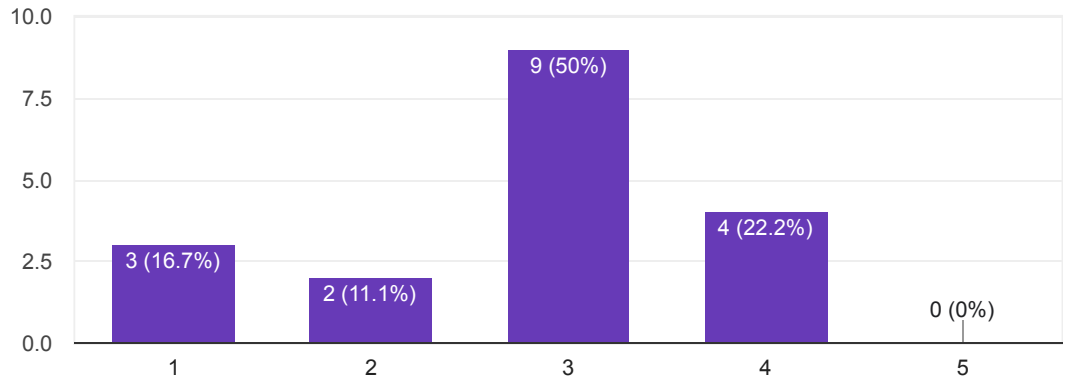
18 responses



What level of trust do you put into blockchain projects?

Copy

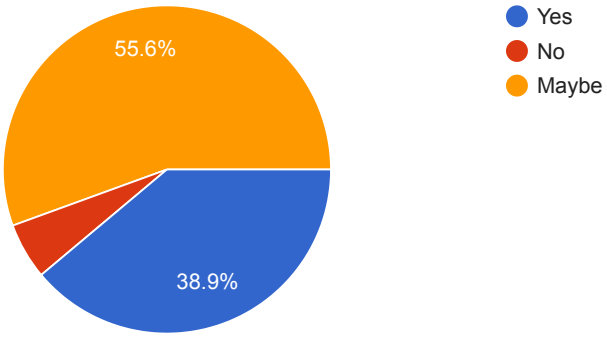
18 responses



A DAO is structured to be governed by its members, would this be a good way of organising (accepting, editing or rejecting) new additions to the Educational Resource that is planned?

Copy

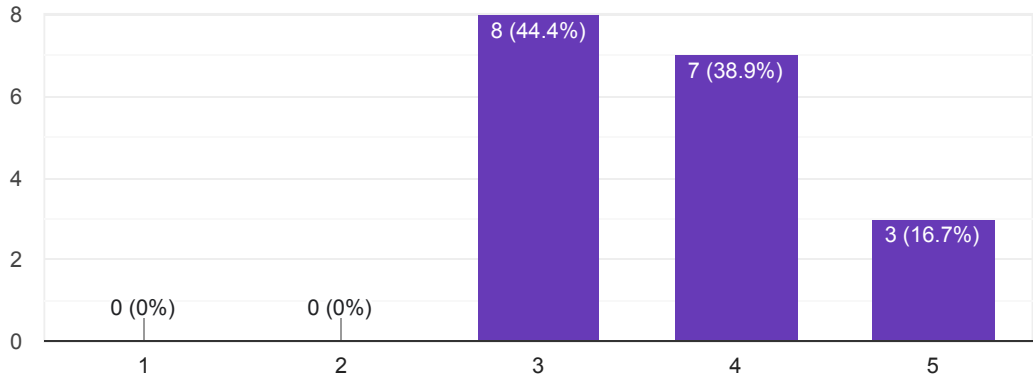
18 responses



UpLink (https://uplink.weforum.org/uplink/s/) is the open innovation platform of the World Economic forum, which proposes challenges that can be submitted to for funding. On a Scale of 1 to 5 how would you rate the design and concept of this platform?

Copy

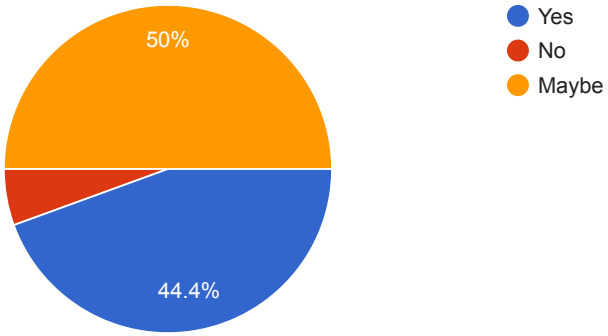
18 responses



DAO Maker (https://daomaker.com/) is a functional decentralized autonomous organization that is a venture investment platform where you can buy tokens of different projects as investment funding. Do you think this structure would be a good way of providing support for new and interesting projects in the blue economy?

Copy

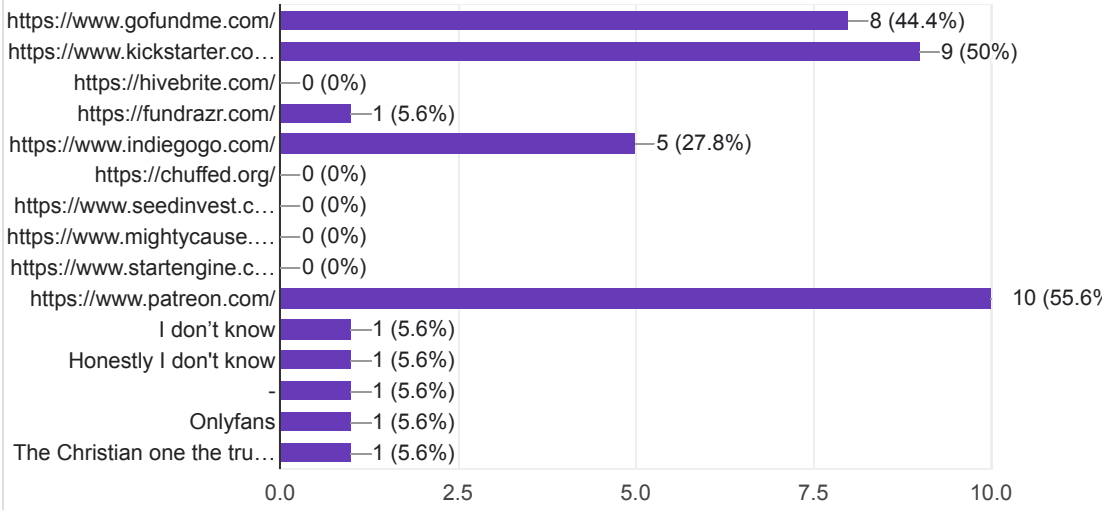
18 responses



Which platforms for 'crowdfunding' or starting new projects do you prefer?

Copy

18 responses



Appendix 4. User Testing Comments from Prototype #1

Earl Guest
Aug 08, 2022

I don't think the sections need to be repeated on each page for Environmental Services, Health and Biotechnology, Food, Economy & Industry, Design Applications, etc.

It could cause the user to load the website slow trying to load in all the additional data.

Earl Guest
Aug 08, 2022

I don't think the "Browse Educational Resources" half banner is needed on each page at the top.

