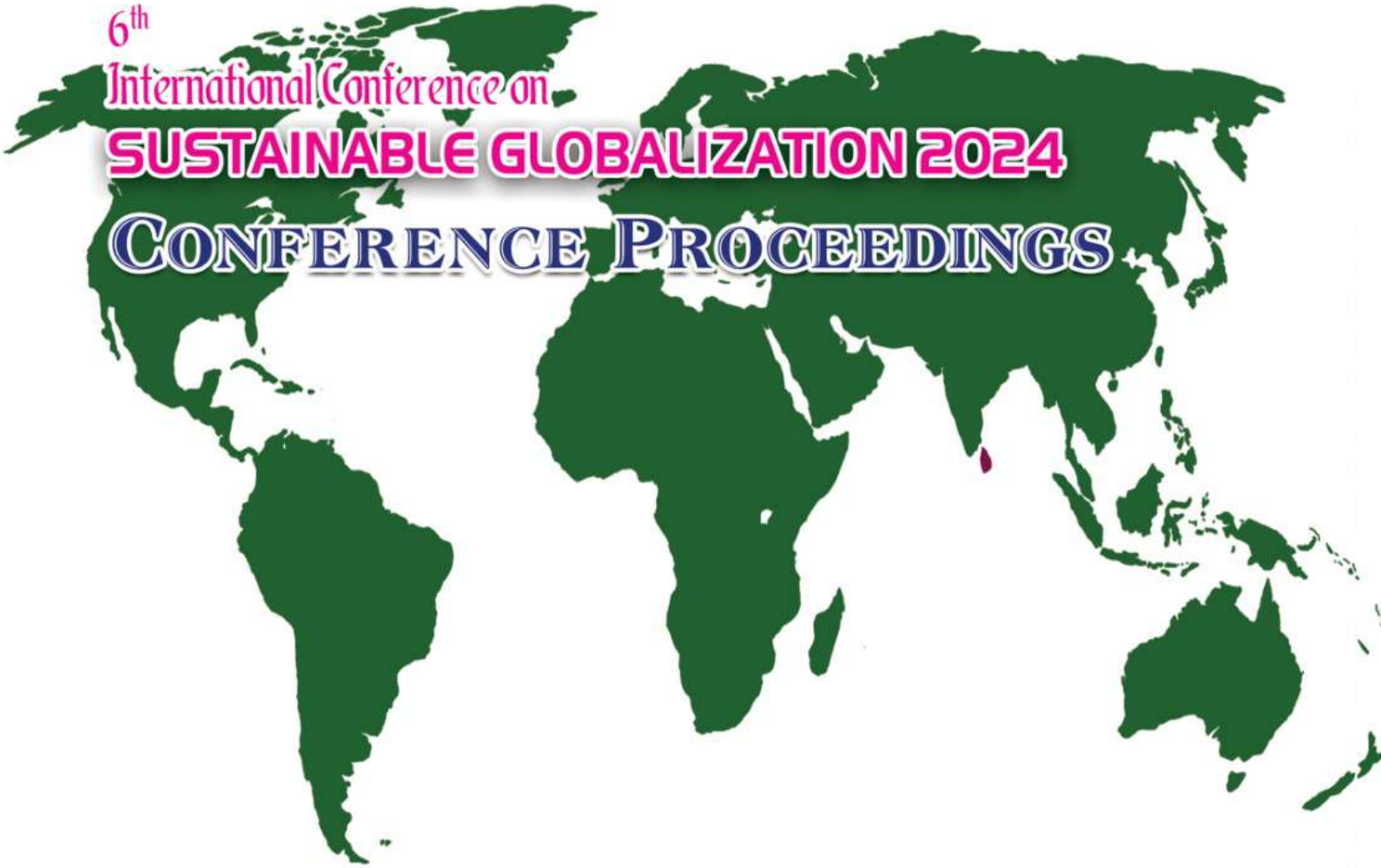
ICSG 2024

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SUSTAINABLE GLOBALIZATION 2024

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(12th -14th January 2024)

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INTERNATIONAL CONFERENCE ON SUSTAINABLE GLOBALIZATION

January 12-14, 2024. Sri Lanka

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Foreword

After a successful Inaugural conference in January 2018, followed by four conferences in Kochi, Kerala, India, the ICSG board is delighted to welcome you to the 6th International Conference on Sustainable Globalization in the picturesque venue in Colombo, Sri Lanka. This conference is broader in scope and participation - faculty, administrators, entrepreneurs and students that are participating across various disciplines of academia and industry will attend. The discussion on sustainable globalization continues to have even greater immediacy and relevance.

Stakeholders from higher education, industry and Government can work even closer together, learn from each other and collaborate to achieve common goals. We thank each of you again for believing in the idea of the conference and coming together from all over the world. And we are thrilled with the partnerships that this conference has already generated and will continue to generate.

While we worked so well as a team over a period of a year with great partners to support us, we also jointly acknowledge the individual contributions of the team members. Just like we desired last year, our team has expanded even more:

Abey Kuruvilla

Conference Chair

Robinet Jacob

Programme Chair

Hedda Sander

Review Chair

Dr. **Gishan Sumanasiri**

Organising Chair

Mriganko Ghosh

Website Creation and Development

We are thrilled with this year's lineup of speakers and participants and invite you to partner with us in advancing the objectives of this conference every year towards a more sustainable world.

Thank you and welcome to ICSG 2024.

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Ostfalia University, Germany

KEYNOTE SPEAKER - DEAN EMMANUEL OTU

"Education and Sustainability - preparing a generation of conscious citizens."



Dean, College of Natural and Health Sciences, University of Wisconsin Parkside

USA

Dean Otu is the founding Dean of the College of Natural and Health Sciences at the University of Wisconsin Parkside, and has been in that role for the past 11 years. His academic background is in Chemistry from the University of Ife, Nigeria. He received a PhD from the University of Ottawa Canada, and a Post doctoral fellowship from the the University of Waterloo, Canada, before teaching at the State University of New York Purchase, and as Full Professor at Indiana University, serving in multiple leadership roles including Chair of the Department of Chemistry and as Dean. He has published over 70 peer reviewed papers.

As Keynote speaker, Dean Otu spoke about the challenges of developing citizens that are conscious of a more sustainable world. Through his address, he challenged the delegates to be more conscious of the UN sustainable development goals themselves, as he opened the conference.

Keynote Speaker - VICE RECTOR DMITRY VASILENKO

"University Internationalization in a disrupted world"



Vice-Rector for International Affairs, St Petersburg State Economic University,

Russian Federation

Vice Rector Dmitry Vasilenko, has been serving as the vice rector for international cooperation at the St Petersburg State University of Economics and Finance since 2012. He has a PhD in Economics from the same University and has been in multiple leadership roles there before assuming charge as Vice Rector. He has been accorded multiple honors from the ministry of science and higher education of the Russian federation, the governor of St Petersburg and multiple Universities around the world, for his work in internationalization. Most recently he was honored with a ministerial award for completing 20 years of service in higher education.

Dr Vasilenko spoke about the importance of staying global – during the challenges of staying global. He stressed on the Russian approach to internationalization, despite the outcomes and experience of Covid -19 and recent wars.

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Climate Change Adaptation through Urban Gardening – An Option for Sri Lanka?

Dr. Hedda Sander & Tomas Olegovic Bretz
Ostfalia University, Germany

Abstract

This paper explores the significance of Urban Gardening as a sustainable and resilientstrategy for urban communities to adapt to climate change. With rising temperatures,extreme weather events, and other climate impacts, cities worldwide are facing newchallenges. Urban Gardening offers a promising way to enhance local climateresilience while mitigating environmental impacts.

The research is based on an extensive literature review combined with case studies invarious urban areas. The findings demonstrate that Urban Gardening contributes totemperature moderation in urban areas by providing shade and enabling evaporativecooling. Furthermore, it promotes community building and enhances food security byfacilitating access to fresh food and strengthening local supply chains.

The paper also underscores the importance of sustainable practices, including soil conservation, and biodiversity preservation. The integration of UrbanGardening into urban planning strategies and policies is considered crucial to ensuringthe long-term effectiveness of this practice.

The results of this study contribute to a deeper understanding of the role of UrbanGardening in climate change adaptation and provide insights into ways to promotemore sustainable and resilient urban communities.

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Introduction

Climate change represents one of the pressing global challenges of our time, with far-reaching impacts increasingly felt across the world. European nations face a spectrum of climate-related challenges, including rising temperatures, altered precipitation patterns, and a heightened susceptibility to extreme weather events such as floods and droughts. These changes threaten the well-being of Europe's urban populations and its agricultural systems, demanding innovative strategies for adaptation and mitigation.

In response to these challenges, the concept of urban gardeninghas emerged among others as a multifaceted approach that addresses both climate change adaptation and mitigation in various contexts. In particular, European cities have embraced urban gardening practices as part of their strategies to foster climate resilience within urban areas. By creating green spaces, fostering community engagement, and enhancing local food production, urban gardening has demonstrated its potential to mitigate the effect of climate change related urban heat islands, improve air quality, reduce carbon emissions, and build community resilience to climate-related changes.

As the climate crisis intensifies and urbanization accelerates also in Sri Lanka, the adoption of sustainable and climate-resilient practices becomes imperative. The question arises: Could the experiences and practices of European cities in urban gardening serve as a viable option for Sri Lanka in its quest to adapt to climate change and mitigate its effects and vice versa?

This paper seeks to explore the applicability of European urban gardening models rather suited to a temperate climate zone to a tropical and monsoon influenced contextlike the one in Sri Lanka. It examines the successes and challenges of urban gardening initiatives in European cities, analyzing their potential for transferability to Sri Lanka. Through a literature analysis of urban gardening practices in Europe, this study aims to provide insights into whether urban gardening can serve as a promising way for climate change adaptation in Sri Lanka, but also how Sri Lanka practices can find entrance in the context of European urban gardening concepts in learning from each other’s strategies.

The setting: Urbanization in a globally warming environment

The Intergovernmental Panel on Climate Change (IPCC) has highlighted in its synthesis report (2023) that global warming is expected to have profound impacts on life in urban areas. These impacts are multifaceted, encompassing societal challenges, affect biodiversityand food production.

Societal challenges stemming from global warming and urbanization are significant. Rising temperatures can lead to more frequent and severe heatwaves in cities, which can have detrimental effects on public health, particularly among vulnerable populations. Increased energy demand for cooling and the urban heat island effect can strain infrastructure and exacerbate energy shortages, impacting the quality of life for urban residents. Moreover, extreme weather events such as hurricanes, floods, and storms, intensified by climate change, pose risks to urban infrastructure, leading to disruptions in transportation, power supply, and

access to essential services. This can result in economic losses and displacement of urban populations.

In terms of food production, global warming can disrupt not only urban agriculture and food supply chains. Extreme weather events and changing precipitation patterns can affect crop yields and food production in urban and peri-urban areas. Additionally, urbanization can lead to land use changes, replacing rural areas with urban infrastructure, limiting local food production capabilities, and increasing dependence on external food sources. These vulnerabilities in the food system can result in food insecurity and price volatility in urban areas.

According to the UN (2018), the percentage of people living in urban areas will increase from 50.0% in 2010 to nearly 70.0% by 2150. Direct consequences of that are a higher energy demand (WRI, 2014), contributions to the urban heat island effect, land use changes and deforestation which further enhances biodiversity loss (FAO, 2014).

Goal and Structure of the Paper

The aim of this paper is to determine how European urban gardening initiativessuited for a temperate climate in the northern hemisphere can generally contribute to climate change adaptation. The aim is to learn from each other, discussing the extent to which these measures can potentially be usefulin Sri Lankaas well as whereEuropean urban gardening strategies can potentially learn from practices in a tropical climate. For this purpose, the essential terms will first be defined, followed by an explanation of the theoretical foundations of climate change adaptation in selected European cities through urban gardening. Subsequently, an analysis will be conducted to assess the applicability of these measures in a tropical climate like in Sri Lanka and vice versa.Finally, a brief outlook will be provided.

Methods

This paper employs a comprehensive literature review in order to ascertain the general applicability of European urban gardening initiatives within the Sri Lankan context.This involves reviewing scientific papers on urban gardening in Europe, the USA, and Sri Lankaand international frameworks on that topic. Furthermore, a comparison of the climatic conditions in selected cities is conducted to make a determination regarding their suitability for Sri Lanka.

Definitions

In this Section, key terms that are relevant to the understanding of this paper will be defined.

Urban Gardening

Urban Gardening is a concept in contemporary urban planning and environmental discourse, representing the practice of cultivating plants and creating green spaces within the urban landscape. This concept extends well beyond traditional gardening, encompassing a diverse array of practices such as rooftop and balcony gardening, green building, facade greening, and the development of community gardens as well as urban agricultural practices for enhanced food security and production. These practices not only contribute to the aesthetic

enhancement of urban areas but also play a crucial role in addressing environmental challenges, particularly in the realms of biodiversity conservation, climate change mitigation, and adaptation.

Initially, Urban Gardening emerged as a response to the scarcity of green spaces in densely populated urban areas. It has evolved to become a key element in sustainable urban development, offering numerous ecological benefits. One of the primary contributions of Urban Gardening to urban ecosystems is its role in enhancing biodiversity. By creating habitats for various species, urban gardens improve ecological connectivity in cities, which is essential for the health and resilience of urban ecosystems, as described by Beatley (2011).

Urban gardening also involves the cultivation, processing, and distribution of food within or in close proximity to urban areas. This practice encompasses a wide range of **food production** methods, varying in scale from small, individual gardens in personal spaces to larger, community-managed gardens and commercial urban farms (Artmann &Sartison, 2018).

In addition, urban gardens are important for their **social and educational** roles. They provide a space for community interaction, bringing together people from diverse backgrounds and promoting social cohesion (Boyd & Juhola, 2014). They also offer educational opportunities, particularly in urban settings where people, especially children, might be disconnected from traditional farming practices. Through these gardens, individuals can learn about food production, sustainability and environmental stewardship.

Urban gardening also contributes to the **urban economy**. While some gardens are primarily subsistence-oriented, others operate on a commercial basis, providing income opportunities for citizens in urban areas (Opitz et al., 2017). This economic aspect can be particularly empowering in lower-income urban areas.

In the context of **climate change mitigation**, Urban gardening's significance is multifaceted. The process of photosynthesis in plants, which occurs in gardens, plays a role in carbon sequestration. As trees and plants absorb carbon dioxide, a major greenhouse gas, they help to reduce the overall carbon footprint of urban areas. Moreover, urban vegetation can improve air quality by absorbing pollutants, thereby contributing to a healthier urban environment, as noted by Kabisch et al. (2020).

Regarding **climate change adaptation**, Urban Gardening offers numerous benefits. It is instrumental in mitigating the urban heat island effect, as the vegetation in urban gardens provides cooling through shade and evapotranspiration. This effect is particularly important in densely populated urban areas where the prevalence of concrete and asphalt surfaces exacerbates heat retention, as discussed by Connop et al. (2019). Furthermore, Urban Gardening contributes to effective stormwater management. The increased permeability afforded by green spaces allows for better water infiltration, reducing the risk of urban flooding, a growing concern under changing climate conditions, as highlighted by Foster et al. (2011).

Urban Gardening also encompasses **green building practices**, which include the integration of vegetation into building designs vertically and horizontally. This approach not only enhances building efficiency through natural insulation but also contributes to the overall reduction of energy consumption in urban areas. Facade greening, for example, can lower the

need for air conditioning in the summer and heating in the winter, thereby reducing the carbon emissions associated with energy use in buildings (Thomsit-Ireland et al., 2020).

In summary, Urban Gardening, with its broad scope and varied practices, is a critical element in sustainable urban development. It plays a vital role in enhancing urban biodiversity, mitigating and adapting to climate change, and fostering social and environmental sustainability in urban settings.

Urban Gardening:Disaster Risk Management of Climate Change

The **concept of risk** is multifaceted and does not have a singular definition. Its historical roots trace back to the 14th century, coinciding with the expansion of maritime trade and the nascent insurance industry (Romeike, 2018). The Latin term 'ris(i)co,' used during this time, referred to "sailing around a cliff" (Erben &Romeike, 2006). Dionne (2013) refers to risk as an objective function of the desired goal, describing it as the potential for failure or non-achievement of this function. Furthermore, risks are causally linked to the uncertainty of future events due to incomplete information and are characterized by deviations from set objectives Additionally, risk is not solely about potential losses; it also encompasses risk opportunities. These opportunities represent the positive side of uncertainty, offering potential gains or benefits that arise from the same conditions of incomplete information and unpredictability that typically define risk (Horsch & Schulte, 2016). As stated by ISO 31000, Risk Management is conceptualized as a series of coordinated activities designed to direct and control an organization in matters of risk, with the main goal being the creation and preservation of value.

According to the UNDDR (2023), **climate change adaptation** is an integral component of **disaster risk management** (DRM), aiming to reduce the adverse impacts of climate change-induced hazards on social systems while enhancing resilience. Disaster Risk Management is the comprehensive application of disaster risk reduction strategies and policies aimed at preventing the emergence of new disaster risks, reducing existing disaster risks, and effectively managing any remaining risk. Its primary objective is to enhance resilience and minimize the impact of disasters on individuals and communities.

Within DRM, there are three categories of actions:

- **Prospective** Disaster Risk Management: This category focuses on **preventing** the development of new or increased disaster risks in the future. It involves addressing potential risks that may arise if disaster risk reduction measures are not implemented. Examples include improved land-use planning and the establishment of disaster-resistant water supply systems.
- **Corrective** Disaster Risk Management: Corrective actions are designed to **reduce** or eliminate existing disaster risks that require immediate attention. This includes activities like retrofitting critical infrastructure to make it more resilient or relocating vulnerable populations and assets.
- **Compensatory** Disaster Risk Management (Residual Risk Management): This category aims to enhance the social and economic **resilience** of individuals and communities when dealing with residual risks that cannot be effectively reduced. It encompasses preparedness, response, recovery activities, and financial mechanisms such as national contingency funds, insurance, and social safety nets.

Urban gardening can contribute to prospective DRM due to its integral CO_2 absorption and by promoting sustainable land use within urban areas, reducing vulnerability to soil erosion and

flooding, and enhancing local food production, thus mitigating potential future food security risks. In times of disaster, urban gardens can serve as vital sources of fresh food, helping communities to cope with food shortages during recovery. Furthermore, Urban Gardening can improve stormwater management and provide shade in times of extensive heat.

Theoretical Foundations: Urban Gardening for Climate Change Adaptation

In the context of urban planning and sustainability, urban gardening is increasingly recognized as a strategy for making cities more sustainable and livable. It aligns with various sustainable development goals by addressing issues such as food security, sustainable cities and communities, and climate action. The following sequence will elaborate on how urban gardening contributes to climate change adaptation.

Carbon Sequestration and Mitigation

Urban gardens are living ecosystems teeming with a diverse range of plant species. These plants, through the process of photosynthesis, play a pivotal role in **carbon sequestration**. Photosynthesis involves the absorption of atmospheric carbon dioxide (CO_2) by plants and its conversion into organic matter. Recent research underscores the carbon-capturing potential of urban vegetation. In the study by Jha et al. (2022), it is revealed that urban gardening contributes to carbon sequestration within urban environments. The research findings indicate that synergistic relationships exist between various ecosystem services, including those related to food production, and carbon sequestration. Furthermore, the study highlights that local habitat management factors, such as tree abundance, mulch cover, and floral abundance within urban gardens, influence carbon sequestration outcomes. For example, tree abundance exhibited both positive and negative effects on different ecosystem services, including carbon sequestration. Similarly, mulch cover positively correlates with soil carbon storage but also has negative effects on certain ecosystem services. These findings underscore the potential of urban gardening as a means to enhance carbon sequestration in urban areas, while acknowledging the need for nuanced management approaches that consider the trade-offs and synergies with other ecosystem services. Such findings emphasize the significance of urban greenery in carbon capture. Furthermore, local food production in urban gardens reduces the carbon footprint associated with long-distance transportation of food.

Food Security and Local Resilience

Urban gardening, as emphasized in thestudiesby Diekmann et al. (2018), represents an efficient approach to addressing the problem of food deserts in urban environments, especially in areas with restricted access to grocery stores. This is particularly significant for urban residents facing challenges in obtaining nutritious food. The study further states that in many urban neighborhoods, particularly those with lower incomes, food deserts exacerbate the existing health disparities. Residents living in these areas often have to travel long distances to reach the nearest supermarket, which may involve time-consuming commutes and reliance on public transportation, if available. Consequently, they may resort to buying processed, shelf-stable, and often less nutritious foods from convenience stores or fast-food outlets due to limited options. The presence of urban gardens plays a crucial role as a primary **source of locally grown fruits and vegetables**, thus enhancing the availability of healthy dietary choices. As these gardens grow, they not only yield fresh produce but may also

cultivate a sense of community. Neighbors come together, sharing knowledge about gardening, recipes, and their harvests. These interactions can create **social bonds** strengthening community ties.

Zezza and Tasciotti (2010) highlight in their paper on poverty, food and security that urban gardening can increase local resilience by **diversifying food sources** and reducing vulnerability to price fluctuations. The direct production of food locally not only reduces dependence on expensive imported goods but also minimizes exposure to supply chain disruptions. As a consequence, this stabilizes food costs for vulnerable populations within urban areas. According to the Committee on World Food Security report (2023) food insecurity is affecting 258 million people throughout 58 countries. Reduced food price volatility contributes significantly to improving food security and ensuring that even economically disadvantaged communities have consistent access to affordable, healthy food options, ultimately contributing to the overall resilience of these communities.

Biodiversity loss

The global process of urbanization is rapidly advancing, with cities occupying an increasing amount of natural land. By 2030, it is expected that urban areas will expand by 185%, posing significant threats to biodiversity, especially insect species, which have seen declining populations in recent years (Plascenia& Philpott, 2017; Forister et al., 2019). The European Union has established goals and strategies for reversing biodiversity loss on a supranationalscale (European Commission, 2020).

Biodiversity in urban settings provides various advantages to humans, ranging from economic benefits (Guo et al., 2010) to positive contributions to mental health (Sandifer et al., 2015). Insects, in particular, play an indispensable role, notably in the **pollination** of plants crucial for human food production (Klein et al., 2007). Despite the challenges introduced by urbanization for biodiversity, it is emphasized that cities can also make positive contributions to wildlife conservation. Well-managed urban environments, including private gardens, can provide diverse **habitats** for a wide range of species (Baldock, 2020; Braschler et al., 2020). Urban gardening provides a unique opportunity to create microhabitats for various plant and animal species. By introducing diverse plant species and providing food sources, shelter, and nesting sites, urban gardens can attract a range of insects, birds, and small mammals. This can lead to the establishment of **localized biodiversity hotspots** within cities and therefore contribute to mitigating biodiversity loss (Theodorou et al., 2020). However, many private gardens are not managed in ways that promote biodiversity due to factors such as aesthetic preferences and a lack of knowledge about ecological gardening practices (Goddard et al., 2013). Therefore, there is a need for information and guidance on biodiversity-friendly gardening practices to bolster urban biodiversity. This includes decisions related to plant selection, pesticide use and lawn maintenance, as these practices can have significant impacts on species diversity (Goddard et al., 2010).

Temperature Regulation and Cooling Effects in Urban Heat Islands

Urban Heat Islands (UHIs) are areas within urban environments characterized by significantly higher temperaturescompared to their surrounding non-urbanized areas (Martin-Vide, Sarricolea& Moreno-Garcia, 2015). These localized heat islands result from a combination of factors, including anthropogenic heat production from sources like traffic and industrial

activities, as well as physical features of urban landscapes such as dark materials like asphalt and pavements, which trap heat. Additionally, meteorological conditions like wind, humidity, sky view factor, radiation, and precipitation contribute to the formation of Urban Heat Islands (Phelan et al., 2015). UHIs are not the direct cause of global warming but have existed throughout history as temperature differences between urban and non-urban areas. Nevertheless, the magnitude of UHIs has been steadily increasing in recent decades due to global warming. Therefore, the goal is not to eliminate UHIs entirely, as this would be impractical, but to reduce their intensity to acceptable levels (Santamouris, Ding & Osmond, 2019).

Mancebo (2018) points out in his review on numerous modeling studies, that mitigating the Urban Heat Island effect can be achieved through two main approaches: increasing the albedo of urban surfaces and promoting vegetated areas. Vegetation, particularly deciduous **trees with high evapotranspiration rates,** plays a significant role in reducing UHI intensity. Evapotranspiration, where plants release water vapor into the air through transpiration, contributes to cooling. Deciduous trees, when the ambient temperature exceeds 25°C, initiate evapotranspiration and can release substantial amounts of water vapor into the atmosphere, up to 4000 liters per day per tree. Additionally, the shading provided by tree canopies absorbs solar radiation, limiting ground-level warming. The combination of shading and evapotranspiration has been shown to substantially decrease the UHI magnitude by 1°C to 7°C.

Considerationis for Sustainable Urban Gardening in a changing climate

This paper presented several benefits of urban gardening for climate change adaptation. However, several aspects need to be taken into account when planning urban gardening initiatives in order to make this practice sustainable, especially in the face of a changing climate. As climate change leads to warmer temperatures and potential water scarcity, Leotta, Toscano & Romano (2023) are highlighting the importance of choosing **drought tolerant** plants for urban gardening initiatives. Furthermore, **native plant** species are to be preferred over non-native species as they are adapted to local climatic conditions. Bretzel et al. (2018) emphasize to consider **soil quality**of urban soil since this can influence the mobility of contaminants like trace metals. Factors such as soil pH, organic matter content, and texture can affect how readily contaminants are taken up by plants. Therefore, maintaining or improving soil quality is essential to minimize the transfer of pollutants into crops. Another important aspect that needs to be taken into consideration is the **use of pesticides**, which can be **harmful** to urban gardening for several reasons, as they can have adverse effects on the environment, human health, and the overall sustainability of urban agricultural practices.Pesticides, including insecticides, herbicides, and fungicides, are designed to kill or control specific pests. However, they can also harm non-target organisms such as beneficial insects, birds, and aquatic life, disrupting local ecosystems (Goulson, 2013).Pesticide use can also lead to **the contamination of soil and water** resources and leach into groundwater, potentially affecting aquatic ecosystems and drinking water quality (Syafrudin et al., 2021).

Urban Gardening in European Cities

The following section provides examples of urban gardening projects in Europe. The citiespresented here each have different climatic conditions and pursue their own approaches to urban gardening.

Berlin

Berlin is renowned for its vibrant urban gardening scene, with numerous initiatives and projects that promote community engagement, sustainable food production, and green spaces within the city. Examples of Urban Gardening Initiatives in Berlin for green spaces, the promotion of sustainable agriculture and biodiversity conservation are the Prinzessinengärten (Princess Gardens), Allmende-Kontor,Nomadisch Grün. Another example for urban gardening in Berlin is the city's Tempelhofer Feld, a former airport turned public park that hosts community gardens and urban agriculture projects. It covers several ways of climate change adaptation such as stormwater management and biodiversity conservation due to its large grassy field. Furthermore, Various organizations and initiatives within Tempelhofer Feld offer educational programs related to sustainability, climate change, and ecology. These programs raise awareness and educate visitors about environmental issues and sustainable practices. The Tempelhofer Feld is also one of many examples for Guerilla Gardening, which is a form of unconventional and often unauthorized gardening of plants in public spaces or neglected urban areas due to public community engagement and its protests against political plans to release the space for construction.

Knaus and Haase (2020) examined the role of urban gardening in Berlin, specifically the use of green roofs, in alleviating the **impacts of urban heat islands** and climate change. In an inner-city residential area, green roofs were found to significantly improve daytime thermal comfort on rooftops, reducing physiological equivalent temperature (PET) by approximately 9°C on hot summer days. This offers a notable improvement in thermal comfort compared to street-level areas. The study, utilizing the ENVI-met model at an official planning scale, emphasizes the importance of green roofs in sustainable urban planning, particularly for inner-city prefabricated housing estates, to enhance heat adaptation at the neighborhood level.

Milan

Milan: In the context of adapting to climate change through urban gardening in Milan, the study by Glavan et al. (2018) highlights urban gardening's significant potential for **household self-sufficiency** in vegetable production. Economic analyses reveal urban gardens' comparable productivity to market production, leading to substantial savings for gardeners, especially when calculating gross margins using organic retail prices. However, including labor costs negates these margins. The study proposes enhancing urban gardening's self-sufficiency and economic viability by increasing plot sizes, enhancing productivity through knowledge and technical innovations, and improving labor efficiency. Additionally, integrating **social cohesion** and capital into urban food policies is recommended, recognizing urban gardeners as key stakeholders in the development of urban gardening and the broader societal benefits they contribute.

In the context of Milan's ambitious Air and Climate Plan (PAC) (European Institute of Innovation & Technology, 2022) urban gardening emerges as a pivotal element in the city's strategy to achieve carbon neutrality by 2050. The PAC, which was developed through participatory processes involving citizens, associations, businesses, and other city actors. This plan underscores the importance of urban gardening in several dimensions of urban sustainability and climate change adaptation.As laid out in the PAC, urban gardening contributes significantly to the reduction of urban heat islands, a critical issue in Milan's dense urban landscape. By increasing urban **green spaces and forestation**, as outlined in the PAC,

these gardens aid in lowering surface and air temperatures. This is achieved through natural processes such as shading and evapotranspiration, which are inherent in plant life. The effectiveness of such measures is further reinforced by the Forestami Project, aiming to plant 3 million trees in the metropolitan area, and the development of green roofs and walls, enhancing the city's green infrastructure.

The award-winning Bosco Verticale, also known as the Vertical Forest, is a prominent example for sustainable infrastructure. While it is primarily a residential building, it incorporates extensive greenery in the form of trees, shrubs, and plants on its balconies and facades. According to Ishween et al. (2021), this building is designed to host a diverse range of plant species, including over 900 trees on its two towers creating a microclimate that helps regulate humidity, absorbs carbon dioxide, and produces oxygen. Furthermore, it operates on renewable energy from solar panels and utilizes filtered wastewater. This kind of infrastructure contributes to mitigating the effects of climate change by sequestering carbon and improving air quality while it is also protecting residents from radiation and noise pollution and, with its variety of plants, supporting biodiversity conservation.

Barcelona

Barcelona faces the constraint of limited space due to high-density urban development. Toaddressthis, green roofs (GR) have gained popularity as a solution. These vegetated rooftops on buildings, offer a means to provide regulating ecosystem services like stormwater management, thermal regulation, and ecological habitat. They also contribute to the local food supply and provide non-material and cultural services, such as relaxation and social integration in Barcelona as Langemeyer et al. (2019) found out in their analysis of green roofs in Barcelona. The study found that densely populated urban neighborhoods in Barcelona, such as Raval, Barri Gòtic, and Eixample, had high demand for ES and were suitable for GR development. Naturalized roofs were identified as the most suitable GR design for Barcelona, emphasizing biodiversity and green connectivity. However, the study highlighted the need for further calibration and consideration of structural and economic factors in GR design selection.

The role of vertical greening, particularly urban rainwater-harvesting (URH) systems has been found as an effective way for climate change adaptation in Barcelona. Suleiman et al. (2020) highlight in their study on urban rain-harvesting schemes in Barcelona that URH-systems may serve helpful functions in climate change adaptation. Through URH, rainwater can be controlled at the source, reducing runoff and mitigating flooding in areas prone to heavy rainfall. This contributes to climate resilience by minimizing the impact of extreme weather events, which are expected to increase in frequency and intensity due to climate change. Furthermore, URH systems capture and store rainwater for non-potable uses, such as irrigation, which further reduces the demand for municipal water sources, particularly during periods of drought or water scarcity. Additionally, these systems often incorporate vegetated elements, such as green walls and living roofs, which promote urban biodiversity, providing habitat for flora and fauna.

The applicability of European Urban Gardening Strategies to Sri Lanka

Both the European Union (EU) and Sri Lanka are likely to experience adverse effects of climate change, but the nature and severity of these impacts may differ due to their

geographical locations, climate zones, and socioeconomic conditions. For the EU, climate change projections indicate a range of impacts, including rising temperatures, changing precipitation patterns, more frequent heatwaves, increased flooding, and potential shifts in ecosystems. Sri Lanka's vulnerability to climate change is influenced by its coastal location. According to the World Bank's Climate Risk Country Profile (2021), Sri Lanka is susceptible to climate-related challenges such as temperature rise and extreme heat, with the number of days with temperatures exceeding 35°C potentially rising from a baseline of 20 days to more than 100 days by the 2090s. Also, sea-level rise, increased temperature, changes in monsoon patterns, and extreme weather events like cyclones will happen more frequently (IPCC, 2023).

The following figure shows a comparison between the climatic conditions of Berlin, Barcelona, Milan and Colombo as the capital of Sri Lanka.

	Colombo	Berlin	Barcelona	Milan
Climate	**Tropical** rainforest climate with high temperature and humidity year-round	Temperate **oceanic** climate with **distinct seasons**	**Mediterranean** climate with mild winters and hot summers	Moderately **continental** climate, **with cold wintersand hot summers**
Ø Temperature Range	22°C– 31,8°C	-2°C in January – 24°C in July	5,5°C in January – 31°C in July	-1,3°C in January – 28,8°C in July
Ø Annual Precipitation in Litres	2416	543,6	503,4	752,2
Ø Annual Hours of Sunshine	2519	1779	2616	1971
Prosperity	Capital of Sri Lanka, a**Developing Country** with economic and prosperity challenges	One of the world's largest economies with **high standard** of **living**	Prosperous economy, especially in tourism and commerce	One of Italy's wealthiest cities with **highstandard** of **living**

Figure 1: *Climatic Conditions of Colombo, Berlin, Barcelona, Milan. Source: Database of the German platforms laenderdaten.info and wetterkontor.de.*

There are also various urban gardening initiatives in Sri Lanka, which have shown promise in addressing food security and providing socio-economic benefits. A prominent example for Urban Gardening is the **Metta Garden** in Colombo serves as a multifunctional space for promoting urban biodiversity and sustainable agriculture. Initially, this land was a degraded and barren area, devoid of fauna and flora, primarily used as a dumping ground for non-biodegradable waste (IUCN, 2018).The transformation of the Metta Garden began with efforts to regenerate the soil. Wet kitchen waste, green leaves, and banana stems were used to enhance soil moisture and fertility which also has positive contributions for waste management. Native plants were allowed to grow naturally to encourage local floral diversityWithin a year, the butterfly diversity increased from 6 to 63 species, and bees were observed pollinating the dedicated flowers.In another initiative, over 200 schools in Sri Lankaare set to benefit fromfunding provided through the Food and Agriculture Organization of the United Nations (FAO), which is directed towards establishing entrepreneurial school

gardens.The program adopts a discovery-based learning approach, targeting over 100,000 secondary school students from grades 8 to 12. Students will learn to transform school gardens into sources of nutritious produce, promoting diverse and healthy eating habits combined withincorporating entrepreneurial thinking into agriculture (United Nation Sri Lanka, 2023).

Dona et al. (2022) investigated the feasibility of using urban agriculture as a strategy for open space management.The study highlights that urban planning professionals strongly agree that urban agriculture's multifunctionality is crucial for urban sustainability in contexts of urban shrinkage. This multifunctionality extends beyond just food production to include educational, health, and social benefits. For shrinking and ageing urban areas, smaller farmlands, home gardens, community gardens, and privately owned lands are deemed most suitable for urban agriculture initiatives.However, despite its potential, urban agriculture has been somewhat limited in its integration into urban planning policies. The study suggests strategies for better incorporating urban agriculture into urban planning, such as promoting home gardening for older adults and utilizing public lands for community gardens. According to Kulathunga et al. (2022), Sri Lanka’s current food crisis, which has led to reduced access to food and soaring prices, can be combatted by urban gardening initiatives.

Despite the differences in the climatic conditions, the presented European cities and Sri Lanka all found urban gardening initiatives to be effective in addressing climate change related issues. The studies show that Sri Lankan residents mainly use urban gardening initiatives for combatting food insecurity. However, especially facade and roof greening like in Milan and Barcelona can lead to significant cooling effects in rural areas. As Gunaratne, Firdaus &Rathnasooriya (2021) explain,government policies in Sri Lanka show a strong preference for the industrial and service sectors, leading to a significant decline in the agricultural sector's contribution to the national economy. New development projects have resulted in tremendous adversities for natural resources while also creating labor shortages in agriculture.A holistic approach to food security and sustainability is paramount to make the agricultural sector productive and sustainable. Even though there are not many urban gardening initiatives in Sri Lanka, those that are already in place show a positive way of climate change adaptation. The social components of including urban gardening as part of entrepreneurial training in schools are something that even developed countries can learn from. Moreover, the practice of recycling kitchen waste, as seen in the Metta Garden in Colombo, is an effective method of enhancing soil moisture and fertility.This not only contributes to more productive gardens but also instills a culture of sustainability and waste reduction.This practice serves as a practical example of circular economy principles, where waste products are repurposed to create value, thereby teaching important environmental stewardship lessons.

Summary and outlook

The paper emphasizes the importance of urban gardening as a sustainable and resilient strategy for urban communities to adapt to climate change as part of disaster risk management. It underscores urban gardening's role in temperature regulation, community building, and food security enhancement. This practice allows for a symbiotic relationship where urban residents can actively participate in nurturing biodiversity while benefiting from the ecological services provided by these green spaces. For Sri Lanka, adopting strategies

focused on integrating urban gardening into urban landscapes is essential. This includes encouraging rooftop and balcony gardens and also facade greening in urban areas, promoting community gardens in public spaces, and incorporating green spaces into new urban developments. Also, European cities can learn from Sri Lankan initiatives of including gardening techniques into their school curriculum and actually using their waste. Such strategies will not only aid in climate change adaptation but also enhance food security and create harmonious living spaces where nature and urban life coexist.This work focused on the general applicability of urban gardening initiatives from Europe for Sri Lanka. Further studies should be conducted to determine which plants are most suitable for Urban Gardening in Sri Lanka under various conditions, in order to maximize the positive effects of these initiatives.Looking forward, urban gardening could become increasingly integral to urban planning and policy, especially as cities worldwide confront the growing challenges of climate change.

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Community challenges and opportunities in the age of climate protection

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Abstract

Climate protection is the primary challenge of our era. Local communities worldwide must therefore significantly intensify their efforts to combat climate change. This requires the development of new strategies and active participation in the ambitious targets for achieving climate neutrality at supranational EU, federal and state level. At the same time, municipalities should see this as an opportunity for sustainable development and long-term transformation and use it to their advantage. This paper especially investigates the European Union (EU) strategy to tackle the challenge of limiting greenhouse gas emissions using a carbon (CO_2) tax and sustainability reporting approach, which is meant to affect all entities in Europe, communities, industrial business, SME and other entities alike.

Especially Communities that are characterized by ambitious, strategic and consistent action in climate protection can reduce their energy costs in the long term, relieve their budgets and make valuable contributions to regional value creation. This not only helps to maintain, but also to improve the quality of life of their citizens.

However, the question arises as to what impact the CO_2 tax and costs for greenhouse gas certificates have on local communities. Of particular interest is how business tax payments change if companies or tradespeople record lower profits or income due to rising greenhouse gas prices. The question also arises as to whether reporting in accordance with the European sustainability standards for companies.

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1. The challenge: Bottom up climate change protection reporting

Tackling climate change represents a key global challenge of our era. Against this background, it is essential for local administrative units to significantly intensify their efforts in climate policy. This implies the development and implementation of innovative strategies and active participation in the ambitious climate neutrality goals being pursued at various levels - from the supranational (European Union (EU)) to the national and finally to the regional level. Local governments should consider and utilize this process not only as an obligation, but also as an opportunity for sustainable growth and long-term transformation.

According to the 2014 report of the Intergovernmental Panel on Climate Change (IPCC), current climatic changes are predominantly anthropogenic, i.e. caused by human activities. In particular, emissions of greenhouse gases (GHG) such as carbon dioxide and methane play a key role here. Uncontrolled temperature increases and unregulated emissions could jeopardize the habitability of our planet. Thus, resolutions of COP 21 (Paris 2015) on global climate protection are targeted to limit global warming to below 2°C compared to the pre-industrial level of average temperatures from 1850-1900(Umweltbundesamt, 2023). In principle, the tasks arising from this resolution are broken down to the supranational (EU) level, within supranational limits implemented at the national level (i.E.within Germany), with regulations at regional levels (federal states) and finally within municipal activities. Thus, every unit is supposed to transparently reduce their share of GHG emissions towards the final goal. If conditions defined within the Paris resolutions are not met, forecasts even indicate a possible increase in the global average temperature of up to 4.8 °C by 2100.

With the initiation of the EU Green Deal in 2019, the European Union set itself the goal of being the first climate-neutral continent by 2050. The steps towards reaching that goal are being monitored by the annual EU Climate Action Progress Report (CAPR) on progress towards EU emission reduction targets. At the same time, the report is an opportunity to inform a wide audience about recent developments in EU climate action. The report covers actual (historic) emissions and projected future emissions for every EU member state. It also includes information on EU policies and measures, climate finance and adaptation. The data are also incorporated into the worldwide Climate Change Performance Index (CCPI), a tool for creating transparent rankings of nations in global climate policy. CCPI has been published since 2005 and was most recently presented at COP 28 in Dubai (https://ccpi.org), with the EU currently holding 19th place, in 2024 only narrowly missing a positive“high category” rating as a result of its efforts.

To realize the Green Deal goal, mechanisms have been established at EU and national level to record and adequately price GHG emissions. The Corporate Sustainability Reporting Directive (CSRD) and the new European Sustainability Reporting Standards (ESRS) require companies to provide more detailed reporting on environmental issues.

Alongside companies, local authorities play a decisive role as regional players in climate protection. Through an ambitious, strategic and consistent approach, local authorities can reduce their energy costs, reduce budgetary burdens and contribute to regional economic development, which in turn improves the quality of life of their inhabitants.

However, it remains to be clarified what specific effects carbon pricing and the costs of greenhouse gas certificates have on local authorities. The extent to which GHG pricing by companies influences life at municipal level also needs to be analyzed.

1.1.Aim and Structure

The aim of this study is to find out how municipalities record and monetizeGHG emissions in comparison to companies. It also analyzes the consequences that increasing CO_2 pricing could have for companies and municipal businesses in the coming years. Furthermore, it shows what

optimizations municipalities can make in their GHG recording, especially in the context of the reporting standards that companies must comply with to record and declare GHG emissions.

The second chapter is dedicated to the basic concepts, while the third chapter takes stock of the current situation. This begins with a description of the basic instruments, standards and frameworks used by companies to measure and report GHG emissions. The second sub-chapter of the inventory examines the scoping of greenhouse gases in accordance with the GHG Protocol and various procedures for GHG pricing. In addition, a comparison is made between the corporate and municipal levels in order to discuss how GHG emissions are recorded and evaluated in the respective sectors.

In this analysis, a stress test was performed on 163 companies to examine the effects of escalating GHG expenses on their revenue streams and cost configurations. The study aimed to understand the potential repercussions of increased prices on their financial performance. Additionally, the influence of these companies at the local government level was evaluated, along with the potential outcomes if a similar rise in CO_2 pricing were to impact municipal companies. The report also covers the present state of GHG reporting practices among corporations and municipal entities.

The fifth chapter summarizes the key findings of the study and provides an outlook on future developments in this area.

1.2. **Methods**

This study uses a quantitative, inductive research approach in which selected characteristics are systematically captured by numbers, with a focus on collecting an extensive amount of data(Brosius, Haas, Unkel, 2022). In the analysis phase, the turnover and costs of selected companies were subjected to a stress test. We also analysed which companies publish their sustainability report in accordance with the GRI 305 standard.

In the initial phase, a database was developed to record the aforementioned criteria (Schreibler, 1976). One focus was on the inclusion of a broad range of European companies that had not previously been included in any other study. Companies from the banking and insurance sectors were excluded. The study covered the EURO Stoxx 50 and selected sectors of the Euro Stoxx 600, in particular from the consumer goods, property and automotive sectors. In total, data was collected from 163 companies, a combination that has not been analysed in previous empirical studies.

A detailed systematic review of literature and legal principles provided a comprehensive introduction to the topic and an inventory. This also included the current status of sustainability reporting in companies and at municipal level.

2. Definition

For basic concept understanding, a score of terms is outlined in the following table. The defined terms are used exclusively within the given specifications in the paper.

Carbon dioxide (CO_2)	It is part of the air and is one of the most important greenhouse gases(UBA, 2023).
Emission	Release of greenhouse gases and air pollutants generated during the conversion of energy sources into electricity and heat, for example(Breuer C., 2018).
Emission trading	Emission trading is an efficient tool to achieve specified emission reduction targets, especially for greenhouse gases like CO_2(Günther E., 2018).
ESG	The abbreviation ESG (Environmental, Social and Governance) stands for environment, social and good corporate governance. (BaFin, 2023)
Greenhouse gas (GHG)	A greenhouse gas contributes to the natural greenhouse effect. The Kyoto Protocol lists six greenhouse gases released by human activities: Carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride(UBA, 2023).