Earl Guest
Aug 08, 2022

On Page 12 the "UN SUSTAINABLE DEVELOPMENT GOALS" pictures don't appear clear with the dark background.

Iuliia Guest
Aug 09, 2022

"Un sustainable development goals" line is moving around the page, when you scroll it, better to make it stable. (page 12)

Iuliia Guest
Aug 09, 2022

Don't think that Un sustainable development goals with all the icons has to be repeated on every single page

Iuliia Guest
Aug 09, 2022

Some pictures are not clearly visible. Also text is difficult to read. (Page 12).

Iuliia Guest
Aug 09, 2022

Logo of OZEAON moves on the top of the text while you are scrolling the page. (Page 6)

Iuliia Guest
Aug 09, 2022 (edited)

When the text about benefits is expanded, because of the dots on the background is not clearly readable. (Page 11)

Iuliia Guest
Aug 09, 2022

When you clicking to expand blocks (FOOD for instance), page is always moving back to the top. During navigation page have to follow user journey and show titles of expanded line. (Page 15).

Iuliia Guest
Aug 09, 2022

Here if you scrolling projects, they're crossing the line and making underlined options invisible (Followed, Popular, Featured, New, Coming soon) Page 29

Iuliia Guest
Aug 09, 2022

Here would be nice also to make underlined section (Open Projects, Approved projects, Pending projects and ect.), Page 32

Appendice 5. Informal Feedback Emails

(Answers in Red)

Participant #1

Name: Earl Wagner
Age: 36
Occupation: Software Developer
Nationality: American
Skills: Software Development, Project Management, IT Consulting,
Interests/Hobbies: Effective Altruism, VR Gaming, VR Socializing, IRL Socializing
Goals: Develop Software and IT solutions to help Effective Altruism (EA) Organizations and/or EA aligned organizations improve their ability to have positive impact on the world.
If you were interested in pursuing to work in this field or create a volunteer group or something, can you tell me about what your motivations and current frustrations might be?
Motivations: If it is EA aligned and has a potential for massive impact I'm more likely to be motivated.
Frustrations: I lack the time currently to dedicate myself to other projects.

___

In the past you have spoken a lot about something called Effective Altruism, what does that mean to you and how do you see the potential of my project possibly being a force for good and maybe an example of effective altruism? https://www.effectivealtruism.org/ Besides algae and seaweed being good for the reasons you mentioned above, they are also good to help with disaster recovery across several kinds of global catastrophies.
You are a software engineer as I understand, what do you think the main challenges will be for designing a system that can effectively do the things I am hoping for it to do (being able to help to inspire people to work in this field and gain funding through the webapp system I'm designing)? I am not specialized in blockchain technologies and cryptocurrencies. I'm not sure that people will trust crypto enough to want to integrate with it due to the regular occurrence of crypto crashes and scams.
What do you think are the main advantages of designing a Webapp instead of a website and mobile app separately? Reduced development time. Reduced amount of code to maintain.
What do you think are the main disadvantages of designing a Webapp instead of a website and mobile app separately? Depending on how the app is built and what all features it needs, native apps will likely offer better performance.
Blockchain technology is complicated so I know it will be difficult to actually build for the system/project/webapp - do you think it's a good structure for something like this and worth the time and/or effort? I am not confident that doing anything with blockchain/crypto will sufficiently incentivize organizations to integrate/use the system or individuals to contribute research.
Crypto markets have taken a big hit recently and have suffered many security issues in the past, do you think that this effects the perception of trust in blockchain technology for the long term? I believe it will have an negative impact on trust for a while.
I'm not sure about blockchain in the longterm.
In this project I am considering it a system for ReFi or Regenerative Finance (ReFi is the combination of two distinct disciplines: regenerative economics and decentralized finance. Regenerative economics focuses on a balanced, circulatory flow of capital that integrates both positive and negative externalities while taking care of people and the commons.1 It explores how to design the economy to regenerate what has been lost and conserve what remains while ensuring long-term financial prosperity. Decentralized finance aims to remove opaque, centralized intermediaries to democratize both the access to financial services and the management of the financial system itself.)
Do you think that ReFi is a good solution to providing real world value with blockchain technology and maybe restore some trust? Because I don't understand how ReFi is supposed to achieve its claims, I don't trust it myself.
Are you aware of the numerous benefits that can be delivered from the ocean with new advancements

in technologies and algae research? And would you like to know more? I am somewhat familiar and would like to learn more though.
What specifically interests you about this and the project itself? I like the idea of trying to help grow the technologies, research, and products produced with the technologies to help people
What doesn't interest you about this and the project itself, or where do you think I'm making a potential mistake? I'm not convinced blockchain/crypto is needed and could even harm the project.
Do you have any of your own advice or like to add anything? Not yet but I want to think about it more and discuss it with you.

Participant #2

Name: Rob Jensen
Age: 58
Occupation: United Nations Civil Servant
Nationality: Canada, Ireland
Skills: Languages, basic IT, raising contracts, procurement of goods and services for UN
Interests/Hobbies: Gardening, reading
Background: 1st class Honours BA from University of British Columbia, Canada. French and German studies. Fluent in French and German.
Goals: spend time with my family.
If you were interested in pursuing to work in this field or create a volunteer group or something, can you tell me about what your motivations and current frustrations might be?
Motivations: Idealism. We need to change our behavior as a species. That means adopting new ways of living to lessen the negative impact we are having on the planet. Our current way of living is destroying the planet.
Frustrations: Corporate and individual greed that prevents progress. A small group of people and companies make vast amounts of money and influence our politicians to maintain the status quo. The political elite do not work for the good of the people, they serve their own interests and the interests of the rich.

___

So, I think the obvious first question from me is - In the understanding of health and wellbeing and a clear understanding of the world, do you think that there are benefits for society to be derived from a better understanding of the ocean and its role in the health and wellbeing of the world?
The role the ocean plays for our health is enormous. The ocean is home to many species that we rely on for food. Ocean currents play a part in weather patterns. However, we can overfish the ocean leading to the extinction of fish stocks. Global warming is changing ocean current patterns and this will drastically effect weather and lead to extreme weather events and the melting of ice at the poles.
What do you think about an internet web application designed as a tool to help people to organise like minded thinkers for creating new understandings, systems and solutions with the ocean?
I think it would work if it connected people with similar interests and goals. Also it could be a gateway for raising capital from investors.
Sustainability is a key word thrown around a lot, what are your thoughts on the word?
And what does a sustainable world look like to you?
I like the idea of sustainability. To me, it means managing limited resources in a capable and responsible way. Mismanagement of resources is unsustainable management that leads to squandering what you have. The Bible has a great story about the sons who inherit talents. Talents were money, back in those days, one talent was a 25-70kg ingot of metal. They had gold talents, silver talents, copper talents etc etc. One son got 100 talents and when he died he had none left. Another son got 100 talents and when he died he still had 100 talents. The other son got 100 talents and when he died he had 1,000 talents. The moral of the story is that people might manage resources responsibly but they might also squander what they have. Our goal should be to manage our limited resources in a responsible way. That is the essence of the SDGs of the UN.
It is clear that the world of cryptocurrencies are under a lot of scrutiny these days (well deserved as it may be), do you think that blockchain technology is unreliable for organising people into a similar

thought pattern, psychologically?
Blockchain technology is like any other technology: the way you apply it determines success or failure. We know the technology is good and it works. Some applications will fail while others will succeed. For virtual currencies, the blockchain does work, the problem is that entities who control existing currencies, our fiat money, such as Wall Street banks, the federal reserve system, National Governments, have a monopoly using the existing system, and feel threatened by cryptocurrencies which they cannot control. Therefore, they have an interest in destroying crypto currencies and to a certain extent crypto currencies are struggling against fiat currencies. No one is buying goods today on Amazon.com with bitcoin or Ethereum, for instance. For better or for worse, that is just a fact.
A Decentralized Autonomous Organization (DAO) is what I personally think will be the best way for an online ecosystem to self govern. I understand that there are ways in which the ecosystem can be more or less controlled by a singular force of higher voting power. What are your thoughts on this?
Voting is an ancient way to manage our affairs. We run countries with the majority view. Minorities have to accept the will of the majority. That makes sense. It is the basis of democracy. If the majority of users within an ecosystem decide to turn left, and not turn right, then it would be arbitrary to turn right. The single force of higher voting power is "x" and "x" is the majority of the users, not one individual, or narrow group of individuals. However, when you look at the world today, you see that many individuals or small groups have seized power in order to benefit themselves, and not to benefit the majority of people.

Participant #3

Name: Landon Kibby
So Firstly, I guess my first question would be - What drew you to becoming an Ocean Engineer in the first place?
Quite frankly i wanted to build structures in the ocean.
And what are the most exciting developments you see in the field now?
I believe at this stage the latest developments in offshore renewables are the new kids on the block and doing the best stuff.
And what are you most excited about in ocean engineering for the future?
Probably looking at automated farming it appears that there is some really interesting things there, especially along the lines of deep ocean pumping utilizing wave energy.
As I know you have flirted with the idea of starting a carbon sequestration company, what do you think the biggest challenges are for this industry?
Getting something to a low enough price point to outcompete forestry or another green industry, i have recently started working on biofuels and for a lower price point you can reduce carbon emissions on the actual emissions side. i think eventually there will be a method for lowering the price point, perhaps growing in remote areas in the Atlantic/pacific islands.
Are you aware of the health and environmental benefits of ocean life such as algae?
no apart from carbon sequestration and some anecdotal health benefits
What would you see as the best way to garner more interest and funding opportunities for something like this?
probably to start a pilot plant and attempt to cultivate seaweed for only carbon sequestration or a desktop study/thesis to see if its possible

Participant #4

Name: Iuliia Egorova
Age: 35
Occupation: Data analyst
Nationality: Russian
Skills: IT
Interests/Hobbies: Music, art, sport, hiking
Background: Moved to Portugal 5 years ago
Goals: Self development, take part in positive environmental changes

If you were interested in pursuing to work in this field or create a volunteer group or something, can you tell me about what your motivations and current frustrations might be?
Motivations: to help people fight hunger, minimize plastic pollution by replacing it with bio plastic, populate
Frustrations: access to knowledge, access to social network focused on improving environment and raising funds

___

So I think the most obvious question is, what drew you to cryptocurrency in the first place?
Great opportunity to become a part of a new innovative decentralized financial system and invest in perspective projects in different areas
Have you heard of the terms, Regenerative Finance (ReFi) and Decentralized Science (DeSci)?
Yes
Do you have much trust or faith in the promise of blockchain and cryptocurrency technologies?
Yes, I do
If you take a look at https://www.cryptoaltruism.org/ - Does this help to get a better understanding these terms and provide you with more trust?
Yes
In my studies I am designing a prototype for a webapp platform that uses blockchain technology to raise funds for people wanting to start new projects related with the ocean like 3D farming (seaweed and shellfish farming) to regenerate the ocean ecosystems and biodiversity.
Have you heard much about the potential for positive change with these new ocean technologies?
Yes. Such a great positive impact on ecology, help to resolve hunger issues, develop medicine
Are you aware of some of the health and environmental benefits of algae and marine life?
Yes
Do you think there needs to be more easily accessible information about these benefits?
Yes, of course.
Would you be interested in using a platform like this, and do you think it would benefit the health and wellbeing of society?
Yes, I would like to use it.

The following feedback was sent to me via one of my supervisors:

Por mais que eu gostasse de continuar a dar o meu contributo ao projeto, discordo totalmente com a premissa do uso de criptomoedas para incentivos ao financiamento de investigação. Como o formulário atual já não me parece receptivo a este feedback, eu deixo aqui o meu comentário em relação ao assunto que a professora pode partilhar com o aluno ou o resto da equipa envolvida.
"For an open educational resource, the description of this project is remarkably vague and obtuse, especially for users not familiarized with the jargon of cryptocurrencies. Considering that it is unlikely that the target audiences are familiar with this lingo, I can predict some issues conveying the ways in which this organization functions.
Of course, my issues lie primarily not with how this information is presented, but with the premise of the project itself and the incentives provided by the use of cryptocurrencies and NFTs, among others. Contributions to the DAO being decided via ownership of an exclusive currency rather than expertiese in the field can lead to the creation of content that is primarily self-serving, interested in attracting investment not because of its scientific goals, but for maximum profitability within the system. Needless to say this is, to me, an absolutely unacceptable means of funding research. Additionally, claiming that a DAO where participation and decision-making is ultimately in the hands of owners of a currency is not democratic or inclusive, and stating otherwise in the project's description is a deceptive lie."
Deixo de parte a questão da sustentabilidade energética envolvida no uso destas tecnologias, que acho ter mencionado num email anterior quando recebemos o primeiro formulário. Acrescento também que admiro o trabalho e a dedicação do aluno, ainda que não concorde com o seu objetivo. O design e organização da página estão bastante bons na minha opinião.

Appendice 6. Full Results of User Testing of Prototype #2

User Testing - OZEAON Prototype

Hi, and Happy New Year

Thank you for participating in user testing for my research. Your contribution will be very useful.
This Usability Test will take 15mins of your time.

As you know the project for my Masters in Design for Health and Wellbeing I am working on is called OZEAON.

—

It's a new Open Educational Resource and Decentralised Autonomous Organization. Exploring new ideas in science and technology of the oceans, with it I hope to bring together education and creators in the field, scientists, fisheries, entrepreneurs and industry for creating a global community of ocean lovers, searchers, researchers and innovators.

It will be coupling the ideas of a social network with crowd funding, summarised scientific knowledge articles and blockchain technology to hopefully inspire people to develop more solutions in this field.

The main issue it is concerned with is the health and wellbeing of humanity and the natural world, focusing on the ocean and the benefits that can be harnessed with it.

Through working with algae and new ocean technologies we can protect the world's environment, restoring ocean ecosystems while developing sustainable opportunities for humanity.

—

There are 3 sections.
(1) Participant information; (2) Scenarios feedback; (3) Prototype evaluation.

Kind Regards,
Joseph Flynn

Masters Student
3200165@my.ipleiria.pt
Master in Design for Health and Wellbeing
ESAD.IPL (School of Arts and Design)
www.esad.ipleiria.pt

* Indicates required question

1. Email *

User Testing - OZEAON Prototype

17 responses

Publish analytics

Participant Information

What is your Name?