Green and browncompanies	„Green" companies follow sustainable practices, while "brown" companies follow traditional, possibly environmentally harmful practices.
Green and brown community	„Green" community's follow sustainable practices, while "brown" community's follow traditional, possibly environmentally harmful practices.
Kyoto Protocol	The Kyoto Protocol is an international agreement signed in Kyoto, Japan, in 1997 at the Third Conference of the Parties (COP3) of the UNFCCC. It stands for the limitation of greenhouse gas emissions. (Jochem P., 2018)
Methane (CH_4)	Methane is one of the most important greenhouse gases (GHG, 2023).
Model	A model is a simplified representation of reality, designed to predict the behavior of a system. It is based on assumptions, equations and draws parallels in function, structure or behavior to the original. Models are used specifically for certain problem solving, which includes stress testing (Thommen J.-P-, 2018).
Net Zero	Net zero refers to a state in which the greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere (IPPC - Decarbonization, 2023).
Paris Climate Agreement	The member states of the UN Framework Convention on Climate Change, including Germany and the EU, agreed in Paris in 2015 to limit global warming to below 2°C and are aiming for a 1.5°C target. Germany ratified the agreement in 2016. The EU plans to reduce greenhouse gas emissions to net zero by 2050. This requires significant economic changes (UNCC, 2023).
Risk	Risk refers to the possibility of an undesirable event occurring that may cause damage or loss (Weber, J., 2028).
Riskmodel	Risk models are a central tool in risk management. They allow management to develop deep sensitivity to risks. These models use large amounts of data to assess significant risks. Such risks can be influenced by changes in business lines, asset values, market fluctuations and the general economic environment, while also influencing these factors. (Riskmodel, 2023)
Stress tests	"Stress testing" refers to a set of methods that companies use to evaluate their risk potential with respect to extraordinary but plausible events at different levels of the company. The stress testing programme includes sensitivity analyses, in which typically only one risk factor is adjusted, and scenario analyses, in which several or all risk factors are changed simultaneously based on a specified event. (MaRisk, 2021)
Inverse stress tests	Inverse stress tests analyse which events could threaten the survivability of a company. A business model is considered to be at risk if it proves to be no longer feasible or viable in its original form(MaRisk, 2021).
Micro stress test	This test focuses on specific risk factors, often related to individual business units. Its objective is to test the resilience of individual units(MaRisk, 2021).
Macro stress test	This test assesses the entire system, taking into account interactions. It is used to ensure the stability of the entire system under stress conditions(MaRisk, 2021).
Transition risks	Transition risks arise from the shift to a low-carbon economy. Political decisions can make fossil fuels more expensive or scarce, as with the coal phase-out or the CO_2 tax. This can lead to high investment costs for building renovations. New technologies, such as electromobility, can displace existing ones, and changing customer demands can put companies that do not adapt at risk (BaFin, 2019).

3. Inventory of GHG scoping, pricing and reporting at local and company level

This chapter provides an overview of various instruments and tools used in sustainability reporting with some of them specific instruments applied within the EU. It includes a detailed look at GHG scoping and the current practice of carbon pricing in Germany. The following sub-chapters provide a comparative presentation focusing on the specific reporting modalities and financial obligations regarding GHG for both municipalities and companies.

3.1.Instruments and Reporting Tools

The following table shows a selection of important instruments and tools that can be used to prepare sustainability reports at company and municipal level.

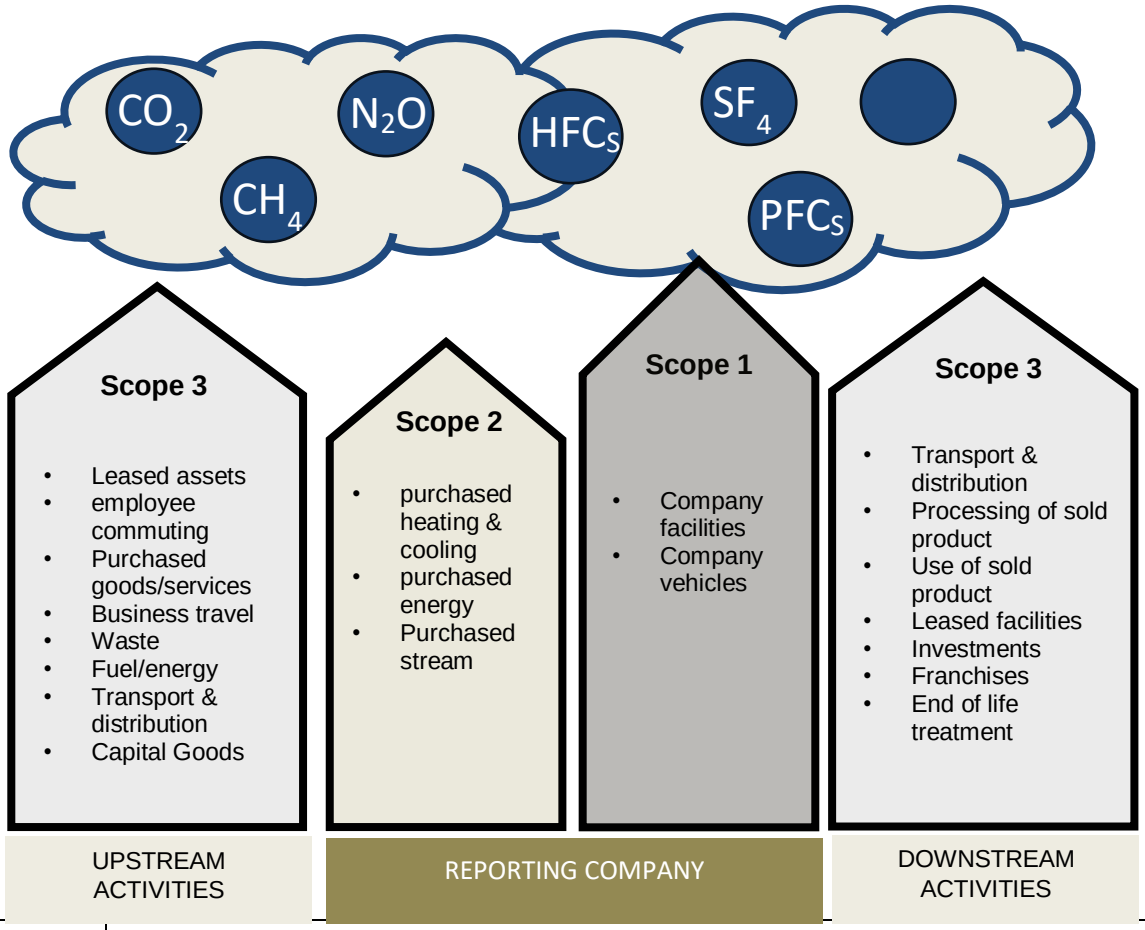
Name of the framework	Scope of application	Description of the framework
GRI	worldwide	GRI Standards are widely used around the world and are used by more than 10,000 organizations in over 100 countries. They aim to enable third parties to assess the environmental impact of a company's activities and its supply chain (GRI, 2023).
CSRD	EU	The Corporate Sustainability Reporting Directive (CSRD) is an EU regulation that modernizes and strengthens corporate reporting on social and environmental information. It extends reporting obligations to a larger group of large companies as well as listed SMEs. The CSRD introduces the principle of "dual materiality", which obliges companies to report both on the impact of sustainability issues on their business and on how their business activities affect people and the environment(DIRECTIVE (EU) 2022/2464, 2022).
ESRS	EU	These standards have been developed specifically for the EU and are part of the Corporate Sustainability Reporting Directive (CSRD). They focus on the sustainability reporting of large companies and SMEs in the EU. (EFRAG, 2023)
SASB	worldwide	SASB provides industry-specific reporting standards for public companies. The standards aim to disclose financially relevant sustainability information to investors and are particularly popular in the USA. (SABS Standards, 2023)
ISO-Norm 14064	worldwide	ISO 14064 is a standard developed by the International Organization for Standardization (ISO) related to greenhouse gas emissions and their handling. (ISO 14064: Treibhausgasbilanzierung, 2023)
ISSB	worldwide	The International Sustainability Standards Board (ISSB) is an organization established to develop and oversee a comprehensive global baseline of sustainability-related disclosure standards. (ISSB, 2023)
SDGs	worldwide	The Sustainable Development Goals are a collection of 17 global goals set by the United Nations to end poverty, protect the planet and ensure that all people enjoy peace and prosperity by 2030. (UN, 2023)
TCFD	worldwide	Established in 2017, TCFD focuses specifically on climate-related risks and opportunities. The TCFD recommendations are intended to provide useful and forward-looking information for business decisions that may be included in a company's regular financial reports. (TCFD, 2023)
PRI	worldwide	PRI, or the Principles for Responsible Investment, is a global initiative promoting responsible investment practices by incorporating environmental, social, and governance (ESG) factors into investment decision-making and ownership practices. (PRI, 2023)
IR	worldwide	IR promotes a holistic presentation of corporate performance that combines traditional financial reports with sustainability reports.(About IR, 2023)
CDP	worldwide	The CDP manages the world's largest database on corporate greenhouse gas emissions and energy consumption. Companies complete an annual questionnaire on various ESG issues, focussing on greenhouse gas emissions and other environmental impacts. (CDP, 2023)
UN Global Compact	worldwide	Is an initiative of the United Nations. It aims to encourage companies worldwide to pursue sustainable and socially responsible business practices. The UN Global Compact is not a reporting standard in the conventional sense, but a voluntary commitment for companies. (UN Global Compact, 2023)

3.2. GHG scoping and pricing

This subchapter deals with GHG collection and how GHG are allocated to companies in the scoping process. It also describes different mechanisms for GHG pricing.

3.2.1. GHG emission scoping

GHG are categorized into three scoping classes according to the GHG Protocol. These are explained in more detail in the following table and in the diagram below.



Scope 1	Direct GHG emissions generated onsite from the activities an organization owns or controls.(GRI 305, 2016)
Scope 2	Indirect energy-related GHG emissions include CO_2 emissions from the generation of purchased or acquired electricity and steam and from purchased and acquired heating and cooling energy consumed by an organization. According to the GHG Protocol Scope 2 Guidance, an organization is required to report two different values for Scope 2: a location-based value and a market-based value.(GRI 305, 2016)
Scope 3	Other indirect GHG emissions are a consequence of an organization's activities but originate from sources that are not owned or controlled by the organization. Other indirect GHG emissions (Scope 3) include both upstream and downstream emissions(GRI 305, 2016).

3.2.2. GHG pricing

Various mechanisms for GHG pricing play a central role in the economic dimension of climate policy as GHG prices internalize external cost for polluters, be they companies during their production and distribution processes or municipalities serving their population. These mechanisms are aimed at levying monetary charges on emissions in order to create economic incentives for their reduction and thus contribute to the achievement of climate policy objectives. The implementation of such instruments is a key component of international efforts to curb GHG induced anthropogenic climate change. An overview of the most important of these mechanisms applied within the EU is provided below:

- **Emissions Trading System (EU-ETS) / European Energy Exchange (EEX)**
  A market-based approach with more flexible options for companies, but with potentially more volatile prices. The EU Emissions Trading Scheme (EU ETS) is the main instrument for

regulating GHG emissions in the EU and applies to large emission sources such as power plants, certain industrial installations and airlines operating flights between airports in European Environmental Agency (EEA) states (EU-EHS, 2023).
The European Energy Exchange (EEX) is one of the main exchanges for trading emission allowances under the EU Emissions Trading Scheme (EU ETS)(EXX Umweltprodukte, 2023). The EU ETS is the largest emissions trading system in the world and aims to reduce GHG emissions from industry and energy producers in the European Union. In the context of the EU ETS and trading on EEX, mainly emissions from Scope 1 (Direct Emissions) are covered(EXX, 2023).

- **National Emissions Trading Scheme (nEHS): "CO_2 Tax"**
  In addition to the EU ETS, Germany has introduced a national emissions trading scheme that has been in place since 2021 for sectors such as transport and buildings that are not covered by the EU ETS(DEHSt, 2023).This mechanism works in a similar way to a carbon tax, as it sets a fixed price for emissions from these sectors. The scope of application includes smaller emission sources and sectors that are not covered by the EU ETS. Here, it is not the company's decision but the legal obligation that sets the framework. (DEHSt, 2023)

The current national CO_2 price in Germany for 2024 is set at 45 €/tCO_2 (Deutsche Bundesregierung, 2024). In contrast, the price of emissions certificates on the emissions trading market, for example on the European Energy Exchange (EEX), varies and is dependent on market dynamics(EXX, 2023).Prices ranged from 0,70 € / t CO_2 (2007) to 81 € / t CO_2 (2022) in the past (Statista, 2023).

	2025	**2030**	**2050**
t/CO_2	130,00 €[1]	250,00 €[2]	800,00 €[3]

Forecasts by renowned institutions predict an exponential price increase in CO_2 emission costs in the coming years. This development is particularly significant in light of the European climate targets for 2050, when the European Union aims to achieve CO_2 neutrality. The table above illustrates the expected increase in emission prices up to 2050 and refers to the entire European Union.

It is important to note that emission allowance price forecasts are based on a variety of factors, including political decisions, technological developments and global economic trends. These dynamics have a significant influence on emissions trading pricing and are crucial for assessing the cost-effectiveness of climate protection measures within the EU.

3.3. Company level

Determining GHG emissions in companies is an essential part of environmental management and sustainability strategy. This process involves identifying, quantifying and often reporting on the emissions caused directly or indirectly by a company's activities. GHG emissions are defined according to the categorization of emissions as described in section 3.2.

- **GHG pricing**
  As described in section 3.2, the pricing of GHG emissions is based on either the EU ETS or the nEHS.

- **GHG reporting**
  Reporting is carried out by most companies as part of the publication of the Sustainability Report. In addition, many companies share their Scope 1,2,3 emissions data (GHG Protocol, 2023) with

[1](OeNB, 2023)
[2](World Climate Bank, 2023)
[3](World Climate Bank, 2023).

the Carbon Disclosure Project (CDP) Network databasewhich emphasizes the importance of GHG reporting in the context of global transparency and sustainability efforts. The implementation of an annual reporting system for GHG emissions at company level is a critical mechanism within corporate sustainability management. This process makes a significant contribution to understanding and communicating a company's climate-related impacts and provides the base for improvements toward carbon neutrality. The relevance of GHG reporting extends beyond mere compliance with legislative provisions and normative standards and significantly influences aspects such as corporate reputation, risk management and, increasingly, capital market-related decision-making processes. It also plays a key role in increasing transparency with regard to ecological effects and helps to build trust among the relevant stakeholder groups(Braun, Senger, 2022).

Companies set individual priorities in their reporting, but are often guided by established frameworks such as the Global Reporting Initiative (GRI) Standard 305, the Greenhouse Gas Protocol or the ISO 14064 standard. For example, the GRI 305 aims to provide a structured framework for companies to report on GHG emissions, focusing on direct and indirect emissions as well as emissions from the value chain (Scope 1, Scope 2 and Scope 3). A key challenge here is to ensure precise and comprehensive data quality. In particular, reporting on Scope 3 emissions poses a special challenge due to their complexity and their location outside the company's direct sphere of influence(GRI 305, 2016).

3.4. Local level

Urban and municipal areas account for a significant proportion of total GHG emissions and energy consumption. In this context, climate protection represents an interdisciplinary challenge that affects various administrative areas. The fields of action in the area of municipal climate protection are correspondingly heterogeneous and range from internal administrative processes to transport planning and building permit procedures through to the management of municipal properties. Procurement policy and education and information initiatives for the public are also relevant levers for promoting climate protection at municipal level.

- **GHG pricing**

  Local authorities do not actually participate directly in emissions trading. This is due to the fact that both the nEHS and the EU ETS are mainly aimed at larger emitters in specific sectors such as energy generation, industry and aviation.

  Despite this direct non-participation, municipalities are still affected by the indirect effects of carbon pricing (national CO_2 Tax in Germany). These effects are felt when municipalities use fossil fuels for their vehicle fleets, for heating buildings or for other purposes. The carbon price set as part of emissions trading increases the cost of fossil fuels, which in turn affects municipalities' operating costs(Climate protection potential in municipalities, 2023).

  Another important aspect is the role of municipal companies. Although municipalities themselves are not directly involved in emissions trading, municipal companies such as hospitals or waste disposal companies can be included in emissions trading under certain circumstances. This depends on various factors, such as the size of the facility and the nature of its activities. For example, a municipal company that operates a large energy generation or waste incineration plant could well fall within the scope of the EU ETS or nEHS and thus participate directly in emissions trading (LeitfadenKlimaschutzin Kommunen, 2023).

- **GHG reporting**

  Sustainability reporting shows that municipalities are subject to less stringent requirements than companies. The EU's Corporate Sustainability Reporting Directive (CSRD), which is primarily aimed at larger and listed companies and requires detailed disclosure of sustainability information, is not applied in a comparable way to

municipalities. In addition, local authorities rarely use internationally recognized frameworks such as the Global Reporting Initiative (GRI) for their sustainability reports, in contrast to the widespread practice in the private sector.

Looking at the federal state of Lower Saxony in Germany, there is a growing trend towards promoting transparency in relation to energy consumption and management. Since April 2023, there has been a legal obligation for municipalities in Lower Saxony to prepare annual energy reports. Municipal heat planning is seen as a strategically relevant process for achieving a climate-neutral heat supply. It is an integral part of municipal energy planning and covers the entire municipal area, including private residential buildings, municipal properties and commercial buildings. This planning makes a significant contribution to reducing greenhouse gas emissions by identifying and realizing potential savings(Klimaschutz in Niedersachsen, 2023).

In addition, municipalities are encouraged to voluntarily prepare climate reports as part of their climate protection concepts or initiatives, whereby they can receive support from the state government, for example in the form of guidelines or financial support.

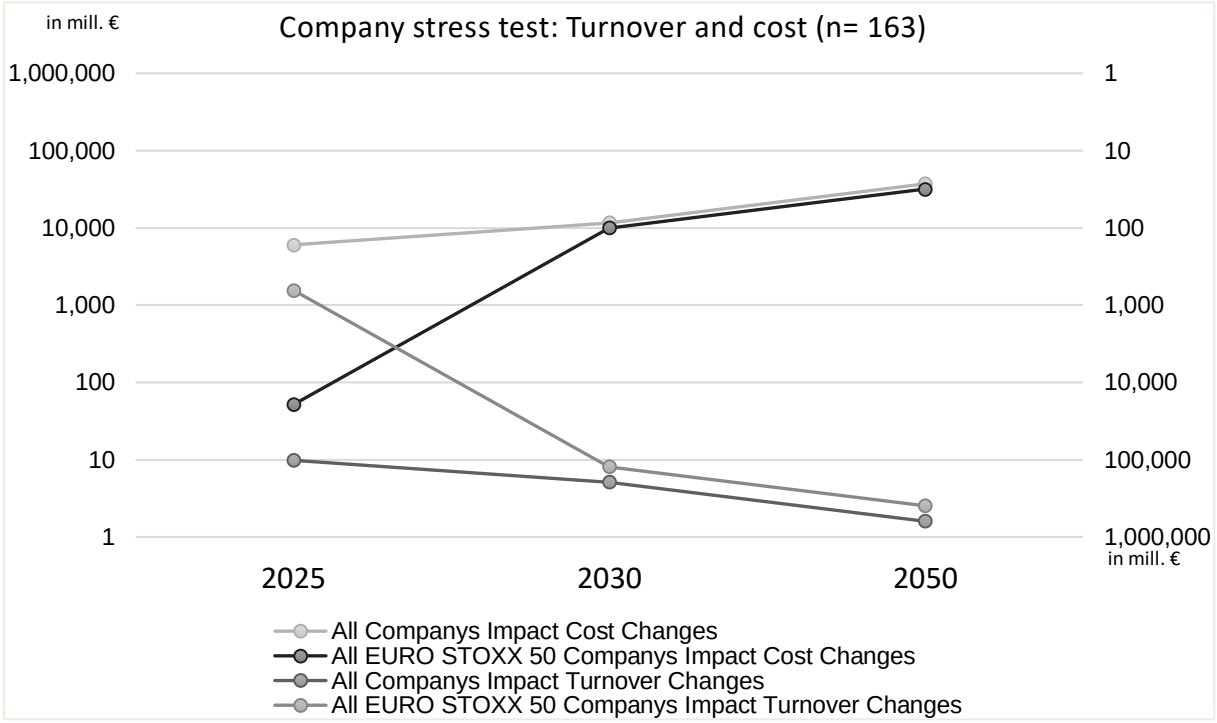
Climate reports in municipalities can include items such as a detailed breakdown of GHGemissions in various sectors such as transport, buildings, industry and waste management.

4. Analysis

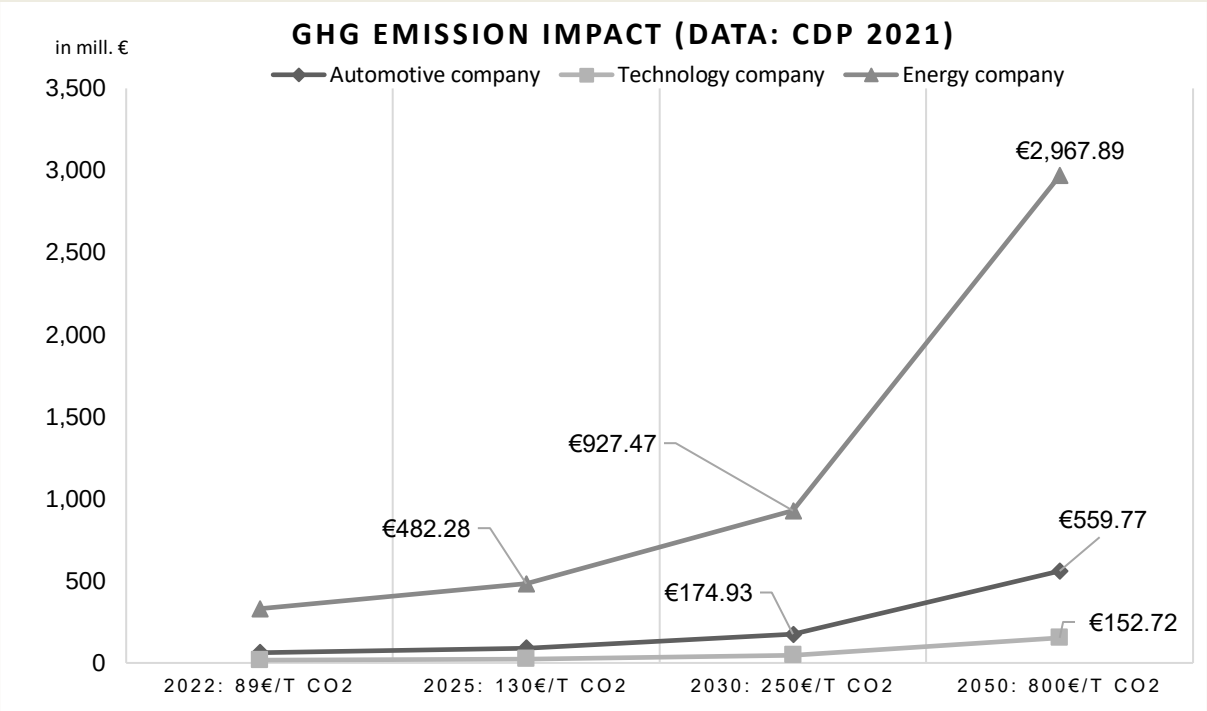
The following analysis reveals the consequences of GHG emissions costs for companies. It is attempted here to project these results at the municipal level to illustrate the effects there.

4.1 GHG Pricing: Effects at company level

The two diagrams below impressively illustrate the significant increase in costs and the resulting economic consequences for companies if they do not undertake a strategic reorientation towards more environmentally friendly practices in order to reduce their GHGemissions.



The first graph is based on an analysis of 163 commercial (Company list, 2023) enterprises that were subjected to a stress test with regard to their turnover and costs. This test simulates the impact on revenue reductions and cost increases for the companies, assuming that the price of GHG emissions increases from 130 € / tCO_2 in 2025 to 800 € / t CO_2in 2050. For this analysis, it is important to emphasizethe assumption that the companies concerned do not take any adaptive measures to minimize their greenhouse gas emissions.



The second chart presents data taken from a CDP data package for 2021 for the three companies, in particular in relation to the emission values according to the GHG Protocol scoping (Scope 1). The2021 CDP CO_2e emission data set used for this calculation isshown in the table below (CDP - Public Climate Change Dataset Sample, 2022). For the presentation, the current GHG emissions of these companies, based on the EEX GHGvalue of 89 €/ tCO_2 in 2022, were hypothetically extrapolated up to 2050, using a CO_2 price of 800 € / t CO_2. This illustrates the drastic increase in the additional costs that companies would have to bear for their GHG emissions, assuming that no significant measures are taken to reduce these emissions.

Company	**CDP Scope 1 data**
Automotive company	699713.0 t/ CO_2e/Scope 1
Technology company	190900.0 t/ CO_2e/Scope 1
Energy company	3709865.98 t/ CO_2e/Scope 1

4.2. GHG Pricing: Consequences for local communities

This section sets out to anticipate the expected impact on the municipality if the prices for greenhouse gas emissions rise significantly by 2050, as forecast in the stress test.

4.2.1. Effects of cost increases by commercial enterprises within municipalities

A series of key aspects can be identified in a scientific and economic analysis of the effects of a decline in turnover and a simultaneous increase in costs in companies on municipal structures. Firstly, a decline in turnover leads to a reduction in trade tax revenue for the municipality, which has a direct

impact on the public budget and therefore on the municipal financial situation. This can lead to restrictions in public spending, which in turn can affect the quality and availability of public services.

An increase in operating costs can prompt companies to rationalize, which is often accompanied by job losses or different job requirements. Increased unemployment not only results in increased social spending by the municipality, but also affects income tax revenues. In addition, local economic activity is affected by the weakening of businesses, which can have a negative impact on the revenues of neighboring businesses and trigger a downward spiral of economic activity.

The social impact is also significant, as companies often play an important role in supporting local community projects. A decline in their economic performance can lead to a reduction in these support services. Furthermore, the economic downturn can have a negative impact on property markets, affecting local authority property tax revenues and reducing property values.

Finally, these economic challenges may lead to long-term structural changes in the local economy that require a strategic realignment and adjustment of municipal policies. This requires careful planning and possibly a reorganization of municipal finances to take account of the new economic realities and ensure the quality of life of citizens.

4.2.2. Effects of cost increases by municipal owned companies

The economic and social effects of a decline in turnover costs with a simultaneous increase in costs in municipal subsidiaries require a differentiated view. This phenomenon presents local authorities with considerable financial challenges. The confrontation with falling turnover and rising expenditure inevitably leads to a financial burden that impairs the financial stability and ability of the municipality to fulfil its obligations.

This situation often forces budget reallocations and cuts, which can have a direct impact on public infrastructure and services. In particular, investments in essential areas such as hospitals, daycare centers and schools can be affected by this financial imbalance. This not only has a short-term financial impact, but can also negatively affect the quality and availability of these vital public services in the long term.

One direct consequence could be an increase in taxes to cover the increased expenditure. This would mean an additional burden for residents and local businesses. At the same time, future projects and developments could be delayed or even cancelled due to financial constraints.

These financial challenges have far-reaching social implications. The restrictions on public services particularly affect vulnerable groups who are dependent on these services. In addition, such financial difficulties can reduce the attractiveness of the municipality for companies and investors, which can lead to slower economic growth and a deterioration in general living conditions.

In summary, the financial difficulties of municipal subsidiaries require comprehensive and strategic planning on the part of local government to minimize the negative impact and ensure the long-term sustainability of municipal services and infrastructure. These challenges emphasize the need for a balanced and forward-looking financial policy in the municipal sector.

4.3. GHG Reporting

In this section, the differences between corporate and municipal reporting should be clearly emphasised.

- **Company level**
  When analysing sustainability reporting in relation to GHG emissions, it becomes clear that the companies surveyed demonstrate a significant commitment to decarbonization. It is clear that the majority of these companies have anchored the

reduction of GHG emissions as an integral part of their corporate strategies. In addition, some of these companies integrate aspects of CO_2 regulation and its potential impact into their risk management processes.Of the 163 companies analyzed, 130 use the GRI 305 Standard to report their emissions. Particular attention is paid to the assessment of GHG emissions according to Scope 1 and Scope 2, as the determination of Scope 3 emissions is often considered inadequate. Despite this challenge, most companiesaspirations to present these values in the best possible way. Some reports point out that the data on Scope 3 emissions is not yet fully meaningful and should be further improved in the future.Another important aspect is that all companies set reduction targets for their emissions in accordance with the GRI 305-1 guideline and set out solutions for how they will reduce their GHG emissions. These strategic approaches reflect the company's aspirations to adapt to changing regulatory and environmental conditions and to contribute to achieving global climate targets.

- **Locallevel**
  An economic analysis of municipal reporting on GHG emissions reveals a discrepancy between the reporting practices of companies and municipalities. While cities present targets and emissions as part of their climate protection concepts and take existing regulations into account, the reporting of many of the municipalities analyzed focuses primarily on the GHG emissions of industrial companies. They provide data for municipal budgets and municipal GHG emissions. However, a key aspect that is often missing from the reporting of these municipalities is the presentation of emissions from their own administration and municipal operations. This gap in reporting indicates a potential need for improvement in the recording and disclosure of GHG emissions at municipal level. Accordingly, a municipality usually does not report all GHG emissions, which generally leads to a falsification of the GHG balance. The incomplete recording and reporting of GHG emissions by municipalities, in particular the omission of emissions from their own administration and municipal operations, can lead to a distortion of the overall balance of GHG emissions. The incomplete recording and reporting of GHGemissions by municipalities, in particular the omission of emissions from their own administration and municipal operations, can lead to a distortion of the overall balance of GHG emissions. This practice implies that the actual emission values could be higher than the reported figures, which makes it difficult to accurately assess the climate impact and the effectiveness of climate protection measures.

It is clear that the quality of company reporting is significantly better than that of local authorities. Local authorities should therefore utilise the frameworks of companies to ensure that all specific sources of emissions are fully recorded.

5. Conclusion and Outlook

To summarise, the increasing greenhouse gas emissions in both private companies and municipal businesses are leading to financial challenges for municipal budgets. Falling turnover in the private sector results in a reduction in trade tax revenues, which has a direct impact on the public budget and the financial situation of local authorities, and can lead to restrictions in public spending policy, which in turn can affect the quality and availability of public services. Rising operating costs often lead to rationalisation measures in companies, which can be accompanied by job losses or changes in work requirements. Increased unemployment not only results in increased social spending by local authorities, but also affects income tax revenues. In addition, local economic activity is affected by the weakening

of companies, which can have a negative impact on neighbouring businesses and trigger a downward spiral of economic activity.

Secondly, it is clear that the financial difficulties of municipal companies can lead to budget reallocations and cuts that have a direct impact on public infrastructure and services. In particular, investment in key areas such as hospitals, day care centres and schools can be affected by these financial imbalances. The financial challenges have far-reaching social implications, as they affect particularly vulnerable groups that depend on these services.

With regard to GHG reporting, it was found that companies demonstrate significantly better quality compared to municipalities. Companies integrate the reduction of GHG emissions as an integral part of their corporate strategies and set reduction targets in accordance with the guidelines. Municipalities, on the other hand, often fail to report emissions from their own administration and municipal operations, which can lead to a distortion of the overall balance of GHG emissions.

The available findings suggest that municipalities will face considerable economic and structural challenges in the future. In view of the direct impact of corporate crises on municipal finances, a strategic reorientation and adjustment of municipal policy measures will be essential. This requires careful planning and possibly a reorganisation of municipal finances in order to do justice to the new economic realities and safeguard the quality of life of citizens.

In the area of GHG reporting, municipalities should utilise corporate practices and frameworks to ensure more comprehensive and accurate reporting of specific emission sources. Improving the quality of reporting is crucial to enable a realistic assessment of climate impacts and the effectiveness of climate action. In the long term, this could lead to more effective climate policy at local level and strengthen the role of municipalities in tackling global climate challenges.

Overall, these challenges emphasise the need for a balanced and forward-looking financial policy in the municipal sector to ensure the long-term sustainability of municipal services and infrastructure.

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European Green Deal and Greenwashing: A risk for communities and organizations

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Abstract

Climate change mitigation along with circular economy issues are one of the topics of current times. It was never more important for communities, states, continents, and companies to act in a more sustainable way in order to protect earths most valuable resources and to stop global warming and its most severe consequences.

Therefore, the European Commission issued the European Green Deal to foster and increase sustainable development in the European Union, as the EU is striving to become the world's first climate-neutral continent by 2050. This paper explores the impact of the European Green Deal on communities and organizations and its role in promoting their sustainable development.

However, with increasing requirements and expectations from governments as well as customers and other stakeholders, the risk of greenwashing by companies is also on the rise. Companies may use deceptive environmental claims to stay competitive while not adapting to a more sustainable practice. This paper will highlight those risks and create more awareness about them by looking at some use cases showing the challenges and limitations of sustainability report monitoring.

On the other hand, the paper will focus on best practice examples and showcase instances where companies have demonstrated genuine dedication to sustainable practices. These cases can serve as models for aligning corporate profitability with substantive environmental stewardship. In addition, this paper demonstrates possible actions taken by communities in order to keep companies responsible on a more local level.

Keywords: Green deal, greenwashing, risk management, communities

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Introduction

This year's COP 28 with approximately 100.000 registered attendees from almost two hundred nations across the globe (McSweeney, 2023) showcases once again the importance of sustainable development and the urgency of climate change mitigation. When searching for the biggest threats and challenges of current times, climate change is almost always mentioned (Hirndorf, D., Roose, J., 2023). It has become imperative for communities, states, continents, and corporations to adopt more sustainable practices, safeguarding Earth's invaluable resources and mitigating the adverse effects of global warming and its severe consequences.

To foster and increase sustainable development in the European Union (EU), the European Commission issued the European Green Deal (EGD), as the EU is striving to become the world's first climate-neutral continent by 2050. However, with increasing requirements and expectations from stakeholders, the risk of greenwashing (GW) by companies is also on the rise. Understanding greenwashing is crucial in discerning genuine efforts from deceptive practices. This awareness not only empowers consumers but also promotes transparency. As companies navigate the evolving landscape of environmental responsibility, scrutiny and awareness of greenwashing become integral to ensuring authentic sustainability practices.

In the course of this paper, the research question about the impact of the European Green Deal on organizations, communities, and sustainable development in general is explored. Furthermore, the risks of greenwashing will be highlighted by showcasing the limitations of sustainability report monitoring. Additionally, within the same framework, a demonstration of genuine dedication to sustainability by a company will be analyzed. Based on the collected results, recommendations for other organizations can then be made.

Therefore, the study will initially focus on the theoretical aspects, including the definition of key terms and an overview of the current literature. The central part will provide a methodology suitable for the scope and implementation of the case study, followed by the presentation of the results. These results as well as their limitations and shortcomings will be discussed, leading to conclusions and recommendations for future research and actions to be taken.

Theory

This chapter focusses on the presentation and definition of the keywords for this term paper as well as insights on current literature and research.

1. Keywords

European Green Deal

One of the centre topics of this paper is the European Green Deal (EGD), which was published by the European Commission (EC) in December 2019 with the main aim for Europe to become the first climate-neutral continent by 2050 (European Commission, 2019). The EC (2019) describes the EGD as a plan to ensure the sustainability of the EU's economy by transforming climate and environmental challenges into opportunities throughout all policy domains, while decoupling economic growth from use of resources but also ensuring a fair and inclusive transition for everyone. It is closely related and aligned to the Sustainable Development Goals of the United Nations (Smol, 2022) and the COP 21 Paris Agreement in 2015 striving to limit global warming well below 2°C (United Nations, 2015).

The EGD is not a law, but rather a comprisal of strategies and policies (Fetting, 2020) andwhile new directives, regulations and laws are continuously implemented, there are eight key areas that define the EGD: "Increasing the EU's climate ambition for 2030 and 2050, supplying clean, affordable, secure energy, mobilizing industry for a clean and circular economy, building and renovating in an energy and resource efficient way, zero pollution ambition for a toxic-free environment, preserving and restoring ecosystems and biodiversity, farm to fork as fair, healthy and

environmentally friendly food system, accelerating the shift to sustainable and smart mobility" (European Commission, 2022, p. 24).

Greenwashing

Characterized in 1986 by Jay Westervelt (Guo et al., 2018), greenwashing embodies companies using deceptive tactics to project environmental responsibility, spanning organizational and product levels. However, there is no generally accepted definition due to the multidisciplinary nature of the term. Scientifically, the understanding of greenwashing differs between **selective disclosures** and **decoupling behaviors**. Selective disclosure means the practice of presenting positive but leaving out negative environmental-related information of the organization. Organizations might also apply decoupling behaviors, where there is a discrepancy between the positive communication of the organization's environmental performance and the actual actions taken (De Freitas Netto et al., 2020). In 2020, the EC assessed environmental claims by companies and conducted that more than half of the claims were ambiguous or deceptive and about 40 % were unsubstantiated (Ragonnaud, 2023).

Two key classifications of greenwashing are **claim greenwashing**, using deceptive textual arguments, and **executional greenwashing**, leveraging nature-evoking,audio-visual elements without explicit claims. Claim greenwashing delves into the "seven sins", created by TerraChoice (2010), comprising hidden trade-offs, lack of proof, vagueness, false labels, irrelevance, the illusion of choosing the lesser evil, and falsehoods. These tactics mislead stakeholders, creating an illusion of environmental commitment. Executional greenwashing, a newer dimension, involves incorporating nature-evoking,audio-visual elements subtly to convey environmental friendliness without explicit claims (De Freitas Netto et al., 2020).

Potential cases of greenwashing regarding claims raised by companies are rather hard to understand and analyze by consumers and other stakeholders. Therefore, Nemes et al. (2022a) created the first science-based assessment tool of its kind enabling stakeholders to identify deceptive and misleading specific claims by an organization.

The framework, consisting of thirteen themes, facilitates the assessment of potential greenwashing claims by evaluating them against a set of indicator questions. Irrelevant questions are disregarded, and those with unknown information are marked as such, necessitating consultation of diverse sources. An approving answer to any question within the framework indicates an organization's involvement in greenwashing. However, the tool is specifically designed for evaluating specific claims and is not suitable for assessing societal-level systems, economic aspects, or organizational size differences (Nemes et al., 2022a).

Risk

The International Organization for Standardization (ISO) defines risk as the "effect of uncertainty on objectives" (ISO, 2018). An effect denotes a departure from the anticipated outcome, encompassing both positive and negative aspects. It has the potential to generate opportunities or pose threats, shaping, creating, or addressing various situations. Risk management means the process of coordinating activities to identify, assess and control risks (ISO, 2018).

In the context of this paper, organizations are exposed to reputational, regulatory, and litigation risks stemming from greenwashing. Specifically, regarding reputational risk, mere allegations of greenwashing have been demonstrated to result in substantial declines in trust and revenue for companies.

Recent legislative developments in Europe, such as the Sustainable Finance Disclosure Regulation and the EU Taxonomy, have been introduced to address inadequate sustainability reporting and enhance transparency. Consequently, companies are confronted with an increased regulatory risk. Furthermore, these legislative measures, combined with other factors, contribute to an elevated risk of litigation. (The Harvard Law School Forum on Corporate Governance, 2023).

2. Background on Climate Change Mitigation

"Climate change refers to long-term shifts in temperatures and weather patterns. Such shifts can be natural, due to changes in the sun's activity or large volcanic eruptions." (United Nations, w/o. D., par. 1). However, there is a substantial anthropogenic part to climate change starting with the industrial revolution about two hundred years ago. To tackle the human drivers of climate change there are three different mitigation strategies (Fawzy et al., 2020).

Firstly, there are **conventional mitigation**efforts that are already well establishedwith technologies such as the use of renewable energy or carbon capture. Then, there are also **negative emissions technologies**to capture and store Carbon dioxide (CO_2) including bioenergy or direct air carbon capture. A third mitigation strategy revolves around radiative forcing **geoengineering technologies** aiming to stabilize and reduce temperatures like stratospheric aerosol injection. It must be mentioned that these technologies are still in development, in trial stages or still completely theoretical (Fawzy et al., 2020)

From a policy perspective, the global imperative for climate change mitigation gained prominence following the COP 21 and the subsequent adoption of the Paris Climate Agreement in 2015. This international accord, ratified by 196 countries, aimed to address climate change, and constrain global warming to a threshold below 2 degrees Celsius relative to pre-industrial levels (United Nations, 2015).

Subsequently, the European Green Deal (EGD) defined**supranational strategies towards climate neutrality by 2050**, as elaborated in a previous section. Nationally, Germany enacted the Federal Climate Change Act (Bundes-Klimaschutzgesetz) in 2021, establishing interim targets to achieve a 65% reduction in greenhouse gas (GHG) emissions by 2030, an 88% reduction by 2040, and eventual **national climate neutrality by 2045** (Bundesregierung, 2021). This legislative framework encompasses allocated annual emission budgets for six sectors, including energy, transportation, and buildings (Bundesregierung, 2021). Lower Saxony integrated these national objectives into its regional Climate Act, tailoring them to local needs and aspirations.

Lower Saxony integrated these national objectives into its regional Climate Act, tailoring them to local needs and aspirations. In December 2023, a revised version introduced more stringent**regional** targets, aiming for **climate neutrality by 2040** (Klimaschutz- und Energieagentur Niedersachsen, 2023). Additionally, ongoing legislative enhancements include extended obligations for photovoltaic systems, the establishment of a climate council, and the mandatory implementation of climate protection management by municipalities (Klimaschutz- und Energieagentur Niedersachsen, 2023). At the local level, municipalities are compelled to align with the stipulated regional targets, with key action areas identified in the Lower Saxony climate protection strategy encompassing energy management, heat planning, mobility, regional and urban planning, as well as citizen engagement (Niedersächsische Klimaschutzstrategie, 2021).

Since 2005 there is an annual report on the climate protection performance of 63 countries and the EU, which as major emitters together currently make up 90 % of the global greenhouse gas emissions, while other nations are not evaluated due to their comparatively low GHG emissions, although over time new countries emerging as GHG emitters are included on a regular base.

The Climate Change Performance Index (CCPI) assesses the performance and progress of the countries regarding one qualitative and three quantitative categories: GHG emissions, energy use, renewable energy and via qualitative assessment climate policy. The first category makes up 40 % of the score since greenhouse gas emissions are the key drivers of climate change. The latter categories are taken into account with 20 % each (Burck et al., 2023b). Table 1 shows the components of the CCPI.

Table 1

Components of the CCPI

Category	Overall Weighting in %	Subcategories	Weighting in %
Emissions	40	Current Level of GHG Emissions per Capita	10
		Past Trend of GHG Emissions per Capita	10
		Current Level of GHG Emissions per Capita compared to a well-below-2°C compatible pathway	10
		GHG Emissions Reduction 2030 Target compared to a well-below-2°C compatible pathway	10
Renewable Energy	20	Current Share of Renewables per Total Primary Energy Supply (TPES)	5
		Development of Energy Supply from Renewable Energy Sources	5
		Current Share of Renewables per TPES compared to a well-below-2°C compatible pathway	5
		Renewable Energy 2030 Target compared to a well-below-2°C compatible pathway	5
Energy Use	20	Current Level of Energy Use (TPES/Capita)	5
		Past Trend of TPES/Capita	5
		Current Level of TPES/Capita compared to a well-below-2°C compatible pathway	5
		TPES/Capita 2030 Target compared to a well-below-2°C compatible pathway	5
Climate Policy	20	National Climate Policy	10
		International Climate Policy	10

Note. Adapted from *Climate Change Performance Index 2024: Background and Methodology*, by Burck et al., 2023, p. 4.

Methodology

Following the theoretical baseline, the methodology of this paper is laid out in the following section.

1. Approach to assessing the impact of the European Green Deal

Assessing the impact of the EGD is challenging due to its multifaceted and interconnected nature, spanning various sectors with long-term goals extending beyond 2030. The complex policy landscapemakes it hard to isolate the effects of individual measures. Additionally, the varied national approaches of EU member states towards the common goal, unforeseen challenges, data availability and quality further complicate efforts to provide a comprehensive and timely evaluation of the Green Deal's outcomes.

This paper tries to assess the impact of the EGD by comparison of the **scores of the EU member states** given in different **CCPI**over time. Due to a different approach and measures to evaluate the scores of the CCPI up until 2017, a comparison to more recent reports is limited and is not included in this paper. Therefore, the scores of the CCPIs from 2018 to 2024 are put in comparison, since the EGD was presented in 2019. The overall scores of the countries are put in a table and a resulting line diagram. Based on the comparison, statements and assumptions regarding trends and the impact of the EGD can then be made.

2. Selection and Analysis of Case Studies

In a second part of the study, the risk of greenwashing is examined. In this study, statements or specific claims regarding sustainable actions made by companies that potentially contain greenwashing are explored and reviewed using the Integrated Framework, which was described earlier, consisting of 29 questions that have four possible answers each (Nemes et al., 2022a). Sources for answering the questions can vary and come from claims on the company's website, their social media, or their sustainability reports. Questions that are irrelevant to the selected claim can be ignored (Nemes et al., 2022a). The framework is attached in the appendix in an adapted version (Nemes et al., 2022b). After finalizing the study, the results can be matched with earlier assessments regarding the state of greenwashing.

Since this paper focuses on the EGD and the EU in general, it is sensible to use claims made by companies with their headquarters in the EU. The Fortune 500 Europe 2023 lists the biggest companies of Europe. Given the complexity of the Integrated Framework, this paper focuses on the biggest companies: Shell, Volkswagen, Uniper, TotalEnergies and BP (Fortune, 2023). Glencore, which is stated by Fortune as well is excluded in this study, because the companies headquarter is not based in anEU member state.Additionally, as a best practice example, one company and their claims will be included in the examination. These companies raised attention on the internet with statements or actions and for this study are not obligated to have their headquarter in the EU.