14 responses

Andreia Sousa

Sónia

Carmen

Guy

Robert Jensen

Henrique

Siddarath Ahuja

Earl Wagner

Iuliia Egorova

landon James Kibby

Alice Martins

Isabela Silva

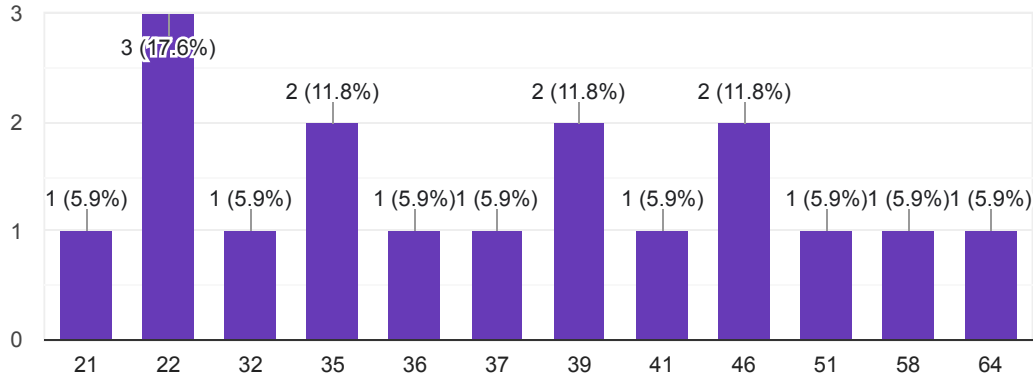
Tom

Larisa

What is your Age?

Copy

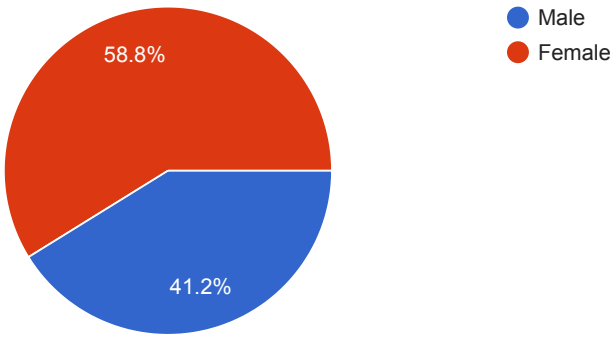
17 responses



What is your Gender?

Copy

17 responses



What is your Occupation?

17 responses

Student

Professor and Researcher

Técnico Superior

Researcher

Professor

Software engineer Student/ stay at home dad

United Nations Civil Servant

Master Student

Investing

IT/Software Development

Data analyst

Engineering Consultant

Researcher at MARE-Polytechnic of Leiria

Student

Retailer

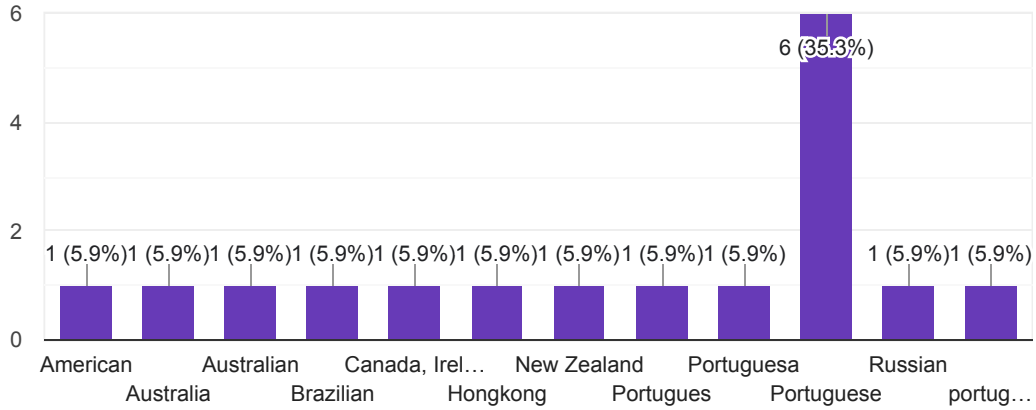
Analyst

student

What is your Nationality?

Copy

17 responses



What are your Skills?

13 responses

Proactivity, team work

Zooplankton Ecology and conservation, global change, zooplankton life histories, ecosystem functioning, ocean literacy

Scientific Research

Maths/Communication

Languages, basic IT, raising contracts, procurement of goods and services for UN

Teamwork, interest in macroalgae and microalgae

Buisness development, research

IT/Software Development/Project Management

IT

Offshore Construction, Renewable energy, Biofuels

Chemistry/Biochemistry

Microbiology, researching, communication

Going for walks

What are your Interests / Hobbies?

14 responses

Music, volunteering, reading

Travel, sports, exploring ideas and knowledge

Music

Science and history. Reading sci-fi and fantasy. Fishing.

Gardening, reading

Macroalgae and Microalgae,Playing Cello

Sports, Cinema

Effective Altruism. VR.

Music, art, sport, hiking

Mountain biking, diving, sailing

Music, Moovies, Travel

I like drawing, painting, volunteering in dog shelters, going out

Going for walks and swimming and music

Art

What is your Background?

11 responses

Bachelor in Marine Biology and Biotechnology

Biological Science

Marine Biotechnology

Married with kids. Previously worked as doctor.

1st class Honours BA from University of British Columbia, Canada. French and German studies. Fluent in French and German.

Graduation in Marine Biology and Biotechonology

IT/Software Development/Project Management

Moved to Portugal 5 years ago

13 years oil and gas offshore construction, 1 year as consultant

Research in plant natural products with biological properties. Chemistry teaching

Christian of European descent

What are your Goals?

13 responses

Finish the MSc in Marine Resources Biotechnology. Work with algae.

My main objective is to deliver innovative tools and approaches to fully leverage ocean knowledge and advance ocean sustainability

To be happy making a positive diference in other people lifes

Continued education. Trying to be healthy.

Spend time with my family

Research, conservation and cultivation of macroalgae and their properties

Invest in impactful organizations

-Build SaaS (Software as a Service) Projects
-Use my skills in IT/Software Development/Project Management to assist Effective Altruism organizations or run my own
-Develop skills in Data Science, Machine Learning, and AI to improve scientific advancements and work on Effective Altruism causes

Self development, take part in positive environmental changes

to help spearhead great engineering solutions to issues that exist both inside and outside green revoloution

Excelence in scientific research and teaching

I want to be an important researcher in the future and make part of an interesting discovery

Tell the truth

What are your current Motivations? (If there were some in context to ocean and algae research)

13 responses

Know the compounds and properties of algae.

To preserve ocean for the current and future generations.

To develop sustainable strategies based on the marine environment to deliver new products/services for humans' health and wellbeing

I worry about the environmental future for my kids.