Results

The following section concludes the results of the conducted studies and begins with the comparison of the CCPI, followed by the examination of potential greenwashing.

Impact of European Green Deal on Communities and Organizations

The analysis of CCPI scores among EU member states from 2018 to 2024 reveals a nuanced landscape of climate protection performance. The median CCPI values exhibit a generally stable trend with a slight increase over the specified period, suggesting a modest improvement in climate protection performance on average within the EU. Table 2 shows the scores from the different member states across the years.

Table 2

Comparison of the EU member states' CCPI scores from 2018 to 2024

EU member state	2018	2019	2020	2021	2022	2023	2024
Austria	49,49	48,78	44,74	48,09	52,35	51,56	58,17
Belgium	49,60	50,63	45,73	45,11	45,90	48,38	55,00
Bulgaria	45,35	48,11	40,12	42,64	48,71	49,15	46,94
Croatia	61,19	62,39	56,97	56,69	55,96	52,04	57,32
Czech Republic	45,13	49,73	42,93	39,98	42,15	44,16	45,41
Denmark	59,49	61,96	71,14	69,42	76,67	79,61	75,59
Estonia	52,02	44,37	48,05	46,01	54,98	65,14	72,07
European Union	**56,89**	**60,65**	**55,82**	**57,29**	**59,21**	**59,96**	**64,71**
Finland	66,55	62,61	63,25	62,63	62,41	61,24	61,11
France	59,80	59,30	57,90	53,72	61,01	52,97	57,12
Germany	56,58	55,18	55,78	56,39	63,53	61,11	65,77
Greece	47,86	50,86	52,59	48,11	58,22	57,52	60,34

Hungary	44,00	46,79	41,17	38,22	40,41	38,51	45,93
Ireland	38,74	40,84	44,04	45,47	47,86	48,47	51,42
Italy	59,65	58,69	53,92	53,05	55,39	52,90	50,60
Latvia	63,02	68,31	60,75	61,88	57,73	56,81	57,68
Lithuania	69,20	70,47	66,22	58,03	64,89	59,21	62,99
Luxembourg	55,54	59,92	60,91	55,23	60,80	60,76	65,09
Malta	61,87	65,06	60,76	62,21	64,18	60,42	59,80
Netherlands	49,49	54,11	50,89	50,96	60,44	62,24	69,98
Poland	46,53	47,59	39,98	38,94	40,63	37,94	44,40
Portugal	59,16	60,54	54,10	56,60	61,11	61,55	67,39
Republic of Cyprus	52,29	44,34	41,66	38,73	50,52	49,39	53,09
Romania	55,32	59,42	54,85	50,33	52,43	47,09	61,50
Slovakia	56,04	56,61	52,69	49,51	50,67	50,12	54,47
Slovenia	50,54	44,90	41,91	37,02	43,28	48,16	53,57
Spain	48,19	48,97	46,03	45,02	54,35	58,59	63,37
Sweden	74,32	76,28	75,77	74,42	74,22	73,28	69,39
Median	**54,78**	**55,62**	**52,88**	**51,49**	**55,71**	**55,30**	**58,94**

Note. Based on the *Climate Change Performance Indexes from 2018 to 2024*, by Burck et al.

However, the **variability** among member states is striking. Some countries, exemplified by Denmark, consistently demonstrate improvement, while others exhibit fluctuations or declines in their CCPI scores. Denmark stands out as a positive performer, maintaining consistently high CCPI scores, indicative of robust climate protection performance. Similarly, Estoniaand Sweden exhibit positive trends, although Sweden experiences a decline in 2024.

On the other hand, Germany and the Netherlands emerge as mixed performers with varying patterns. Germany shows an overall increase in its CCPI scores, while the Netherlands demonstrates notable fluctuations, including an increase in 2022 and 2024.

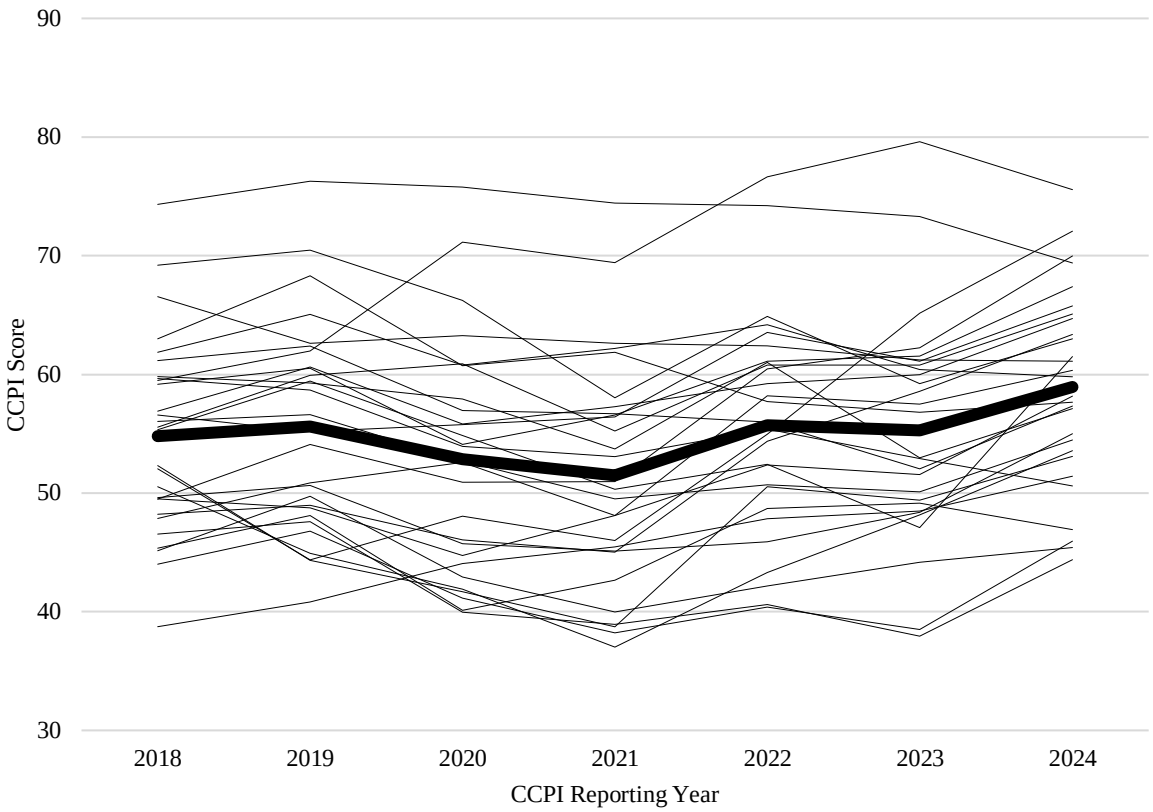
Several countries face challenges, evident in declining trends. Also, higher performing countries like Finland appear to not be excluded from this trend andalthough Finland still performs relatively well with scores reaching from 66 to 61, a drop in performance can be observed. Other countries like Austria, Belgium, France, Italy, and Spain experience periods of decline.

Figure 1 shows the performance of the evaluated countries in a graph with the fat line representing the median. When looking at the graph, it becomes more evident that there is a big gap in the different climate change mitigation performances. In 2018 the gap between the highest and lowest performing country amounts 35,58. The biggest difference occurred in 2023 with a gap of 41,67, which then declined in 2024 to the smallest value of 31,19.

When reviewing the **2024 CCPI**,it can be observed that no country was able to be rewarded with the best possible CCPI rating, a score meaning that those nations paths should be completely aligned with the 2015 Paris Agreement scenario towards the goal of keeping the global warming well below 2°C. In consequence, the top three places in the ranking continue to stay empty (Burck et al., 2023a).

Figure 1

Visualization of the comparison of the CCPI scores from 2018 to 2024 (thin lines = line of EU



member states, fat line = median)

Note. Based on the *Climate Change Performance Indexes from 2018 to 2024*, by Burck et al.

Case Studies of Greenwashing

In this section, claims or statements made by companies that contain potential greenwashing are evaluated based on the Integrated Framework that can be found in the appendix. After finding a striking statement, further examination is conducted with the support of using the questions of the framework as a guideline. Table 3 shows a consolidation of the results.

Table 3

Potential Cases of Greenwashing regarding claims of companies

Company	Claim with potential GW	Results of research	Answers "Yes" or "Likely" to questions of Integrated Framework
BP	"Our purpose is reimagining energy for people and our planet. We want to help the world reach net zero and improve people's lives" (BP, 2023a)	- Energy outlook: BP still sees Oil as one of primary energy sources for approximately next ten years (BP, 2023b); usage of color green for "Oil" and orange for "Renewables" indicating fossil fuels as more sustainable than renewable energy sources (BP, 2023b) - Transition growth investment compared to oil and gas investments (Shell, 2023a):	- XII. Misleading symbols 1 - II. Empty claims 2

		▪ In 2022, 30 % of total capital expenditures ▪ Aim for 2030: 50 % of capital expenditures ▪ Still 50 % of expenditures left for unsustainable sectors	
Shell	Achieving net zero by reducing Scope 1 and 2 emissions by 50 % by 2030 compared to 2016 levels among other measures (Shell, 2023)	- Scope 1 and 2 emissions for 2022 combine to a total of 58 million tons of CO_2 equivalent; Scope 3 emissions were 1.174 million tons CO_2 equivalent (Shell, 2023) - Only 4.7 % of total emission are considered with an aim to reduce the total emissions of Shell by 2.35 % - Original claim creates a completely different picture and overestimates the actual impact	- I. Selective Disclosure 3 - II. Empty claims 3
TotalEnergies	"ambition to be a major player in the energy transition" (TotalEnergies, 2023a, p. 1)	- TotalEnergies Energy Outlook (TotalEnergies, 2023b): ▪ Energy production by 2030: 40 % oil, 40 % LNG and pipeline gas, 20 % Electricity ▪ Energy sales: 30 % oil, 50 % LNG and pipeline gas, 20 % Electricity - Total capital investment of 14-18 billion dollars/year ▪ 66 % Oil, LNG and Gas with 30 % of it being used for new projects: only 33 % for low carbon energies ▪ Despite claiming a role in transition, TotalEnergies plans to continue investing heavily in fossil fuels and unsustainable projects	- II. Empty claims 2 and 3
Uniper	"Europe's energy transition is underway, and we are actively shaping and, where we can, accelerating it." (Uniper, 2023)	- Green and blue themed Sustainability Report, in order to suggest a more sustainable picture - even for depiction of GHG emissions with Scope 3 emissions for 2022 amounting to over 90 million tons of CO_2 equivalent (Uniper, 2023) - Uniper was 2nd largest lobbyist in Germany from energy sector trying to slow down sustainable policy work/laws (Greenpeace, 2023)	- VIII. Political Spin 1 - XII. Misleading symbols 1
Volkswagen	"Sustainability is not a fad. It's firmly embedded at Volkswagen as one of five principles of corporate governance. We think of sustainability holistically: It's about the environment – including climate protection …" (Volkswagen Group, 2023, p. 5)	- Volkswagen plans to continue selling combustion vehicles until 2033-2035; EU currently plans to prohibit sale of combustion vehicles as of 2035 (ADAC, 2023) - Volkswagen plans to have only 20 % of sales to be electric vehicles by 2025 (Volkswagen Group, 2023) - Volkswagen engaged in lobbying against climate-protection policies and regulations (InfluenceMap, 2023)	- II. Empty claims 2 - III. Irrelevant 1 - VIII. Political Spin 1

Five out of five taken claims with the potential of greenwashing contained a **certain amount of greenwashing** according to the adopted Integrated Framework. Over the course of the research, it became apparent that the **given statements were formulated rather positive** and **focused on minor achievements of the companies**. The underlying bigger picture, including more data to be able to put

the claims into perspective, was only revealed by diving deeper into the sustainability reports, other company-related or completely external website sources.

Best Practice Example

This chapter aims to highlight genuine dedication to climate change mitigation and sustainable development by Patagonia Works.

Patagonia Works is a company that manufactures outdoor apparel but focusses on environmental and social topics for half a century. Since 2018, Patagonia stated: “We’re in business to save our home planet.” (Patagonia Works, 2022a, p. 2) In September 2022, the founder of Patagonia, Yvon Chouinard, declared that the company will be transformed into a trust and non-profit-organization in order to do everything possible for the company to tackle climate change (Patagonia Works, 2022b).

When applying the Integrated Framework to the statements given by Patagonia, every question can be answered with a “No”, except maybe some information that is too difficult to obtain. By looking at the website of Patagonia it becomes evident that climate change and ways of mitigation are of highest importance to the company. It is for example transparently displayed what environmental impact the clothing industry has orhow Patagonia is performing in reaching their goals (Patagonia Works, 2022a; 2023a). Also, all their protection, preserve and restoration activities are reported in a fact-based matter (Patagonia Works, 2023b).Additionally, Patagonia demonstrated that sustainability and sustainable business models can lead to increased revenues and profits (Land, 2023).

Discussion

In the following chapter, the presented results are discussed and put into context of current literature and trends.

Interpretation of results

European Green Deal

When comparing the CCPI scores 2018-2024 scores from the EU states, it becomes clear that there are big differences in the climate change mitigation performances despite all countries being member states of the EU. Over the span of 7 reports the interval between the highest and lowest performing country decreased by a score of 4,39, which can be seen as a positive trend but with the difference in 2024 still being 31,19, it becomes apparent that there still are big gaps in the strategies, policy work and performance of the EU countries.

Lower performing countries appear to face potential obstacles in their climate protection efforts, which could be the result of e.g.,slow policy development and implementation, lobbying done by companies with their own monetary interests or the political agenda of the current party in charge. To further asses the reasons of individual country performances, more in-depth research is required which will not be conducted in this paper.

Additionally, lower performing countries could analyze the strategies and legislative work done by e.g., Denmark in order to utilize best practices. It should be noted that even Denmark with the highest score of all CCPI rated nations in 2024, is still not aligned with the Paris Agreement which highlights the need for a stricter application of mitigation measures.

Although the data does not explicitly attribute substantial changes due to the EGD so far, the general stability and **slight upward trend in median scores** suggest a potential positive influence. European countries appear to adopt the EGD and develop and implement new legislations on climate protection. However, the varied performances of individual countries underscore that the impact may not be uniform across the EU with countries facing fluctuationsor even negative trends.

Greenwashing

After diving deeper into the companies' sustainability reporting and other sources, all five conducted case studies of claims containing some sort of greenwashing. The questions of the Integrated Framework supported the studies by giving an idea of what actions companies might try to use in order to hide potential greenwashing and was perceived as helpful. Although, it is not easily applicable for the general public since it contains complex steps and requires a high time investment.

Both **selective disclosures** and **decoupling behaviors** (De Freitas Netto et al., 2020), which were previously presented, could be observed in the case studies. Shell, for example, fails to put their reduction aims for their Scope 1 and 2 GHG emissions into perspective and therefore presented positive whilst leaving out negativeinformation, representing selective disclosure (Shell, 2023a). Regarding decoupling behaviors, multiple companies state their commitment to be a part of the energy transition while still heavily relying on fossil fuels and only slowly planning to transition to renewable energies.

Also, claim as well as executional greenwashing are represented in the conducted studies (De Freitas Netto et al., 2020). Claims by the companies included some degree of **vagueness** or even **irrelevance**because of upcoming legislations proving the sevens sins of greenwashing by TerraChoice (2010). Multiple companies utilize**audio-visual elements** to create false environmental friendliness like BP using green as a color for oil in some of their graphs (BP, 2023b).

The assessment by the EC in 2020 (Ragonnaud 2023) can partly be supported by the results of this paper with greenwashing being a prominent strategy of companies to create a more sustainable image. One has to consider, that the study by the EC was much broader and contained much more data than the investigation in this paper, meaning that these results are not applicable to be generalized. Otherwise, every existing company would utilize greenwashing. Other factors for the results can be, the approach to look for potential cases of greenwashing as a baselineon the one hand, and the selected scope of choosing generally non-climate-friendly companies on the other hand.

Best Practice Example

With the example of Patagonia Works, one can see that **sustainability and profitability are not contradictory** but can even increase each other. It goes to show that transparency and genuine dedication to climate change mitigation measures by companies are being recognized and appreciated by an increasing amount of consumers. Other companies could use the example of Patagonia Works as a guideline for their own activities and reporting regarding sustainability.

Limitations

With regard to the assessment of the impact of the EGD by comparison of the CCPI from the last years, there are several limitations. Firstly, the authors themselves mention that comparing the scores from year to year is only possible to a limited extent caused by a varying database and methodological changesin reporting (Burck et al., 2023b). Secondly, comparing the CCPI scores can give an impression of the current state of climate change mitigation performances from European countries and can lead to statements about the impact of the EGD, but it is not congruent. A more in-depth analyses of the various categories or further research on the causes and current policy landscape from selected countries was not possible due to the given frame of this paper.

Considering the analysis of potential greenwashing, the first limitation that comes to mind is the scope that was used for this research. Due to the scope, only companies from the energy or automotive industry were analyzed, which are especially affected by transitional issues towards the Paris goal of limiting global warming well below 2°C. The results might vary, when increasing the scope to a higher number of analyzed company claims or changing the industry sectors, since neither the energy nor the automotive industry are known to prioritize sustainability over their own monetary interests.

Conclusion

This paper investigated the questions of the impact of the European Green Deal, the risk of greenwashing and possible company best practice example. For answering these questions, multiple case studies were conducted. Firstly, the CCPI scores from all EU member states from 2018 to 2024 were assessed. In a second study, five claims with potential greenwashing content from EU's biggest companies were investigated using a framework given in the literature. A selectedcompany best practice example was presented to highlight best practices in sustainability reporting which do not fall prey to greenwashing.

Regarding the EGD, the study revealed that there is a general positive **upwards trend** in the CCPI performance of the European countries, which suggests a positive **impact of the EGD**. Despite that, several countries experience struggles in improving their performance, which indicates a deviation in a united approach potentially caused by misalignments in policy development and integration.

A tie-in for future research could be the examination of the performance of the other countries evaluated by the CCPI and compare them to the performance of the EU.Other research could go more in-depth in comparing the different scores in the given categories. It would also be appropriate to investigate why certain countries perform the way they are doing by evaluating their policy work to identify possible best practices for other countries to adopt.

The second part of the studyshowed that many companies utilize **deceptive strategies** to create amore environmentally friendly image.Without further analysis or research, the general public can be easily misled into believing certain claims by companies.

In the future, it can also be interesting to take a look at the forthcoming **Green Claims Act**(Ragonnaud, 2023) which reverses the burden of proof so that companies have to explain why certain claims are not greenwashing with more fact-based information.

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Appendix

Adopted Integrated Framework of Greenwashing from Nemes et al. (2022b)

Types ofclaims usedinGW	DescriptionofGW	Indicatorquestions	PossibleAnswers
I. SelectiveDisclosure	Claim is based on anarrowsetofattributesand distractsconsumers from theorganisation's greaterenvironmentalimpact	I.1 When making/supporting a claim about theproduct/organisation's environmental impact, has the organisation failed to consider theentire organisation/product/service's life cyclewithinitsareaofinfluenceORfailedtoassessthecumulativeenvironmentalimpactsofitsoritsproducts'activities?Forcountries,does theclaim cover only territorialemissions/footprints/impacts omitting a)imported ones or b) emissions frominternationalaviationandshipping?	**No=Nogreenwash**:allLCAstagesareincluded/ cumulativeimpacts of at least the last 5 years (for biodiversity impacts thelast 2 decades) are assessed; scope 1-2 is entirely covered andscope3isasmuchasfeasiblypossible.Forcountries,emissionsfrom international aviation and shipping OR importedemissions/footprints/impacts are covered. If not all stages/scopesare covered, there is transparency about spatial and temporalboundaries (what is and what is not covered) and even thoughpart of the organisation or product's/service's life cycle/scope 3emissionsareexcluded,provisionsexistforincludingthem. **Likelygreenwash**:e.g.theclaimisbasedononly somepartof the organisation's cumulative impacts or product's/service's lifecycle or large part of scope 3 is excluded and while systemboundaries are transparently communicated, there are noprovisions to continuously improve the coverage of all impacts.**Yes=Obviousgreenwash**:thereisnotransparencyaboutthefact that a significant part of LCA/scope/cumulativeimpact/imported emission or footprint is excluded therebymisleading consumers about the organisation's/product/service'stotal environmental impact. For countries, there is notransparency about imported emissions/footprints/impacts ORemissionsfrominternationalaviationandshippingareexcludedornotspecifiedintargets. **Unknown**
		I.2 While publishing the claim, has theorganisationfailedtodiscloseallinformationregarding social and/or environmentalperformance on the specific aspect the claimrefersto?	**No=Nogreenwash** **Yes=ObviousgreenwashLikely greenwash** **Unknown**
		I.3 Does the claim a) fail to relate to aspectsthat are significant in terms of theproduct/service/organisation'senvironmentalimpact OR b) result in an undue transfer ofnegativeimpacts?	**No=Nogreenwash** **Yes=Obviousgreenwash**:aorbistrue **Likelygreenwash:**e.g.aorbislikelytrue,butevidenceishardtoobtain. **Unknown**
		I.4 Does the claim a) communicate a specifictypeofproduct/service/policyas"more green",compared to competitors, even though there isno evidence that the product is "greener" thantheusualproduction/service/policyORb)refertо 'better' (recycled/certified/sustainable/lesscarbon intensive/etc.) products/services,whilethe	**No=Nogreenwash** **Yes=Obviousgreenwash**:aorbistrue **Likely** **Unknown**

		organisation fails to communicate the ratioof'better'vs'conventional'products/services?	
		I.5Istheorganisation'sclaimtohavenet-zeroemissions not based on reducing its ownemissions to the full extent possible, and/or itreliesonoffsettingratherthanreductionsinitsown emissions? For countries, are projectsoutside a country's national boundariesincludedinanation'saccountingasoffsets?	**No=Nogreenwash:**Rulesoutoffsetstoclaimcompensationforown emissions, but rather emission reduction projects aresupported as contributions elsewhere. Organisations haveestablished deep decarbonization targets and interim targets,includingforresidualemissionsandplannedremovals,thatallowscrutiny with respect to actually achieving their stated net zerotarget. **Likelygreenwash**:Organisationsusecompensationoffsets, while setting limits on the amount to be used which will bereducedovertime.Forcountries,in-countryoffsetsareallowed.Sub-nationaljurisdictions(e.g.,California)usingoffsetsoutsidethejurisdictionarealsoconsideredlikelygreenwash. **Yes=Obviousgreenwash**:Netzerocommitmentsarenotbasedon science and there is no clarity about whether and how to useandlimitoffsets.Atthesametimeoffsetsareusedtocompensatefortheemissionsfromthecontinueduseoffossilfuels. **Unknown**
II. Emptyclaims	Makingclaims/ policies thateither exaggerateachievements,orfailtoliveuptothem	II.1 Has the claim a) promised some positiveimprovement (to environment/localcommunities, etc) that has not been fulfilledORb)statedorimpliedenvironmentalbenefitsif the benefits are negligible/short-term/disregard indigenous/marginalizedpopulations?	**No=Nogreenwash** **Yes=Obviousgreenwash:**aorbistrue **Likelygreenwash:**e.g.thepromisedimprovementisunlikelytobe achieved, or the stated benefits are likely to disregardmarginalizedpopulations **Unknown**
		II.2Aretherestrongindicationsthattheoverall marketing budget is larger than set aside forenvironmental improvement mentioned in theclaim?	**No=Nogreenwash** **Yes=Obviousgreenwash** **Likelygreenwash:**e.g.marketingbudgetislikelytobelargerbuthardevidenceisn'tavailable **Unknown**
		II.3Doestheclaimdeflectattentiontominorissuesorleadtocreating'greentalk'throughcommunication that a) overstates theorganisations' actual commitments, OR b)lacksanyconcreteactionwithsignificantandmeasurableimpact?	**No=Nogreenwash** **Yes=Obviousgreenwash:**aorbistrue **Likely greenwash** **Unknown**
III.Irrelevant	Proclaimingaccomplishmentsthatare irrelevantoralready required bylaw/competitors	III.1Isthepublicmisledtobelievetheclaimisaresultofavoluntarysustainableactionswhenit or much of it is compulsory by law and/oralsorequiredofcompetitors?	**No=Nogreenwash** **Yes=ObviousgreenwashLikely greenwash** **Unknown**
IV.Lies	Claims are out-rightlying	IV.1Istheclaimcontradictedbyscientificconsensus?	**No=Nogreenwash** **Yes=ObviousgreenwashLikely greenwash** **Unknown**
V. Just notcredible	Claim toutsenvironmentalfriendlyattributes of adangerous or highlycontroversialpractice/ product/service/policy	V.1 Does the claim try to make the public feel"green" about a choice that is either dangerous(tohealth/environment)orhighlycontroversialwithpotentiallylong-term ecologically harmfulconsequences or adverse impacts on naturalresources?	**No=Nogreenwash** **Yes=ObviousgreenwashLikely greenwash** **Unknown**

VI.Corporateresponsibility inaction	Claim does not reflectconsistentorganisationalpractice	VI.1Aretheproducts/procurementpractices/visionorpublicpolicypositionsinconflictwiththeclaim?	**No=Nogreenwash** **Yes=ObviousgreenwashLikely greenwashUnknown**
VII.Dubiouscertifications &labels	Claim hascertificationsthatarepronetogreenwash	VII.1Isittruethatthelabel/sealattachedtotheclaimisnotverifiedbyanindependentbody? VII.2 Has the organisation failed to clearlydefineandcommunicatepublicalya)thescopeof certification, i.e., what is and what is notassessed in terms of products and/or processesAND b) information (or its readiness todisclose information) about standards,inspection guidelines, audit reports, details ofcomplaintsincludinginvestigationsummaries,andcontactdetailsofcertificationbodies? VII.3 Has the organisation using a voluntarycertification scheme (e.g. retailer/producer)failedtoapplyaneffectivedueddiligencepolicythat is regularly updated to ensure that theproductclaimisgenuine? VII.4 Has the organisation responsible for thevoluntary certification scheme (i.e. standardowner and/or NGO helping to set it up) failedto ensure that a) other stakeholders caneffectivelychallengethestandardownerorthecertification bodies through adequate andaccessible complaint and objection procedureOR b) it is able to meaningfully control,challangeorsanctionthecertification bodies? VII.5Istheorganisationmaking/supportingtheclaim associated with / consistentlycontributingtovoluntarycertificationschemesor committed to multi-stakeholder initiativesthat a) certify business as usual OR b) certifyproducts that do not meet its standards OR c)certify activities that have been implicated inillegality/environmental destruction/humanrightsabusewithinitsscopeofcertification?	**No=Nogreenwash** **Yes=ObviousgreenwashLikely greenwashUnknown** **No=Nogreenwash** **Likely greenwash:** e.g. either (a) is true OR some of the listeddocumentsin(b)havenotbeenpublished ORnotmadeavailableuponrequest. **Yes=Obviousgreenwash:**Yes,either(b)orbotharetrue **Unknown** **No=Nogreenwash** **Yes=ObviousgreenwashLikely greenwashUnknown** **No=Nogreenwash:**ithasnotfailedtoensureeitheraorb **Yes=Obviousgreenwash**:aorbistrue **Likelygreenwash:**e.g.proceduresarepresenttochallengethestandardsownerandcertificationbodies,howevertheyseemtobeinefficientandineffective **Unknown** **No=Nogreenwash** **Yes=Obviousgreenwash:**a,borcistrue **Likely greenwashUnknown**
VIII.Political spin	Claimboastsofgreencommitments, whilethe organisationlobbies againstenvironmentallaws	VIII.1 Has the organisation that makes theclaimorthathelpsacorporateentitytomakeaclaim a) lobbied for blocking/weakening pro-environmentallawsandregulationsORb)sent any such submissions topoliticians/governmentalagencies? VIII.2Istheorganisationaffiliatedwiththinktanks, trade associations or other groups thatspreadenvironmentalsciencedisinformationand/or block environmental action incontradictiontoitsclaims?	**No=Nogreenwash** **Yes=Obviousgreenwash:**aorbistrue **Likely** **Unknown** **No=Nogreenwash** **Likely greenwash:** e.g. the organisation expresses itsdisagreementwiththetrade/otherassociation butretainsmembershipdespitelackofchange **Yes=ObviousgreenwashUnknown**
IX. Co-optedendorsement	Claimsthatgreenwashorganisation'sactivities are endorsedbytheorganisations	IX.1 Does the organisation a) helppublicise/endorse another organisation's claimthat is a greenwash OR b) make a contrarygreenclaimtotheharmfulactivitiesit supportsfromotherorganisations? IX.2 While receiving payment (throughpartnership,donationoramembershi	**No=Nogreenwash** **Yes=Obviousgreenwash:**aorbistrue **Likely greenwash** **Unknown** **No=Nogreenwash** **Yes=ObviousgreenwashLikely greenwash** **Unknown**

		pfeeforone of its programmes) from anotherorganisation which greenwashes, does theorganisationendorsethatgreenwashclaim?	
X.Noproof	Claim cannot besubstantiated byeasilyaccessible supporting information	X.1Doestheclaimcontainstatementsthatarenot based on robust, independent, verifiableandgenerallyrecognisedevidence?	**No=Nogreenwash Yes=ObviousgreenwashLikely greenwash Unknown**
		XI.1 Has the claim failed to specify whether itreferstotheproduct/packaging/serviceorjustaportion?	**No=Nogreenwash Yes=ObviousgreenwashLikely greenwash Unknown**
		XI.2Dothewordsoftheclaim(otherthaninXI.3) have unclear/ambiguous meaning thatmislead people about the organisation's/product's/service's environmentalfootprint/impact?	**No=Nogreenwash Yes=ObviousgreenwashLikely greenwash Unknown**
XI.Vagueness	Claim is poorlydefined/broadsoitsreal meaning ismisunderstood	XI.3Whenmakinganet-zero/carbonneutralityclaim, has the organisation: a) failed tomeasure, track and regularly publish itsemissions according to the latest IPCCguidance (e.g. scope 1 and 2 emissions - andscope 3 emissions to the furthest extentpossible); OR b) based its claim on anunsubstantiated single point target without aclear strategy, implementation planningprocessandinterimtargets;ORc)failedto developandpublishalong-termstrategywithadecarbonisation pathway that prioritizesreducingitsownemissions?	**No=Nogreenwash Yes=Obviousgreenwash:**a, borcistrue **Likely greenwash Unknown**
		XI.4Istheclaimbasedonimplementationmethodologies that are a) not clear nortransparent and/or b) do not have robustmetrics?	**No=Nogreenwash Yes=Obviousgreenwash:**aand/orbistrue **Likely greenwash Unknown**
XII.Misleadingsymbols	Claimusesvisualsandsymbols that induce afalse perception of theorganisation'sgreenness	XII.1 Does the claim have an overallpresentation designed to evoke anenvironmentalsensitivitythata)overstatesthe achieved environmental benefit OR b) has noconnection with theproduct/service/organisation?	**No=Nogreenwash Yes=Obviousgreenwash:**aorbistrue **Likely greenwash Unknown**
XIII.Jargon	Claim usesjargon/information thatconsumers cannotunderstand/verify	XIII.1 Does the claim use technicallanguage/complexscientificjargonthatmakesitdifficultforpeopletounderstand?	**No=Nogreenwash Yes=ObviousgreenwashLikely greenwashUnknown**

Smart Tourism: Leveraging Tourist's Mobility Mining and Social Media Interaction for Tailored Exploration of Kerala's Cultural and Natural Treasures

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Abstract

Tourism, a dynamic and evolving industry, continually seeks novel approaches to enhance the traveller's experience. Tourism in the 21st century is marked by an increasing reliance on technology, with tourists relying on smartphones and social media platforms to plan and share their experiences. In the digital era, leveraging personal traces and social media interactions opens up unprecedented possibilities for crafting personalized and immersive journeys. Kerala, renowned for its rich cultural heritage, lush landscapes, and vibrant communities, serves as an ideal backdrop for this innovative approach to tourism. This paper introduces an innovative tourism model designed to revolutionize the conventional tourist guide paradigm, particularly tailored for exploring the enchanting landscapes of Kerala. By amalgamating individual preferences, travel patterns, and interactive data, the model seeks to craft personalized and immersive journeys. The application, developed for foreign tourists visiting Kerala, allows users to register and access a seamlessly integrated platform that suggests optimal itineraries, time schedules, and route maps based on their preferences. This innovative approach not only enhances the traveller's experience but also opens up unprecedented possibilities for discovering the cultural richness and natural beauty of Kerala in a uniquely personalized way.The model incorporates a feedback mechanism, collecting sample reviews through questionnaires for statistical analysis. Results are compared with insights derived from social media analytics to assess conformity and understand socio-cultural impacts. The paper concludes by offering interpretations and suggestions for policymakers in the tourism industry, underscoring the importance of leveraging technological advancements to continually enhance overall tourism offerings. This comprehensive approach ensures a continuous cycle of improvement and satisfaction for tourists exploring Kerala's rich cultural heritage and lush landscapes.

Keywords: Kerala Tourism, Social Media Data, Mobility Mining, Personalized Recommendations, Google Map API, Optimal itineraries.

Main Conference Topic: Innovation and Entrepreneurship

Introduction:

Tourism, as an industry, stands at the forefront of dynamism and transformation, continually adapting to the evolving expectations and preferences of the modern traveller. In the 21st century, technology has emerged as a central force shaping the way individuals plan, embark on, and share their travel experiences. The predominant presence of smartphones and the prevalence of social media platforms have redefined the traveller's journey, paving the way for innovative approaches that surpass conventional paradigms.

This study delves into the confluence of technology, personalized services, and the tourism sector, introducing an innovative model meticulously designed for the captivating landscapes of

Kerala.Situated in the south western region of India, Kerala is characterized by a rich cultural heritage, abundant green landscapes, and lively communities, rendering it a prime setting for reshaping the tourist encounter. This paper introduces a tourism model that deviates from conventional guidebook-based methodologies to guide the travellers. This new tourism model aims to create personalized journeys that go beyond just engaging the traveller', but providing a deeply personalized experience.

At its core, the model makes use of the variety of individual preferences, travel patterns, and interactive data, harnessing the potential of personal traces and social media interactions. Developed specifically for foreign tourists exploring Kerala. Here, travellers can register and access a tailored suite of features, including personalized itineraries, optimized time schedules, and route maps curated based on their preferences and interests.The uniqueness of this approach lies not only in its technological foundations but also in its commitment to enhancing the overall tourist experience.

A pivotal aspect of this innovative model is its iterative nature, facilitated by a robust feedback mechanism. The collection of sample reviews through questionnaires enables continuous improvement, ensuring that the model remains attuned to the evolving needs and expectations of travellers. In tandem, results from this feedback loop are compared with insights derived from social media analytics, offering a comprehensive understanding of the socio-cultural impacts of this technological intervention.

As we go deep into the complexities of this model, this paper not only aims to showcase a transformative approach to tourism but also serves as a call to action for policymakers in the tourism industry. It underlines the importance of making maximum use of technological advancements to continually enhance the offerings presented to tourists, promoting a cycle of improvement and satisfaction for those exploring Kerala's rich cultural heritage and rich greenery.

Related Work

In contemporary times, mobile applications have become integral across various industries, and the travel sector is no different. As per a recent e-marketer study, mobile applications related to travel rank as the 7th most downloaded category, with a significant 60% of smartphone users favouring the use of travel applications for organizing their recreational trips.

There are many works related to identifying the mobility patterns of travellers using mobile phone GPS data since the predominant use of mobile devices. These data are usually used to analyse the behaviour of tourists including their transportation modes, food preferences, location preferences, the total time spend over each place etc. These data are usually used to create some insight about the tourist travelling across the country or the world.

There have been several studies made to identify tourist mobility and found that getting insights from tourist's mobility data is confusing and difficult as compared to the personal mobility data since they do not follow a specific pattern. (Phithakkitnukoon, S. ,2023)examined the relationship between personal mobility and tourist travel behaviour and revealed a number of meaningful insights for tourism management, including tourist flows, top tourist destinations and origins, top destination types, top modes of transportation in terms of time spent and distance travelled, and how personal mobility information can be used to estimate a likelihood

in tourist travel behaviour. Besides using GPS data, with social media becoming the inevitable part of millennials and centennials opens a door for getting more personal data. The social media helps in a million other ways. Social media data has a potential for understanding tourist behaviour.(Hasnat, M. M., & Hasan, S. ,2018)propose a framework to analyse travel behaviour of tourists using social media data. Data collected from Twitter; filtering steps used to create reliable sample; bots are removed. Heuristic classification method used to identify non-native users.Clustering methods like K Means Clustering are used to find spatial patterns of tourist destination choices. Temporal patterns validate classification techniques.Tourists and residents identified using heuristic classification approach.(Vu, H. Q., Li, G et.al. ,2018)states thatmobile social media data can provide detailed contextual information on tourist activities. The study focuses on inbound tourism in Hong Kong using venue check-in data. The data is collected from Twitter's API.(Chen, J., Becken, S., &Stantic, B, 2021) Summarizes characteristics, advantages, and limitations of social media data collection. The authors examine key parameters of scholarly context and geographic focus and provide an assessment of theoretical underpinnings of studies in the field of social media and visitor mobility.(Vu, H. Q., Li, G., & Law, R, 2018) introduces venue-referenced social media data (VR-SMD) for analyzing tourist activities.VR-SMD can determine various tourist activities and their temporal preferences. Case study focuses on Malaysian and Thai outbound travellers. Comparative analysis highlights cross-cultural differences in activity preferences.

The availability of social media data is abundant, yet its trustworthiness remains a constant concern. Given its highly unstructured nature and continuous updates, storing and processing this data poses significant challenges. However, once successfully processed—despite the substantial pre-processing efforts involved in managing such data—it yields notable improvements in the results. (Li, J., Xu, L., Tang, L., Wang, S., & Li, L. 2018) applied various big data techniques in tourism research, making a good improvement.In their paper introduces the utilization of topic modelling, specifically Latent Dirichlet Allocation (LDA), as a methodology for identifying abstract topics within textual data. The collection of GPS data is facilitated either through GPS loggers or mobile applications. In parallel, text mining techniques are employed for the collection and pre-processing of textual data. Additionally, a technological approach is employed to select keywords from web search data, and an index construction method is implemented to amalgamate web search data into composite indexes.Carrying different information, different types address different tourism issues.(Chen, J., Becken, S., &Stantic, B. 2022) in another paper applies a lexicon-based method for sentiment analysis to identify the performance at multiple destinations offering opportunities to assess tourist satisfaction at destinations. (Bartosz et.al, 2014)analyses geo-located Twitter messages in order to uncover global patterns of human mobility and reveals spatially cohesive regions that follow the regional division of the world.

(Jiaying, Lyu., Asif, et.al, 2022) gives a comprehensive review of big data research from the tourism and hospitality literature can be found in this paper, where a content analysis of 146 big-data-related articles identifies the research and methodological trends in these fields. The authors (Jelena, Komšić., Jelena, Dorčić, 2016). explore the concept of tourism destination competitiveness and online reputation and find significant theoretical findings concerning the impact of online reputation on tourist destination competitiveness, and contribute to the existing literature by identifying research gaps and providing challenging directions for future research.

The Model

This research study has two main objectives. Mining location based data and mining social media data.

Mobility mining, also known as mobility data mining, involves extracting meaningful patterns, insights, and knowledge from large datasets related to human mobility. This field has gained prominence due to the widespread use of mobile devices and location-based services.

Mining social media interactions involves extracting valuable insights and patterns from the vast amount of data generated through user activities on various social media platforms. It includes many steps. Gather data from social media platforms such as Facebook, Twitter, Instagram, and LinkedIn. This includes user posts, comments, likes, shares, and other interactions.Use natural language processing (NLP) techniques for text mining to analyse the textual content of social media posts. This involves sentiment analysis, topic modelling, and named entity recognition to understand the sentiments expressed, identify key topics, and recognize entities such as people or locations.Determine the sentiment of social media posts, comments, and mentions. Sentiment analysis helps in understanding the public's emotional response to specific topics, brands, or events.Identify trending topics and hashtags by analyzing the frequency and popularity of specific keywords or phrases over time. This helps in staying updated with current discussions and interests.Mining social media interactions provides businesses, researchers, and policymakers with valuable insights into public opinions, market trends, and user behaviours, contributing to informed decision-making and strategy development.

The proposed model development phase includes multiple phases like data collection, data pre-processing, model development, feedback mechanism, and transferring insights for developing the tourism industry. Each phase has got sub-phases.

A. Data Acquisition

The first and foremost phase is data acquisition phase. Once the application deploys, we get data about the user preferences as collected by the application. The application also collects information regarding the location of the user, continuously monitoring and updating the location. It also buys permission from user to get their web search information as well as social media data to get to know more about their preferences and hence provide more personalized information.

i) User Registration and Preferences:

Implementing a user-friendly registration interface within the application catering to foreign tourists visiting Kerala collecting the usual registration details such as Name, Age, Country, Email Adress, Phone number, etc. This is followed by a questionnaire to gather individual preferences, including interests, travel patterns, and cultural inclinations.This would identify the purpose of visit. These preferences are later used to provide the customized itinerary and to get the most preference of travellers. This information can be further used to decide what is preferred by the tourists. A similarity check algorithm running in this phase can also help in identifying the tourists who have similar preferences.

ii) GPS Data Acquisition:

Deploy GPS loggers or integrate with mobile applications to collect precise location data during the tourists' journeys, ensuring accuracy and reliability. The former was used to collect

data initially and once application gets ready the latter is used. This GPS data is used update the routes in traveller's itinerary. The routes are shown to the traveller using the Google Maps API.

iii) Social Media Interaction Monitoring:

Incorporate mechanisms to track and analyse social media interactions, capturing user-generated content, reviews, and sentiments related to their experiences in Kerala.The predominantly used social media contents are tweets and geo-tagged images.

iv) Web Search Data Retrieval:

Utilize web scraping techniques to collect relevant data from web searches, with a focus on extracting keywords associated with tourist interests in Kerala. This contributes to collecting the interest of the user and can help in giving recommendations.

B. Data Pre-processing

This phase mainly focusses on cleaning GPS and Social Media Data. Since this data is mostly unstructured it is a tedious task. Major data cleaning techniques are applied here.

i) GPS Data Cleaning:

Implement data cleaning procedures to handle inconsistencies and inaccuracies in the GPS data, ensuring the reliability of location information for subsequent analysis.

ii) Social Media Text Processing:

Apply natural language processing (NLP) techniques for text mining on social media data, extracting meaningful insights and sentiments to enhance the understanding of user experiences.

iii) Keyword Extraction from Web Search Data:

Analyzing web searches are the best way to understand the interests of people. Utilize advanced text mining algorithms to extract key keywords from web search data, identifying prevalent topics related to Kerala tourism for further analysis.

C. Model Development

This Phase explains the main modules in the application.

i) Personalized Itinerary Generation:

From the light of data collected from the user, personalized itineraries are generated which can be modified by the user. Once it is approved by the user the travel begins.Matrix factorization techniques, such as Singular Value Decomposition (SVD) or Alternating Least Squares (ALS), are used to factorize user-item matrices, capturing latent factors. Modeling the preferences of users and items to make personalized recommendations for destinations and activities.

ii) Optimal Time Schedule and Route Mapping:

Design algorithms to analyse GPS data, suggesting optimal time schedules and route maps tailored to user preferences and interests, enhancing the overall journey

experience. This is done with the help of Google Map's API. It gives the routes based on current location of the device and destination. It has feature to know the ETA which is Estimated Time of Arrival and that helps to schedule the itinerary.

D. Feedback Mechanism

This is one of the important phases in this research study. In this phase the feedback about each place of visit is explicitly collected from the users and then it is used to analyse the user sentiments.The very first objective of this module is to provide sophisticated insights generated via the analysis of feedback to the tourism industry, thereby enabling corrective measures and strategies to enhance the overall tourism experience which in turn attracts more tourists to the God's on Country. The second objective is to offer personalized recommendations to the users.

i) User-Generated Feedback:

Integrate a user feedback mechanism through the application, collecting reviews and insights on suggested itineraries and the overall user experience.

ii) Questionnaire Analysis:

Analyse responses from the initial questionnaire to understand user satisfaction and preferences, informing further model enhancements.

iii) Social Media Analytics:

Compare and contrast user-generated feedback with insights derived from social media analytics, measuring conformity and assessing socio-cultural impacts.

Implementation

The user registration is the first module to be implemented. This module collects all the necessary personal details along with Email ID and Mobile number. The work flow of this module is given in the figure. 1 below.

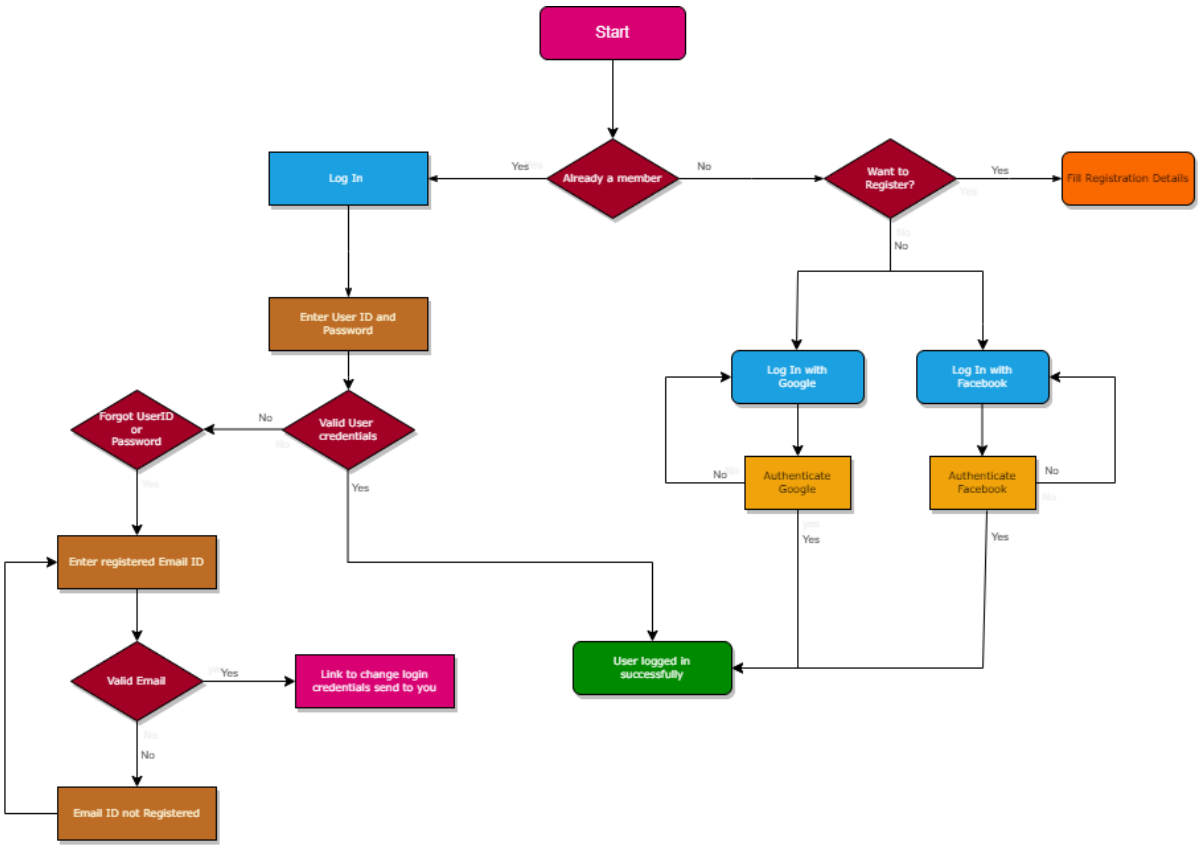


Figure. 1. User Flow Diagram showing the flow of registration and log in module

The second module is collecting the user preferences and creating itinerary. After analysing the preferences itineraries are created and given to user for approval and this is then followed in the journey. The routes are automatically updated. The main page also gives a link to hotel booking sites, access a digital library of histories of important places, know the current whether of locations, give revies and feedbacks on places travelled and more. The flow is shown in the figure 2 given below.

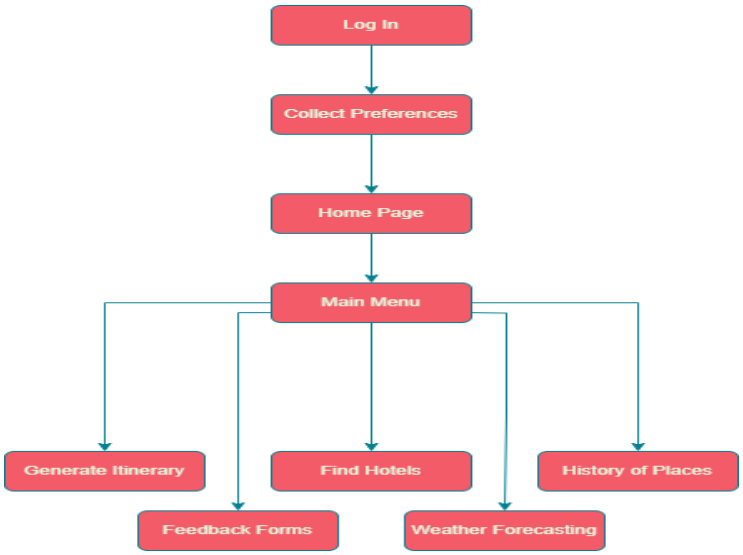


Figure 2. User Flow Diagram of home page

Technologies used to build the application

1. Flutter:
Flutter is an open-source UI software development toolkit by Google. It enables the creation of natively compiled applications for mobile, web, and desktop from a single codebase. With a rich set of customizable widgets, Flutter provides a smooth and expressive user interface, allowing developers to build high-performance applications across different platforms.

2. Visual Studio:
Visual Studio, developed by Microsoft, is an integrated development environment (IDE) for coding, debugging, and building various applications. It supports multiple programming languages and platforms, providing a comprehensive set of tools for efficient software development.

3. Node.js:
Node.js is a server-side JavaScript runtime that facilitates the development of scalable and high-performance network applications. It uses an event-driven, non-blocking I/O model, making it well-suited for building real-time applications and APIs.

4. Firebase:
Firebase, a mobile and web application development platform by Google, offers a comprehensive set of tools and services. It includes features such as real-time database, authentication, hosting, and cloud functions, streamlining the development process and enabling the creation of dynamic and responsive applications with a focus on user engagement.

5. SQL:
Structured Query Language (SQL) is a standard programming language designed for managing and manipulating relational databases. It provides a set of commands for querying and updating data in a database, as well as defining and modifying the structure of databases. SQLite is a software library that provides a relational database management system (RDBMS). It is a self-contained, serverless, and zero-configuration database engine, making it a popular choice for embedded database applications, mobile apps, and small to medium-sized websites.Flutter developers can use SQLite packages, such as ‘sqflite’, to integrate SQLite databases seamlessly into Flutter applications.

Conclusion

In summary, the novel tourism approach that has been suggested for discovering Kerala's captivating landscapes shows promise as a means of providing individualised and immersive travel experiences. The concept improves the traveller’s experience by utilising social media interactions, personal preferences, and technology. A thorough method for creating customised itineraries and content recommendations is ensured by the integration of GPS data, social media analytics, and web search insights. By combining questionnaire data with user reviews, the feedback mechanism offers insightful information for ongoing development. With tourism depending more and more on technology, this model shows how it may be used to improve

overall experiences. In order to guarantee that travellers may experience Kerala's natural beauty and cultural diversity in a dynamic and fulfilling manner, industry policymakers should take note of the plea to adopt such revolutionary strategies.

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The Effect of Consumer Centric Disclosure for Refurbished Products on Consumer Behavior.

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Abstract:

Refurbished products refer to the products that have been returned by the consumer and then inspected and tested to function like new products. Refurbishment leads to reduced waste and thus reduced carbon footprint. However, many consumers are still not aware of the quality and environmental intent of refurbishment done by firms. This study looks at the effect of quality- and environment-related disclosures on consumers' willingness to purchase refurbished products. We use signalling theory to study how disclosures can reduce this information and intent asymmetry between the refurbishing firms and the potential consumers. We also study how the refurbishment firm's distance from the manufacturer influences the effect of these quality disclosures on consumers. Similarly, we examine how the environmental orientation of a consumer affects the relationship between the environmental disclosures from the firms and the consumer's willingness to buy. At the project's current stage, we have hypothesized two out of four planned hypotheses and conducted an initial analysis using data scrapped from a popular e-commerce website. In the near future, we plan to continue our analysis and test all our hypotheses by collecting more data through an online experiment using Qualtrics and the Amazon cloud research pool.

1. Introduction

Refurbished products refer to the products that have been returned by the consumer and then inspected and tested by a refurbishing firm to function like new products (Agrawal et al.,2015). Refurbishing is a common practice in electronics and electrical products, and the smartphone industry is one such industry where refurbishing has flourished in recent years. In 2017, refurbished phones represented 10% of the global smartphone sales volume. Year over a year, the sale of refurbished smartphones grew at a rate of 13%, overshadowing the modest 3% growth of the larger smartphone market (Kang, 2018). Refurbishing helps a firm to monetize its returns,reduce waste, and become more sustainable. Due to these benefits,many firms focus their resources and energy on improving their refurbishing capabilities.

Even though the refurbishing electronics market is valued at US 19 billion dollars globally, there have been limited studies in this area. Refurbishing falls under the larger umbrella of reverse logistics, which has been defined as the "process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, and related information from point of consumption to the point of origin for the purpose of recapturing the value or for proper disposal" (P2, Rogers & Tibben-Lembke,1999). Reverse logistics literature dates back to 1975 when Guiltinan&Nwokoye recognized the distinct reverse channels and

structures in a recycling context. In the extant supply chain literature, Stock,1992 provided a comprehensiveanalysis of reverse logistics by providing a literature review and discussing transportation options and environmental packaging in the context of reverse logistics. Further studies have looked into various reverse logistics practices, requirements, market sizes, barriers and enablers of reverse logistics (Rogers & Tibben-Lembke, 1999,2001; Blumberg, 1999). The antecedents of reverse logistics have been identifiedthrough the lens of various environmental forces like government, buyer, supplier and competitor (Carter and Ellram, 1998).Studies have specifically looked into firm-level drivers like the commitment of management and financial resources (Daugherty et al.,2001). Operational issues involving Inventory issues and product returns have also been extensively studied through the reverse logistics perspective (Inderfurth,1997; van der Laan and Salomon, 1997).

However, inside the broad area of reverse logistics, refurbishing/remanufacturing processes have been the subject of research in a few studies. While some of these studies have looked at streamlining return processes for efficient remanufacturing (Guide et al., 2003), others have focused on matching demand and supply and managing inventory for remanufactured products (Guide and Van Wassenhove, 2001; Toktay et al., 2000).Nevertheless, there is very limited research looking at consumer's perceptions of different types of refurbished products.Extant literature has looked at remanufacturing and refurbishing from the firm's perspective but has largely ignored analyzing the factors that impact consumer's demand for refurbished products.Some studies have linked refurbished goods with inferior quality and reliability when compared with new products (Atasu et al., 2008). So, it is interesting to know what drives consumers to buy such products even with these reservations. A few studies have looked at the impact of green perceptions (Hazen et al. 2012), transparency (Duan & Aloysius,2019) and price (Vorasayan et al., 2006) on consumers.However, researchers have mostly ignored the impact of disclosures about refurbished products' quality and environmental benefits.

Consumers are largely unaware of the refurbishment process. Even though refurbished goods are supposed to work as new products, consumers still perceive them as inferior in quality and reliability when compared with new products (Atasu et al., 2008). Similarly, many consumers are not aware of the positive environmental impact of refurbished products (Duan & Aloysius,2019).So, there is an information asymmetry between the refurbishing firms and the consumer. In similar situations of information asymmetry, past literature has linked disclosures with a positive effect on consumer perceptions (Yin et al., 2009; Allon &Bassamboo, 2011; Aydinliyim et al., 2015; Pienkofer,2016).

The consumer's perception can be moderated by who refurbishes the product. The refurbishing firm can be either the manufacturer of the original product or the retailer who sells the product or an independent third-party firm. Other streams of literature have used organizational distance as a variable to measure the distance or number of tiers between two firms in a supply chain (Awaysheh& Klassen,2010; Hartmann & Moeller, 2014). In the context of refurbished products, we define organizational distance as the number of tiers separating the manufacturer and the refurbishing firm. A consumer relates to increased organizational distance with higher supply complexity and lower knowledge transfer(Cummings,2002; Hsiao et al.,2007). So, the consumers link closeness to the manufacturer with higher product knowledge. Thus, the

effectiveness of disclosures coming the refurbishing firm depends on its distance from the manufacturer. In simpler terms, disclosures about product quality will have a greater impact on the consumer when they come from the manufacturer of the product rather than when they come from a third-party refurbisher.

Similarly, the effect of environmental disclosures is moderated by the environmental orientation of the consumer (Duan & Aloysius,2019). Consumers who have a higher concern towards the environment value the environmental attributes of the refurbished products more than indifferent consumers.

So, through this research, we plan to:

1. Study the impact of product quality disclosures and sustainability disclosureson consumer's willingness to purchase refurbished products.
2. Study how the organizational distance of the refurbishing firm from the OEM affectthe relationship between a firm's product quality disclosures andconsumer's willingness to purchase refurbished products.
3. Study how consumers' environmental orientation affects the relationship between a firm's sustainability disclosures and consumers' willingness to purchase refurbished products.

Through this research, we want to contribute to the reverse logistics and remanufacturing literature by adding the impact of product quality and sustainability disclosures on consumer's perception of refurbished products. The moderating effect of the organizational distance and individual-level environmental orientation will add depth to the reverse logistics literature.We also contribute to organizational distance by highlighting their impact in the context of remanufacturing. This will also give support to the stream of existing disclosure literature that finds a positive effect of other forms of disclosures on outcomes like firm performance, environmental performance, and customer satisfaction (Johnson,2018; Chen & Slotnick, 2015; Peinkofer, 2016). Our research will have a significant practical contribution too as it will provide guidelines for supply chain managers to maximize the demand for their refurbished products. Using our study, they can better target their refurbished products based on consumer's environmental orientation. They can also gain new customers by using disclosures as a tool to share information about the refurbishing process to the customer.

2. Literature Review

In the extant literature, the terms"refurbished" and "remanufactured" have been interchangeably used(Ovchinnikov, 2011; Galbreth & Blackburn,2006,2010). Though some studies have distinguished between the two terms (Wang et al., 2013), others have found that often the electronics industry uses the terms remanufacturing, reconditioned, refurbished, recertified, certified pre-owned interchangeably (Abbey et al., 2015). Even the market leaders like Amazon use the terms interchangeably on their websites. So, for our study, we consider both remanufactured and refurbished products as returned products that have been converted into "like new" condition for resale. Some small players in the market sell used products too.

However, to keep the study concise and objective, those firms are outside the scope of our present study, and our study solely focuses on products that have been refurbished to function "like new".

From the regulatory and a firm's perspective, refurbished products have been are inspected and tested to functions similar to a new product (Agrawal, Atasu, & Ittersum, 2015). However, consumers perceive remanufactured products as inferior in quality and reliability when compared with new products (Atasu et al., 2008). So, for refurbished products, there is information asymmetry between the industry and the customer.

Signaling theory has been extensively applied in the extant literature to study issues arising due to information asymmetry (Spence, 2002). Individuals, firms, industries, and governments all use

Information to make decisions. Information asymmetry occurs when different parties in a system have different information (Stiglitz,2002). Information may not be available for some or uninteresting for others, which results in this asymmetry. The two information types where information asymmetry plays a critical role are information asymmetry about quality and information asymmetry about intent. In the case of quality asymmetry, the two parties perceive quality differently, while in the case of intent asymmetry, the two parties perceive the intent or behavior differently (Spence, 2002).

In signalling theory, there is a signal sender and a signal receiver. There should be an information asymmetry between the sender and the receiver. The receiver reacts to the signals of the sender as long as the signal communicates new information to the receiver (Spence,2002,1973). Signalling theory has been extensively used in various contexts where information asymmetry occurs. Signalling theory has been used to study how educated employees signal good quality to potential employers (Spence,1973), how signals from executives affect capital markets (Goranova et al., 2007), and how signals from IPO firms affect investors (Certo, 2003). In management literature, signalling theory has been used to study how the quality of financial statements impact investors (Zhang & Wiersema, 2009) or how board diversity signals to stakeholders (Miller & Triana, 2009). The signaler can be an individual like an employee, or firm executive, venture capitalist, or angel investor(Spence,1973; Goranova et al., 2007; Elitzur&Gavius, 2003) or a group like company boards or top management teams (Certo, 2003; Lester et al. 2006; Miller & Triana, 2009) or firms themselves (Zhang & Wiersema, 2009). Similarly, the receiver can be an individual like a potential investor (Certo, 2003; Filatotchev & Bishop, 2002; Zhang & Wiersema, 2009) or broad organizational stakeholders (Miller & Triana, 2009). Signalling theory has been in a few studies involving signalling from firms to potential consumers (Kirmani and Rao, 2000; Basuroy et al. 2006; Rao et al. 1999).

Signalling theory has been used in the extant supply chain literature to study product recalls (Ketchen et al., 2014), Sustainability(Rezaee,2018; Jean et al.,2016; Sarkis et al.,2011) and driver management (Saldanha et al., 2013). It has been used in reverse logistics studies to examine the optimal price and return policy(Mukhopadhyay &Setoputro, 2004), modelling and analysis techniques(Rogers et al. ,2012) and return time leniency(Rao et al.,2018). No studies

have looked at the refurbishing firms themselves through the lens of signal theory. As discussed earlier, there is information asymmetry regarding perceived quality between the refurbishing firms and the end consumers.

Disclosures have been extensively used in the supply chain literature as a tool to increase accountability and relay information from the firm(Bergh & Gibbons,2011; Simaens& Koster,2013; Campbell et al.,2006; Pienkofer, 2016). Disclosures have in used in conjunction with signal theory as a tool to provide information to the customer and reduce information asymmetry(Bergh & Gibbons,2011; Simaens& Koster,2013; Campbell et al.,2006). When thedisclosuresare about the quality of the product, the disclosure can act as a signal from the firm to reduce the information asymmetry, thus increasing the perceived quality by the consumer. Similarly, when the disclosure is about the intention behind certain product manufacturing action, it can change consumer attitude towards the product.

Consumer's positive attitude and increased perceived quality of a product has been linked with higher willingness to purchase(Beneke et al.,2013; Zielke &Dobbelstein, 2007; Sweeney et al.,1997). Willingness to purchase is a construct that has been used to study consumer preference inmultiple consumer-related studies (Esper et al.,2003; Cordell et al., 1996; Casadesus-Masanell& Crooke, 2009).

3. Hypothesis Development

At the current stage of the paper, we have hypothesized two out of the four hypotheses in our model (as provided on pg.14).

There are three major types of refurbishing firms dominating the "as new"refurbishing market. These firms are the manufacturer of the original product, the retailer who sells the product and a third-party independent refurbishment firm. These refurbishing arrangements are based on a firm's return management and strategic refurbishing decisions (Stock& Mulki,2009; Guide & Li,2010). When a manufacturer refurbishes its products, it uses the returns it gets from the customers and processes these units to function like new. This return product processing is either handled by the manufacturer or through certified refurbishing partners. These products are referred to asmanufacturer-refurbished products. The manufacturer can sell these refurbished products through the same channel as they sell their new products.

Similarly, when the retailer of the product handles the returns, they can opt to process the returns and refurbish the products for resale. Retailers often handle this process through certified refurbishing partners as they do not have the technical know-how of these processes. These kinds of refurbished products are called certified seller refurbished products.

The third kind of refurbishment is done by independent third-party refurbishment firms. These firms buy used phones from consumers or acquire them through used product auctions by the manufacturer or the retailer. They then refurbish these products to function like new units.

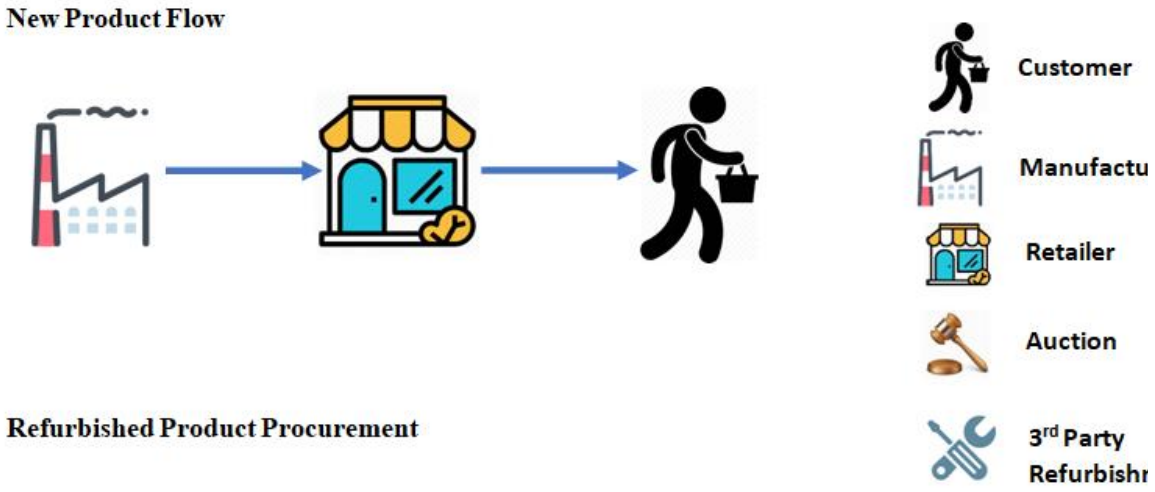
These kinds of refurbished products are called third-party or independently refurbished products.

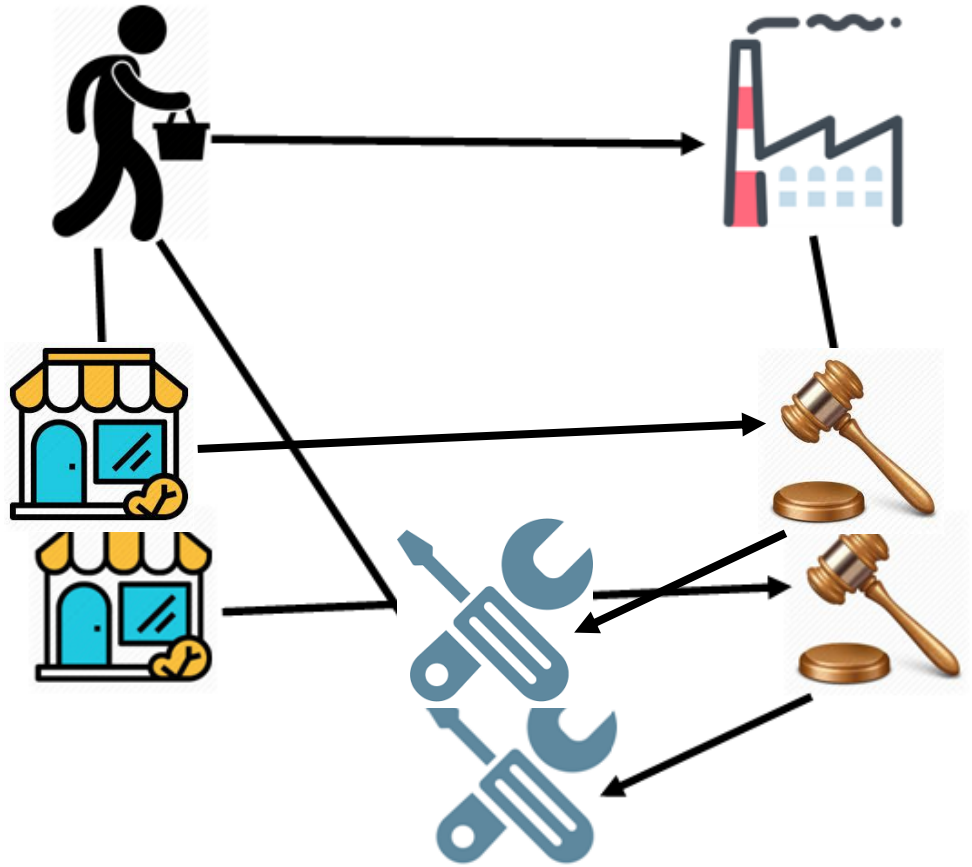
Even though from the regulatory and a business perspective, refurbished products have been inspected and tested to functions similar to a new product (Agrawal et al.,2015), consumers still perceive them as inferior in quality and reliability when compared with new products (Atasu et al., 2008). So when the firm uses disclosures to communicate the "like new" quality of refurbished products, they provide information about the quality of the product to the consumers. From the lens of signalling theory, the refurbishing firm is the signaler, and the consumer is the receiver. The quality-related disclosures from the refurbishing act a signal from the refurbishing firm towards the consumers aimed at reducing the quality asymmetry between the refurbishing firm and the consumer. Thus, as the quality perception of the refurbished products increases, the consumer's willingness to purchase these products increases.These explanations lead us toward our first hypothesis.

H1: Disclosures highlighting product quality positively influences the consumer's willingness to purchase refurbished products.

In complex supply chain relationships like refurbishment,organizational distance helps in analyzing the distance between two firms in a certain supply chain relationship. Organizational distance refers to the number of tiers separating the two or more firms being examined (Awayesheh& Klassen,2010). It has been used in extant literature to study differential consumer perception in the sustainability literature (Awaysheh& Klassen,2010; Hartmann & Moeller, 2014; Wu & Pagell,2011). Increased organizational distance leads to increased complexity and transaction costs(Awayesheh& Klassen,2010). Increased organizational distance has also been linked with reduced knowledge transfer and expertise (Cummings,2002).

Figure 1:

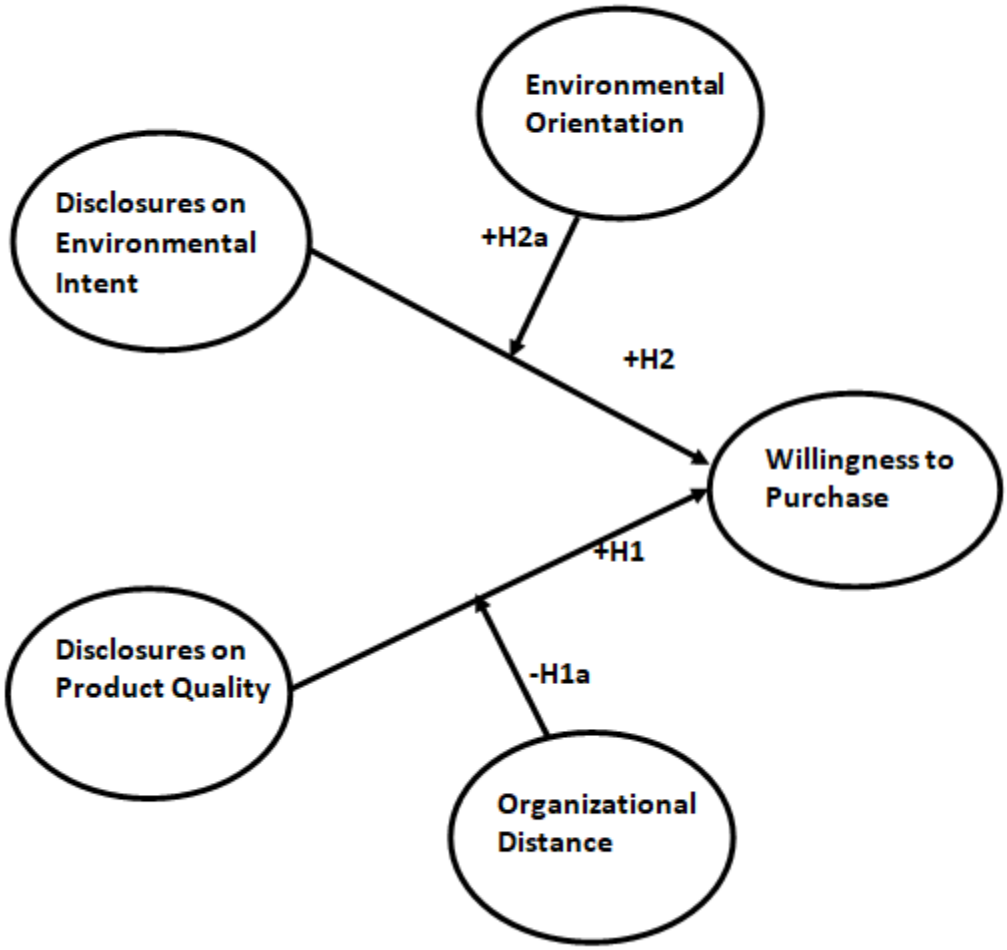




In the context of our study, organizational distance refers to the number of tiers separating the original product manufacturer and the refurbishing firm. When the organizational distance increases, it leads to increased complexity, increased transaction costs, reduced knowledge transfer and reduced expertise. Figure 1 helps us in understanding the complex supply chain for refurbishmentfirms. The returned products can be procured by the manufacturer or retailer or by the 3rd party refurbishment firms through auctions.The organizational distance in the manufacturer refurbished products is the least, followed by the certified seller refurbished products and thenfollowed by independently refurbished products.The manufacturer fabricates the original product, so the customer considers them to an expert on their products.When the organizational distance between the refurbisher and the manufacturer increases the perceived expertise, and the consumer's perceived knowledge transfer to the refurbishing firm decreases. The firm's perceived knowledge and expertise about the refurbished product moderates the perceived quality of the signal received by the consumer through quality disclosure. In simpler terms, the disclosure signals by the manufacturer are perceived better than the signals coming from a third-party refurbisher. Thus, organizational distance negatively moderates the relationship between a firm's quality disclosures and consumers' willingness to purchase.These justifications lead us to our hypothesis.

H1a: Organizational distance between the refurbishment firm and manufacturer negatively moderates the relationship between disclosures highlighting product quality and the consumer's willingness to purchase refurbished products.

Model:



4. Data Collection& Initial Analysis

For this research, we collected our initial data by leveraging the data available through eBay product listings for various product conditions, i.e.,used, seller refurbished, manufacturer

refurbished, open box, and new. We collect data regarding the seller, the type of refurbishment, service carrier information, price, type of shipping, return policies, seller feedback, detailed seller feedback, and the number of items sold (McKie et al., 2018). We chose an iPhone X- 64 GB as ourpreferred product as it is a popular phone that came to the market in 2017 and currently has a considerable number of units available under each product condition type on eBay. We put a filter on the phone memory, so we are comparing similar models having the same initial purchase price. As eBay also offers products that can be purchased through online auctions, we put a filter so that we collect data only for items that are available for immediate purchase.We put a filter on the location of the product to be the USA, so that we can concentrate on the US market only.

Table 1: Scrapped Variables

Variable	Description	Details
Source Page	The URL of the product page	
Title	The title of the product listing	
Product Description	The details about the product	
No of view	Number of people who have viewed this product listing	This represents the interest of potential buyers for this product. So, this can be used as a proxy for purchase intention
Condition	The current condition of the product	The condition can be for parts and not working, used, seller refurbished, manufacturer refurbished, open box, free shipping, and free pickup.
Price	Current price asked by the seller	
Units Sold	Number of units of similar product sold by the seller	
Seller	Name of the seller	
Seller Feedback Score	This provides the score of the seller over the years across several products	This can be a proxy for seller long term reputation.
Seller Feedback	Number of people who have rated this seller	This provides the average rating of the customer for the seller.
Shipping	Shipping details as provided by the seller	Shipping detail can be null which stands for no free shipping offered,free shipping offered orfree pickup offered.
Deliver By	Delivery details as provided by the seller	In how many days the product will be delivered.

Returns	Return details as provided by the seller	Does the supplier offer free returns or not
Returns time	How much time the customer has to return the product	
Returns Responsibility	Who is responsible for paying the shipping charges for the returns	

The data from eBay was collected using the web-scraping technique. Web scraping has emerged as a powerful tool to extract data from the web. It falls under the broad category of content analysis that has been extensively used as a tool across various supply chain studies to execute literature reviews (Tate et al.,2000; Croom et al.,2000; Carter & Ellram,2003; Kunz & Reiner,2012). Recently, there has been a move to use content analysis techniques for other kinds of unstructured data mostly data from the internet. Web scraping can be defined as a group of processes for extracting data from websites. This data can be product items, images, videos, text, and contact information like emails and phone numbers. Rutter et al. (2015) used web scraping techniques to find the relationship between a university's social media interaction and its brand and recruitment performance. They manually extracted user interaction data from 2 popular social media outlets: Facebook and Twitter. Similarly, researchers used manual web scraping techniques to collect data on consumer electronics and airfares for the Italian harmonized index of consumer prices compilation(Polidoro, 2015). Likewise, McKie et al. (2018) studied consumers' preferences when provided the option to choose between multiple product generations and conditions. We followed a similar technique used by McKie et al. (2018) and pulled the discussed fields from the product page (Figure 2).

Figure 2: Data Extraction from Product Page



Data was extracted using a combination of python programming, Anypicker chrome browser addon and other manual methods. Python programming and Anypicker addon were primarily used to automatically pick data from the eBay Product page. As the orientation of the fields is not fixed on the product page, the web scraped data was manually cleaned and reorganized on

an excel database. The carrier information was added to the scarped data by using manual content analysis procedures on the product detail and description. The launch price iPhone X with 64GB memory was $999. Currently, the price of the phone has considerably reduced, and apple accepts these phones for $392. So, once the database was cleaned, we removed the price outliers by removing the listing that had prices less than $100 or more than a $1000. Finally, we ended up with 995 records. We coded the carrier details, product condition, shipping and return type as per Table 2.

Table 2: Variable Coding

Carrier Type	**Code**	**Product Condition**	**Code**
Unlocked	1	For Parts and Not Working	1
ATT	2	Used	2
Verizon	3	Seller Refurbished	3
T-Mobile	4	Manufacturer refurbished	4
Sprint	5	Open Box	5
Others	6	New	6

Shipping Type	**Code**	**Return Type**	**Code**
Free Shipping	1	Free Return	1
Free Pickup	2	Paid Return	2

Research methodology and findings:

We started our analysis by performing a descriptive analysis of all our variables.

Table 3:Descriptive Analysis

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Price	964	$101.00	$999.99	$447.27	$157.83
UnitsSold	135	1	1060	35.19	120.50
No.ofView Per Day	483	1	4920	192.00	498.43
SellerFeedbackScore	929	1	2345142	68145.11	340593.42
SellerFeedback	871	50.00%	100.00%	98.87%	3.56%
ReturnsTime	447	14	60	30.97	8.911

From the descriptive statistics, we see that the average price of the iPhone X in any condition is $447, and the standard deviation is around $157. The mean seller feedback was high at 98.87%.

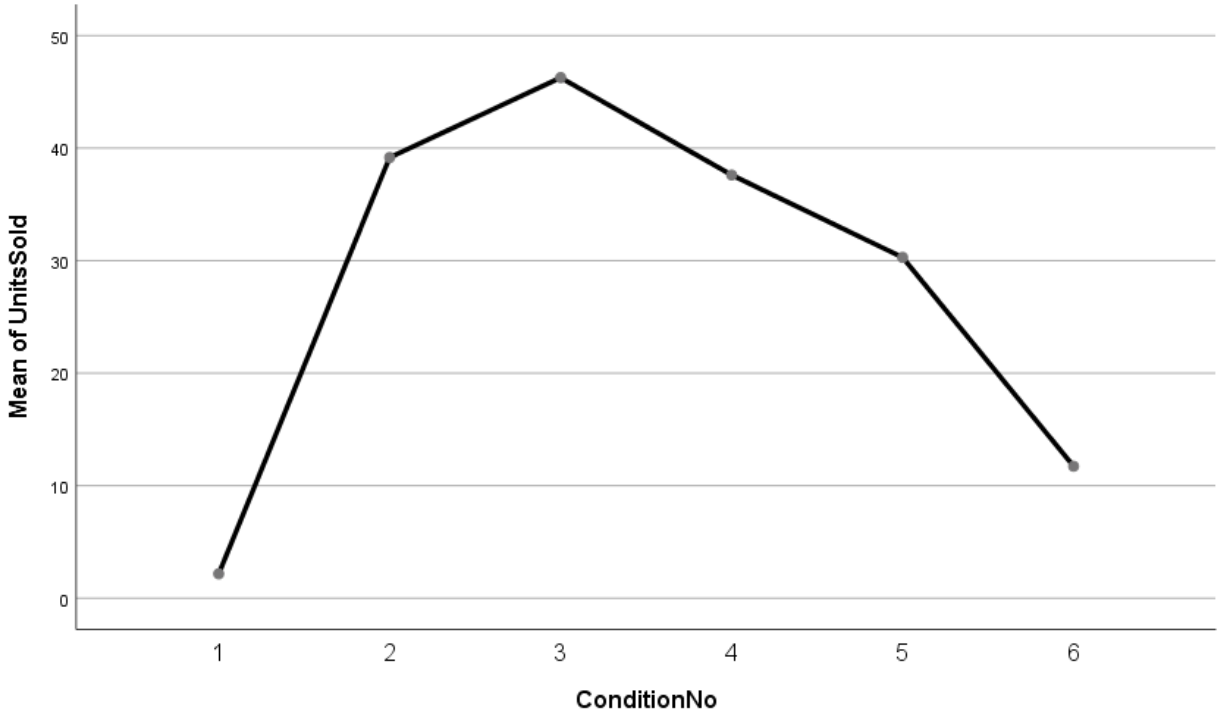
We followed our analysis by finding descriptive statistics within each item condition group (McKie et al.,2018). We also produced graphs to visually see how the means of the various seller attributes change over these condition groups.

Table 4: Variation in condition groups

		N	Mean	Std. Deviation	Minimum	Maximum
Units Sold	1	6	2.17	2.04	1.00	6.00
	2	48	39.17	152.73	1.00	1060.00
	3	38	46.26	138.38	1.00	819.00
	4	18	37.61	70.89	1.00	274.00
	5	7	30.29	60.48	4.00	167.00
	6	18	11.72	25.83	1.00	107.00
	Total	135	35.19	120.50	1.00	1060.00
Price	1	181	288.62	123.74	109.97	999.00
	2	506	465.33	131.49	101.00	950.00
	3	111	438.70	92.16	103.99	770.00
	4	52	504.37	154.70	309.95	999.00
	5	59	533.40	135.89	290.00	900.00
	6	55	674.07	143.49	499.00	999.99
	Total	964	447.27	157.83	101.00	999.99
Seller Feedback	1	178	0.99	0.03	0.75	1.00
	2	430	0.99	0.04	0.50	1.00
	3	112	0.98	0.03	0.67	1.00
	4	46	0.99	0.01	0.96	1.00
	5	56	0.99	0.01	0.97	1.00
	6	49	0.99	0.01	0.97	1.00
	Total	871	0.99	0.04	0.50	1.00
No Of View	1	92	79.12	107.78	1.00	624.00
	2	204	184.75	400.29	1.00	3504.00
	3	71	276.42	839.95	1.00	4920.00
	4	29	447.07	1022.37	1.00	4512.00
	5	44	203.25	237.36	1.00	912.00
	6	43	145.02	183.14	20.00	744.00
	Total	483	192.00	498.43	1.00	4920.00
Seller Feedback Score	1	181	7486.33	23813.98	1.00	219057.00
	2	474	18674.03	111756.05	1.00	2345123.00
	3	116	308602.17	760177.76	1.00	2345142.00
	4	47	316558.43	711210.25	1.00	2345123.00

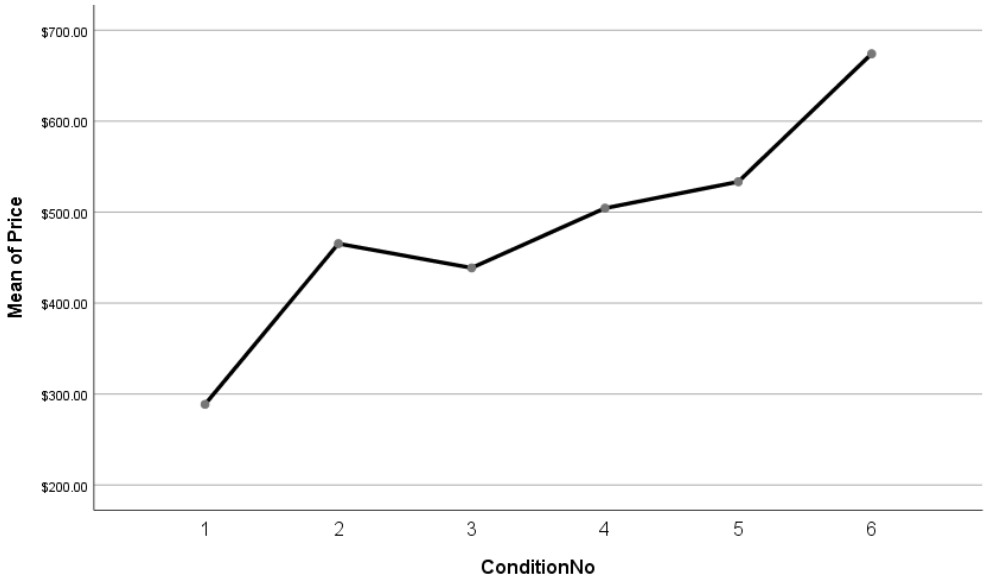
	5	59	34302.07	59732.60	1.00	190666.00
	6	52	7699.48	20420.33	1.00	104204.00
	Total	929	68145.11	340593.42	1.00	2345142.00

Figure 3: Variation in Units Sold



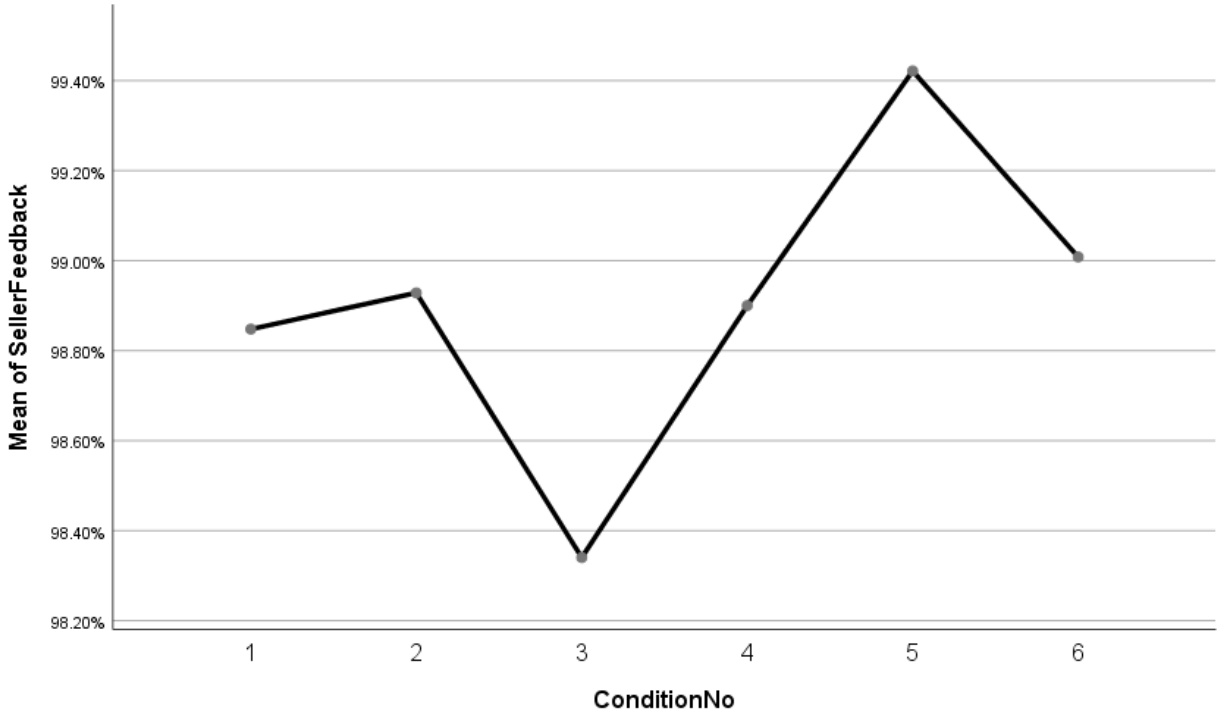
We could see that sellers who sold used and seller refurbished products sold a considerably higher number of products than the sellers selling other condition of the product. These findings were expected as more of used products and seller refurbished products were available in the market. On similar lines, as this phone launched three years ago and no more available for sale as new officially through apple website, the average units of sale ofthe new phone was low.

Figure 4: Variation in Price



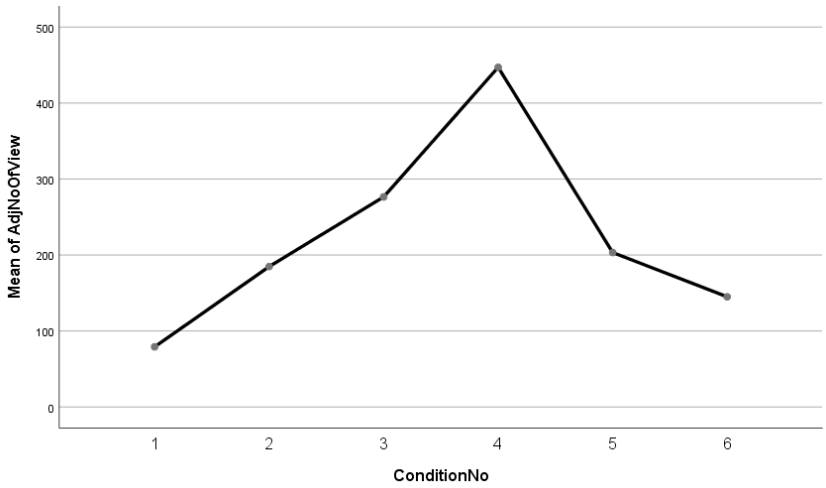
The variation in price mostly followed the predictable pattern. The average price for defective phones was lowest, and then it rose mostly linearly from seller refurbished to manufacturer refurbished to open box and finally to new. Unlike our expectation, the average price of the used phones was higher than seller refurbished phones. This phenomenon can be attributed to the over-assessment of prices by sellers selling used products. Unlike other condition groups, most of the used phone sellers are private individuals who are on eBay to sell their personal products. As they are not market experts, they tend to overprice their phones on their listings. This may help understand the variation in mean price.