Idealism. We need to change our behaviour as a species. That means adopting new ways of living to lessen the negative impact we are having on the planet. Our current way of living is destroying the planet.

study more sustainable resources of marine origin, learn more about the ocean and the applications of its resources and their properties.Learn more about seaweed and its properties

Advance the reasearch, Protect oceanic ecosystems

Effective Altruism. Ocean and Algae research may help prevent global system destabilization and help with global catastrophe recovery

Help to resolve plastic pollution problem

if we can reduce the overall carbon footprint by effectively growing more seaweed in the ocean that would be great to offset some of the things we just cant reduce carbon.

To discover new ingredients from macroalgae with innovative biotechnological applications.

Making the world a better place for people to live and helping people in general

I like no pollution in oceans

What are your current Frustrations? (If there were some in context to ocean and algae research)

11 responses

I am not integrated in any project of the área.

The lack of financial and career support for researchers, which translates into a huge neglect of research.

I have been working for 13 years as researcher, and still do not have a solid position or a job contract

Tragedy of the commons. Over fishing, excessive use of fossil fuels, lack of international cohesion and monitoring.

Corporate and individual greed that prevents progress. A small group of people and companies make vast amounts of money and influence our politicians to maintain the status quo. The political elite do not work for the good of the people, they serve their own interests and the interests of the rich.

Overfishing, plastic pollution,climate change and the consequences on biodiversity

Limited progress, minimal collaboration from all regions of the world, constant degradation of oceanic environment

Access to knowledge about ocean ecosystems to the society, low interest of the society in ecological issues

in my opinion all the current things looking at seaweed farming are not looking enough at targetting the bottom cost (Carbon offset) all these makeups and feeding cows is great but the system cannot be sustainable unless it is economically viable at minimal cost.

The isolation and identification of some marine compounds is very hard.

The lack of interest and trust of people in the science

Please upload a Profile Picture

2 responses

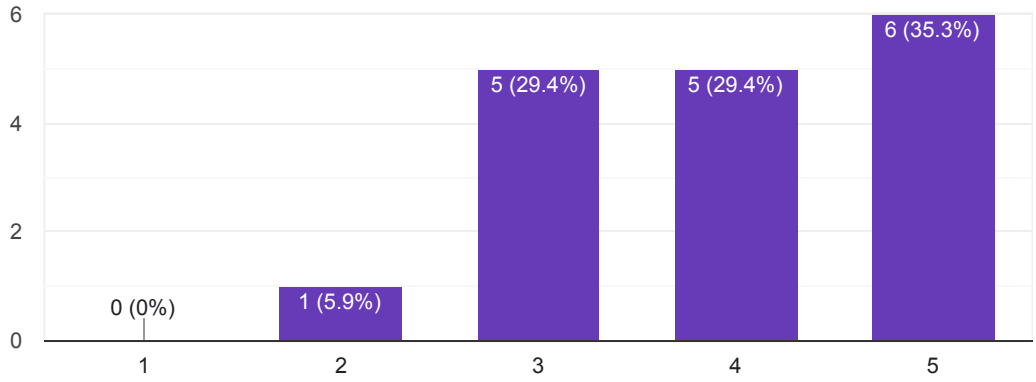
Scenarios feedback

Scenario #1
Layout of Welcome Page to the Educational Resource

Was it easy to navigate through the information and find what topics you were interested in?

Copy

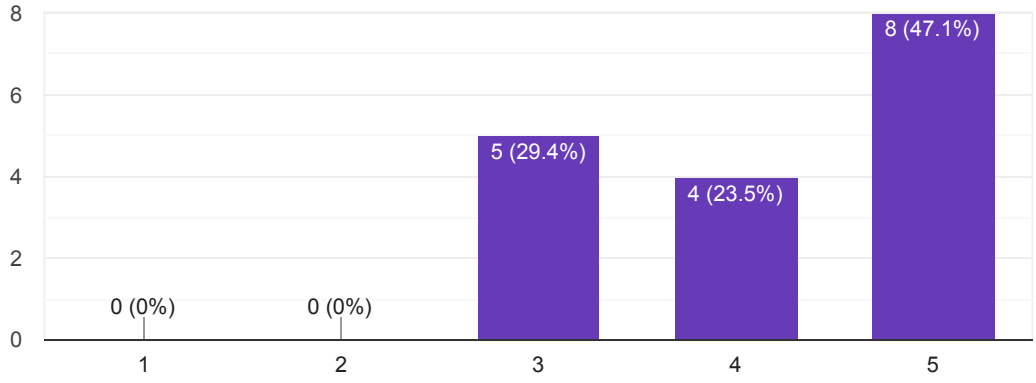
17 responses



Did you find the information relevant and useful?

Copy

17 responses



Do you like the design and layout or is there a preferred way in which the information should be displayed?

17 responses

I like the design.

the design and layout are very appealing and intuitive.

When the design applications menu is selected the page goes to top

too much text

Yes

The website is visually very pleasing, and once one is familiar with the site it becomes easier to navigate, however there is a significant learning curve. The concept of a decentralised crowd funding website running on blockchain tech is innovative, futuristic and begs the question - could this be applied to broader areas of business and research other than the ocean algae?

The design and layout is uncluttered and clean. I like it.

Yes i like the design

Needs some optimization to correctly group the information but overall its acceptable

I don't think it was difficult to navigate to a page that I was interested in reading. I think that there should be a menu that shows the topics of each page on the left to navigate faster to a particular topic on each page instead of having to scroll through everything. I didn't find the information very useful on the page for ecosystem recovery. It was useful in the sense that it mentioned some of the specific concerns but didn't provide much in the way of specific interventions currently being used now, in-development, or ideas.

I like the design very much, looks good to me

its understandable, a bit wierd that it is pages 1-62 like a slideshow but then is navagable

I have preference for more appelative colours in the design.

I like it

It's pretty good but would probably be better if you made the same thing without Adobe XD. Bringing adobe into it is just going to make it less compatible than if you did it without it. For instance, the page didn't work on my iPhone.

Nice and neat

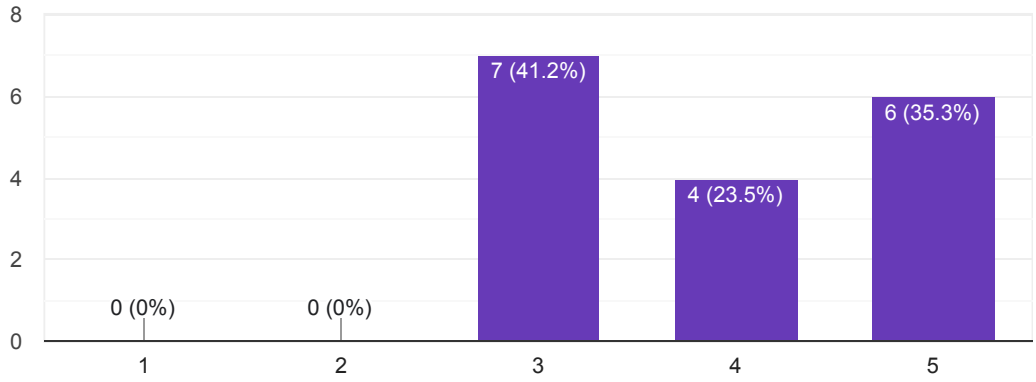
i liked

Scenario #2
Layout of the Home page of the DAO and navigation

Were the menus and layout easy to find and access?