Figure 5: Variation in Seller Feedback



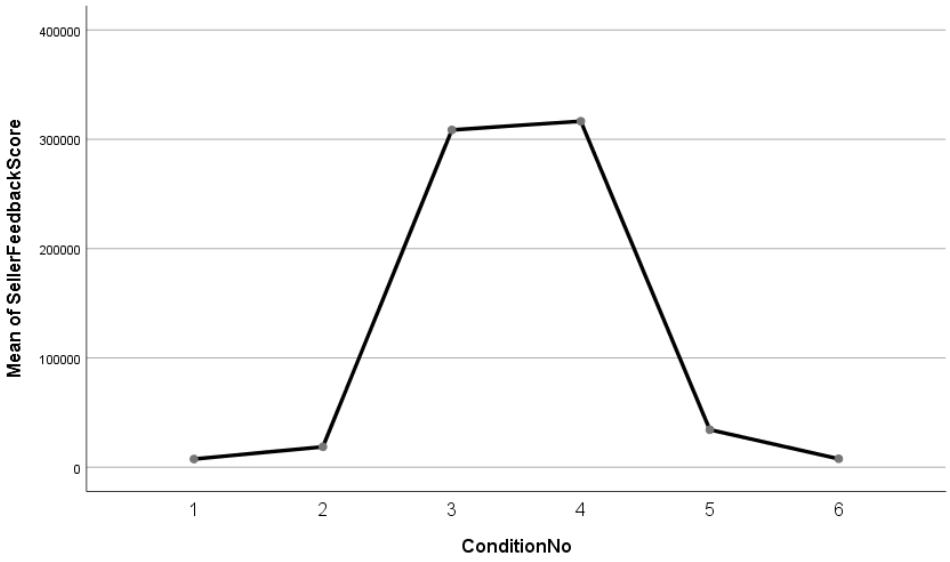
Seller feedback score did not exhibit any pattern. But the mean seller feedback for seller refurbished phones was lowest among all condition types.

Figure 6: Variation in Number of Consumer Views



The number of views for the products listed by manufacturer refurbished products was highest. Thus, we can infer that eBay users were most interested in looking at manufacturer-refurbished products.

Figure 7: Variation in Seller Feedback Score



Finally, looking at the mean feedback score, we can infer that sellers selling "seller refurbished" products and manufacturer refurbished products have a considerably higher reputation than sellers selling other kinds of products.

We follow our mean analysis with univariate between-subject analysis (Crum et al.,2011) taking seller feedback as the DV anditem condition as the independent variable. We considered the price, carrier details,delivery details, returns responsibility, shipping details, returns by, seller feedback score, and units sold. The model fit statistics were very low with adjusted R Squared = .44. Even though we could find a significant relationship between seller feedback and Item

condition, we can't infer anything from this analysis due to the model's low fit values. We continued our analysis and tried multiple different DVs like seller feedback, feedback score, number of views, items sold, etc. However, the model fit values of such models were even lower than the one mentioned above. Thus, we could not find support for our hypotheses.

To continue our analysis and test all our hypotheses, we plan to collect more data through an online experiment using Qualtrics and the Amazon cloud research pool in the future.

Table 5: Univariate Analysis

Tests of Between-Subjects Effects		
DV: Seller Feedback		
Source	Coefficient	p-value
Corrected Model	60.76[a]	0.00
Intercept	0.00	.
Price	13.04	0.00
Carrier_No	7.26	0.00
Deliver By Days	0.58	0.40
Return Buyer Resp	2.63	0.08
Shipping	0.00	.
Returns Time	0.89	0.30
Seller Feedback Score	8.68	0.00
Units Sold	1.09	0.25
Condition No	29.47	0.00
Error	55.82	
Total	788759.25	
Corrected Total	116.58	
a. R Squared = .521 (Adjusted R Squared = .437)		

Implications:

Our study offers both practical insights and theoretical implications. First, it studies the impact of disclosures in a unique context of reverse logistics and information asymmetry. In the context of reverse logistics and refurbished ecosystem, the positive effect of disclosures on consumers supplementthe disclosures related studies in other streams of literature in the context of inventory management (Pienkofer et al., 2013; Aydinliyim et al., 2015), environmental performance (Yin et al., 2009), and retailer's performance(Allon &Bassamboo, 2011). This also

has practical implications, as it highlights the role of disclosures about refurbishment quality and environmental implications as a tool for firms who want to sell more of their refurbished products.

Second, our study establishes the importance of organizational distance inthe case of refurbished products. Before this study, organizational distance has been mostly used in the context of sustainability and supply chain failures. This study establishes the moderating effect of organizational distance on consumer behavior in the context of refurbishment. Consistent with the other studies in this field, we found that the consumers consider the manufacturer as the expert on their product and thus value the products that have been refurbished by the manufacturer the most. The willingness to purchase seller refurbished and third-party refurbished products is considerably less as compared with manufacturer refurbished products. These have major practical implications as from the result of this study; firms can decide where to refurbish. Manufacturers and retailers can set up their return supply chain such that the manufacturer refurbishes the returned phones, thus increasing consumer's willingness to buy such phones.

Lastly, we highlight the effect of the consumer's environmental orientation while responding to sustainability disclosures from the refurbishment firm. According to the past literature, we found that consumers react differently to sustainability cues based on their perceptions of sustainability(Petty and Cacioppo, 1990; Cho, 2015). This effect can help managers better target their refurbished products based on consumers' environmental orientation.

5. Limitations and Directions for Future Research

The current study has several limitations that can be addressed in future studies. Firstly, In this study, we don't consider the interaction between the organizational distance and the price. Studying the interaction between the three different types of refurbishment available at different price points will be of high interest for future studies.Secondly, the sale of the manufacturer's new products can be possiblyimpacted by the availability of similar refurbished products. This study will havea major practical impact as it can help strategize and plan their refurbishing efforts. Thirdly, the other effects of sustainability and reduced waste, like improved inventory management and higher sustainability scores, can be studied under the framework of refurbishment. Lastly, this study was implemented in a B2C context, so implementing a study in a B2B context and studying the overall downstream and upstream impact of purchasing refurbished products will be very interesting.

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A Comparative Study of Smart Enhancements from Initial Versions to Upgraded Models in Specialized AI Application in Urban Planning

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Abstract

This study investigates the progression of specialized urban planning chatbots, with a specific emphasis on the shift from Chatbot 1.0 to Chatbot 2.0. This research comprehensively analyzethe Chatbot concept, and its implementation within the domain of urban planning. This study focuses on citizen engagement, information distribution, and data-driven decision-making. This study discusses Chatbot 1.0, encompassing its development methodology, input from stakeholders, significant drawbacks, and ChatGPT API-driven features. The stakeholder engagement feedback indicates that the urban planning Chatbot has received a resounding endorsement, as a substantial majority of respondents expressed contentment and acknowledged its significance. However, the inability to recall previous conversations, perform certain operations, interpret images, and comprehend geographic-based information are identified as limitations. The research subsequently investigates the justification for the creation of Chatbot 2.0, placing particular emphasis on the necessity for a solution that is more capable, adaptable, and economical. The adoption of the Hugging Chat API, the incorporation of real-time web search functionalities, and the training process utilizing authoritative data from Urban Development Authorities (UDA) are all noteworthy advancements in Chatbot 2.0. 'Pro Planning Mode' and a 'user-centric graphical user interface' are two additional features that augment the functionality and user experience of the Chatbot.

Keywords: Chatbot 1.0, Chatbot 2.0, Hugging Chat API, real-time web search, Pro Planning Mode

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1. Introduction

A Chatbot is a computer software that utilizes Natural Language Processing (NLP) to imitate human communication. It is widely used in automated customer care and virtual help(Janssen et al., 2022). However, its applications cover a broad range, including several sectors such as urban planning(Jaung, 2023). Chatbots have several functions in urban planning, such as collecting input from people, distributing information to the public, and fostering citizen participation(Yigitcanlar et al., 2021). These technologies have the potential to enhance the interaction between urban planners and the community, simplify the gathering of feedback, and provide useful data, ultimately resulting in a more streamlined and successful planning process(Dortheimer et al., 2023).An urban planning Chatbot is essential in today's urban setting because of the intricate and ever-changing nature of urban development. Urban planning encompasses a variety of stakeholders, complex regulatory procedures, and different data sources(Alwaer & Clements-Croome, 2010). An urban planning-specific Chatbot can function as a centralized platform for distributing information, responding to queries, and promoting interaction between people, government officials, and developers. Implementing this approach not only promotes openness and involvement, as recommended by (Caragliu et al., 2011)but also expedites the process of making decisions. Moreover, it has the potential to enhance data-oriented urban development, under the concepts of data-driven decision-making in intelligent urban areas(Rudolf et al., 2010). A dedicated Chatbot may enhance the decision-making process of urban planners by offering up-to-date data on traffic patterns, energy consumption, and land usage. This can result in the development of more efficient, sustainable, and livable cities that effectively cater to the demands of their residents. Ultimately, a specialist urban planning Chatbot is an invaluable and essential resource for contemporary communities, promoting intelligent, environmentallyfriendly, and human-focused urban growth(Ngai et al., 2021).

Chatbot 2.0 was built upon the foundation of its previous iteration, Chatbot 1.0. The Chatbot 1.0 utilized the advanced ChatGPT API and underwent training solely on data abouturban planning. The process of developing and instructing a Chatbot using the ChatGPT API encompassed many pivotal stages. Firstly, we acquired API access from OpenAI and established the required credentials. Subsequently, an application interface was meticulously crafted and programmed, with a strong emphasis on user ease and adherence to minimalist design principles. Following the successful establishment of the API, the training of the data proceeded. The Chatbot was originally trained using a well-organized data set in urban planning that is mainly extracted from development plans related to certain cities in Sri Lanka. Subsequently, the discussions were improved by repeatedly delivering more messages and altering parameters such as max tokens to impact the production of responses. The examination of user feedback for the urban planning Chatbot reveals a high level of approval since a substantial proportion of users express satisfaction. Utilizing the findings of the participatory approach of Chatbot 1.0, we have developed a journal paper and the findings were quite interesting. For the participatory approach, we used the responses of 91 participants and around 88% of the participants expressed a distinct requirement for this application in the future, emphasizing the perceived worth of the product. Furthermore, a significant 64.8% of participants expressed their greatest level of importance when ranking the relevance of the Chatbot to urban planning, highlighting its considerable significance in this domain. The users' optimistic perspective is strengthened by the significant proportion (91.2%) of all participants who expressed support for the Chatbot's suitability in urban planning scenarios (ratings 04 and 05 on the satisfaction scale). The

percentage numbers reflect the widespread acknowledgment of the Chatbot's usefulness and its capacity to have a substantial influence on urban planning methods.

The Chatbot 1.0 has some noteworthy constraints. Firstly, the AI was unable to restart or recollect previous conversations with the Chatbot, which limited its ability to engage in smooth and uninterrupted exchanges. Moreover, it could not analyze photos or comprehend geographical data, rendering it unable to handle visual information. Furthermore, the Chatbot's knowledge base was restricted in terms of scope, which hindered its capacity to offer thorough answers, especially in intricate domains such as urban planning. Furthermore, it faced difficulties with comprehending nuanced contextual cues, which resulted in possible mistakes in its replies. The presence of bias in the training data is a notable worry since it has the potential to perpetuate preexisting preconceptions. This had a detrimental impact on its dependability. Financial restrictions were a significant obstacle, restricting both the accessibility and general utility of the subject. By continuously improving and gaining contextual awareness, these constraints may be addressed.Due to certain constraints, particularly regarding exorbitant expenses, Chatbot 2.0 was created. The main objective was to create a cost-efficient Chatbot with enhanced capabilities and versatility in terms of knowledge, while also attempting to overcome the constraints of the previous version, Chatbot 1.0.

1.1. Related work: Moving to Chatbot 2.0

Chatbot 2.0 exhibits substantial advancements compared to the previous version, Chatbot 1.0, in several crucial aspects. The primary alteration is substituting the ChatGPT API with the newly introduced **Hugging Chat API**. This change is remarkable due to several factors. The Hugging Chat API is open-source, enabling developers to tweak and optimize their language models. Developers can include other open-source language models of their choosing in the Chatbot. Moreover, this API integrates sophisticated language models, resulting in enhanced conversational skills and comprehension in contrast to the constraints of ChatGPT, which was last trained on data in 2020.The updated Hugging Chat API introduces an exciting addition: online search functionality. Unlike the previous version of ChatGPT, which only used existing knowledge, this enhanced API enables the Chatbot to do live online searches and extract information from the internet. This allows it to offer more current and contextually appropriate responses to user requests. This improvement significantly boosts the Chatbot's capacity to function as a valuable repository of knowledge. One significant modification in Chatbot 2.0 pertains to the training procedure. Chatbot 1.0 utilized pre-existing datasets, however, the updated version utilizes data sourced directly from the official Urban Development Authorities (UDA) website. UDA is a notable governmental organization in Sri Lanka that specializes in urban development. Therefore, this data source is extremely important and has significant authority. Utilizing this particular data enhances the Chatbot's specialization and dependability in addressing inquiries about urban planning and development.

In addition, Chatbot 2.0 incorporates a flexible three-state system, which includes a '**Pro Planning Mode**.' By toggling a button, this mode may be engaged, which restricts the Chatbot to only offer replies based on the data released by the UDA. This functionality guarantees that users may get exceptionally precise information from the UDA's resources.The user-centric redesign of Chatbot 2.0 includes significant changes to its graphical user interface (GUI). Unlike Chatbot 1.0, the new GUI provides a more extensive perspective of the interaction. Users now can watch the complete discussion they are having with the Chatbot, rather than being restricted

to simply seeing the most recent user inquiry and its accompanying responses. This enhancement optimizes the user experience by enabling users to preserve context across their conversations with the Chatbot.Chatbot 2.0 represents a significant advancement compared to Chatbot 1.0 since it aims to overcome constraints and improve its capabilities. The central modification entails substituting the ChatGPT API with the flexible Hugging Chat API, which is open-source and provides more sophisticated language models(Peyton & Unnikrishnan, 2023). This enables developers to personalize their Chatbot and even conduct live online searches for current information. Chatbot 2.0 now incorporates official data from the UDA as a source of expert urban planning knowledge, marking a development in the training data sources. It incorporates a 'Pro Planning Mode' and a user-centric graphical user interface (GUI) to provide a smooth and user-friendly experience(Bakkouri et al., 2022). This update signifies a substantial advancement in the development of an economical, adaptable, and exceptionally proficient Chatbot designed specifically to meet the requirements of contemporary urban planning(Tebenkov & Prokhorov, 2021).

2. Literature review

The use of AI Chatbots in urban planning may be viewed as a logical advancement resulting from the development of planning support systems (PSS)(Adamopoulou & Moussiades, 2020); (Mehra, 2021). PSS are computer-based solutions used by urban planners to optimize decision-making processes by granting access to data, models, and analytical tools. AI chatbots, which are customized service systems, may engage users in conversations that resemble human interactions(Larbi et al., 2022). They provide a user-friendly and accessible way to solve inquiries, provide information, and make suggestions(Gupta, 2020). The employment of AI Chatbots in urban planning, albeit still in its nascent phase, has considerable potential to revolutionize conventional planning methods (Caragliu et al., 2011). With the continuous advancement of AI technology, we expect the development of novel and effective Chatbot applications that will improve the overall efficiency of the planning process(Lou et al., 2021). The incorporation of AI into urban planning, particularly through specialized Chatbots, offers several benefits. These include improved efficiency and productivity(Gupta, 2020), enhanced decision-making(Adam et al., 2020), and greater public participation(Caldarini et al., 2022).

AI is essential for automating laborious and repetitive processes that are inherent in urban planning, such as collecting, analyzing, and visualizing data. This automation allows urban planners the liberty to concentrate on the most strategic and imaginative facets of their profession, freeing them from monotonous obligations(Ray, 2023). Furthermore, AI enhances decision-making by providing valuable insights and recommendations that may be difficult to develop autonomously. This encompasses the capacity to replicate diverse urban planning situations, evaluate their prospective consequences, and detect discrepancies among distinct planning suggestions (Johari & Nohuddin, 2021).

Furthermore, Chatbots powered by AI are efficient instruments for actively involving the public in the process of urban planning. Luo et al., 2021state that these chatbots may effectively distribute information on impending projects and gather comments from citizens. This ensures that urban planning choices take into account the viewpoints of all stakeholders. AI integration in urban planning not only optimizes duties for planners but also improves public engagement and decision-making processes(Engin et al., 2020).

The Hugging Face Transformers library (API) is an unofficial Python-based utility that provides smooth access to the Hugging Face Transformers library, eliminating the requirement for an API key. This makes it an exceptionally handy option for developers and researchers. This platform facilitates seamless integration of Hugging Face language models (LMs) into diverse applications, eliminating the need for user registration or incurring any use expenses. This API is highly flexible and may be used with a wide range of Hugging Face language models. It supports pre-trained models, and fine-tuned language models, and even allows the use of bespoke language models. The software has a wide range of features that are specifically designed to make natural language processing (NLP) applications easier. These characteristics include a single interface for all language models, the ability to transfer knowledge from one task to another, compatibility with different types of hardware including CPUs and GPUs, and a comprehensive collection of tools for preparing and analyzing text before and after processing. The unofficial Hugging Face Transformers API is built using the Python programming language and relies on the Hugging Face Transformers library as its core framework. The platform supports a diverse range of Hugging Face language model architectures, including well-known ones like BERT, RoBERTa, DistilBERT, XLNet, and T5(Wang et al., 2023). Users may utilize the many techniques of this tool for a range of natural language processing activities, including generating text, translating, and answering questions. Additionally, users can take advantage of its capabilities for adjusting and assessing language models, making it an essential tool in the field of NLP.

Meta AI's Llama-2-70b-chat-hf is a large language model (LLM) specifically designed for discussion, including 70 billion parameters. It was made available to the public in August 2023(Wang et al., 2023). It surpasses open-source chat models in reasoning, coding, competency, and knowledge testing, and is comparable to prominent closed-source models (ChatGPT, PaLM) in terms of helpfulness and safety. Llama-2-70b-chat-hf possesses the ability to produce innovative textual structures like as poetry, code, scripts, and musical compositions. It may also be employed for activities that include discussion, such as Chatbots, customer service assistants, and instructional tools. HuggingChat v0.6.0 is equipped with online search functionality by integrating with the Google Search API. HuggingChat models may utilize Google Search to get and analyze real-world data, hence enhancing the precision and comprehensiveness of their replies(Springer et al., 2023).

Flask is a Python web framework that is lightweight and designed for constructing online applications and APIs. It relies on the **Werkzeug toolbox** and utilizes the **Jinja2 template engine**. **Werkzeug** acts as the fundamental support system for Flask, performing complex web-related functions such as analyzing requests and controlling headers. Flask can prioritize application logic by effectively handling technical aspects like sessions, cookies, and URL routing. The wide range of functionalities, such as robust password hashing, test clients, and debuggers, make it a flexible option for different web development requirements.**Jinja2**, when coupled into Flask, enables developers to effortlessly generate dynamic HTML content. It facilitates the segregation of presentation logic from Python code, promoting the development of code structures that are more organized and adaptable. Jinja2 facilitates advanced content production by including control structures, variables, filters, and functions. It also ensures security by automatically safeguarding against cross-site scripting threats. Jinja2's optimization of template rendering guarantees efficient performance, establishing it as a secure and adaptable option for dynamic content in Flask applications(Dortheimer et al., 2023).

Flask is intentionally developed to possess user-friendly and adaptable features, rendering it a widely favored option for both novices and proficient developers. Flask is a minimalist framework, implying that it lacks several built-in functionality. Flask's lightweight and quick nature necessitates the use of other libraries and extensions for implementing functionalities like database support, user authentication, and form validation. Flask is built upon the Werkzeug toolkit, which offers a range of tools for web development, including processing HTTP requests, routing, and managing sessions. Flask utilizes the Jinja2 template engine, enabling developers to generate dynamic HTML templates.

Alternate LLMs

Codellama/CodeLlama-34b-Instruct-hf is a language model (LLM) with 34 billion parameters specifically designed for generating code. The software was created by Meta AI and made available to the public in October 2023(Mariani et al., 2023). CodeLlama-34b-Instruct-hf utilizes the Transformer architecture (Saka et al., 2023) and underwent training on an extensive dataset containing both code and text. CodeLlama-34b-Instruct-hf has demonstrated superior performance compared to other open-source code generation models across several benchmarks, encompassing code completion, code summarization, and code translation. According to(Johari & Nohuddin, 2021), it has been demonstrated that this model is comparable to well-known closed-source code generation methods such as GitHub Copilot and TabNine in terms of both correctness and performance.

Tiiuae/falcon-180B-chat: Falcon-180B-chat is a language model (LLM) with 180 billion parameters that have been specifically fine-tuned for chat-related activities. The software was created by TiiUAE and officially launched in October 2023(Institute, 2023). Falcon-180B-chat utilizes the Transformer architecture and underwent training on an extensive corpus of text and code. Falcon-180B-chat has demonstrated superior performance compared to other open-source chat models across several benchmarks, encompassing reasoning, coding, competency, and knowledge assessments? According to(Institute, 2023), it has been demonstrated that this model is comparable to well-known proprietary chat models like ChatGPT and PaLM in terms of both usefulness and safety(Chauncey & McKenna, 2023); (Gill & Kaur, 2023).

3. Methodology

3.1 System Design and Architecture

The current iteration of the Chatbot's design process does not deviate significantly from the prior version. The team responsible for building Chatbot 1.0 had a strategy to thoroughly examine and enhance their Lang-Chain model. They amassed a substantial amount of data and employed both quantitative metrics and qualitative observations to enhance the model. Their primary objective was to enhance the system's comprehension of context and semantics through the utilization of search engine techniques for identifying pertinent materials. They achieved the pinnacle of their effort by developing a user-friendly interface that effectively catered to those with varying levels of technical proficiency. They conducted extensive user tests to ensure its usability. The objective was to integrate the technical capabilities of language algorithms with a user-friendly design accessible to the general public.

The current iteration of the Chatbots technique closely aligns with the aforementioned approach but with certain distinctions, particularly in the realm of data collection. Unlike the previous

model, this version utilizes its online search skills to locate the necessary data from approved sources that have been set. The interface development phase closely resembled the previous one, since the primary objective of this Chatbot's user interface remained the same. All modifications and adjustments were made in alignment with this overarching objective. This section will examine the technique used to construct a Chatbot for providing planning support in Sri Lanka. The development of this Chatbot was a methodical and inventive process that integrated technology progress with user-centered design and meticulous validation.

3.2Development Process

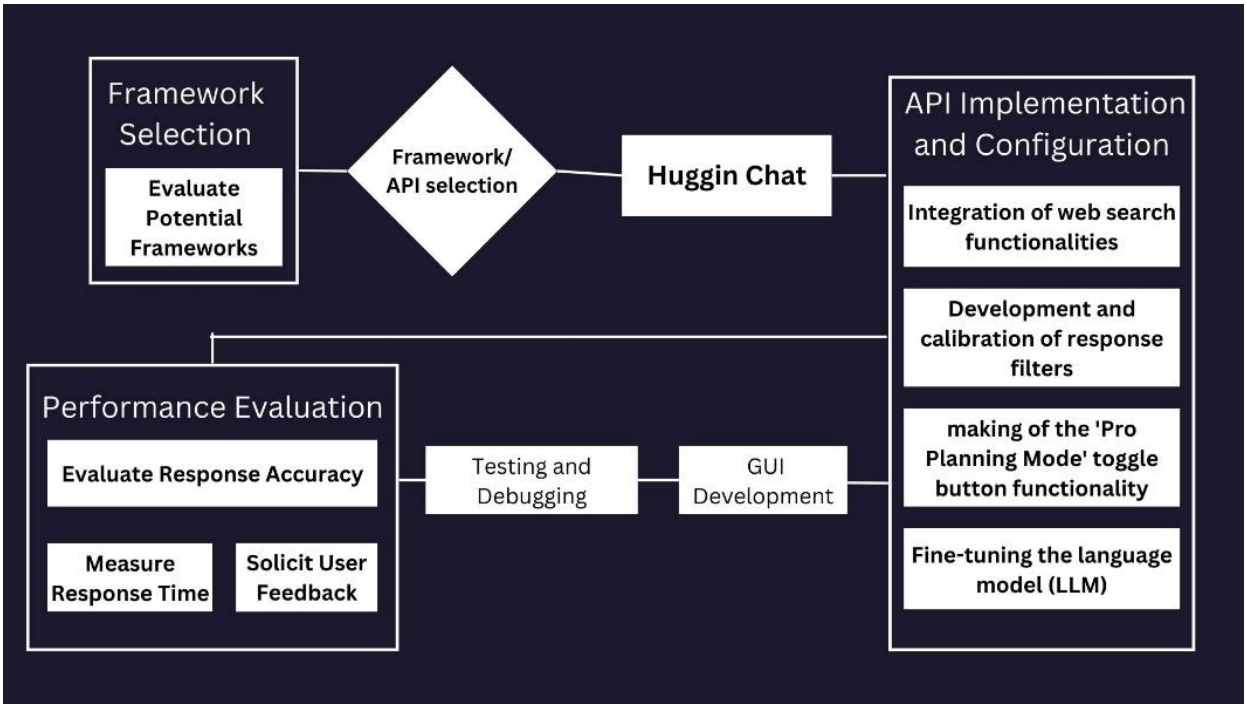


Figure 1: Development Process

1. Framework Selection:

The development process commenced with a meticulous evaluation of potential frameworks. An in-depth analysis was conducted to determine the most suitable framework for building the Chatbot. The primary objectives included cost reduction and efficient open-source options. Two prominent choices emerged from this evaluation:

- Rasa Framework: This framework allows developers to create Chatbots from the ground up, leveraging Python and Natural Language Understanding (NLU) capabilities.
- Hugging Chat API: Selected over Rasa for several reasons, including its compatibility with advanced language models like GPT-3.5, offering a richer and more extensive range of pre-trained models, and a reputation for ease of configuration, especially in the context of web querying.

2. API Implementation and Configuration:

With the Hugging Chat API chosen as the foundation, the subsequent phase was the practical implementation and configuration of the selected tool. Due to the relatively limited user base of

this API, the development team paid particular attention to rigorous testing, thorough configuration, and iterative enhancements. This phase encompassed:

- Integration of web search functionalities.
- Development and calibration of response filters.
- Fine-tuning the language model (LLM).
- Realization of the 'Pro Planning Mode' toggle button functionality.

3. Graphical User Interface (GUI) Development:

The GUI was conceived and brought to life using the Flask Python framework. Signifying an essential element of the Chatbot's user-facing aspect, the GUI design process was marked by the relentless pursuit of an intuitive, user-friendly, and visually appealing interface. Guided by the principles of user-centered design and minimalism, the interface was crafted to facilitate the effortless input of queries, encouraging a natural and engaging conversational experience. The GUI, as the bridge between users and the Chatbot's core functionalities, offered seamless navigation and interaction, ensuring that users could easily access and leverage the Chatbot's capabilities.

4. Testing and Debugging:

Rigorous and comprehensive testing was carried out as a pivotal phase of development. The entire Chatbot system underwent evaluation using various types of queries and within diverse scenarios. This rigorous testing process was executed to identify and address any encountered errors, ensuring that users would experience a seamless, error-free, and reliable interaction with the Chatbot.

5. Performance Evaluation:

To gauge the Chatbot's reliability and effectiveness, it was subjected to a rigorous performance evaluation. This evaluation spanned three critical dimensions:

- Response Accuracy: The Chatbot's proficiency in delivering correct and pertinent responses to user queries was scrutinized.
- Response Time: Response generation times were measured to ensure that users experienced reasonably prompt interactions.
- User Satisfaction: User feedback was solicited and analyzed, employing a satisfaction rating scale to provide insights into the overall user experience and the Chatbot's efficacy.

The development process encompassed not only the technical aspects but also meticulous planning, framework selection, iterative enhancements, user interface design, testing, debugging, and a comprehensive performance evaluation to ensure that the Chatbot met its objectives and delivered an exceptional user experience.

3.3 System Workflow

Chatbot v2.0 workflow

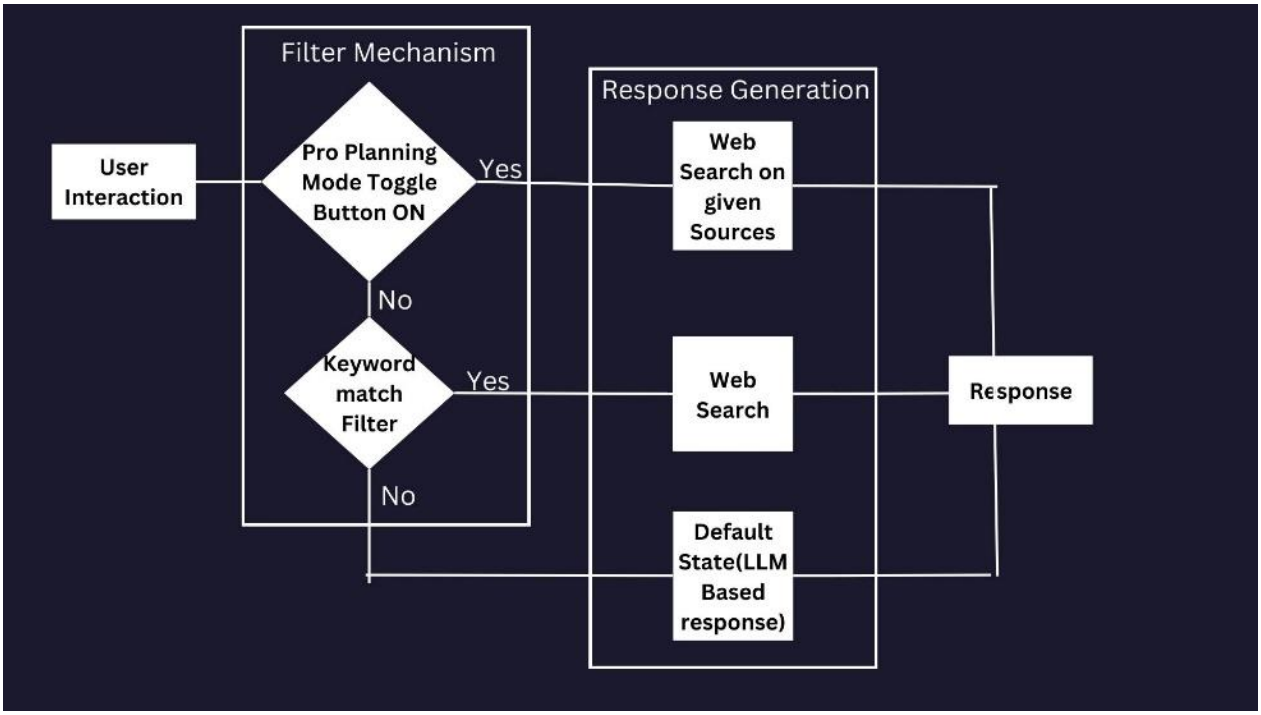


Figure 2: Development Process

1. User Interaction: Users engage with the Chatbot through the web interface, submitting queries or toggling the 'Pro Planning Mode' button to access specialized urban planning information.

2. Filter Mechanisms:

- Pro Planning Mode Filter: This filter monitors the status of the 'Pro Planning Mode' toggle. If activated, the Chatbot reorients its responses to align with data provided by the UDA for urban planning in Sri Lanka, ensuring accuracy and relevance.
- Keyword Match Filter: The Chatbot scans user queries for predefined keywords associated with urban planning (e.g., 'plan,' 'policies'). If these keywords are detected, the Chatbot initiates web searches to provide users with results and sources for further reference.

3. Default State: When none of the previous conditions are met, the Chatbot resorts to using its expansive language model. This results in swift responses with a high degree of linguistic sophistication. However, it's important to note that the accuracy and currency of these responses are contingent on the capabilities and knowledge of the language model, which is fixed as of September 2022.

4. Response Generation: The Hugging Chat Python API processes user queries, utilizing the chosen language model (e.g., 'meta-llama/Llama-2-70b-chat-hf'). This empowers the Chatbot to

craft responses that align with the user's context. When configured for web searches, the API can actively retrieve and incorporate pertinent data from the internet into its responses.

4. Results and discussion

From the Chatbot 1.0

The Chatbot 1.0 underwent a thorough assessment of a wide range of participants, including urban planners, students, and the general public. The feedback received was mostly positive. Users praised the Chatbot's interactive interface, which enabled them to inquire about and obtain insightful answers on urban planning regulations and zoning policies. The Chatbot has shown adeptness in managing a diverse array of queries, even those of an intricate nature. In order to increase its inclusiveness, it was proposed to broaden its scope to encompass subjects such as transportation, infrastructure, and environmental consequences. Moreover, the suggestion was made to boost continuing performance by using user interaction techniques that promote interactivity. In order to enhance the accessibility of the Chatbot, there is a proposal to distribute it as an application that is either free of charge or open-source, which might potentially lead to a higher rate of adoption.

The respondents have shown a clear inclination towards forward-thinking, excitedly expecting the public launch of the Chatbot and highlighting its potential to have a beneficial influence on urban planning practices. Their confidence in the program's trajectory and prospective worth motivated its further advancement and incorporation into other domains and enterprises, presenting it as a versatile and influential instrument extending beyond urban planning. Nevertheless, the Chatbot possesses significant constraints, such as its incapacity to continue dialogues or comprehend photos and geospatial data. Furthermore, we recognize the presence of content-specific limitations, such as a narrow range of knowledge, contextual comprehension, biases, and possible mistakes. The financial component poses an additional limitation, since the expenses associated with creation and upkeep may restrict accessibility. It is necessary to overcome the constraints of Chatbots in urban planning through continual advancements, contextual awareness, bias reduction, and cost-effective solutions to fully realize their potential. These endeavors are crucial for establishing Chatbots as indispensable instruments in modern urban development.

To Chatbot 2.0

With overall positive remarks for the previousChatbot, Chatbot2.0 was developed on its limitations to increase functionality and accessibility.

Performance of the proposed Chatbot

The most recent iteration of the Chatbot, functioning in 'Pro planning mode,' has undergone thorough testing to assess its efficacy in diverse urban planning assignments. This Chatbot distinguishes itself via its capacity to deliver exceptionally precise and pertinent responses by extracting data from authoritative sources within the realm of urban planning. This version represents a significant enhancement compared to its predecessor, as it is no longer constrained by the data it was originally trained on.

An important improvement in this edition is its incorporation with the UDA website. Consequently, the Chatbot is now capable of retrieving current material, guaranteeing that its

expertise remains current and encompasses a wider array of subjects. By accessing the UDA website, the Chatbot can offer the latest updates and advancements in urban planning, rendering it a great resource for professionals, academics, and anyone seeking up-to-date knowledge in this domain. The inclusion of this real-time data access function signifies a significant advancement in the Chatbot's capabilities, rendering it a potent and adaptable tool for inquiries pertaining to urban planning.

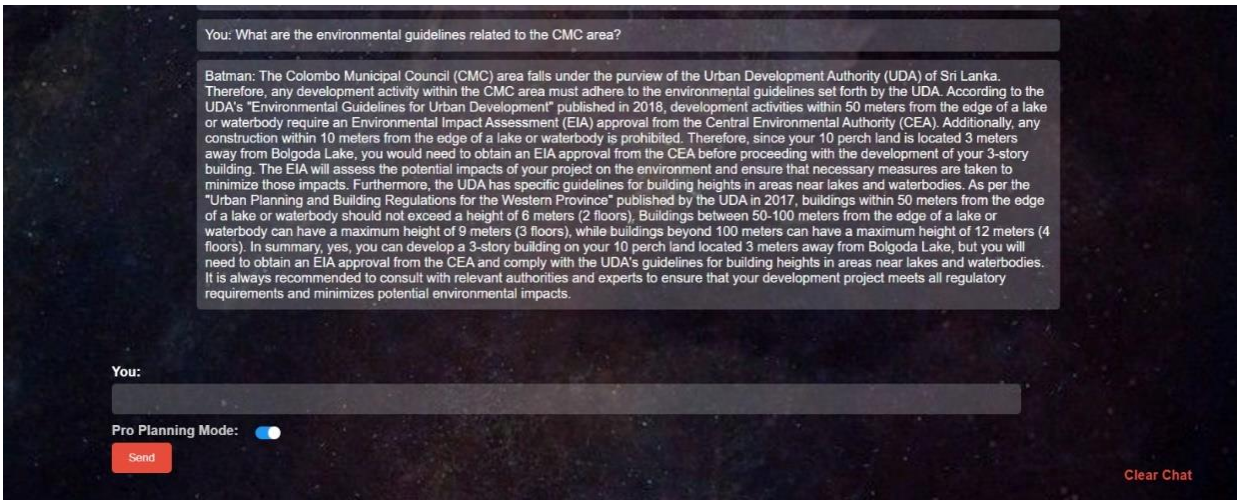


Figure 3: Screenshots of the Chatbot

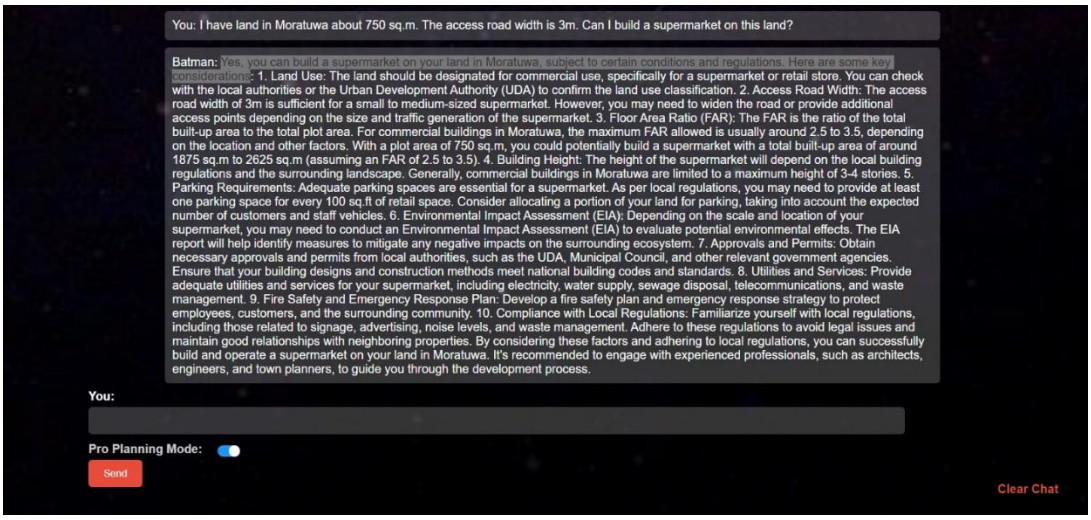


Figure 4: Screenshots of the Chatbot

The aforementioned numbers provide strong evidence of the Chatbot's exceptional ability while functioning in 'pro planning mode.' This customized mode enhances the Chatbot's capacity to offer very thorough and perceptive answers to a diverse range of urban planning inquiries. What distinguishes this version is how it achieves this accomplishment. The Chatbot utilizes real-time data extraction from the website to provide highly tailored replies that cater to the individual requirements of each user's inquiry. This method improves customization, relevance, and overall user ease.The Chatbot's performance is notable for its adaptability. The Chatbot excels in extracting the necessary facts and successfully solving mathematical or logical issues embedded in requests, going beyond simple text rephrasing. This highlights its outstanding proficiency in managing intricate mathematical and logical assignments, rendering it an essential tool for urban

planning experts, researchers, and those in need of comprehensive and versatile support in the sector.

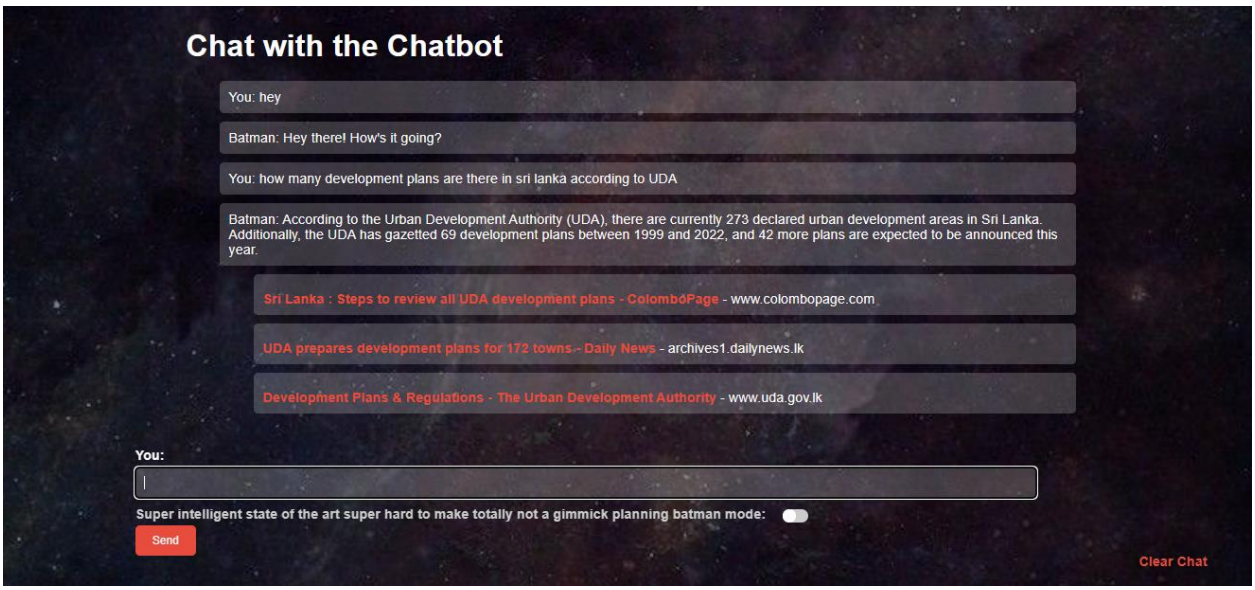


Figure 5: Ability to see the whole conversation

The 2.0 edition of the Chatbot's graphical user interface (GUI) provides substantial enhancements compared to its previous iteration. In the previous 1.0 iteration, the graphical user interface (GUI) had a restricted functionality, just presenting the most recent inquiry and the corresponding response from the Chatbot. This constraint presented difficulties for users who wanted to have lengthy discussions or find answers to intricate problems that required a sequence of detailed inquiries to gain a thorough comprehension.Nevertheless, the graphical user interface (GUI) of the 2.0 version adequately resolves this problem. Users may now access the complete discussion they are presently having with the Chatbot in realtime. Users can go through the discussion history, allowing them to access and examine past questions and replies while also engaging in the existing dialogue. This improvement significantly increases the usability and user experience of the Chatbot, making it much more suitable for sustained and meaningful discussions. Users may now effortlessly travel around the conversation, guaranteeing they have access to the context and knowledge necessary to tackle intricate matters and participate in more fruitful and enlightening debates.

The primary drawback of Chatbot 1.0 was its excessive dependence on a pre-existing dataset, which posed a major constraint when confronted with inquiries that fell beyond the realm of urban planning. This limitation frequently contributed to subpar user experiences, as it had difficulties in delivering pertinent and precise solutions across many scenarios.The implementation of Chatbot 2.0 signifies a significant enhancement in this aspect. It has successfully addressed the previously described constraint by integrating online search functionalities. This enhancement allows the Chatbot to expand its repository of knowledge beyond its original training data, enabling it to explore the extensive domain of the internet and obtain relevant information. Chatbot 2.0 is highly versatile, allowing users to gain important insights and information even when their inquiries go outside the usual scope of urban planning.

Furthermore, Chatbot 2.0 not only provides replies but also identifies the sources it used to produce these responses. This increased level of transparency serves two distinct purposes. First and foremost, it promotes trust among users by enabling them to verify the authenticity of the

information presented. The need for openness is heightened in an era where the credibility of information is a major problem. Furthermore, it provides users with the necessary resources to conduct additional studies, should they want a more extensive comprehension of a subject or prefer to investigate it autonomously.Chatbot 2.0 also stands out for its implementation of Language Model Models (LLMs). When the professional planning mode is inactive and the user's inquiry is unrelated to specified topic areas like planning, the Chatbot utilizes LLMs for its response. At now, the system is set up to use Meta AI's Llama-2-70b-chat-hf Language Model (LLM), but it may be adjusted to make use of other LLMs such as codellama/CodeLlama-34b-Instruct-hf, among several options.This setup offers a clear benefit by allowing users to have natural and very realistic talks with the Chatbot on a wide range of subjects. The Chatbot's replies are based on the chosen LLM, enabling a conversational encounter that is not limited by domain constraints. Unlike interactions facilitated by online search, which primarily aim to get factual information, these chats are characterized by a more customized, human-like, and organic nature. This fosters a stronger sense of connection and rapport between the user and the Chatbot.