Copy

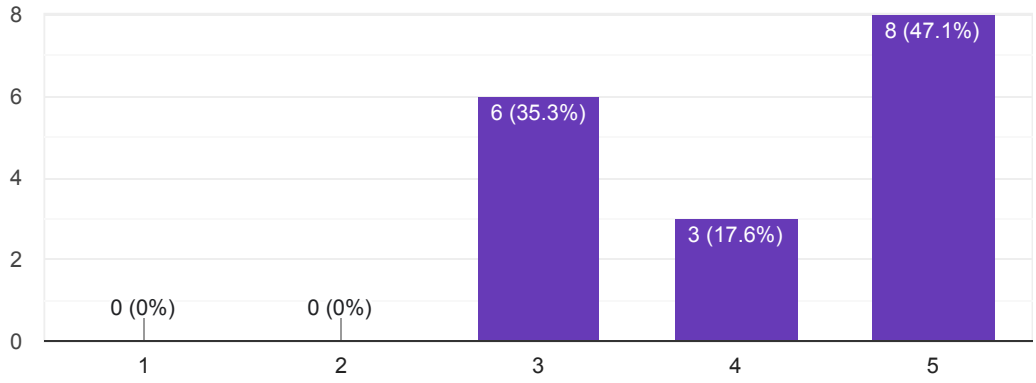
17 responses



Was it simple and easy to navigate to the different main pages, being Home, Profile, Portfolio, Projects, Articles, DIY Tutorials etc?

Copy

17 responses



Do you have any recommendations?

17 responses

No

It all sounds excellent.

no

less text; include a vertical navigation bar

I would prefer to see the homepage upon first arrival at the website and to have a simple navigation bar highlighting the different areas of the site that remains accessible from every page, not suddenly appearing and disappearing as one travels from page to page throughout the site. Also the page index nav bar at the bottom is odd, the homepage in on page 81/82 and yet when we first visit the site we are on page 1/82. Are people supposed to scroll through the entire site from page 1 to page 82 like a book, and if so, why is the homepage on page 81? Also, there doesn't appear to be a natural order to the pages. Also, the initial menu that pops out of the symbol from the landing page is non-intuitive and is only accessible upon initial arrival at the site unless one navigates back the landing page (page 1/82) via the page scroll. So, all in all, if one includes the hamburger menu as well, there seems to be at least 4 methods of navigating the site, none of which are consistently available throughout.

I am not a visual artist however the design of the pages is clean and uncluttered and makes it easier to concentrate on the message instead of a lot of distracting images.

optimize the website and sub-group the sections as much as possible.

Offer filters for project categories to filer the project list

Nope, it looks good. It was easy to find every page

one page clearly states whats going on thats good

It would prefere more color constrast between texts and screen.

Not really

Needs to work on iPhones.

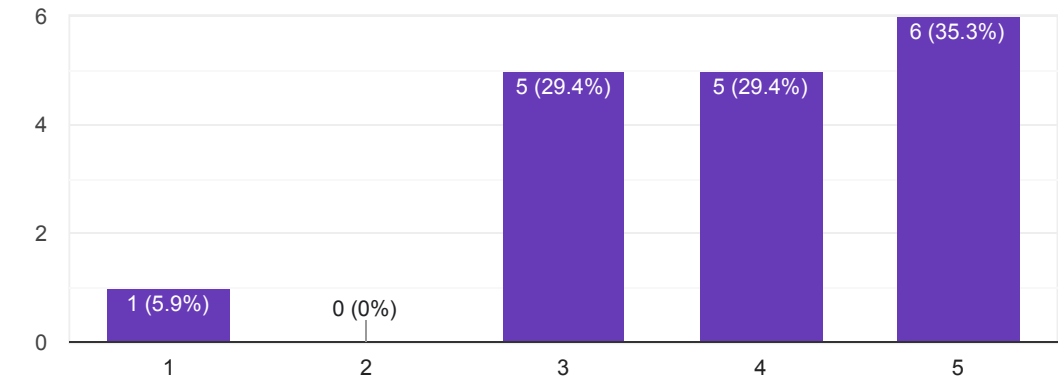
Loaded slowly, maybe too “heavy “

is good already

Scenario #3
Navigating the usability of the DAO

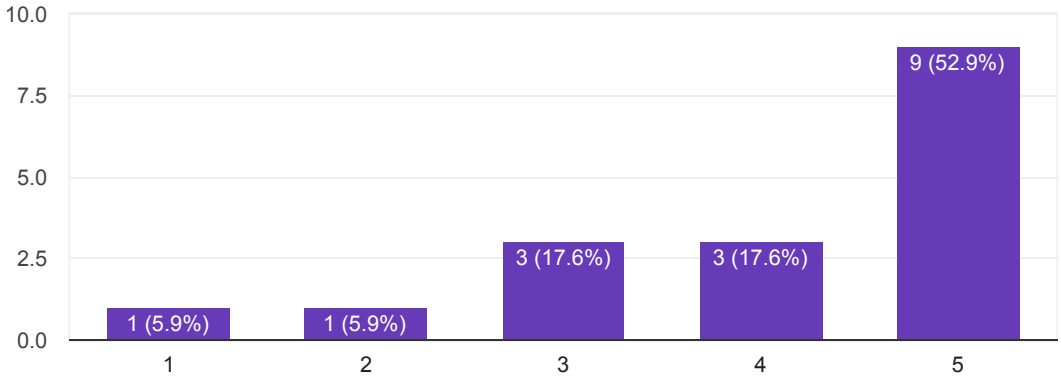
Was it easy to understand the purpose of the DAO? Copy

17 responses



Was it easy to find and access options for creating a new Project, Article or Video etc. and was the process of doing so, simple and clear? Copy

17 responses



Do you have any recommendations?

17 responses

No

no

less text; include a vertical navigation bar

The project section and NFT sections are cool and feel intuitive. It is not obvious whether they are related - could NFTs be linked to specific projects to assist in the projects crowd funding? Learning and managing crypto assets could be a hurdle for user adoption of this site, perhaps and tutorial section would help.

I have no comments about the DAO usability because I did not use it but the content is something I am better able to discuss.

not enough information of why NFTs are a superior form for fundraising or other functions. Those not well versed with Blockchain will need more understanding.

-You say "You can join the OZEAN platform without owning any OZEAN coin, and still access content and Create or Fund Projects". I thought the funding was done with OZEAN coins?
-Cryptocurrencies and NFTs have lost a lot of public trust from all of the crashes and scams. Crowdfunding alone could work.
-DAOs are necessarily easily inclusive since people have to go through multiple technical steps to obtain the coins and have to pay transaction fees.
-DAOs being democratic can be bad. "Majority rule, don't work in mental institutions" -NOFX Song: The Idiots are Taking Over
-DAOs being transparent can be bad under many context (like governments trying to find out who supported something and advertisers using that openly accessible data)
-DAOs being Permission-Less can be bad because certain content that could be dangerous could be promoted and cause problems for everyone. Content moderation is important.
-ReFi is just DeFi for social good projects?
-How are ReFi projects protected against cryptocurrency speculators that are often associated with leading to crypto crashes?
-DeSci and OERs face the same problems about moderating content that perhaps shouldn't be promoted (example could be blueprints for creating a virus that could kill most of the worlds algae).
-DeSci also faces the problem of having a proper Peer-Review System (the other parts of DeSci and OERs are mostly good).

Nope, looks very good

the funding and all that is understandable and works, the part im not sure about is why does there need to be a new cryptocurrency, doesn't that mean that the person with the most valuable information cant edit the website but the person with the most amount of money can make all the changes. also there are probably enough cryptocurrencies in the world already.

No recommendations

Not really

-

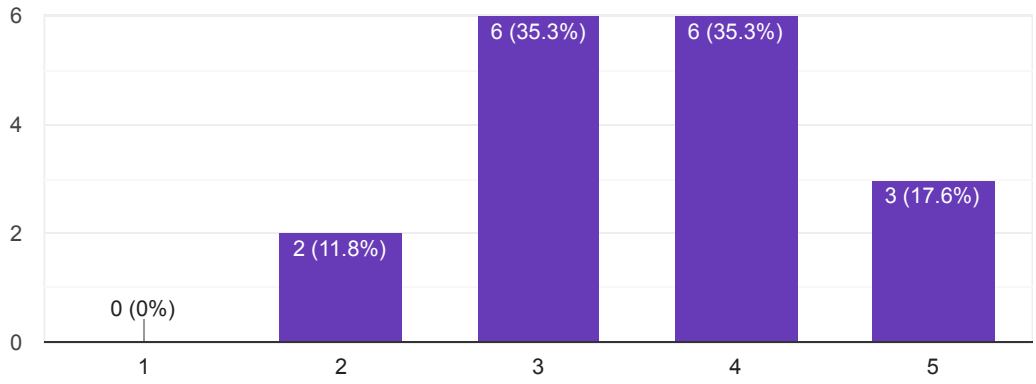
Keep up)

is good already

System Usability Scale (SUS)

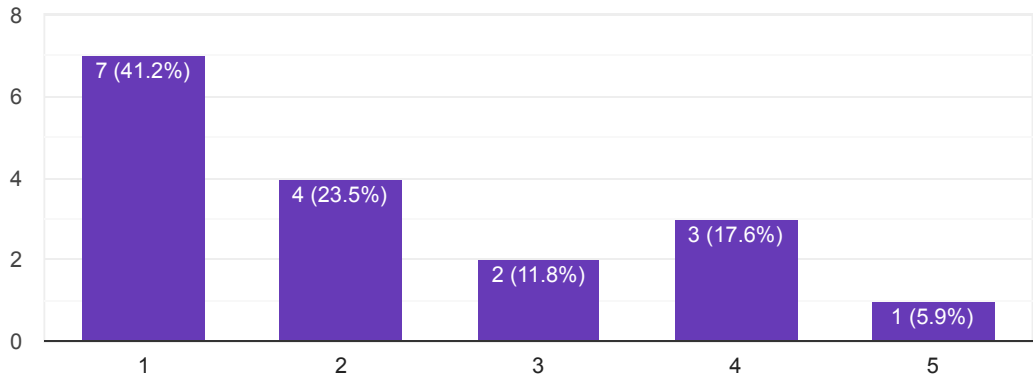
I think that I would like to use this system frequently. Copy

17 responses



I found the system unnecessarily complex. Copy

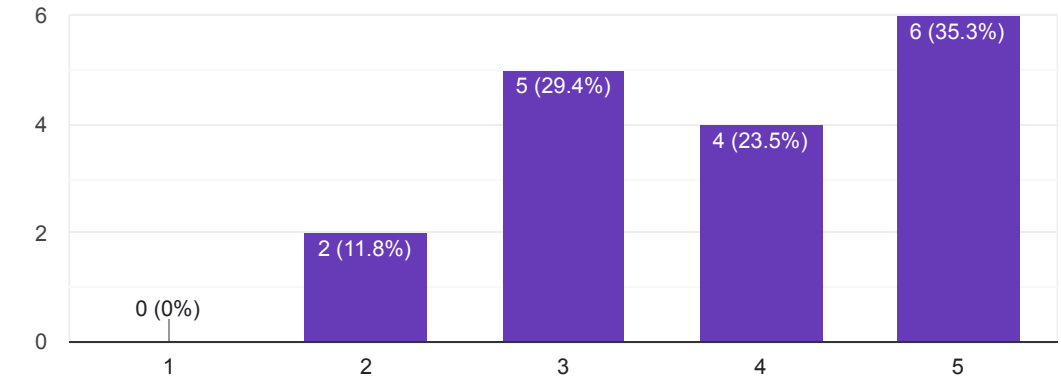
17 responses



I thought the system was easy to use.

Copy

17 responses



I think that I would need the support of a technical person to be able to use this system.

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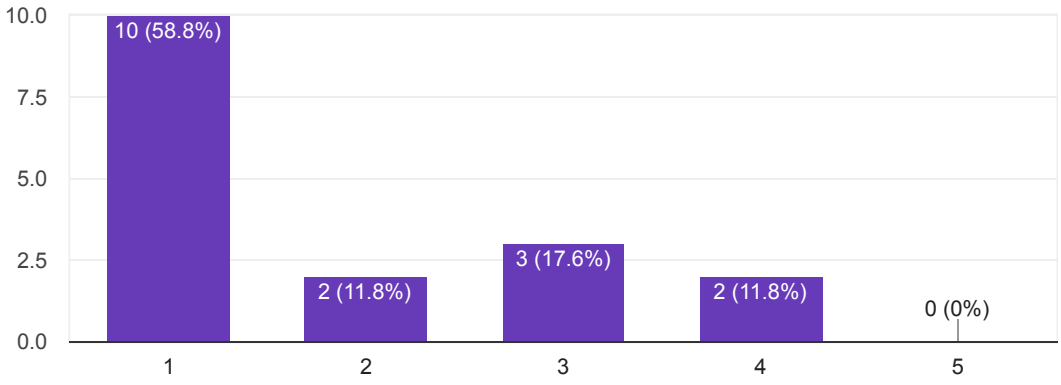
17 responses



I found the various functions in this system were well integrated.