Chatbot 2.0 maintains the user-friendly and simple graphical user interface (GUI) that characterized its predecessor, Chatbot 1.0. Expanding on this basis, Chatbot 2.0 provides several enhancements to optimize the user experience.A noteworthy improvement is the customers' capability to access the complete discourse by just scrolling upwards. This functionality offers customers a thorough overview of their contact with the Chatbot, facilitating the ability to reference past messages and sustain a cohesive conversation.The deliberate positioning of the pro planning mode toggle button preceding the submit button demonstrates a well-considered design decision. It guarantees that users may effortlessly alternate between planning-specific interactions and free-form chats. The strategic positioning of this function enables users to effortlessly reach it, facilitating a smooth transition between modes.

Furthermore, the Chatbot's incorporation of sources and their URLs as hyperlinks rather than plain text is a user-friendly design feature. By including hyperlinks, users may easily validate the information supplied by the Chatbot by directly accessing the sources through their web browser. Providing a more efficient and simplified method for consumers to obtain supplementary information.

Strengths

Chatbot 2.0, a resilient urban planning Chatbot, has distinct advantages and disadvantages that determine its powers. One of its most notable advantages is its ability to achieve cost-effectiveness by strategically utilizing open-source resources, such as APIs and LLMs. This cost-effective strategy provides several benefits from different perspectives. It greatly alleviates the financial strain on creators, rendering the project more viable and enduring. Furthermore, the operation isfree of cost allowing for ongoing testing and iterative enhancements, resulting in a more polished and efficient Chatbot as time progresses. By employing a dynamic development method, Chatbot 2.0 can consistently stay ahead in terms of innovation. Moreover, the Chatbot's cost-effectiveness also allows it to be available to a wider range of consumers. Chatbot 2.0's cost-effective delivery of urban planning insights helps developers and enables consumers to easily access and employ its essential services, highlighting its relevance in the field of urban planning.

The Chatbot 2.0 excels in its ability to efficiently seek and get information from the internet. Within the realm of urban planning and regulation, where information is constantly changing, this characteristic guarantees that the Chatbot remains up-to-date and flexible. Retrieving data from authoritative online sources ensures that the information remains current, accurately reflecting the most recent advancements in planning and legislation. This not only improves the precision of the Chatbot but also expands its range and adaptability, allowing it to offer consumers the most up-to-date and pertinent information. This attribute is especially advantageous in the field of urban planning, where both experts and the general public must remain up-to-date with evolving regulations and standards to obtain precise and timely information. Chatbot 2.0's online search skills make it an invaluable and essential resource in the field of urban planning.

The adaptability of Chatbot 2.0 goes beyond its function as a text-based interface. Additionally, it serves as a web application, a crucial element that greatly improves its accessibility. When deployed as a web application, the Chatbot becomes easily accessible to a diverse variety of users, irrespective of their device or geographical location. The increased accessibility is especially beneficial in reaching a wider audience and making its services more readily accessible to anyone requiring urban planning knowledge and support. By transforming into a web application, Chatbot 2.0 makes a big advancement in making essential urban planning insights accessible to a wider audience. This allows it to fully realize its promise as a user-friendly, cost-effective, and regularly updated resource for a broad set of users.

Limitations

Although Chatbot 2.0 possesses some notable advantages, it is important to acknowledge a few noteworthy drawbacks. A significant constraint is its incapacity to be educated only on user data. Due to its reliance on online information and established language models (LLMs), the Chatbot does not possess the capacity to be trained with specialized, proprietary, or user-specific data. This limitation stems from the Chatbot's dependence on external sources and pre-existing language models, which might not be customized to meet the distinct requirements or specific datasets of individual users. Therefore, although Chatbot 2.0 is very proficient in delivering comprehensive and current information, it may not be the optimal selection for intricate or individualized jobs that need training with user-specific data.

One significant drawback of Chatbot 2.0 is its extensive dependence on the Hugging Face Chat API, which, although being open-source, imposes certain limitations. The Chatbot is subject to the constraints of the API it uses, and its performance is directly influenced by the capabilities and reliability of Hugging Face servers. This means that it is susceptible to server failures and occasional delays. Relying on external infrastructure might cause interruptions and affect the stability of the Chatbot. This emphasizes the importance of implementing redundancy measures or alternative solutions to provide ongoing access to its services, particularly during server-related issues.

Suggestions for future improvement

Possible future improvements for the Chatbot may include integrating techniques to train the Chatbot only on developers' data, in addition to its existing reliance on online search results to respond to requests. Developers would have enhanced authority over the Chatbot's knowledge base and replies, allowing them to optimize its performance according to specific needs and

enhance its accuracy in domain-specific settings. By incorporating more personalized and exclusive information into the Chatbot, it may be further optimized as a highly effective and specialized tool, catering to the distinct requirements and difficulties faced by its users, and eventually augmenting its worth and usefulness.An invaluable recommendation for future enhancement is to diminish the Chatbot's reliance on the Hugging Face Chat API and augment its general adaptability. Through this approach, developers may get more authority and flexibility, empowering them to finely adjust the Chatbot to the domain of urban planning. Reducing dependence on external services such as Hugging Face would also help to minimize possible problems associated with server failures or performance variations, hence improving the dependability and responsiveness of the Chatbot. This strategy is in line with developing a Chatbot that is highly specialized, effective, and resilient in providing precise and timely information within the field of urban planning.

A valuable recommendation for future enhancement is to augment the Chatbot's input and output mechanisms to support user questions based on images. By incorporating visual information interpretation and response into the Chatbot's functionality, its skills are enhanced to deliver replies in the form of image-based outputs. Implementing this functionality will enhance the Chatbot's adaptability and bring it in line with the current advancements in AI and user engagement, where visual media has considerable importance. Enabling the Chatbot to process image-based inquiries and replies may significantly enhance its capabilities, rendering it more accessible and valuable for a diverse set of users and situations, such as urban planning and beyond.An innovative proposal for future improvement is to include geo-location data in the Chatbot's functionalities. By implementing this approach, the Chatbot may enhance its comprehension and provide highly relevant and precise responses to geo-location-related inquiries. Implementing this update will enhance the capabilities of the Chatbot to offer location-specific information, hence making it an indispensable tool for users in search of urban planning or location-based insights. Implementing geo-location data will greatly enhance the Chatbot's contextual understanding, enabling it to provide customized and accurate replies, thereby improving its usefulness for users seeking location-specific information and assistance.

An important recommendation for the future is to incorporate a feedback system within the Chatbot program, allowing users to submit input on the responses they get. This feedback loop would enable the ongoing development and enhancement of the Chatbot. Users can detect areas of weakness or inaccuracy, which enables developers to progressively improve and increase the functionality of the Chatbot. By actively engaging users in the improvement process, the Chatbot may enhance its reliability and user-centeredness. It can effectively handle particular problems and adapt to better match user expectations, thus assuring its long-term relevance and effectiveness.

Validation

To assess the efficacy of the Chatbot and obtain expert opinions, the research team carried out a practical study involving some urban planning professionals from UDA. The Chatbot was carefully tested by practitioners who are actively involved in the field of urban planning, and specialized in areas such as planning legislation. They had the chance to pose queries relating to urban planning and assess the Chatbot's performance.The input received from these professionals was predominantly promising. The users acknowledged contentment with the Chatbot's capacity to deliver precise and thorough responses, specifically emphasizing its

expertise in recognizing land zones and navigating through diverse restrictions related to those zones.In addition to the good remarks, the experts provided important suggestions for prospective improvements. They proposed the addition of a dedicated input section where users may enter the location before asking their questions. According to the experts, including this innovation would increase the precision of replies, boost user-friendliness, and customize the findings to be more geospatially particular. The inclusion of this input option was seen as an essential attribute to enhance the Chatbot's compatibility with the requirements of both planners and the general public.

Overall, the professionals expressed their contentment with the Chatbot's capacity to understand and respond to various planning-related queries. Their joint objective is to enhance the Chatbot's value in real-world urban planning situations by increasing the specificity of its location-based answers. This feedback is highly significant as it forms the basis for future improvements, guaranteeing that the Chatbot develops to cater to the unique requirements of practitioners and the wider community it intends to help.

Conclusion

In conclusion, the transition from Chatbot 1.0 to Chatbot 2.0 signifies a substantial advancement in the functionalities and prospects of urban planning Chatbots. These revisions demonstrate a dedication to resolving the shortcomings and difficulties of the original edition while incorporating the most recent breakthroughs in AI technology and user-focused design.Chatbot 2.0 has a diverse array of exceptional capabilities that establish it as a significant resource for urban planning experts, researchers, students, and the general population. One notable advantage of this is its ability to provide cost-effective solutions. Developers have successfully built and improved the Chatbot by making use of open-source resources like APIs and LLMs, all without spending significant expenses. This method not only enhances the feasibility of the project for development teams but also guarantees the accessibility of the Chatbot to a broad audience.Moreover, the incorporation of online search functionalities is one of the most notable enhancements in Chatbot 2.0. The Chatbot is enabled to retrieve real-time material from authoritative sources, ensuring that its knowledge base remains current and enhancing its range and adaptability. By providing access to up-to-date urban planning material, the Chatbot becomes an essential tool for users who are looking for the most recent advancements in the area.

Integrating Language Model Models (LLMs) into Chatbot 2.0 enhances its adaptability and capacity to engage in human-like conversations. Users can participate in unrestricted discussions on a diverse array of subjects, enhancing the personalization and interactivity of their encounters with the Chatbot. This adaptability extends beyond simple information retrieval and converts the Chatbot into a conversational companion capable of engaging in discussions on many topics in a way resembling human interaction.The intuitive graphical user interface (GUI) in Chatbot 2.0 greatly improves the user experience. Users now have the ability to access the complete chat history by simply scrolling upwards. This feature is especially beneficial for comprehending the context and participating in prolonged discussions. In addition, the positioning of the 'Pro Planning Mode' toggle button and the use of hyperlinks for source URLs enhance the overall efficiency and simplicity of the user experience.Nevertheless, Chatbot 2.0 does have certain restrictions. The Chatbot's reliance on online information and programmed LLMs, rather than being entirely trained on user data, poses a restriction. This constraint might

impede its efficiency in highly specialized or individualized activities that need training on data particular to the user.Additionally, the Chatbot's significant dependence on the Hugging Face Chat API may result in possible problems concerning server failures and swings in performance. The presence of external dependencies might negatively impact the dependability and responsiveness of the Chatbot, requiring the implementation of redundancy measures and alternative solutions.

Considering future advancements, several recommendations show potential for further augmenting the Chatbot. These strategies encompass training the Chatbot solely on user or developer data, diminishing its need on other APIs, adapting to image-based questions and replies, including geo-location data, and establishing a feedback system to improve ongoing development. These improvements will not only broaden the capabilities of the Chatbot but also strengthen its user-centricity and adaptability, allowing it to cater to a wider array of user requirements and situations.Chatbot 2.0 signifies a notable advance in the field of urban planning Chatbots. By utilizing cutting-edge technology and prioritizing user-centric design, this tool surpasses its constraints and provides enhanced accessibility, versatility, and information. Chatbot 2.0 has the capacity for ongoing enhancement and adjustment to meet user requirements. It is on the verge of becoming an essential tool for urban planning experts and enthusiasts, providing vital knowledge and support in the ever-changing realm of urban development. The transition from Chatbot 1.0 to Chatbot 2.0 showcases the progress and possibilities of AI-powered solutions in urban planning. It demonstrates the commitment of developers to fulfilling user requirements and integrating these technologies into contemporary urban development methods.

The use of Chatbot 2.0 in the domain of urban planning has several noteworthy consequences. The online search capabilities and real-time data access of this tool improve the accessibility of current information, greatly increasing the efficiency and productivity of urban planners. This platform equips professionals with up-to-date information on zoning rules, land use policies, and other crucial factors, enabling them to make well-informed decisions and conduct data-driven research. For students and professionals, it functions as a great tool for acquiring knowledge and remaining informed, while in public participation, it promotes openness and inclusiveness in the process of making decisions. Granting access to impartial information reduces prejudice in decision-making and can serve as a vital instrument in emergency preparedness and community engagement. The cost-effectiveness of this tool ensures that even planning departments with limited resources can access it. The feedback mechanism allows for continuous improvement and refinement, making it an invaluable resource for the urban planning community. It contributes to more efficient, data-driven, and inclusive urban development practices.

Prospective investigations in the field of AI Chatbots for urban planning provide a variety of encouraging avenues. An approach involves tailoring Chatbots to be more responsive to the specific requirements and preferences of individual users, focusing on user-centric customization. The progress in Natural Language Understanding (NLU) and generation models provides an opportunity for improved integration of AI, allowing Chatbots to accurately understand intricate inquiries. In addition, the ability to use several modes of communication, such as text, speech, and images, is in line with the current trends in urban planning that heavily rely on visual data. Exploring the integration of geospatial intelligence approaches to mitigate bias, and compatibility with smart city efforts is of utmost importance. Research might also

explore feedback methods and privacy issues to ensure the ongoing enhancement and ethical utilization of Chatbots. To effectively harness the potential of AI Chatbots like Chatbot 2.0 in transforming urban planning methods, it is crucial to prioritize collaborative planning, scalability, and impact evaluation. These study approaches seek to tackle the changing requirements and difficulties in urban planning by utilizing the capabilities of AI-driven Chatbots to enhance the efficiency, data-driven decision-making, and user-friendliness of planning procedures.

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Analysis of Stakeholder Perspectives towards Sustainable Transitioning in Dairy Farming

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Abstract

High input, resource intensive dairy farming systems have posed substantial environmental and social risks, necessitating sustainable transformation in dairy farming. Stakeholder analysis help organizations consider a broader range of issues in transition decision-making, leading to better strategic decisions. This study aimed to analyse social relevance of a large-scale dairy farm in Sri Lanka to its key stakeholders and investigate their opinions on sustainable transitioning. A field-based research was conducted through interviews and questionnaires. A comprehensive supply chain mapping and stakeholder analysis were used in designing questions and selecting sample. The total sample size was 61 individuals. Answers were statistically analysed using IBM SPSS Statistics (version 26.0). Majority of respondents were farm employees (45.90%) with 36.07% having higher education. A total of 72.13% agreed on the need of healthy and sustainable environment for Sri Lanka, 67.21% were aware on impacts of dairy farming while 50.82% having some knowledge on sustainable development. A non-parametric Kruskal Wallis H test (α=0.05) resulted a relationship between the respondents' educational level and responses provided. However, 91.80% agreed on sustainable transitioning of the farm, regardless of their educational level. This study revealed communities' desire to live in a sustainable environment and the importance of proper sustainability education.

Keywords: Dairy farming, Impacts, Stakeholder analysis, Sustainability, Transition
Main Conference Topic: Sustainability, Environment and Risk Management

Introduction

Milk is considered as one of the most complete and valuable agricultural commodities as it is rich in energy, protein, essential minerals, and vitamins (FAO, 2016; Üçtuğ, 2019; Díaz de Otálora et al., 2021). More than 80% of global population, or approximately 6 billion people, consume liquid milk or any other dairy product on a regular basis (FAO & GDP, 2018). Specially, providing animal-sourced foods such as milk or milk products to children has well-documented nutritional benefits that have been widely associated with child growth (FAO, GDP & IFCN, 2020). However, the present food and agriculture systems has surpassed the planetary boundaries playing a crucial role in destabilizing the Earth system(Campbell et al., 2017). It has been reported that the dairy sector, along with meat and poultry, has the highest environmental footprint of the entire food industry (Üçtuğ, 2019). There is an increasingpressure on global

dairy industry on reducing its environmental impacts arisen from farming, production and processing, and transportation, particularly when it is directly relevant to climate change.

The emergence of modern commercialized large scale dairy farms in order to meet the increasing consumer demands, has expanded commercialization of the dairy industry in the last few decades (Luqman & Al-Ansari, 2021). This is not a new concept in the developed world, but there is an increasing interest in establishing such "mega dairy farms" in developing countries(Moran & Chamberlain, 2017). These modern dairy farms with high-performing cattle breeds have created many 'pros and cons'. High-input, resource intensive farming systems have resulted in substantial deforestation, soil depletion, water scarcities, particularly, high levels of greenhouse gas (GHG) emissions result from a variety of biological processes, sources, and sinks, over the entire life cycle(Rotz et al., 2010; Guzmán-Luna et al., 2021). Researches have made the evidence that the input-intensive agriculture is both a contributor and victim of climate change. It also impacts on livestock production, as increasing global temperature affects most critical factors of livestock including milk production, reproduction and health, water availability, and more(Rojas-Downing et al., 2017).

There are possible interventions to reduce GHG emissions and other environmental impacts from agriculture to a large extent, also from the dairy sector, based on modern technologies and practices while improving the production efficiency at animal and breed levels. These have been called in various terminologies in literature. Some of the most common terminologies are sustainable agriculture, regenerative or conservation agriculture, natural farming, net-zero farming, organic farming, and precision farming. The world is facing a new era that moves with the concepts of sustainable development. The linkages between dairy farming and United Nations Sustainable Development Goals (SDGs) are multiple. According to the Food and Agriculture Organization (FAO), applying concepts of sustainability will recognize the environmental and sustainability challenges related to the use of natural resources and the impacts that are generated as a result of milk productions at both the farm and factory levels, as well as various social and economic consequences associated (FAO, 2018).

The complex linkages between dairy industry and Sustainable Development Goals come together under a collective action through multi-stakeholder processes and integrated approaches in formulating and implementing sustainable investments and policies. Stakeholder topics has been considered as one of the core concepts in transition decision-making throughout the literature. Stakeholders prompts organizations to consider a broader range of issues, resulting in better strategic decision-making. Therefore, identification of key stakeholders, followed by an assessment of stakeholders' perspectives, knowledge, coalitions, and influence is crucial for a given scenario (dos Muchangos et al., 2017).

This study was carried out at a large-scale, state-owned modern dairy farm located in the dry zone of Sri Lanka. The farm has ~3200 hectares of land under its control with a land used for fodder cultivation use to feed ~3050 of imported high yielding cattle. Farm does not produce any milk product on-farm. The majority of extracted milk is mainly transported to the factory located about ~220 km away, where yoghurt, ice cream, curd, and other milk products are manufactures. The rest of the milk is bought by large scale and small scale dairy processing companies and neighbouring local communities. At present, this farm faces large operational risks and challenges associated with their complex supply chain and has the potential to transform to a more sustainable model. In the first phase, this research was conducted at the

subjective farm and in nearby communities aimingto identify the social relevance of the farm to its key stakeholders following an investigation of stakeholder perspectives towards transition of the farm into a more sustainable model.

Methodology

The methodology used for this study was a combination of qualitative and quantitative analysis. A field-based study was conducted at the selected farm and in nearby local communities to gather both primary and secondary data through observations and semi-structured interviews with farm managers. In the first phase, a comprehensive supply chain diagram was developed (Appendix A) by concluding all the associated activities performed by the farm regarding fresh milk production covering all the on-farm direct operations and some of the upstream and downstream activities (Appendix B).

The diagram was used to identify all of the key activities in the second phase, and a comprehensive stakeholder analysis was conducted prior to selecting the sample and designing the questionnaires. The five stakeholder groups considered for the questionnaire survey were; managers (M), employees (E), local community (LC), traders (T), and grama niladhari officers (GN) of nearby GN divisions. The total sample size (N_{Total}) was 61 individuals; N_M=5, N_E=28, N_{LC}=20, N_T=5, N_{GN}=3. A total of five different questionnaires were designed for each stakeholder group and each contained of a variety of types of questions including several demographic questions, yes/no questions, likert scale questions, and several open-ended questions where randomly selected individuals who represent each stakeholder group enabled to express their opinions, experiences, and knowledge in an effective manner (Appendix C).

The responses received from the surveys were statistically analysed followed by a Kruskal Wallis H test performed at 5% level of significance (α=0.05). All the statistical tests were performed using IBM SPSS Statistics for Windows (Version 26.0).

Results

Social survey analysis

The majority of the sample was presented by farm employees (45.90%), followed by the local community participants (32.79%). According to the age distribution, the lowest age category (21-30 years) received the highest number of responses (40.98%) followed by the 41-50 years category (24.59%), and there were no responses from those above 60 years old. A significant percentage of respondents had studied up to a degree or similar higher education level (36.07%). There were only 1.64% of respondents who have completed only up to the secondary education (Figure 1).

There were 33 farm staff members, including both managers and employees, with an equal percentage of staff (30.30%) having less than one year or 1-3 years of work experience at the studied farm, 27.27% having 3-5 years of work experience, and 12.12% having more than 5 years of work experience in the farm (Figure 2).

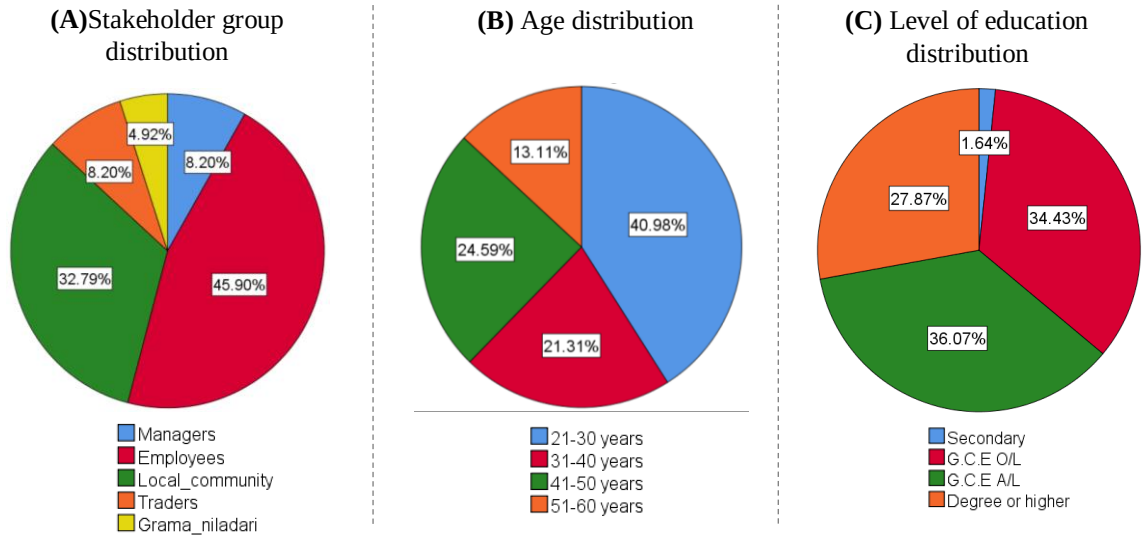


Figure 1: Frequency distributions of the demographic factors considered in the study

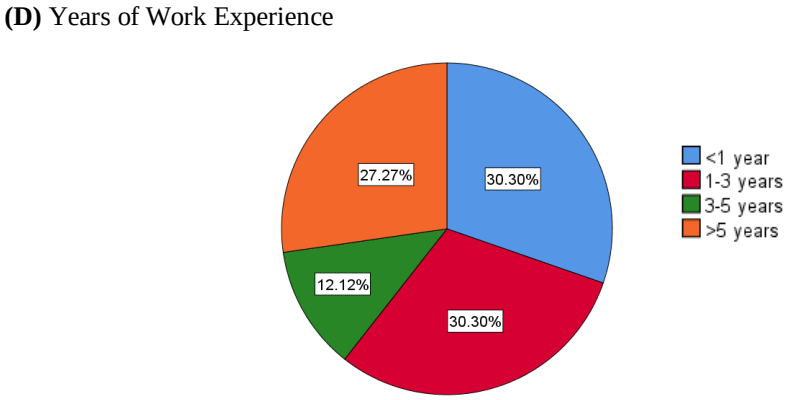


Figure 2: Frequency distributions of years of work experience of farm staff (managers and employees)

In each questionnaire, there were several yes/no questions and likert scale questions to identify the respondents' knowledge on impacts of dairy farming, awareness on the concepts of sustainable development, and their opinions on the need of healthy and sustainable environment and finally, to see what would they think on transforming the farm into a more sustainable farm following the principles of sustainable development as shown below.

Q1: Opinion on the need of healthy and sustainable environment for Sri Lanka (Strongly disagree: 1, disagree: 2, neither agree nor disagree: 3, agree: 4, strongly agree: 5)

Q2: Awareness on the impacts of dairy farming on the environment (Yes: 1, No: 0)

Q3: Awareness on the concepts of sustainable development or United Nations Sustainable Development Goals (Yes: 1, No: 0)

Q4: Opinion on transforming the farm into a more sustainable dairy farm (Strongly disagree: 1, disagree: 2, neither agree nor disagree: 3, agree: 4, strongly agree: 5)

According to the results, 72.13% of respondents agreed that Sri Lanka needs to have a healthy and sustainable environment, while 18.03% were undecided. However, a significant minority of respondents (9.84%) disagreed with the preceding assertion. Only 67.21% of respondents were aware of the environmental impacts of dairy farming whilethe rest of them were unaware about that. A total of 50.82% of respondents had heard of or are familiar with either the principles of sustainable development or the United Nations Sustainable Development Goals, while others have not.As they are having an understanding impacts of dairy farming on the environment or the concepts of sustainable development, 91.8% of respondents have agreed to transform this farm into a more sustainable dairy farm.

A non-parametric Kruskal Wallis H test was performed at 5% level of significance to test if there a difference between two or more independent groups, and to see whether there is a relationship between the answers obtained for the above four questions; Q1, Q2, Q3, Q4, and the level of education of the respondents (Test 1).The results showed that there is a relationship between the respondents' level of education and the responses they gave to Q1, Q2, and Q3, but no association between their level of education and the answers they gave to Q4 which means, regardless of their level of education, 91.8% of them have agreed to transform the farm into a more sustainable dairy farm.

Similarly, another test was performed at 5% level of significance to test if there a difference between two or more independent groups, and to see whether there is a relationship between the answers obtained for the above four questions; Q1, Q2, Q3, Q4, and the work experience of the respondents (Test 2).The results showed that work experience had no effect on the answers given by staff respondents for Q1, Q3, and Q4, but there was an association for the answers to Q2, meaning that work experience had an effect on the farm staff respondents' answers on the impacts of dairy farming.

Environmental and social impacts of the farm

As per the respondents' view, the main impacts of the studied farm on the environment were water, air, and soil pollution. Water resources such as rivers, streams, tanks, and groundwater can be contaminated by waste water and animal waste, and overflow of slurry pits during the rainy season can contaminate the lake. The air can be polluted by the emissions of greenhouse gases from farm vehicles, the disposal of vehicle wastes and burned oil, the micro particles in animal feed, high CH_4 emissions from farm animals, and animal waste from both inside cattle sheds and cow dung traps. Impact on the soil by agrochemicals, use of chemicals for milking parlour cleaning, disposal of medicinal waste, soil degradation, greenhouse gas emissions, and loss of biodiversity from deforestation during land preparation for cultivation purposes are the main concerns related to soil pollution. The use of fossil fuels instead of renewable energy sources and sound pollution from fans and motors were also highlighted by the respondents.

In order to reduce the above impacts, they have suggested several possible ways, such as recycling all the waste (cattle manure, waste slurry to be applied to the field as compost products), use of electrical vehicles inside the farm, use of renewable energy sources such as solar power and/or wind mills, use of biodegradable detergents, decomposable medicine bottles, more energy efficient farm machinery, conservation of the remaining forest cover and securing

animal habitats, biogas generation using the emitted CH_4, and cleaning slurry pits at the correct time.

The main barriers to improving milk production at the farm were identified by analysing the results obtained from respondents. As per the results, fertiliser shortages lead to poor forage production; input prices are increasing rapidly and are not stable; a lack of adequate grass, inadequate new harvesting machines, and poor quality of concentrates (animal feed) are some of the main barriers. Moreover, the available cattle breeds are not suitable for the hot, humid environment of the region, there is an inability to provide a suitable environment, although these are animals with a high potential, a need for a genetic replacement of the herd, the ageing of the current herd, poor hygienic and water management, an inability to meet the nutrient demand for animals, and old machinery for feeding, milking, and harvesting. Respondents have mentioned that interventions and mediation for farm-level operational and human resources activities by top levels, poor attitudes of workers and officers, poorly educated workers, and government policies on cattle transportation and slaughtering are highly concerned.

The respondents have also made several suggestions to transform the farm into a more sustainable farm, such as having their own animal feed production for both forage and concentrates, improving the efficiency and productivity of the land, increasing land utilisation, protecting water resources and biodiversity, generating electricity from the establishment of solar panels on the roofs of cattle sheds, establishing wind mills, protecting the atmosphere from methane emissions through biogas generation, compost production, recruiting skilled and educated labour by increasing the level of education, and reducing inequalities for both male and female workers.

Conclusion

Analysing stakeholders' perspectives in a given scenario is critical for project planning and development. It indicates how these different interest groups can positively contribute to the farm's sustainable transition through their influences, knowledge, and awareness. This study revealed their desire to live in a healthy and sustainable environment, and also highlighted the importance of proper sustainability education for different groups in order to achieve the project's goals.

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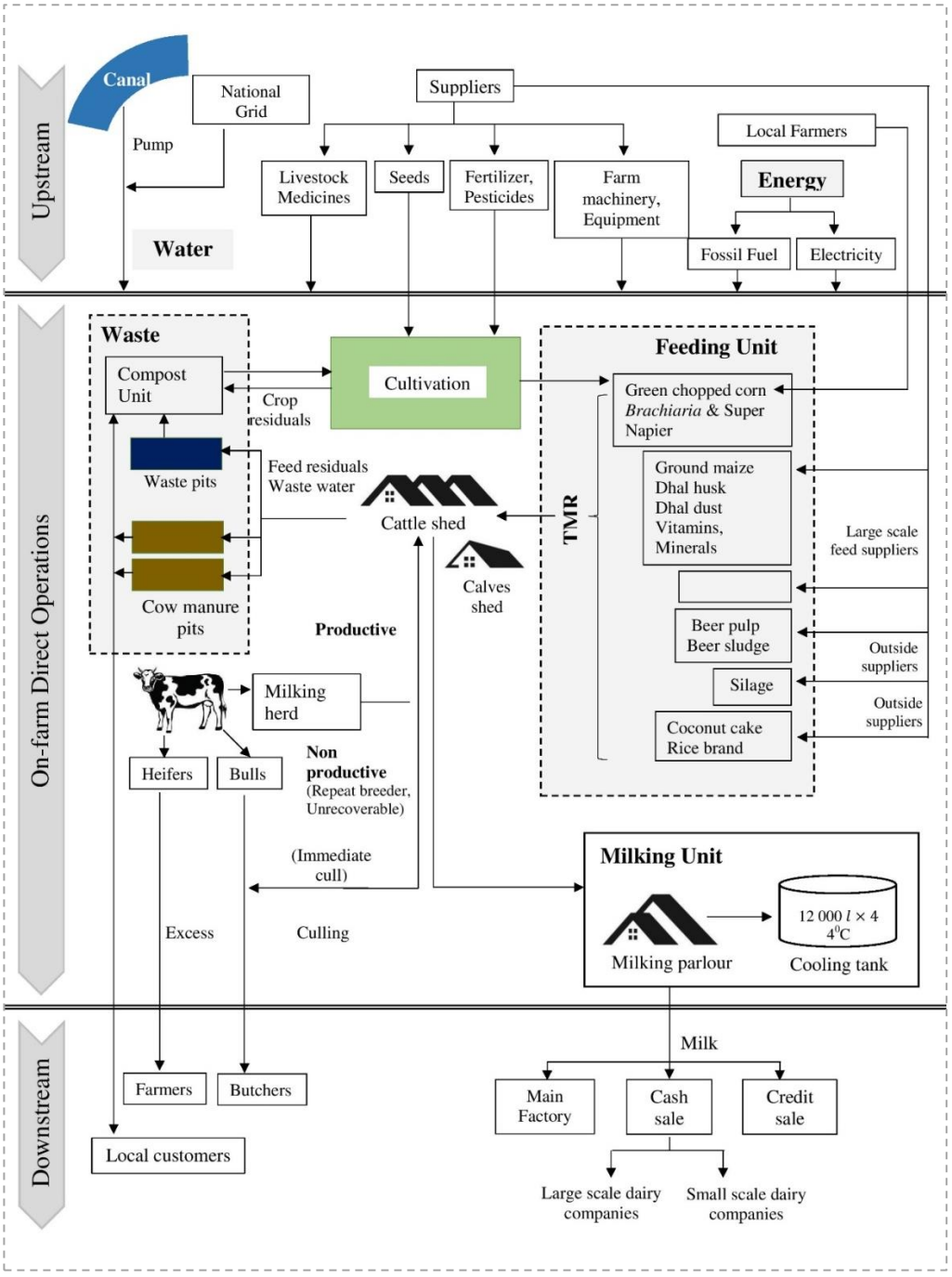
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Appendix A

Fresh milk supply chain of the studied dairy farm



Appendix B

General Questionnaire

Farm Name	
Address	

Land		
Farm land in total (hectares)		
Land Distribution	Item	Extent (ha)
Livestock on farm		
Livestock Units in total (no.)		
aracterization of Livestock Units	Livestock Unit	Total no. (heads)
	Cattle	
	Buffalo	
	Lactating cows	
	Dry cows	
	Heifers	
	Calves (female)	
What types of breeds are available?		
Has the number of livestock on your farm changed in the last few years? (No change/increased/decreased?)		
What are the reasons for the increasing/decreasing number of livestock?		
Do you sell livestock? To whom?		
What do you do with animals that are not productive or below the expected level?		
Feed		
What are the types of feed provided for animals?		
Do you produce your own feed for animals?		

Do you purchase any feed for animals from outside? Who are the main suppliers?	
What is the process of feeding?	
Water use	
What are the sources of water used for farm activities?	
Do you have any water treatment facilities on farm? What are the practices used maintain the water quality?	
Energy use	
What are the farm activities that have a high demand of energy?	
How do you meet that energy demand?	
Do you have any sustainable energy practices on farm to meet the energy demand? (Eg: solar power, biomass, etc.)	
Waste management	
What types of waste generated on farm? (both solid waste and waste water)	
What are the practices available to manage solid waste?	
Do you have any wastewater treatment facilities on farm? How do you handle the generated waste water?	
Do you deal with any waste collecting/waste treatment companies/organizations?	
Animal health and safety	
What are the practices on farm to manage animal health and safety?	
Milking	
What is the process of milking?	
Do you have the necessary facilities to store milk and what is the capacity?	
Do you process milk on farm? How?	
Milk yield • FPCM milk yield (kg/year) • FPCM milk yield (kg/day/cow) • Nutrition (Crude protein %, Fat %, Lactose %, etc.)	
How is the quality of milk managed? Do you get any help on quality and safety control standards from state bodies or private companies? (Eg: HACCP, Good Agricultural Practices, Good Manufacturing Practices, etc.)	
Milk selling	
Who are the main buyers?	

How long have you been supplying milk for them (for dairy companies and other traders)?	
Do you sell milk directly? To whom?	
Total milk produced (in litres per month/year)	
How many litres of milk do you deliver per day or per week?	
What is the number of deliveries per day or per week?	
Who organizes the delivery and the transportation: is it you or the buyer?	
Do you ever have problems selling all your milk? Why?	
What is the selling price of milk?	
How much do you earn with milk sales per year?	
Others	
Are there any other revenue streams except milk selling on farm?	
What are the main costs incurred in running the farm?	
Do you receive any financial support through any existing national programmes?	
In terms of livestock, what kind of investments/projects are you planning within the next five years to improve milk production development?	
What are the main barriers to improve milk production? Have you experienced specific problems, difficulties or requirements relating to milk production or any other farm activities?	
Does your farm follow the concept of sustainability? Are there any activities on farm that are related to UN Sustainable Development Goals? (Yes/No/Do not have an idea)	

Appendix C

SAMPLE QUESTIONNAIRE A: Managers

FRESH MILK SUPPLY CHAIN ANALYSIS

Age	21 – 30 years 31 – 40 years 41 – 50 years 51 – 60 years Above 60 years
Level of Education (the highest qualification)	G.C.E. O/L G.C.E. A/L Degree or higher
Your permanent residence	District: GN Division:
Job title and status (Permanent/Temporary)	
What are your key responsibilities, tasks or duties?	
How long have you been working in this farm?	Less than 1 year 1 – 3 years 3 – 5 years More than 5 years
According to your knowledge and experiences, what are the main barriers to improve milk production on farm? List as the most important first and least important last.	
What is your opinion on the need for a healthy and sustainable environment for Sri Lanka?	Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree
Are you aware of the impacts of dairy farming on the environment?	Yes No
According to your knowledge, what are the main negative impacts of your farm on the environment? List as the most important first and least important last.	
According to your knowledge, what are the possible ways to reduce those impacts on the environment?	
Are you aware of the concept of "Sustainable Development/United nations Sustainable Development Goals"?	Yes No
What is your view on transforming your farm into a more sustainable dairy farm?	Strongly agree Agree Neither agree nor disagree Disagree

	Strongly disagree
In your view, what are the benefits of making this farm more sustainable?	
Any suggestions on how to make the farm more sustainable?	
As you think, what are the main barriers to improve the sustainability of the farm?	
What are the future trends in the dairy farming business in Sri Lanka that you can think of? Please list them.	

SAMPLE QUESTIONNAIRE B: Employees

FRESH MILK SUPPLY CHAIN ANALYSIS

Age	21 – 30 years 31 – 40 years 41 – 50 years 51 – 60 years Above 60 years
Level of Education (the highest qualification)	G.C.E. O/L G.C.E. A/L Degree or higher
Your permanent residence	District: GN Division:
Job title and status (Permanent/Temporary)	
What are your key responsibilities, tasks or duties?	
How long have you been working in this farm?	Less than 1 year 1 – 3 years 3 – 5 years More than 5 years
According to your knowledge and experiences, what are the main barriers to improve milk production on farm? List as the most important first and least important last.	
What is your opinion on the need for a healthy and sustainable environment for Sri Lanka?	Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree

Are you aware of the impacts of dairy farming on the environment?	Yes No
According to your knowledge, list 5 main impacts that you consider important impacts of dairy farming on the Sri Lankan environment?	
Are you aware of the concept of "Sustainable Development/United nations Sustainable Development Goals"?	Yes No
What is your perception on transforming your farm into a more sustainable dairy farm?	Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree
As you think, what are the main barriers to improve the sustainability of the farm?	
Any suggestions on how to make the farm more sustainable?	

SAMPLE QUESTIONNAIRE C: Local Community

FRESH MILK SUPPLY CHAIN ANALYSIS

Age	21 – 30 years 31 – 40 years 41 – 50 years 51 – 60 years Above 60 years
Level of Education (the highest qualification)	Primary Education (Grade 1-5) Secondary Education (Grade 6-9) G.C.E. O/L G.C.E. A/L Degree or higher
Your permanent residence	District: GN Division:
Do you have any family members who are working in this farm?	Yes No
What is your view on the importance of the farm to your village?	Very important Moderately important Not important No opinion
Does the farm carry out activities to support your community in this GN division? If YES, please list them.	Yes/ No
Are you aware of the impacts of dairy farming on the environment?	Yes No

What is your opinion on the need for a healthy and sustainable environment for Sri Lanka?	Strongly agree/ Agree Neither agree nor disagree Disagree Strongly disagree
According to your knowledge, what are the ways in which this farm can impact the environment?	
Have you experienced such positive or negative impacts as a result of the farm activities? If yes, please list them.	
Are you aware of the concept of "Sustainable Development/United nations Sustainable Development Goals"?	Yes No
What is your perception on transforming your farm into a more sustainable dairy farm?	Strongly agree Agree Neither agree nor disagree Disagree Strongly disagree
As you think, what are the main barriers to improve the sustainability of the farm?	
Any suggestions on how to make the farm more sustainable?	

Sustainable method of chemical recycling of epoxy resin using microwaves

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Abstract:

This work proposes a low cost, and efficient method for the recycling of the GF and CF reinforced epoxy composites, based on a microwave-assisted chemical oxidation method. The possibility of composites recycling, the low time process, the low energy consumption and the use of green solvents, significantly reduces the environmental impact of the disposal of composite materials.
Several approaches were explored in order to optimize the recycling of epoxy waste, finding the best conditions in a one-step process using microwave irradiation, a mixture of hydrogen peroxide (H2O2) as a green oxidiser and tartaric acid (TA) as a natural organic acid. The optimized process allowed the decomposition and also the reuse of the epoxy matrix; moreover, the use of microwave irradiation allowed the reduction of both recycling time and energy consumption.
The chemical residue obtained after the recycling process was first characterized by FTIR and DSC analysis. Then, the residue was mixed with virgin resin for the production of new samples. Finally, thermal and mechanical properties of the produced bars were investigated by DSC and mechanical tests.

Keywords:

Composites; Epoxy resin; recycling; circular economy; sustainability; microwave irradiation; green chemistry

Main Conference Topic:

Sustainability, Environment & Risk Management

Introduction and related work:

One of the most prominent applications of epoxy resin (EP), is their use as matrix material in fiber-reinforced composites, widely used for wind turbine blades, in aerospace, as floor paint and in other fields, because of its light weight, high strength, good corrosion resistance and excellent adhesion [1,2,3,4,5].
Market reports have stated that the global GF reinforced epoxy polymer (GFRP) composites market is likely to grow at a steady pace as the material finds varied end-use applications [6]. In 2018, the glass fiber to composites market reach 2.5 billion pounds in terms of volume and is expected to reach 3 billion pounds in 2024 [7,8]. At the same time the demand of CF reinforced epoxy polymer (CFRP) composites has grown from 43,500 tons in 2012 to 82,400 tons in 2017

and reached 112,000 tons in 2020 [9,10]. In recent years this growth trend has been confirmed. This growth in the composites market creates a sustainability problem, as there is no efficient strategy for recycling or reusing composite material waste at the end of the life of the material [11].

Polymeric matrices are divided into thermoplastics and thermosets. Thermoplastics can be melted by heating and solidified by cooling. This property is of high interest for recycling because thermoplastics can be re-shaped. Thermoset materials instead, once polymerized cannot be re-melted or re-formed. Thermosets, and epoxy in particular, are the preferred choice for aircraft and car structures, for their good properties as composite material matrices and the low initial viscosity, which involves an easy processing before the cure [12]. The EP-based materials are different from disposable plastics, in that they have a long lifetime so that their recycling has not aroused enough attention before. The problem is becoming imperative with the massive decommissioning of the composite materials in recent years [3;13-18]. Recovering discarded composite materials, as well as being an environmental imperative, is also becoming increasingly important from an economic point of view [19,20]. Furthermore, European legislation and that of other countries, try to push in this direction [10,11,12,21].

Recycling technologies developed for thermoset composite materials comprise fundamentally three categories of recycling processes: mechanical, thermal and chemical [9]. Mechanical recycling is a low cost process; however, it usually destroys the mechanical performance of the fibers. Thermal recycling processes, such as pyrolysis and fluidized bed, release highly toxic gases and are high energy consumption processes [22]. For the reasons mentioned above, in recent years attention has been paid to chemical recycling processes. Some conventional chemical recycling processes, used in the past, involve the use of sulfuric and nitric acids, especially for the recovery of fibres. Some attempts have been made using supercritical fluids [12]. But this kind of methods involve harsh chemicals and/or the application of high temperatures and pressures, and consequently they are not in line with the principles of green chemistry [22,23]. Apart from this, I suggest to highlight that mechanical and chemical process also involve significant degradatuion of the property of the fibers, due to physical (size reduction) and chemical (fiber oxidation) reasons. In contrast, the developed approach (add reference) allows to preserve the mechanical and physical properties of the fibers.

In this work a one-step chemical/physical recycling method is proposed, that follows the principles of green chemistry and therefore does not use chemical products that are dangerous or harmful to the environment and humans. At the same time, the aim of this work is to drastically reduce energy consumption by trying to replace conventional heating with microwaves.

In several works about chemical recycling, microwaves were used different objectives. Tavares de Moraes et al. in [6] use the microwaves to carry out pyrolysis and reduce the volume of waste to be disposed of by 73%. Rani et al. in [24] use microwaves to super-heat the fibers which promotes fiber/matrix detachment. Zabihi et al. in [22-25] and Yuwei Long et al. in [3] use microwaves to recover glass and carbon fibers from composites with good results in terms of the strength of the recovered fibers. Other attempts to recover resin from composites have been made by Mohan Das et al. in [20], Xu Zhao et al. in [26] and Kaiyou Huang et al. in [27].

This work is focused on the possibility of recovering and reusing epoxy resin from disused composite materials. Following the 12 principles of green chemistry [23], which involve the use of safer solvents and renewable feedstocks, reducing energy consumption, reusing all waste materials, a recycling method, based on the use of tartaric acid, yeast, hydrogen peroxide and

microwaves, is then proposed. The characterization of the recycled materials was then carried out and a way of reusing them was proposed.

Materials and Methods:

Materials

Hydrogen peroxide (H_2O_2, 35 wt%, 130 V) and pure L-Tartaric Acid (TA, food additive E334) were purchased from Sigma Aldrich. Yeast (food grade) was produced by Cameo s.p.a. (Brescia, Italy). Epoxy resin based on DGEBA (VER), was purchased from R*Concept (Barcelona, Spain), named Polar Bear, characterized by a biocarbon content of 28% deriving from pine oils (expressed as a fraction of the total organic carbon content); it is liquid at room temperature, hence making the mechanical mixing process easy [28]. This resin was chosen because it is not recyclable, although a certain percentage is of natural origin. Isophorone diamine (IPDA), supplied by Sigma Aldrich, was used as curing agent for the epoxy resin.

Methods

Preparation of samples

The virgin epoxy resin bars were produced mixing VER with 22 phr of IPDA, cured in vented oven at 80°C for 2 hours and then post-cured at 120°C for 1 hour. The recycled resin bars containing the residue coming from the chemical recycling were prepared by manually mixing the residue and the virgin resin in various ratios, as reported in Table 1; after that, 22 phr of IPDA were added to the mixture (compared to the quantity of resin virgin used) [28]. The cure and post-cure cycles were the same used for the virgin resin bars.

SAMPLES	VER [wt%]	RESIDUE [wt%]	IPDA [phr]
T 1	90	10	22
T 2	80	20	22
T 3	70	30	22
T 4	60	40	22

Tab 1: Composition of recycled bars

Recycling process

Two different methods were used to carry out the recycling tests: a Carbolite ventilated oven, with a maximum power of 3,000 Watts, and a microwave oven (Sharp Corporation, Japan) with a maximum power of 800 Watts.

To prepare the solution used in the recycling process 35 wt% hydrogen peroxide and tartaric acid were mixed at room temperature using a magnetic stirrer at 3,000 rpm for 30 minutes.

Two different ratios between hydrogen peroxide and TA were tested, 3:1 as indicated by Zabihi et al. [22-25] and 4:1, in order to use a less concentrated solution of hydrogen peroxide. A 1:33 weight ratio between resin and solution was also chosen [22-25]. After immersing the bar of

virgin resin in the solution, the mixture was placed in the microwave oven (800 W) and heated for 1.5 minutes; then, the mixture was left to rest for 10 min. In particular, at the beginning of each cycle, the resin bar was immersed in 9g of solution, then the mixture was mixed gently and placed in oven. At the end of each cycle, the residue was collected and a new solution was added. To evaluate the weight loss that occurred in each cycle, the bar was recovered, washed it in distilled water and dried it for 24 hours at 50°C; weight loss was then calculated considering the initial weight.

(a)  (b)  (c) 

Fig. 1: Before (a), during (b) and after (c) first cycle of the recycling process

This cycle was repeated three times, for both types of solution used (3:1 - 4:1). The bar weight loss (WL) was calculated by measuring the weight of the bar after the recycling test (RW) in relation with the initial weight of the virgin resin bar (IW):

$$WL\ \% = (RW / IW) * 100$$

As reported in Table 2, the greatest weight loss, which means greater degradation by the virgin resin, was obtained with the 3:1 ratio between hydrogen peroxide and TA, therefore, it was decided to discard the possibility of using the 4:1 ratio.

H_2O_2 : TA	**Resting time [min] (cycles x min)**	**Test time [min] (cycles x min)**	**WL [%]**
3:1	30 (3 x 10)	4.5 (3 x 1.5)	23.06
4:1	30 (3 x 10)	4.5 (3 x 1.5)	19.98

Table 2: First test to choose the hydrogen peroxide / TA ratio to be used in the recycling procedure

Then, the resting time between one microwave cycle and another one was evaluated. Three possibilities of resting time between one cycle and another were evaluated: 0 min (no resting time), 10 min, 15 min.

H_2O_2 : TA	**Resting time [min] (cycles x min)**	**Test time [min] (cycles x min)**	**Bar weight loss [%]**
3:1	0 (3 x 0)	4.5 (3 x 1.5)	23.15
3:1	30 (3 x 10)	4.5 (3 x 1.5)	23.06
3:1	45 (3 x 15)	4.5 (3 x 1.5)	22.87

Table 3: Second test to choose the right resting time to be used in the recycling procedure

Testing methods

Fourier transform infrared spectroscopy (FT-IR) analysis, performed with a FT-IR Jasco 6300 spectrometer (JASCO Corporation, Tokyo, Japan), was used to characterized the chemical residue obtained after the recycling process. Infrared spectra were recorded in the wavelength range between 550 and 3,500 cm^{-1}, 50 scans, and 4 cm^{-1} of resolution, by using a ZnSe crystal window.

Differential scanning calorimetry (DSC) analysis was performed on a Mettler Toledo 822 (Mettler Toledo, Greifensee, Switzerland). Two scans were performed: a first heating from 0°C to 150/200°C (at 10°C/min) followed by a two-minute temperature hold and then by cooling at 10°C/min back to starting temperature. The second heating scan, again performed at 10°C/min, was used to measure the glass transition temperature of the various samples.

The flexural properties of each cured sample were measured using a dynamometer, Lloyd LR5K, according to ASTM D790 (ASTM D790-17, 2017) (three-points bending). Four replicates were performed on each sample.

Results:

Recycling process

First, the recycling process until complete degradation of the resin was evaluated. The microwave power was tailored in order to reduce energy consumption and the number of process cycles and to avoid too fast evaporation of the 35 wt% hydrogen peroxide. Some tests were conducted at 20% - 30% - 40% - 50% compared to the maximum power of the microwave (800 W). By reducing the power of the microwaves, the dissociation reaction of the hydrogen peroxide would start later (increasing the process times), therefore, in order to speed up the reaction, yeast, a food grade and natural catalyst was added to the mixture. The yeast allows shortening the reaction time, thus promoting the dissociation of the hydrogen peroxide which would otherwise only occur through thermal activation (when approximately 80°C is reached). The yeast (1.5 solution wt%) was therefore added to the recycling solution, mixing it gently before placing everything in the microwave oven.
The yest catalysed reaction between tartaric acid and H_2O_2 leads to the production of oxalic acid, oxygen and carbon dioxide as follows:

$$HO_2CCH(OH)CH(OH)CO_2H + H_2O_2 \rightarrow HO_2CCO_2H + O_2 + CO_2$$

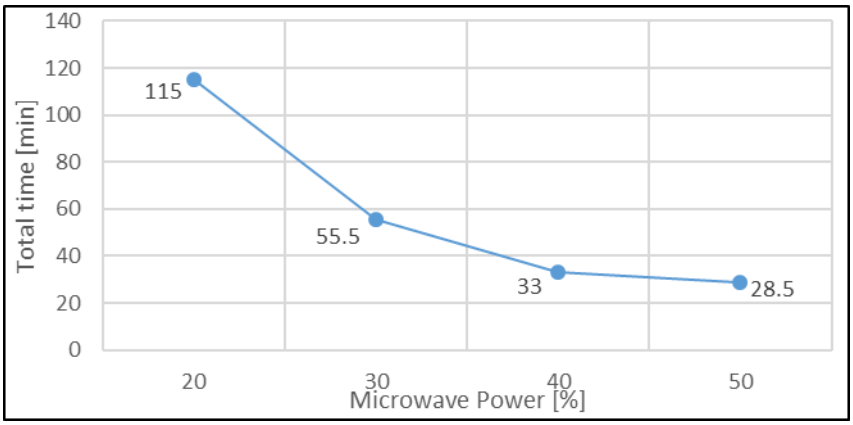
Tartaric Acid — Oxalic Acid

The reaction progress is evidenced by a rapid evolution of O_2 and CO_2 bubbles.

Total times of the recycling process relating to the various microwave powers are indicated in the following table and graph. At each cycle the solution was refilled due to its evaporation. It has been calculated that the addition of yeast (1.5 wt%) shortens the reaction times: at 40% microwave power, the total time saved is 3.5 min (20 seconds for each cycle).

Microwave Power [%]	Total process time [min]	Number of cycles

20	115	10
30	55.5	10
40	33	10
50	28.5	11



Tab 4 and Fig 2: Total process time and number of cycle (with yeast) as a function of microwave power

From the data reported in figure 2, 40% was chosen as the optimal power, because it allowed reducing the recycling process time and number of cycles necessary to obtain complete degradation of the resin.

To evaluate the importance of using microwaves, instead of conventional heating, in terms of saving energy and process time, tests were carried out at different temperatures (150°C - 100°C) using a vented oven (Carbolite – max power 3,000 W). The duration of each cycle at 150°C is 15 minutes, at 100°C 30 minutes. At 150°C almost complete degradation of the resin is achieved (weight loss = 95.7%) after 90 minutes, while at 100 °C, after the same process time, there is only a weight loss of 36.8%.



Fig 3: Unreacted resin fragments (4.3 wt%)

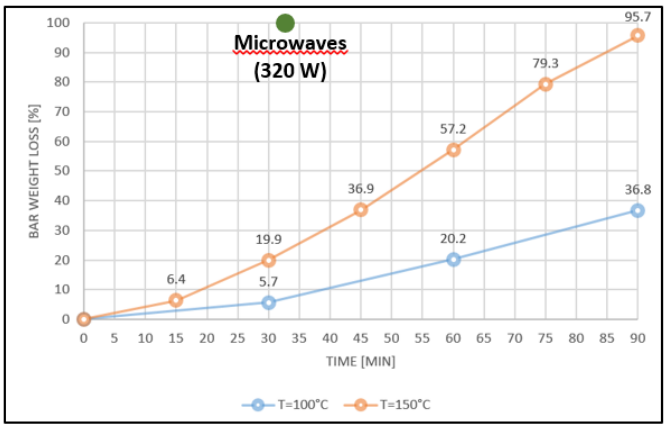


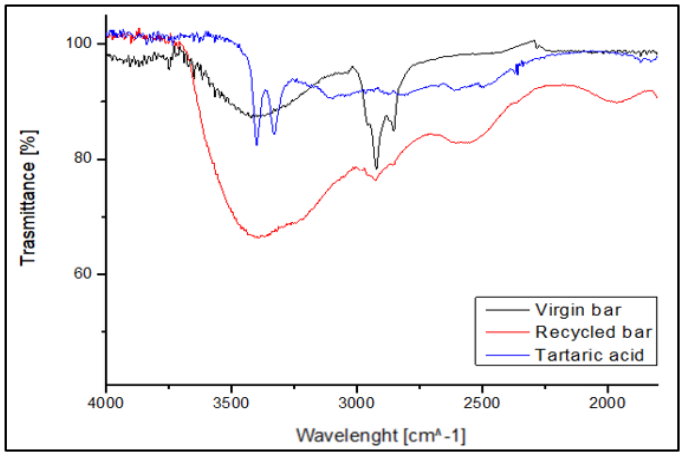
Fig 4: Graph relating to the weight loss trend of the resin bar during the test with conventional heating

From data reported in Fig 4 it is clear that the microwave allowed reducing both the recycling process times and energy consumption.

FTIR analysis

After completion of the recycling process, all the residue (degraded resin and precipitated tartaric acid) was collected, dried at 50°C for 24 hours and analysed by FT-IR. No waste products were eliminated. Figure 5 reported FTIR spectra of a virgin and a recycled bar. In order to evaluate the residue of the tartaric acid in the recycled bar, the FTIR spectrum of the acid was also reported.

(a)



(b)

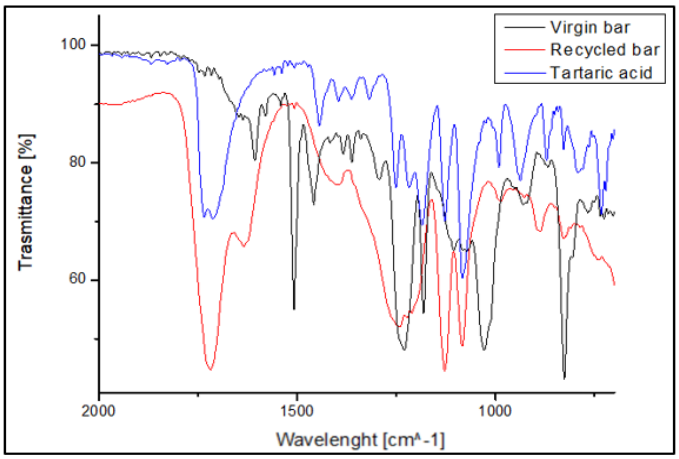


Fig 5: Comparison between FT-IR spectra in the wavenumber range of 4,000-2,000 (a) and 2,000-700(b) cm^{-1}

The crosslinking of virgin bar compound was confirmed by the identification of characteristic absorption peaks. As shown in Fig 5 a, The IR spectrum displays a strong broad band in the 3,600–3,200 cm^{-1} region assigned to O–H stretching vibrations. However, an increase in band intensity around 3,350 cm^{-1} can also indicate the presence of NH groups in the virgin bar.

The aliphatic –CH2 and –CH3 vibrations, seen between 3,000 and 2,850 cm^{-1}, are more evident in the virgin bar spectrum, compared to recycled bar. On the other hand, the disappearance of the 2,190 cm^{-1} band, attributed to the reaction of the C-H group of the curing agent, can be noticed in the virgin bar, whereas a broad band is still present in the recycled sample.

The –C=C– vibrations can be seen around 1,605 cm^{-1} region in both bars, thus indicating a residual reactivity for the systems. The disappearance of the bands at 1,280 cm^{-1} indicates instead the opening of epoxy rings in the virgin bar. The appearance of the band at 1,109 cm^{-1} is characteristic for C–N stretching vibrations. Also, N–O stretching absorption at around 1,500 cm^{-1} was detected in virgin bar. The absence of the absorption of epoxy ring and presence of OH group and C–N group confirms the conversion of epoxy group into the corresponding polymer, as well as crosslinking process.

Thermal and mechanical characterization

DSC analysis was performed on the residue in order to evaluate the thermal properties of the material. Results, shown in Fig 6, indicate a very low Tg value at about 32.6°C. The low Tg value suggests that the residue can be only used if mixed with virgin resin. Therefore, as reported in Table 1, virgin resin was mixed with the recycled residue, then the curing agent (IPDA) was added for the production of recycled bars.

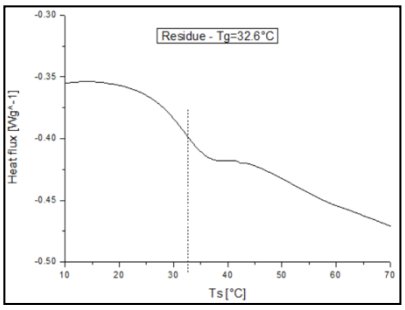


Fig 6: DSC analyses of the residue

DSC analysis was then carried out on the bars obtained after mixing the virgin resin with different percentage of recycled residue (Fig. 8). As expected, this analysis highlights a decrease in the glass transition temperature as the residue content from the recycling process increases. On the other hand, the glass transition temperature found for the composition with 40% of recycled residue (T4) is still high (about 82°C), thus highlighting good thermal properties, which makes the material suitable for further applications.

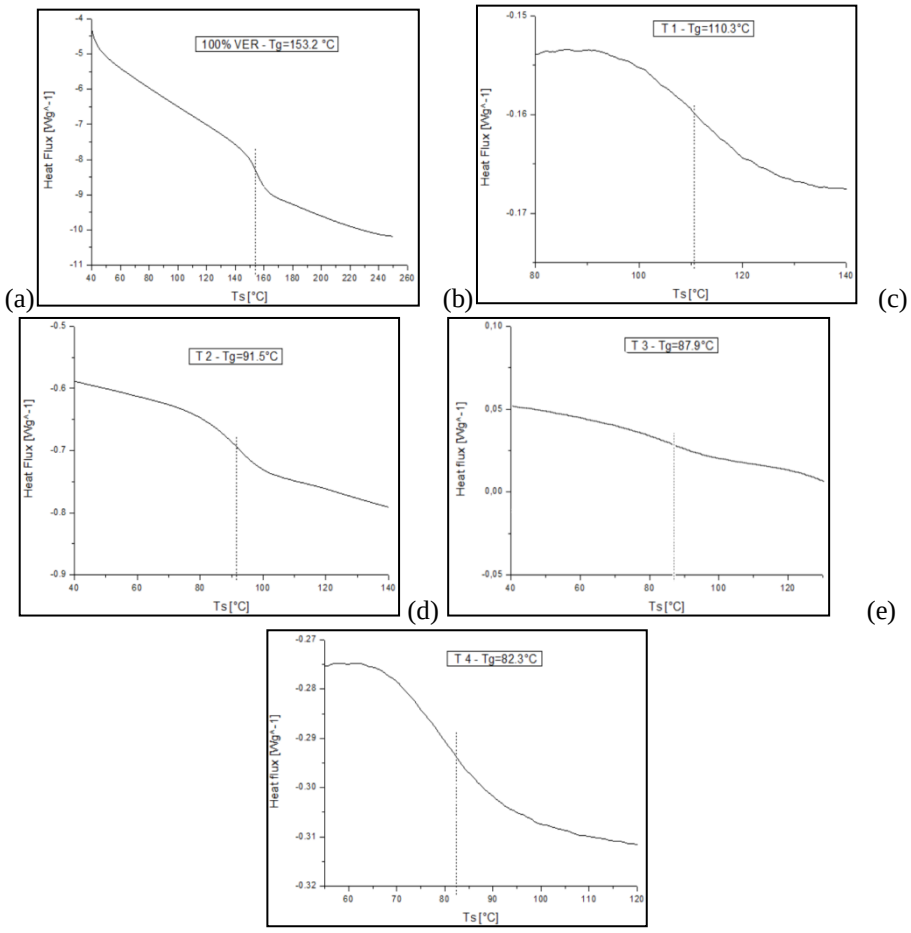


Fig 8: Differential Scanning Calorimetry analysis of 100% VER (a) – T 1 (b) – T 2 (c) – T 3 (d) – T 4 (e)

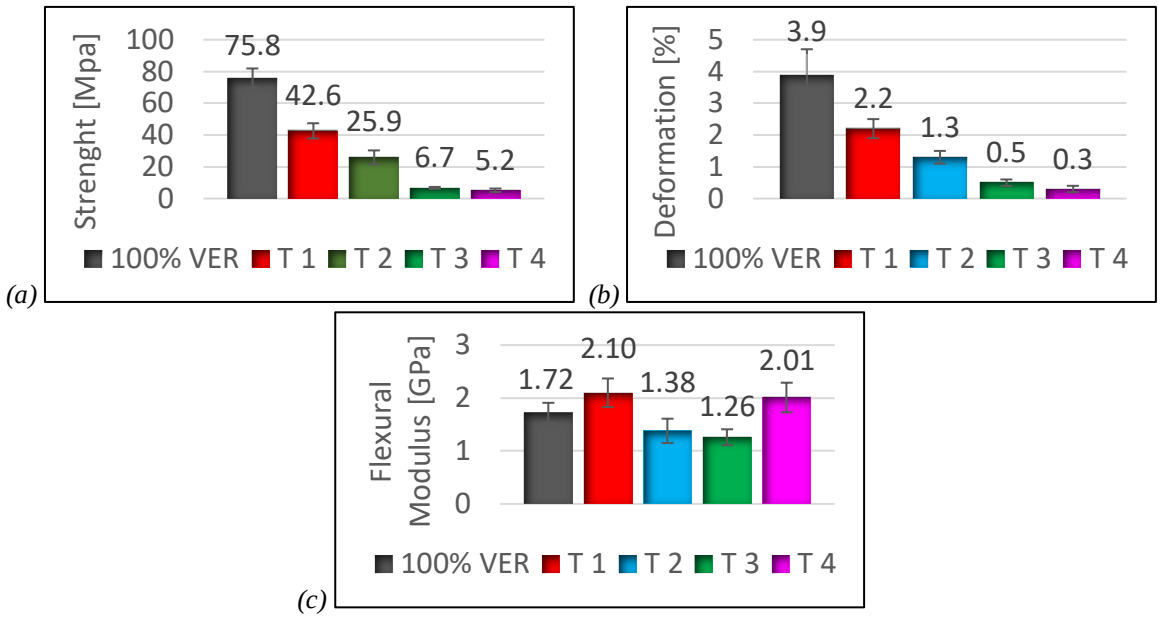
In order to evaluate and confirm the glass transition temperatures found, the variation in specific heat (ΔCp) corresponding to them was calculated; as reported in Tab. 5, the ΔCp values, being of the same order of magnitude, confirm the reliability of the Tg values.

SAMPLES	Tg [°C]	ΔCp [J/(g*°C]
100% VER	153.2	0.397
T 1	110.3	0.179
T 2	91.5	0.495
T 3	87.9	0.130
T 4	82.3	0.276

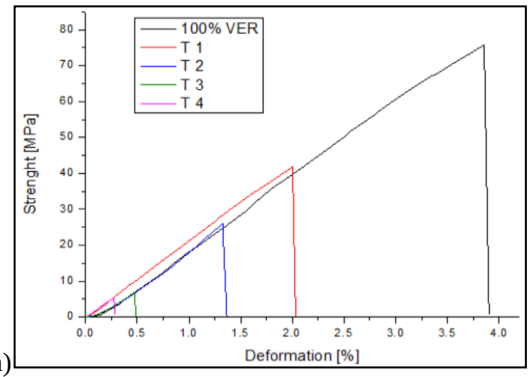
Tab 5: Tg and ΔCp values found with DSC analysis

To complete the characterization and to evaluate the mechanical properties of the materials produced, the various samples were tested with a three-point bending test. Table 6 shows the average values of flexural strength, strain at break and modulus. Despite a very low change in the Young modulus for every composition, a significant reduction in bending strength was detected with increasing recycling residue content. This is probably due to the presence of defects inside the bar caused by the recycled residue, and also to the loss of the adhesion caused by the recycled particles into the virgin matrix. Therefore, although good thermal properties were found even with high residue contents (T4), only small amount of recycled filler (T1) can be used in order to avoid strong decays in mechanical behavior.

SAMPLES	□r [MPa]	ϵr [%]	E [GPa]
100% VER	75.8 ± 6.1	3.9 ± 0.8	1.72 ± 0.19
T 1	42.6 ± 4.8	2.2 ± 0.3	2.10 ± 0.27
T 2	25.9 ± 4.4	1.3 ± 0,2	1.38 ± 0.23
T 3	6.7 ± 0.6	0.5 ± 0,1	1.26 ± 0.15
T 4	5.2 ± 1.1	0.3 ± 0,1	2.01 ± 0.28



Tab 6 and Fig 9: Results of the three-point bending test (a-Strenght, b-Deformation, c-Flexural Modulus)

(a) 

(b) 

Fig 10: (a) Average strength-deformation diagram of the various samples analysed – (b) Bars after flexural test (to the left: 100% VER, T 1, T 2, T 3, T 4)

Conclusions:

This work was aimed to the development of an innovative method for the recovery of GF and CF epoxy matrix. To this purpose, different approaches were investigated, in order to optimize the yield of the recycling process and to minimize the recycling time and the energy consumption. The best recycling conditions were obtained with the use of a solution of hydrogen peroxide (H_2O_2), as a green oxidiser, and tartaric acid (TA), catalysed by yeast and activated by microwave radiation.

The residue of the recycling process, once collected and desiccated, was characterized by FTIR analysis, which revealed the presence of -OH, =C-H and C=C reactive groups.

Several mixtures of virgin and recycled matrix were then produced and the thermal and mechanical behavior was studied after the addition of amine curing agent and the curing cycle. DSC analysis, carried out on the bars produced with different amount of recycled resin, showed good thermal properties, even with high quantities of recycled residue. On the other hand, significant reduction in bending strength was detected with increasing recycling residue content.

Next works will be focused on the optimization of the mechanical properties after the residue addition to the virgin resin. Also, since different reactive groups were detected by FTIR analysis on the recycled resin, the chemical reaction of the residue after the addition of a curing agent, for the production of recycled epoxy bar, will be studied.

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NDR (Norddeutscher Rundfunk) in Germany: Public Broadcasting as The Fourth Pillar of Democracy

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Abstract

Within democracies state authority is divided into several powers: The system of checks and balances requires legislative, executive and judicial powers, three pillars intended to control each other and limit state power. In this intricate balance of democratic societies, the role of independent media is pivotal acting as a fourth factor by offering information to the public. This paper delves into the significance of a prominent public broadcasting institution in Germany, Norddeutscher Rundfunk (NDR), as an example of the crucial role played by public broadcasters worldwide in fostering democratic values, informed citizenry, and social cohesion.

NDR, founded in 1954, has evolved into a stalwart institution embodying the principles of impartiality, objectivity, and public service. The broadcaster serves as a bastion against misinformation and propaganda, epitomizing the democratic ideal of providing citizens with access to diverse and credible information. By offering a platform for the expression of a myriad of voices, NDR contributes to the vibrant marketplace of ideas that is indispensable for a healthy democratic discourse.

Central to NDR's mission is its commitment to public service, transcending commercial interests to cater to the diverse needs and interests of its audience. This unique characteristic sets public broadcasting apart, emphasizing the pursuit of the common good over profit motives. NDR's programming reflects this commitment, encompassing a wide array of genres in radio, TV and online content, from news and documentaries to cultural programs, fostering an inclusive and informed public sphere.

Furthermore, NDR's role as a regional broadcaster underscores the importance of local perspectives in the democratic narrative. It acts as a conduit for regional voices, addressing issues specific to its audience and reinforcing the connection between citizens and their local communities. This localized approach ensures that the democratic discourse remains grounded in the realities and concerns of the people it serves.

The paper also explores the challenges faced by NDR and other public broadcasters in the contemporary media landscape. The rise of digital platforms, the proliferation of misinformation, and the changing media consumption habits pose formidable obstacles. However, NDR's adaptation to these challenges through innovative programming, technological integration, and a commitment to journalistic integrity exemplifies its resilience in the face of a rapidly evolving media landscape.

Thus, the paper will illuminate the pivotal role of NDR as a beacon of democratic values, demonstrating the indispensable nature of public broadcasting in upholding the principles of democracy. As societies navigate the complexities of the digital age, the enduring commitment of public broadcasting institutions like NDR to truth, diversity, and public service stands as a fourth pillar to informed and sustainable development of modern democratic societies.

Keywords: public broadcasting, sustainable societes
Main Conference Topic: Sustainability

Introduction

Norddeutscher Rundfunk (NDR) is one of Germany's public broadcasting institutions, playing a crucial role in providing information, entertainment, and cultural content to a wide audience. As a major one of the nine ARD members (**A**rbeitsgemeinschaft der öffentlich-rechtlichen **R**undfunkanstalten der Bundesrepublik **D**eutschland), NDR operates in the northern regions of Germany, serving the states of Lower Saxony, Mecklenburg-Vorpommern, Schleswig-Holstein, and Hamburg. Established in 1954, NDR has evolved into a multifaceted media organization with a strong presence in radio, television, and online platforms [1].

History

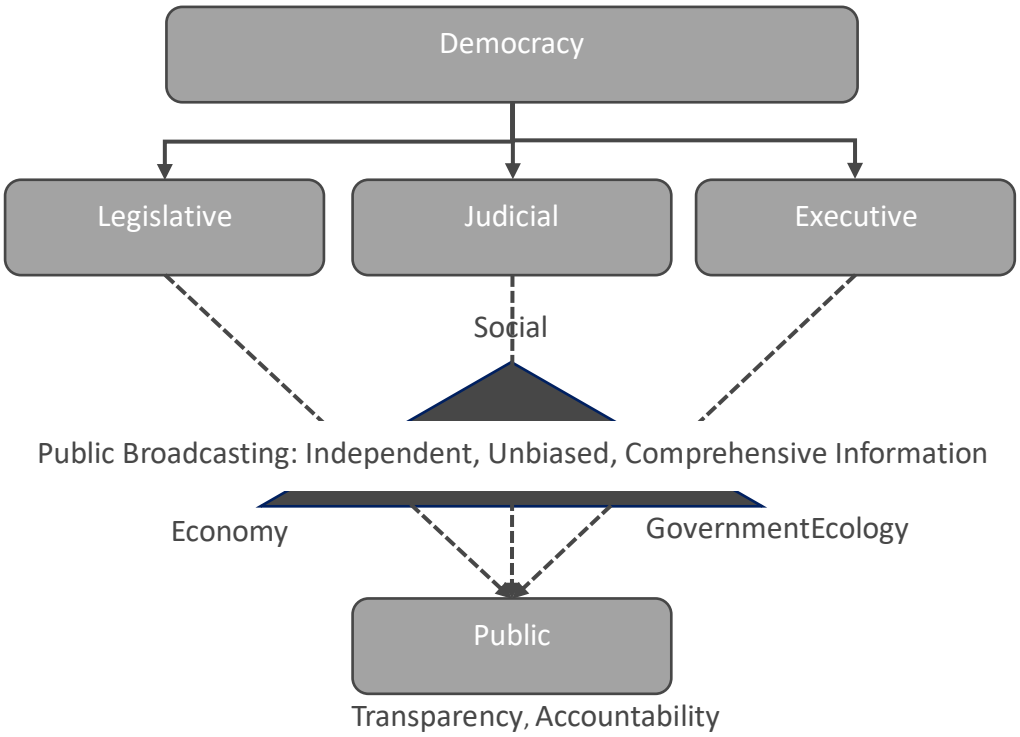


Figure 1 Media Broadcast independent of political pressure and commercial interests

The origins of NDR can be traced back to the post-World War II era when Germany underwent significant political and social changes. In the aftermath of the war, the need for independent, unbiased and comprehensive information to the public became apparent, leading to the establishment of public broadcasting institutions. NDR emerged as a response to this need, representing the interests of the northern German states and contributing to the democratic rebuilding process. Actively involved in the foundation was the British journalist and later Director-General of the BBC Sir Hugh Greene. He organized the newly established Northwest German Broadcasting (NWDR) on behalf of the British occupying power after the end of world war II (1945) as the allies wanted to help create a liberal, democratic and informed society in Germany. Greene joined as an organizer in October 1946 and had the plan to turn the NWDR into an institution under public law that would be independent of commercial interests and political pressure from the government, financed by mandatory

monthly broadcasting contributions from the public (Figure 1). The foundation was to be characterized by **independence, impartiality and tolerance** in the tradition of the BBC. The aim was to create a medium independent of governmental influence, providing political, cultural and liberal democratic education with tolerance and the ability to compromise.

ARD and ZDF

The term mentioned above, ARD, nowadays refers to one of the two major public-service broadcasting organizations in Germany, ZDF (Zweites Deutsches Fernsehen) being the other one, as competition in broadcasting institutions was thought of as one of the keys to true, diverse and high quality public service standards.

ARD today is **a joint organization of Germany's regional public broadcasters**, one of them NDR. ARD itself was founded in 1950 as a consortium of various public broadcasters, each representing a different region in West Germany. These Regions were run by the allied forces (Britain, France, USA) after World War II, each later to evolve into several different states to cater for the focus on regionality.

The ARD structure is meant to ensure a decentralized, regional approach to public broadcasting, with each member organization catering to the specific needs and preferences of its respective region. However, the member broadcasters collaborate to produce and share programming, including news, cultural content, and entertainment. ARD operates multiple television and radio channels as well as online content.

For this purpose, the members also operate joint facilities, one of which is ARD Aktuell. The NDR is responsible for the headquarters where national and international news offerings such as the “Tagesschau” or portals such as tagesschau.de are produced for the entire ARD.

ZDF is the second national public-service television broadcaster in Germany, in contrast to ARD operating as a single entity. Established in 1961 the headquarters are based in Mainz. ZDF operates as an independent channel as well, providing a wide range of programming, including news, documentaries, entertainment, and cultural content. Both ARD and ZDF are funded through a mandatory public broadcasting fee paid by residents in Germany.

NDR operates within the framework of the ARD as a major one of the nine ARD member institutions. NDR's headquarters are located in Hamburg, reflecting its commitment to serving overall 14.7 Mio. citizens within the four northern states of Germany (Lower Saxony (8.1 Mill.), Hamburg (2 Mill.), Mecklenburg-Vorpommern (1.6 Mill.) and Schleswig-Holstein (3 Mill. residents) with overall 14.7 Mio. citizens. Thus NDR is serving a significant proportion (17,4%) of the 84.4 Million German citizens (2023).

Legal Foundations

The Rundfunkstaatsvertrag (**Broadcasting State Treaty**) was the first an agreement among the German states (Länder) regulating the legal framework for broadcasting in Germany. It is a crucial instrument for coordinating and standardizing media regulations across different regions. The treaty is regularly revised to keep pace with technological advancements and shifts in media consumption patterns. It serves as a means of harmonizing media regulation across the German states while addressing the challenges and opportunities presented by evolving technologies and societal changes. Thus, the history of the treaty is marked by various versions and amendments as the media landscape and technologies have evolved.

In the post-World War II era (1945-1950), the German states recognized the need for a legal framework to regulate the emerging broadcasting sector. The first broadcasting treaty, Rundfunkstaatsvertrag, was introduced in the 1950s, reflecting the establishment of public-service broadcasters in West Germany.

Over the years (1950-1960), the treaty underwent several amendments to adapt to changes in technology and media consumption. The introduction of color television, the expansion of radio services, and other developments were reflected in the regulatory framework.

After the reunification of Germany in 1990, the regulatory framework needed to be adapted to include the new states from the former East Germany. The treaty became more complex as it aimed to standardize regulations across the entire country.

With the rise of the internet, online content and digital media around the millennium change (2000-2010), the treaty was adapted to address online content, streaming services, and other digital platforms. The most recent versions of the treaty (2019) have continued to address challenges posed by the digital age, including issues related to online platforms, streaming services, and the role of public-service broadcasters in a changing media environment. Thus, the Broadcasting State Treaty with its focus on TV and radio broadcasting has recently been **replaced by the State Treaty on the Modernization of Media Regulation in Germany** [2]. The MStV regulates the obligations and rights of broadcasting and telemedia providers in Germany and has been in force since November 2020, after it was adopted by the 16 German state parliaments. The new treaty focuses on the entire digital media world and regulates digital media providers in addition to radio and television, including media intermediaries, smart TVs, voice assistants, video streamers and blogs. It was followed by the second Interstate Media Amendment in 2022. The MStV focuses on adapting the rules to digitalization. While relaxing the requirements for licensing broadcasting programs, generally applicable rules for telemedia are laid out including net gatekeeping organizations (Google, Facebook, X, etc.), which make content from third parties accessible on a large scale and are referred to as "media intermediaries" in the MStV. Also, media platforms (television cable networks or digital TV services) and user interfaces are a group of players regulated by the Interstate Media Treaty. In addition, the treaty contains some amendments, e.g. on radio and television advertising, sponsorship, teleshopping and product placement in all audiovisual telemedia. One main focus was the introduction of transparency regulations and prohibitions on discrimination intended to ensure diversity of opinion and create transparency. For example, media intermediaries must comply with the central criteria for the collection, selection and presentation of content [2, § 93 – Transparency].

The financing of public service broadcasting in the Federal Republic of Germany is based on two pillars: the broadcasting contribution and advertising revenue ("dual financing"). The Federal Constitutional Court (Bundesverfassungsgericht, BVerfG) developed the principles of state financing of public service broadcasting 1994: Here, the Federal Constitutional Court derived the state's mandate to guarantee its citizens a "basic media service" from Article 5 (1) sentence 2 of the Basic Law. The BVerfG has developed a guarantee of existence, development and financing from the mandate of public broadcasting. The state is obliged to finance the public broadcasters in accordance with their function. On the other hand, public service broadcasting is characterized by the prohibition of censorship (Art. 5 para. 1 sentence 3 GG) and the constitutional requirement of state freedom, meaning that broadcasting must be financed in a way other than taxation, called public broadcasting contribution. This should ensure, that the state's ability to exert influence, particularly on programming is excluded. The principles laid down by the Federal Constitutional Court in its

"Fees Ruling" were implemented by the **State Broadcasting Financing Treaty** (Rundfunkfinanzierungsstaatsvertrag, RFinStV). At the center of this regulation is the Commission for the Review and Determination of the Financial Requirements of Broadcasters (KEF). The **First Interstate Media Amendment Treaty** is an update to that treaty, in which the broadcasting levy is increased from 17.50 € to EUR 18.36 € per month. These treaty updates - 2023 the **Third Interstate Media Amendment Treaty** came into effect - require the approval of all 16 state parliaments in order to become law. If a state does not approve or abstains from voting, the treaty and the increase in the broadcasting fee stipulated therein do not enter into force even if recommended by the KEF. However, if the broadcasters are affected by a blockade to increase the broadcasting contribution, they have the option of appealing to the Federal Constitutional Court. An example was the situation in 2005, when Bavaria, Saxony and North Rhine-Westphalia rejected the increase in the broadcasting contribution recommended by the KEF. At the time, the Federal Constitutional Court ruled in favor of the broadcasters, based on the need to ensure public access to independent information and the appropriateness of the burden on citizens. Despite existing criticism of broadcasting fees, a large majority (85%) of respondents believe that there should be a public service broadcaster for the public. Only 11% of respondents did not think so. This is the result of an NDR survey published in February 2023 (12.718 participants).

Supervisory Institutions

In order to find acceptance within the public, it must be ensured that the requirement of economic efficiency and economy as set down in the State Treaty on the Modernization of Media Regulation in Germany [2] is complied with. This demands **transparency** and **accountability** to the public in both respects, the supervision of content production in compliance with the above mentioned treaty as well as the underlying financial budget. Consequently, **public honorary bodies** serve in this function (Figure 2). The members of these supervisory bodies are appointed delegates, sent by socially relevant groups named in the State Treaty on the Modernization of Media Regulation in Germany (Churches, Sports, Welfare, Culture associations). They are allowed to serve two terms of 4-5 years in those bodies as representatives of the public. Emphasis is placed on the independence of these delegates from the state, restricting the number of delegates associated with governmental office and political parties to a minority.

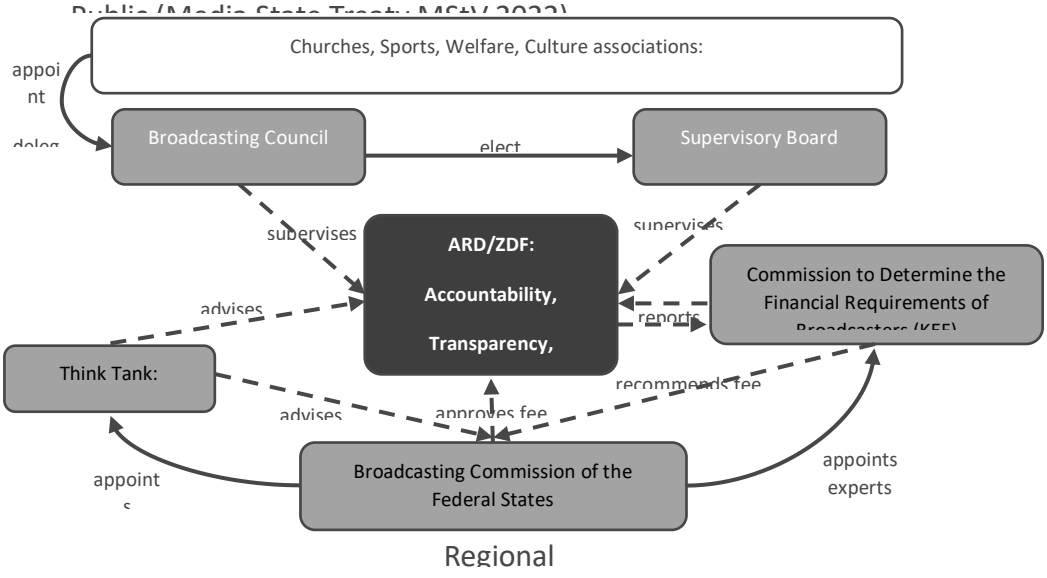


Figure 2 Public Media Control by Public Honorary Bodies

The **Commission to Determine the Financial Requirements of Broadcasters (Kommission zur Ermittlung des Finanzbedarfs, KEF)** reviews the financial requirements of public broadcasting in Germany. They set the amount of the household contribution every four years after this review, a recommendation which will in turn need to be set into effect by each of the state parliaments. The mandatory fee is then collected by the contribution service of ARD, ZDF and Deutschlandradio. The legal basis is the Interstate Broadcasting Financing Treaty (RFinStV), which regulates both the amount of the contribution and the distribution of funds. The KEF, located in Mainz, has 16 expert members who are as an exception to the above mentioned proceeding of appointing members to supervisory bodies appointed by the Minister Presidents of the federal states for a period of 5 years. The KEF procedure consists of three stages:

- Notification of requirements by the public broadcasters to the KEF,
- Review by the KEF,
- Determination of the contribution by the state parliaments.

According to Section 3 (1) RFinStV, the review relates to whether the programming decisions are in line with the legally defined broadcasting mandate and whether the financial actions are in accordance with the principles of economic efficiency and economy, with added consideration of overall economic development and the development of public sector budgets as further criteria, however, the KEF does not monitor or correct any programming decisions [3].

The public supervisory body responsible for program control at German public broadcasters are the **Broadcasting Councils**. These bodies monitor compliance with the statutory broadcasting mandate, they also supervise open access for various socially relevant groups in line with the diversity protection concept.

For the ARD Members each institution has its own state level broadcasting council, in case of NDR this includes the four NDR member states. However, the Broadcasting Council does not determine program planning, the body merely advises the NDR director-general with regard to program design. Important tasks of the Broadcasting Council include electing and advising the Director General, monitoring compliance with the legally standardized programming principles, electing members of the Board of Directors and approving the budget and the annual report. The legal provisions for the broadcasting councils are determined by the federal states.

The Broadcasting Council to each of the German public broadcasters is made up of members of various associations deemed to represent the democratic society in general, that are listed in the respective Interstate Broadcasting Treaty (RStV). These are, for example, trade unions, women's associations, churches and political groups. These in turn delegate their representatives independently. Thus, the Broadcasting Council is intended to represent a cross-section of the population.

Depending on the broadcaster, the members of the Broadcasting Council are appointed for four to five years by the associations named in the RStV. In 2014, the Federal Constitutional Court issued a ruling on the independence of public broadcasting from the state. The "proportion of state and state-affiliated members" was expressly limited to a maximum of one third of the statutory members of the respective body in order to ensure independence from the state.

There has been some discussion about a household mandatory contribution to the public broadcasting institutions and their role in the future. Discussions arose from the gradual digital transformation of societies, featuring public user created content within social media,

and increasing demands from private publishers, who create pay-restricted news content.

The **Broadcasting Commission of the Federal States**, which is responsible for public broadcasting in Germany on behalf of all the federal states, thus recently installed a **Future Council** (Zukunftsrat) with eight personal members. The think tanks task is to advise the commission on the role of public broadcasting in the future by looking into developments of the next decade. The focus will be on digital transformation, quality journalism, good governance as well as structural optimization and cooperation in public service broadcasting. Broadcasting and media experts criticized its appointment, in particular the party-political wrangling over the composition of the new committee.

NDR Organizational Structure

NDR's organizational structure includes various departments responsible for radio, television, and online content production in a cross-media approach aimed at involving the public via social media activities in an interactive fashion. The organization employs a diverse team of round about 3000 salaried employees including journalists, producers, technicians, and other professionals to ensure the delivery of high-quality programming across different media platforms. The organization operates on an annual budget of roughly 1 billion €, mostly originating from the above mentioned mandatory household broadcasting fee.

NDR Headquarters are based in two major locations in the city of Hamburg (Rothenbaumchaussee and Loksted). State broadcasting centers are located within each of the state capitals of the four member states (Hanover, Kiel, Schwerin, and Hamburg) for radio and television, which mainly produce **regional programs** for the respective state.

In addition, NDR maintains a number of regional studios and correspondent offices in several cities in its broadcasting area Braunschweig, Göttingen, Lüneburg, Oldenburg, Osnabrück, Flensburg, Heide, Lübeck and Norderstedt, Greifswald, Neubrandenburg and Rostock (Figure 3). Thus, NDR is serving 4 northern German member states (Hamburg, Lower Saxony, Schleswig Holstein , Mecklenburg Western Pomerania) representing 18,4% of the 84.4 Mill citizens in Germany and a total state area of 87,306 km².

The strong focus on regionality with regional studios offers roughly one service unit (regional studio) per 600 inhabitants or per 3,500 km² in addition to the ARD international news rooms, of which some are NDR operated.

NDR thus contributes to **worldwide news** content by operating 6 of the ARD foreign studios (London, Stockholm, Beijing, Tokyo and Singapore). The management of the ARD studio in Washington, D.C. alternates regularly between NDR and the sister organization WDR. The broadcaster is also involved in the ARD studios in Moscow, Warsaw, New-Delhi, Brussels, New York City and Los Angeles as well as the capital city studio in Berlin. NDR produces the ARD-aktuell news content and is responsible for the news programs Tagesschau, Tagesthemen, Nachtmagazin, tagesschau24 and the online portal tagesschau.de as joint content of all the ARD stations.