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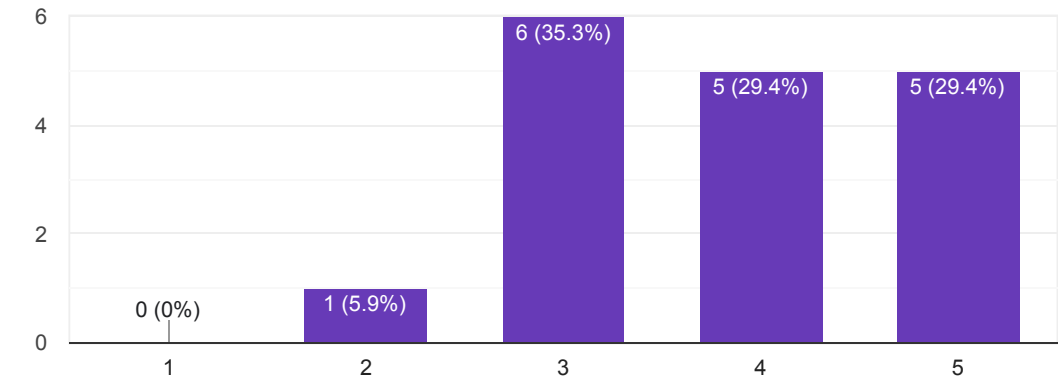
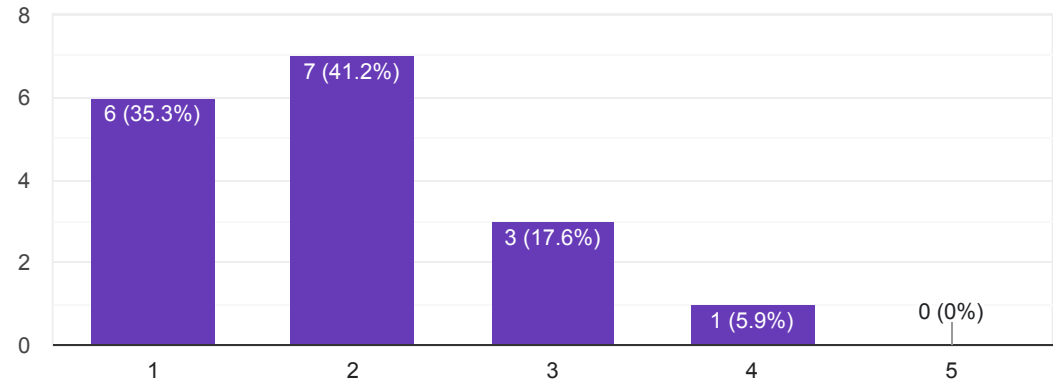
17 responses



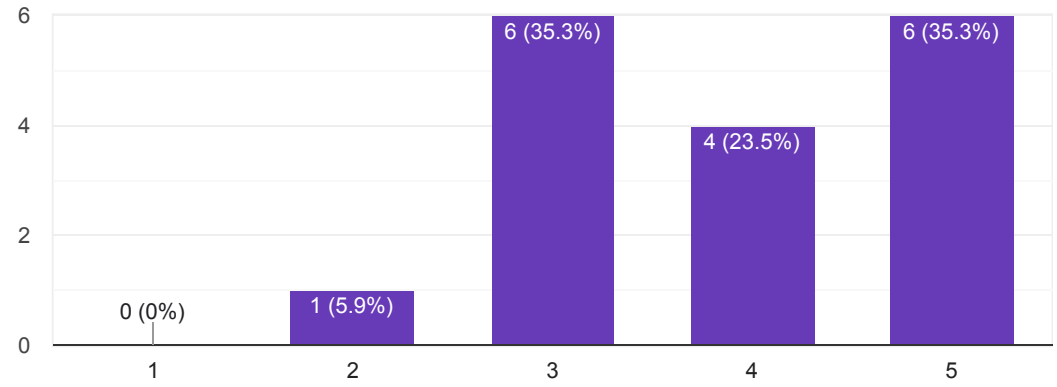
I thought there was too much inconsistency in this system. Copy

17 responses



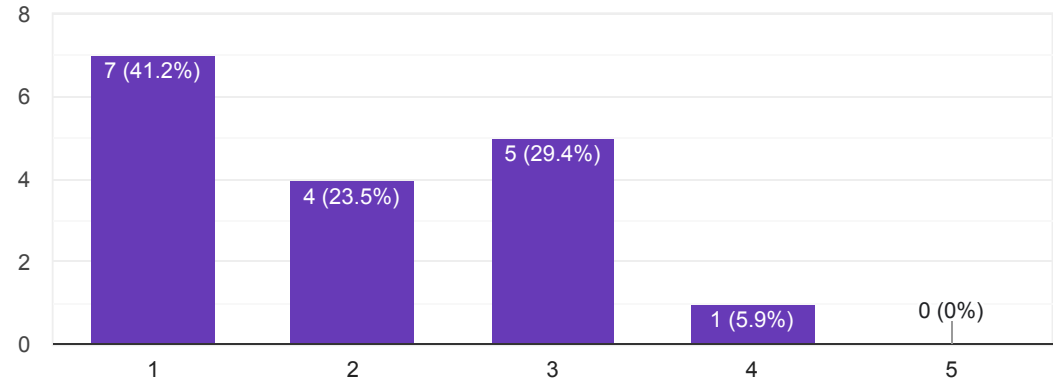
I would imagine that most people would learn to use this system very quickly. Copy

17 responses



I found the system very cumbersome to use. Copy

17 responses



I felt very confident using the system.

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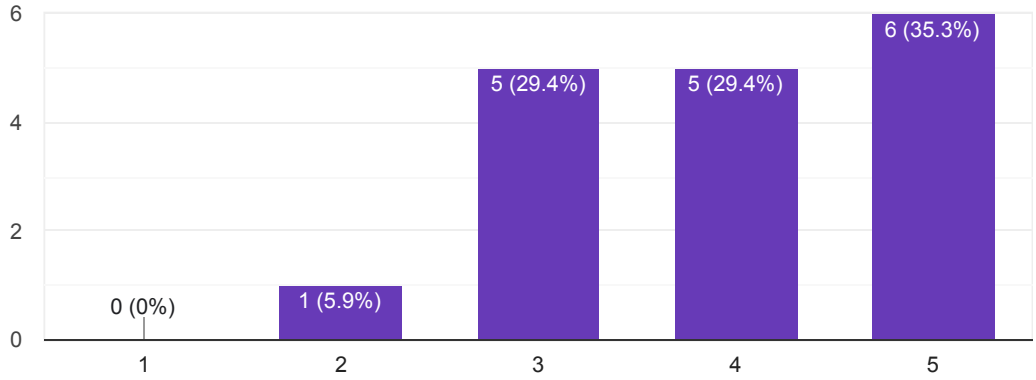
17 responses



I needed to learn a lot of things before I could get going with this system.

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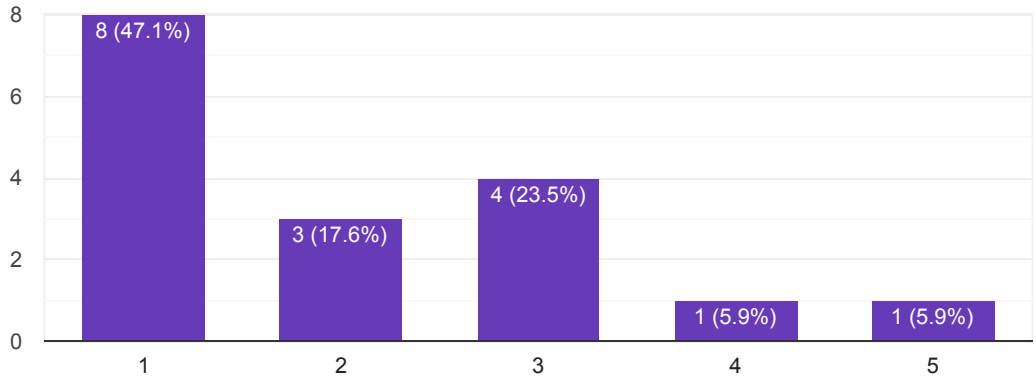

Thank You

OZEAON