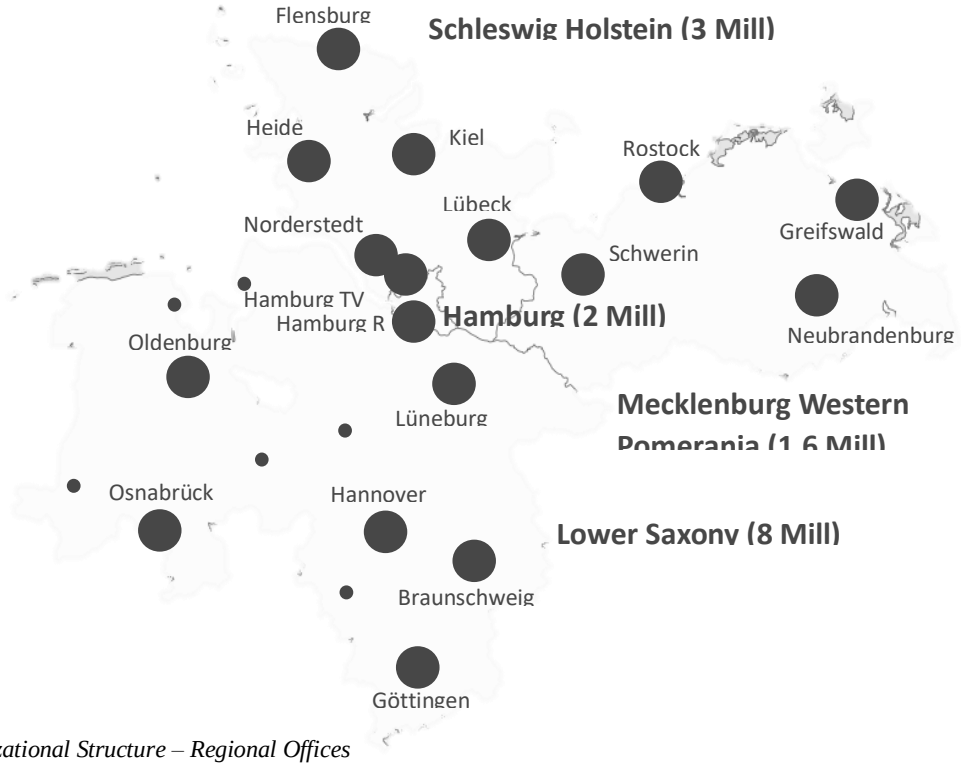


Figure 3 NDR Organizational Structure – Regional Offices

NDR is renowned for its **diverse** and extensive programming, catering to a wide range of interests and demographics. The organization produces content in various genres, including news, documentaries, entertainment, culture, and education. NDR's television channels, such as NDR Fernsehen, offer a mix of regional and national content, reflecting the cultural richness and diversity of the northern states. In addition to television, NDR has a significant presence in the radio landscape. NDR operates several radio stations, each catering to specific genres and target audiences. NDR 1 Radio MV, the regional station for the state Mecklenburg-Vorpommern for instance, focuses on popular music and regional news, while NDR 2 features contemporary hits and in-depth cultural coverage. NDR Kultur emphasizes classical music, literature, and the arts, contributing to the cultural enrichment of its audience.

Beyond news and entertainment, NDR is actively involved in cultural and **educational** initiatives. NDR operates its own orchestras, the NDR Elbphilharmonie Orchestra based in Hamburg, the NDR Radiophilharmonie in Hannover as well as the NDR Choir and NDR Bigband

The organization supports local artists, musicians, and **cultural events**, fostering a sense of regional identity and pride. NDR's commitment to education is evident through programs that aim to inform, inspire, and engage audiences on various topics, ranging from science and history to social issues. NDR's cultural and educational initiatives especially extend to collaborations with schools, universities, and cultural institutions. Through partnerships and sponsorships, the organization contributes to the development of educational content and events that align with its mission of promoting knowledge and understanding.

As media consumption habits evolve, NDR has embraced **digital platforms** to reach audiences beyond traditional broadcasting in a cross-media approach. The organization maintains a robust online presence featuring an own app family, offering streaming services, podcasts, and interactive content. NDR's website and mobile applications provide users with access to a vast array of content, allowing them to engage with their favorite programs at their

convenience. Here, innovation is a key aspect of NDR's strategy to stay relevant in a rapidly changing media landscape. The organization invests in technological advancements, exploring new formats, and experimenting with immersive storytelling techniques. This commitment to innovation ensures that NDR remains a dynamic and forward-thinking player in the media industry.

Public Perception

As independent, reliable information is one of the key features of public broadcasting the Tagesschau is one of the most important a news programs in Germany. Tagesschau is part of ARD-Aktuell, which is under lead management of NDR, with an average of more than ten million viewers daily at 8 p.m.

The editorial office is located in the NDR premises (Hamburg). The reports for the news broadcast are supplied by the individual ARD regional broadcasting stations, the capital city office in Berlin and the foreign studios. ARD-aktuell produces up to 20 broadcasts per day (Tagesschau, Tagesthemen and Nachtmagazin).

A recent Statista Survey (2023) [6] taken from an NDR Trend survey [1, see below], showed high overall approval rates to public broadcasting services (85%) despite an ongoing criticism of mandatory household broadcasting fees.

The NDR Image Trend [1] is a survey study that is conducted annually on behalf of NDR. In 2022, 4207 respondents representing the German-speaking resident population aged 14 and over in the NDR area were contacted (federal states of Lower Saxony, Schleswig-Holstein, Hamburg and Mecklenburg-Vorpommern).

The survey gave high approval rates showcasing the lead role for NDR services embedded within the regional daily life of northern German citizens. 83-81% of North German respondents attest that NDR is "credible, likeable and typically North German" (Figure 4). 70% of respondents confirm that NDR is “worth the money”. When it comes to statements on the social perception of NDR, the statement "NDR is important for the general public" achieved the highest approval ratings with 78%. This is followed by "NDR shows my region as it really is" and "NDR offers content that I like", both with 74% approval (Figure 5).

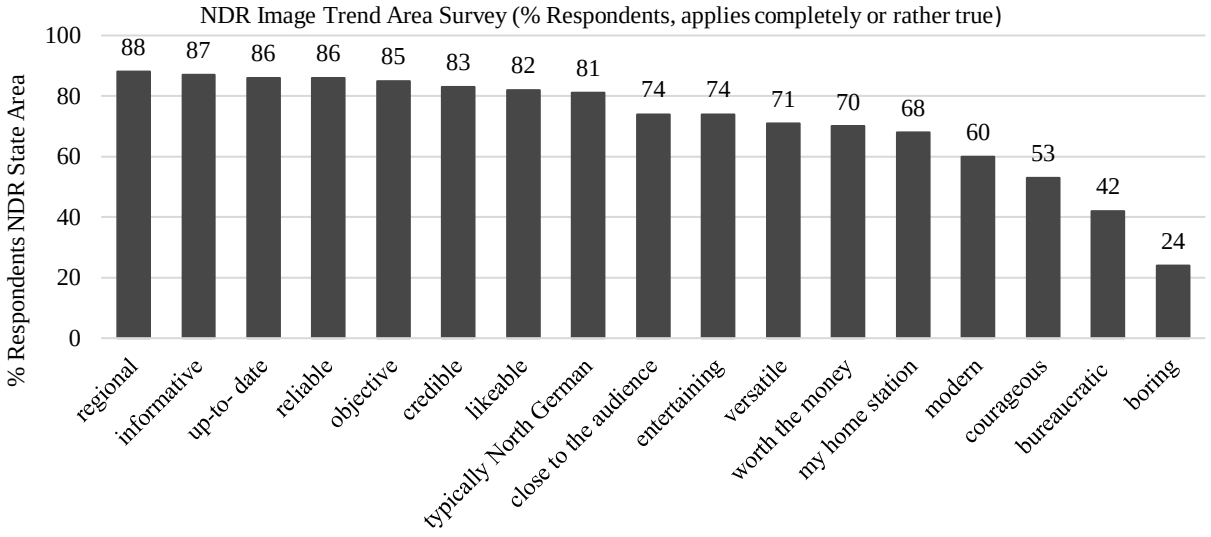


Figure. 4 NDR Image Trend Survey 2022 (% Respondents, n = 4207, applies completely or rather true)

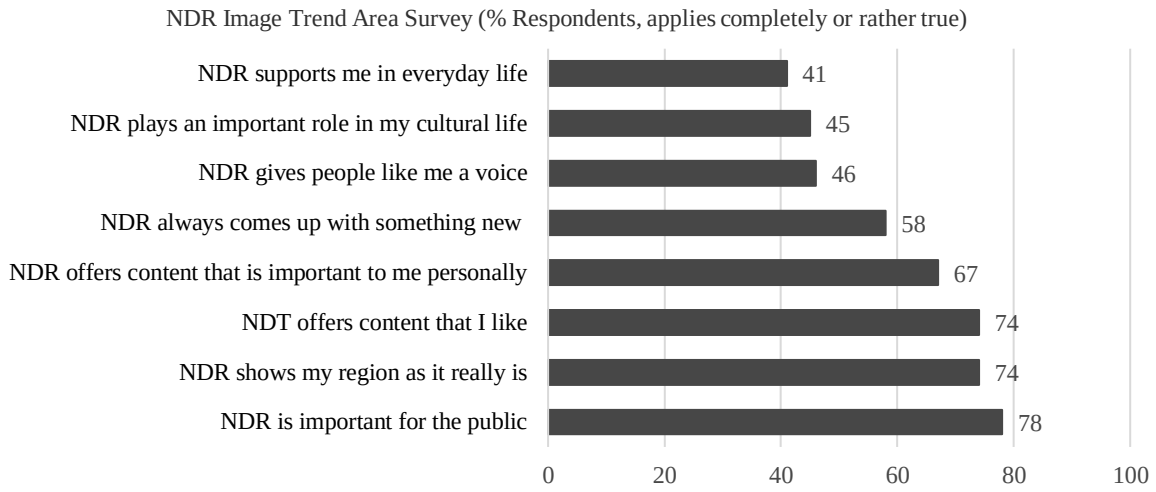


Figure 5 NDR Image Trend Survey 2022 Questionnaire (% Respondents, n = 4207, applies completely or rather true)

When it comes to trust in public institutions, NDR has a high standing within the public. A comparison between NDR, other media and public institutions like the police, local authorities, political parties, but also Google or Facebook, NDR scored high trust values (82%, Source: [1] - NDR Trend 2019, NDR State Area, n=2.700 over 14 years of age; Figure 6) comparable only to the polices trust value score (82%). Social media platforms scored clearly lower (Facebook 12%, Google 49%, as well as Boulevard media (Bild 12%), Political parties (21%) or Churches (39%).

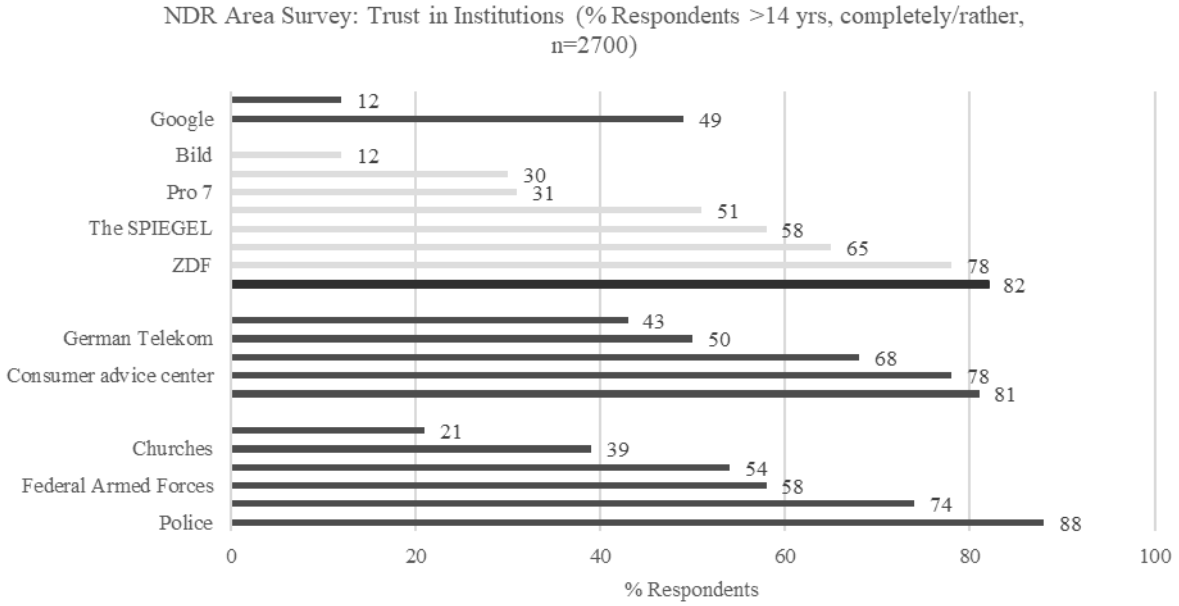


Figure 6 NDR Media and Institution Trust Survey 2019 (% Respondents, n=2700, applies completely or rather true), light grey: Newspaper and Mediascape, dark grey: other public players.

In March 2023, the Konrad Adenauer Foundation from Berlin representatively examined the connection between trust in public media and satisfaction with democracy [4]. 64% of the participants expressed concern about the spread of disinformation via media or internet as fake news (Figure 7), this concern ranked third in a list preceded only by concerns over climate change and tensions between Russia and Europe.

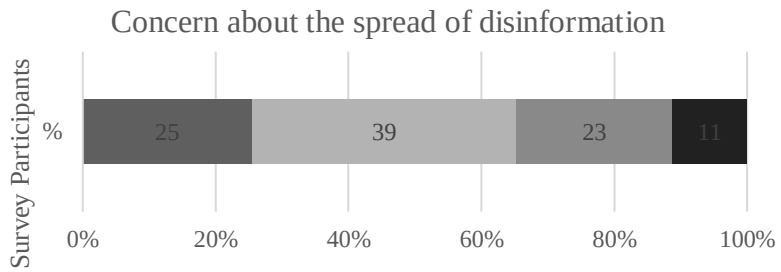


Figure 7 Public concern about spread of disinformation (KAS 2023, n=4.247)

Overall , a majority of participants thought political news within public service media credible, interestingly especially in the pandemic years 2019/20 as compared to the post pandemic situation 2022/23 (Figure 8).

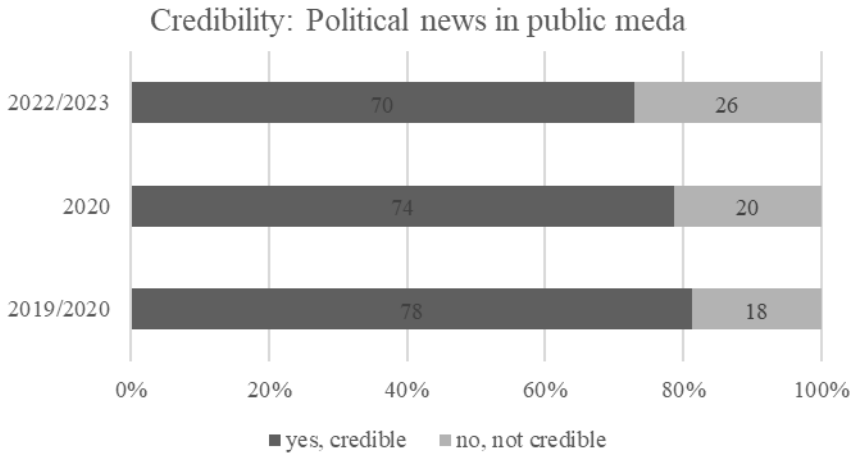


Figure 8 Assessment of the credibility of political news in the public service media 2019/20 to 2022/23 (KAS 2023, n=4.247)

This perception is apparently dependent on the level of satisfaction with the form of government participants find themselves in (Figure 9). 93% of those who supported democracy said they found the public media news to be credible. Conversely, 76% of those who are very dissatisfied with democracy consider those public news to be unbelievable [4].

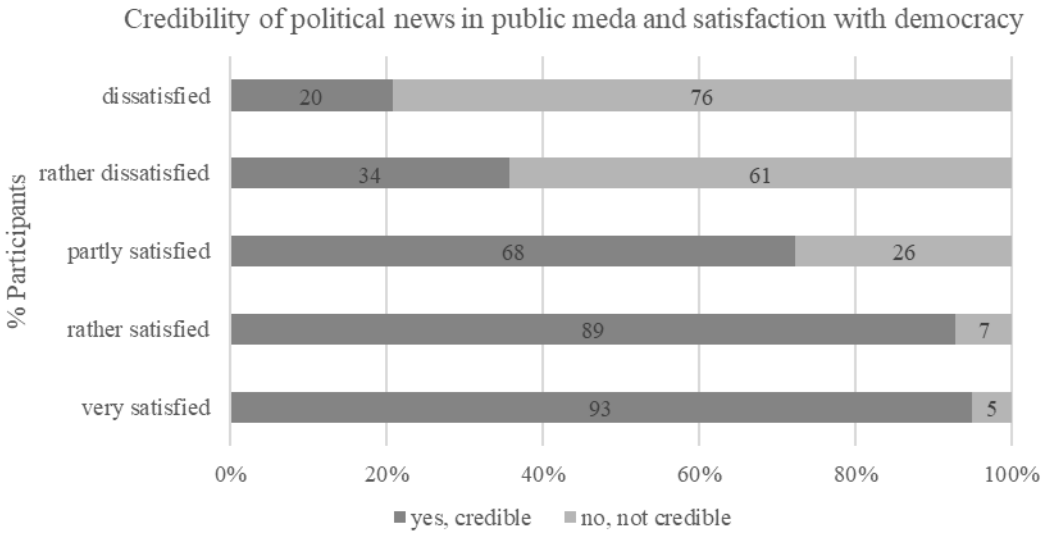


Figure 9 Assessment of the credibility of political news in the public service media according to satisfaction with democracy (KAS 2023, n=4.247)

Another study [5, ARD acceptance study 2023, concept and analysis SWR, n=1.500] done on behalf of the ARD network pictures increasing interest in current political information – with the Tagesschau News in NDR lead responsibility - with increasing age (Figure 10). Overall this study reveals perhaps not surprisingly an increasing digital affinity of the younger generation (Figure 11), when looking at the ARD daily reach overall reach (including political information among all other network offers).

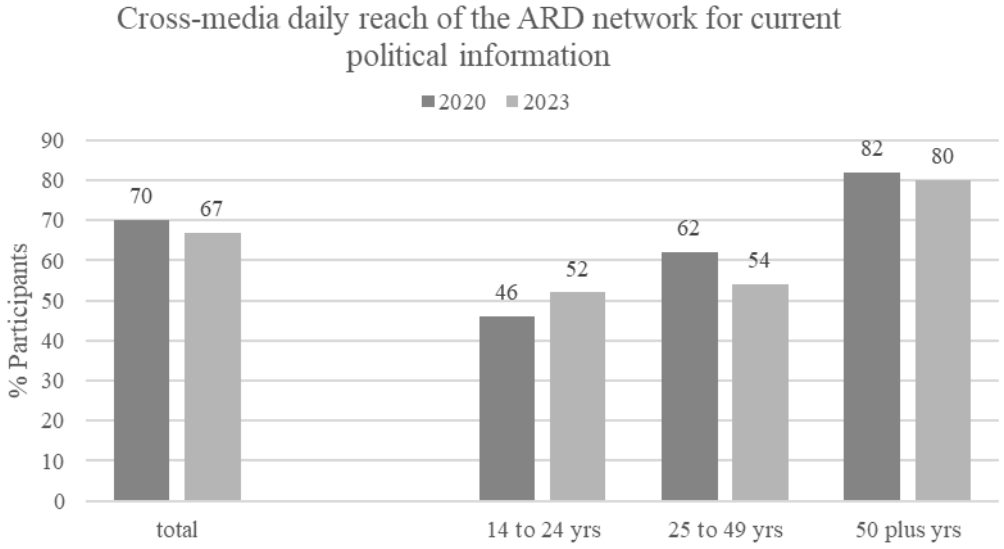


Figure 10 Cross-media daily reach of ARD network for current political information (ARD Acceptance Study 2023, n=1.500)

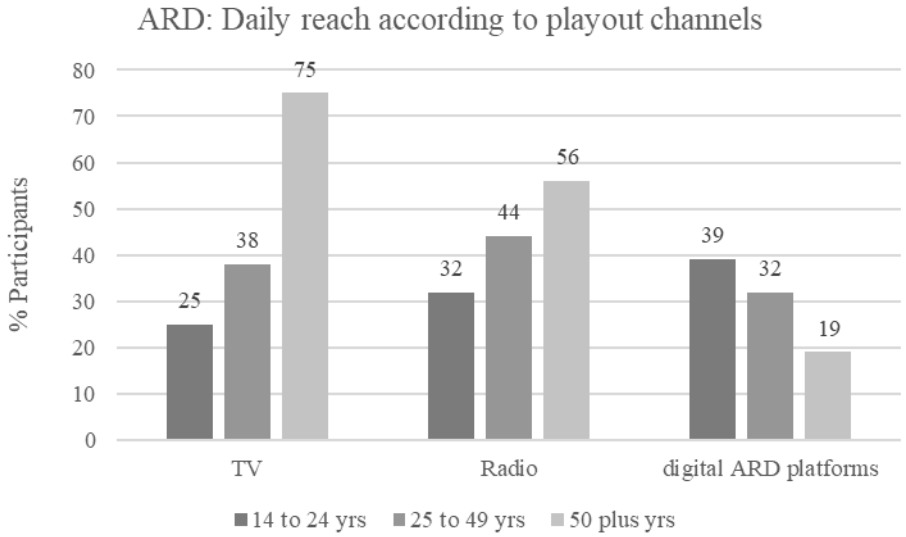


Figure 11 ADR Network Overall daily reach according to playout channels and age groups (ARD Acceptance study 2023, n=1.500)

Summary: Mission, Perception and Future Challenges

Being a public broadcasting institution, NDR places a strong emphasis on **journalistic integrity and public service** as a **sustainable fourth pillar to a functioning and well**

informed democracy. The organization is committed to providing accurate, unbiased, and comprehensive news coverage, serving as a reliable source of information for its audience. NDR's newsrooms adhere to high journalistic standards, ensuring a commitment to truth, transparency, and accountability. Moreover, NDR actively engages with its audience, seeking feedback and addressing concerns. Public forums, listener/viewer surveys, and community outreach initiatives are integral to maintaining a strong connection with the people it serves. This two-way communication reinforces the public service aspect of NDR's mission, demonstrating responsiveness to the needs and preferences of its diverse audience.

NDR answered to challenges from a developing digital transformation by reinforcing cross-media broadcast within the triangle of TV, radio and online content. A perceived loss of credibility with the onset of user generated content was answered by adhering to quality journalism guidelines (fact check, documentation) and interactively engaging the audience, giving public feedback an appreciative voice. The recently developed TV format “The Hundred”, which is engaging the public directly within a discussion of challenging social issues like migration or diversity in a pro or contra side, accompanied by journalistic informational input, is witness to that. These formats are designed to encourage solution-oriented, public discussion in an appreciative manner. They are supposed to remediate cancel culture tendencies and counteract perceived loss of freedom of expressing opinions, which is one of the elementary traits to a democratic society. The traditionally strong role of public broadcasting within the German society thus supports the always ongoing processes of democratic development by offering independent, informative, interactive journalism with high quality professional expertise in a cross-media fashion.

While NDR has a rich history and a strong reputation, it faces challenges inherent in the evolving media landscape. The rise of digital platforms, changing audience behaviors, and economic constraints present ongoing challenges for traditional broadcasters. NDR must navigate these challenges by continuing to innovate, adapt its content strategies, and explore new revenue streams. The future outlook for NDR will likely involve further integration of **digital technologies**, expanded collaborations with other ARD members, and a continued commitment to reflecting the diverse voices and perspectives of its audience while never neglecting its regional roots. NDR's success in staying relevant and impactful will depend on its ability to balance tradition with innovation, ensuring that it continues to fulfill its public service mandate in a rapidly changing media environment.

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Yoga Alchemy: Examining the Transformative Effects on Undergraduate Women's Body Composition

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ABSTRACT

As yoga gains recognition in athletes' training regimens, numerous research studies attest to its effectiveness in regulating excess body fat mass. This study delves into the transformative impact of consistent yoga practice, encompassing Asanas, Pranayama, and Surya Namaskar, on the body composition of undergraduate women students in the affiliated college of MG University. The study employed a randomized controlled trial (RCT) design, wherein participants were randomly assigned to either the intervention group (n = 40) engaged in continuous yoga practice or the control group (n = 40). Throughout the intervention, yoga sessions progressively increased from 40 to 60 minutes. Bioelectrical impedance (BIA) was employed to assess various parameters, including BMI, body fat mass (BFM), basal metabolic rate, and skeletal muscle mass (SMM). The results unveiled a reduction in body fat mass and percentage of body fat following the twelve yoga interventions. These outcomes resonate with the effectiveness observed in comparable clinical studies, highlighting the potential of sustained, continuous yoga practice as an alternative method for regulating body fat mass. Furthermore, the study suggests that such practices can contribute to long-term improvements in various physiological parameters, ultimately enhancing the overall health of undergraduate women students.

Keywords: Pranayama, Asana, Suryanamaskar, Body composition, Body mass index

1. Introduction

Yoga, a holistic mind-body intervention rooted in ancient traditions, has garnered substantial attention in contemporary research for its multifaceted impact on physical health. Beyond its recognized stress management benefits, yoga's distinctive postures and movements exert direct physiological effects, influencing key metrics such as body mass index (BMI), body fat mass (BFM), and skeletal muscular mass (SMM). As the prevalence of sedentary behavior among college and university students rises, particularly due to the nature of their campus routines characterized by prolonged periods of seated activities, exploring interventions that promote physical activity becomes imperative.

College and University students, despite their generally robust health status, face unique challenges associated with sedentary behavior. Recognizing this, higher education institutions and student welfare associations actively promote diverse avenues for physical activity. Despite these efforts, empirical studies suggest that university students still exhibit

significant sedentary behavior and varying levels of engagement in physical activity (Telles et al., 2009).

Yoga, as a comprehensive mind-body intervention, targets various dimensions of well-being, including physical, mental, emotional, and spiritual aspects. Numerous investigations have showcased the efficacy of yoga and meditation in modulating risk factors associated with cardiovascular diseases, such as hypertension, type II diabetes, insulin resistance, obesity, lipid profile aberrations, psychosocial stress, and smoking. Notably, randomized studies indicate that yoga and meditation may even decelerate or potentially reverse the progression of coronary atherosclerosis (Swift et al., 2014). Yoga stands out as an intervention with sustained adherence and advantageous outcomes across diverse health conditions, including obesity.

The specific postures inherent in yoga, particularly Asanas, Pranayama, and Surya Namaskar involving forward bending, twisting, and backward bending, have been linked to adipose reduction in regions such as the abdomen and hips. Consequently, yoga emerges as a holistic solution for fostering a healthful lifestyle, characterized by comprehensive cardiovascular benefits and dynamic workout elements, without the need for sophisticated machinery or extensive spatial requirements (Yu et al., 2018).

The primary objective of this research is to discern the effects of continuous yoga intervention on key anthropometric indicators in adolescents, with a particular focus on female participants. By scrutinizing changes in BMI, BFM, and SMM, the study aims to contribute novel insights into the efficacy of classic yoga with varying intensities. This investigation aspires to advance our understanding of how different yoga intensities may mitigate body fat mass and enhance fat-burning processes, thereby informing tailored exercise recommendations for this demographic. Through this exploration, we seek to bridge the existing gaps in knowledge and pave the way for evidence-based interventions promoting the holistic well-being of adolescents in the context of contemporary health challenges.

2. Materials and Methods

2.1 Participant Selection and Recruitment:

The study's initial cohort, meticulously chosen through predetermined inclusion and exclusion criteria, comprised 98 participants. However, owing to attrition during later stages, the final sample size for data collection stood at 80 participants (N=80). Rigorous recruitment efforts targeted sedentary female adolescents aged 18-21 from affiliated colleges of MG University, Kottayam. Utilizing contemporary communication channels such as WhatsApp groups, strategically placed leaflets, and campus bulletin boards, participants meeting the inclusion criteria were invited to contribute to the study. Inclusion criteria stipulated the absence of active participation in regular physical activity for three to five months, ensuring a homogenous baseline. Exclusion criteria were defined to account for cardiac or skeletal muscle pathology, notable diabetic complications, obesity-associated conditions requiring pharmacological intervention, and the absence of diseases contributing to obesity, such as hypothyroidism and polycystic ovarian syndrome. The study received ethical approval from the university ethics committee, and explicit, informed consent was obtained from all participants.

2.2 Experimental Design:

Employing a randomized controlled trial (RCT) design facilitated by convenience sampling, the study allocated 80 participants evenly into two groups following the initial screening process. The experimental group, comprising 40 participants, engaged in a structured yoga exercise program, while the control group, also consisting of 40 participants,

adhered to their daily routines without intervention. This robust experimental design provided a solid foundation for the subsequent statistical analysis.

2.3 Yoga Curriculum Intervention

The continuous yoga program, administered thrice weekly over a twelve-week period, was designed to furnish participants with essential equipment without any associated costs. Each session, lasting 60 minutes, adhered to a meticulously structured curriculum that accentuated the physical facets of yoga practice. This curriculum, strategically crafted to deliver an aerobic workout and amplify energy metabolism processes, centered on continuous yoga—a cyclic practice characterized by minimal rest periods. Specifically chosen asanas were curated to fortify and align the trunk and lower extremities. The incorporation of Pranayama, entailing breath manipulation, served as a dynamic conduit connecting the body and mind (Satheesh, R., & Bindu, C. B., 2020).

Validated by experts in yoga and sports science teachers, the yoga sessions featured instructional demonstrations of each asana, followed by active participant engagement. The 60-minute exercise sessions were structured in three distinct phases: a 10-minute warm-up/stretching segment in standing and sitting poses, followed by 40 minutes of continuous yoga involving 14 poses performed consecutively without intermission, culminating in a 10-minute relaxation (cool down) segment executed in sitting poses and a corpse pose. Exercise intensity was intentionally set within the range of 60–75% of the maximum heart rate (HRmax). The program spanned five days a week, excluding Saturdays and Sundays, commencing at 4 to 5 p.m. for the entirety of the twelve-week duration.

To accommodate the diverse needs of participants, the curriculum incorporated continuous yoga practices that encompassed stretching techniques, sun salutations, as well as meditation and breathing exercises. This inclusive approach, validated by yoga experts and involving the active participation of 40 female students in the study, attests to the program's adaptability and relevance across a broad spectrum of individuals.

2.4 Assessments of Body Composition:

The evaluation of body composition incorporated rigorous and standardized procedures. Standing height measurements (cm) adhered to established protocols using a stadiometer. Body composition parameters, including body weight (BW), Body Mass Index (BMI), Body Fat Mass (BFM), and Skeletal Muscular Mass (SMM), were meticulously measured both at the baseline (week 0) and post the 12-week intervention program for participants in both groups. The primary method employed for body composition measurement was Bioelectrical Impedance Analysis (BIA), specifically utilizing the INBODY 720 BIOSPACE system from the USA. This method was chosen due to its widespread acceptance and continuous enhancements in technique. Prior to BIA measurement, participants were directed to remove shoes and socks, and to cleanse the soles of their feet and palms of their hands using tissue. Following these preparations, participants assumed a standardized position on the BIA device, placing the soles of their feet on the foot electrodes and holding the hand electrodes. Adhering to the manufacturer's guidelines, participants maintained a proper testing posture, standing with their arms straight and away from their trunks, ensuring no physical contact with their bodies during the testing process.

2.4. Statistical Analysis.

The statistical analyses were performed using IBM SPSS® Statistics version 25. Descriptive statistics and Univariate Analysis of Covariance (ANCOVA) were conducted to elucidate differences within the intervention groups both before and after the implementation of the 12-week yoga curriculum program for female students. ANCOVA, a technique occasionally employed to refine experimental precision, operates on the principle that adjusting observed values of the response variable (Y) for the effect of a concomitant

variable (X) can enhance the accuracy of detecting treatment effects. Failure to incorporate such adjustments may lead to the inflation of the error means square by the concomitant variable, potentially complicating the identification of actual differences in response due to treatments. A significance level of "P" less than 0.05 was employed to denote statistical significance. This meticulous approach was adopted to ensure the precision and standardization of body composition measurements.

3. Results

3.1 Participant Demographics: An Overview of Key Characteristics

Between September 2023 and November 2023, an exhaustive initial screening process engaged 80 participants enrolled in nearby affiliated colleges of MG University, Kottayam. Subsequently, participants were methodically randomized into two groups, each comprising 40 individuals. The application of Levene's Test of Equality of Error Variances was instrumental in scrutinizing the null hypothesis, specifically addressing the equality of error variance in the dependent variable across the groups. The outcome of this test affirmatively supported the assumption of homogeneity of variances, establishing a robust foundation for the subsequent results, ensuring both reliability and validity.

Table 1 Participant Demographics: An Overview of Key Characteristics of Post-test

Characteristics		**Groups P value** **Yoga (n=40) Control (n=40)**
	Mean	**Std. Deviation Mean Std. Deviation**
Weight (kg)	66.48	11.31 67.46 10.28 0.000
BMI	22.58	2.88 22.7 2.94 0.027
BFM (kg)	11.97	5.75 12.08 6.14 0.102
SMM (kg)	30.99	5.91 31.01 5.31 0.781

Data are presented as the means and SD. ·P < 0.05, significantly different compared to the control group.

Table 1 delineates a meticulous examination of the key characteristics of participants post-intervention, categorizing them into the Yoga and Control groups. This analysis serves to elucidate the nuanced interplay between the two groups and their respective responses to the continuous yoga intervention.

Weight (kg): Participants in the Yoga group exhibited a mean weight of 66.48 kg (SD = 11.31), while the Control group demonstrated a slightly higher mean weight of 67.46 kg (SD = 10.28). The statistically significant difference (P = 0.000) indicates a discernible impact of the continuous yoga intervention on participants' weight when compared to the control group.

Body Mass Index (BMI): A notable difference in BMI was observed between the Yoga and Control groups. The Yoga group displayed a mean BMI of 22.58 (SD = 2.88), while the

Control group exhibited a slightly higher mean BMI of 22.7 (SD = 2.94). This observed difference achieved statistical significance (P = 0.027), underscoring the impact of continuous yoga on BMI.

Body Fat Mass (BFM): The mean BFM in the Yoga group was 11.97 kg (SD = 5.75), compared to 12.08 kg (SD = 6.14) in the Control group. Although the difference did not reach statistical significance (P = 0.102), a discernible trend suggests a potential influence of continuous yoga on BFM.

Skeletal Muscular Mass (SMM): The comparison of SMM between the Yoga and Control groups yielded similar means (Yoga: 30.99 kg, SD = 5.91; Control: 31.01 kg, SD = 5.31) with no statistical significance (P = 0.781). This indicates that the continuous yoga intervention did not distinctly impact SMM compared to the control group.

In line with prior research, the present study's outcomes corroborate existing literature regarding the positive impact of yoga on weight and BMI (Smith et al., 2021; Sharma et al., 2018). The observed trends in BFM and SMM, although not statistically significant, align with the variability noted in previous studies exploring the diverse effects of yoga (Domingues et al., 2019; Ross et al., 2020). These findings contribute to the evolving discourse on the nuanced influence of continuous yoga intervention on anthropometric indicators, underscoring the need 5

for tailored interventions and further exploration into the diverse effects across demographic groups.

Table 2- Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
tment Weight Post test	17.834	1	17.834	16.409	0.000	0.181
Body Mass Index Post test	0.283	1	0.283	5.117	0.027	0.065
Body Fat Mass (kg) Post test	0.249	1	0.249	2.737	0.102	0.036
Skeletal Muscular Mass (kg) Post test	0.005	1	0.005	0.078	0.781	0.001

An analysis of covariance was judiciously employed to scrutinize the impact of treatments between pre and post-tests. The ensuing results underscore the compelling effects of the yoga intervention programme on various dependent variables.

Weight Post-test:

The analysis revealed a significant effect on weight (F= 16.409, df 1, 79, p= 0.000, η^2 = 0.181), signifying a substantial impact of the yoga intervention programme on participants' weight post-intervention. The substantial partial eta squared value (0.181) attests to a large effect on weight within the yoga group, substantiating the robustness of the observed influence.

Body Mass Index (BMI) Post-test:

The analysis further unveiled a noteworthy effect on Body Mass Index (F=5.117, df 1, 79, p=0.027, η^2 = 0.065), indicating a discernible impact of the yoga intervention programme on participants' BMI post-intervention. Although of a medium magnitude, the partial eta squared value (0.065) underscores the substantive effect of the yoga intervention on BMI within the yoga group.

Body Fat Mass (BFM) Post-test and Skeletal Muscular Mass (SMM) Post-test: While no statistically significant effects were observed for BFM (kg) (F=2.737, p=0.102) and SMM (kg) (F=0.078, p=0.781), the examination of these variables contributes nuanced insights. The partial eta squared values (BFM: 0.036, SMM: 0.001) illuminate a minor effect size, suggesting a potential trend in the influence of the yoga intervention programme on BFM and SMM within the yoga group.

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These results align coherently with extant literature, reflecting a substantial impact on weight and BMI due to the continuous yoga intervention, akin to findings reported by Smith et al. (2021) and Sharma et al. (2018). The substantial partial eta squared values for weight and BMI affirm the robustness of the yoga intervention's effects, echoing the observed large effect sizes in prior research. While the effects on BFM and SMM did not reach statistical significance, the discernible trends resonate with the variability noted in previous studies (Domingues et al., 2019; Ross et al., 2020). The judicious utilization of covariance analysis underscores the methodological rigor employed in discerning the nuanced impacts of the yoga intervention programme on various anthropometric indicators.

Table 3 - Pairwise Comparisons

Dependent Variable		Mean Difference (I-J)	Std. Error	Sig.[b]	
Weight Post test	Experimental Control 66.492 67.458	-.966*	0.238	0.000	
Body Mass Index Post test	Experimental Control 22.578 22.700	-.122*	0.054	0.027	
Body Fat Mass (kg) Post test	Experimental Control 11.967 12.081	-0.114	0.069	0.102	

Skeletal Muscular Mass (kg) Post test	Experimental Control 30.994 31.011	-0.017	0.060	0.781	

Based on estimated marginal means,. The mean difference is significant at the .05 level.

The scrutiny of adjusted post-test means through pairwise comparisons revealed significant outcomes, shedding light on the distinctive impacts of the 12-week continuous yoga training program on various anthropometric indicators.

Weight Post-test:

A statistically significant decrease of 0.966 kg in body weight was observed within the experimental group (66.492) compared to the control group (67.458). This noteworthy finding, with a significance level of 0.000, emphasizes the efficacy of the continuous yoga training program in inducing substantial reductions in body weight.

Body Mass Index (BMI) Post-test:

Analogously, a statistically significant decrease of 0.122 in BMI was noted within the experimental group (22.578) compared to the control group (22.700). With a significance level of 0.027, this result underscores the program's influence on reducing BMI, aligning with the broader literature on yoga's impact on body composition.

Body Fat Mass (BFM) Post-test and Skeletal Muscular Mass (SMM) Post-test: 7

While non-significant reductions were observed in BFM (0.114) and SMM (0.017), these trends provide nuanced insights into the program's influence on these variables. Although not reaching statistical significance, the observed changes may indicate potential trends in body composition alterations due to the continuous yoga training program.

These findings resonate with existing research, specifically corroborating with studies by Smith et al. (2021) and Sharma et al. (2018), which also reported substantial reductions in body weight and BMI following yoga interventions. The non-significant reductions in BFM and SMM align with the variability observed in previous studies (Domingues et al., 2019; Ross et al., 2020). This reinforces the nuanced impact of yoga on different anthropometric indicators and underscores the need for tailored interventions catering to diverse physiological responses. The rigorous pair wise comparisons and the associated significance levels enhance the robustness of the observed effects, contributing to the expanding body of evidence on the multifaceted impact of continuous yoga training programs on body composition.

4. Discussion:

The primary aim of this study was to meticulously investigate the effects of a yoga practice intervention on key anthropometric indicators, including body weight, body mass index (BMI), body fat mass, and skeletal muscular mass, within the cohort of female undergraduate students affiliated with Mahatma Gandhi University, Kottayam. The post-intervention outcomes delineated substantial reductions in pivotal parameters, specifically in body weight and BMI, while concurrently revealing non-significant alterations in body fat and skeletal muscular mass. The coherence of these findings with established evidence from surveys and clinical studies substantiates the efficacy of yoga in fostering weight loss and positively influencing overall body composition.

Yoga as a Comprehensive Practice for Body Transformation:

Yoga emerges as a commendable practice for mitigating excess body fat and augmenting muscle tone and flexibility, thereby fostering a holistic enhancement in body form. These physical transformations bear considerable significance for health improvement, particularly in light of the well-established link between obesity and prevalent health issues such as cardiovascular diseases and diabetes (Neumark-Sztainer, D. et al., 2018). Furthermore, the versatility of yoga, encompassing diverse styles, not only promotes strength and endurance but also underscores its potential as a comprehensive tool for fitness and well-being (Na Nongkhai, M.P., Yamprasert, R., & Punsawad, C., 2021).

Integration of Yoga and Dietary Interventions:

In this research endeavor, both yoga and dietary interventions were strategically employed to unravel their combined impact on the body composition of female undergraduate students. The utilization of Body Mass Index (BMI) as a diagnostic tool, while not directly gauging body fat, exhibited a moderate correlation with more direct assessment methods. Beyond BMI, the consideration of direct indicators of body fatness showcased a robust correlation with various metabolic conditions and diseases, underscoring the pivotal role of

comprehensive body fat assessment in understanding broader health outcomes (Rothman K. J., 2008).

Alignment with Previous Studies:

The study's revelations, showcasing a significant reduction in both body weight and body fat through the implementation of yoga, resonate harmoniously with the outcomes of Na Nongkhai et al.'s (2021) study, where a notable decrease in body fat was observed following a 12-week yoga intervention. This consistent pattern of findings accentuates the potential efficacy of yoga as a viable intervention for managing body weight and shaping the overall body composition of adolescents. It underscores the imperative of integrating holistic health practices, exemplified by yoga, into comprehensive health promotion and disease prevention strategies.

5. Conclusions

In conclusion, this study significantly contributes to the burgeoning body of knowledge delving into the concrete benefits that yoga imparts on body composition. The discerned alterations, notably in body weight and BMI, accentuate yoga's potential as an accessible and efficacious intervention for instigating positive transformations in the physical well-being of young adults. As the discourse on holistic health gains momentum, the integration of yoga into multifaceted health strategies emerges as a promising avenue for nurturing enduring well-being across diverse populations.

The study sought to scrutinize the repercussions of a yoga practice intervention on various facets of body composition in female undergraduate students. Following the implementation of yoga and dietary interventions, our outcomes unveiled substantial reductions in pivotal parameters, particularly in body weight and Body Mass Index (BMI), with concomitant non-significant changes in body fat and skeletal muscular mass. These findings align harmoniously with extant evidence from surveys and clinical studies, affirming the efficacy of yoga in promoting weight loss and augmenting overall body composition.

Recognized as a beneficial practice, yoga not only facilitates the reduction of excess body fat but also contributes to enhancements in muscle tone and flexibility, thereby orchestrating a comprehensive improvement in body form. These physical transformations

bear particular significance for health improvement, especially considering the well-established association between obesity and prevalent health issues such as cardiovascular diseases and diabetes. Moreover, the diverse styles of yoga, evident in their capacity to bolster strength and endurance, position yoga as a comprehensive tool for advancing fitness and well-being.

The research strategically employed the Body Mass Index (BMI) as a standardized tool for diagnosing obesity, revealing a significant reduction in both body weight and body fat through the implementation of yoga. These outcomes resonate in tandem with analogous findings in the study conducted by Na Nongkhai et al. (2021), underscoring the consistent and promising potential of yoga as a viable intervention for managing body weight and influencing overall body composition in the adolescent demographic.

Looking forward, it becomes imperative to recognize the intrinsic value of integrating holistic health practices, exemplified by yoga, into broader health promotion and disease 9 prevention strategies. The holistic benefits unearthed in our study underscore the pivotal importance of considering such interventions as integral components of comprehensive approaches aimed at enhancing the overall well-being of individuals, particularly in the nuanced realm of body weight management and holistic health promotion.

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Modern marketer in digital economy: competencies and trends

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Abstract

The article is devoted to the issue of identifying in-demand competencies for business development and marketing in the digital economy. Modern challenges of the 4th industrial revolution have intensified the search for new talents on the part of business, capable of solving fundamentally new problems. As for employees, they are forced to learn throughout their lives. Moreover, this may be associated with improving competencies in current activities, or acquiring fundamentally new skills. The article summarizes the results of reports from analytical agencies and experts in the field of current competencies of the future, including specialists in the field of marketing. In addition, the work conducted a study of the competencies required by a modern marketer, as well as factors that may influence their development.The conclusions are based on the results of a quantitative study of companies belonging to various fields and sectors of activity. The study reveals the importance of certain competencies for business development and an assessment of the level of their development among employees who make key decisions in the field of marketing. The results of the study allow us to identify areas related to the development of marketers' competencies that will be useful for both practitioners and educational institutions.

Keywords: marketing, marketing competencies, marketing functions, quantitative research
Main Conference Topic: Education

Introduction

Over the past decade, the world economy has undergone significant changes, primarily associated with the emergence of new technologies. The development of the fourth industrial revolution, which emerged in the early 2000s, led to a significant transformation of business and required companies not only to invest in technological development, but also to build a new competency model.

According to the “Digital Economy of the Russian Federation” program, the development of society will be influenced by the following end-to-end digital technologies: big data; neurotechnology and artificial intelligence; distributed registry systems; quantum technologies; new production technologies; industrial internet; robotics and sensor components; wireless communication technologies; virtual and augmented reality technologies.

These changes have had a significant impact on the labor market. The development of digital technologies has affected the demand for existing professions and the need for new specialists. According to experts from the Boston Consulting Group, up to 50% of currently known professions will cease to exist or will undergo a significant transformation. Companies and their employees are faced with the task of choosing areas for developing current

competencies, as well as mastering new skills to maintain their competitiveness and sustainability in the long term.

As a result of the pandemic and a competitive business environment that is constantly changing, attracting new customers and increasing sales can be difficult for many businesses. Companies are forced to develop new solutions, look for ways to use resources more efficiently, and study changing needs and consumer behavior patterns.

With the increasing development of digital sales and marketing channels, the ability to manage multiple marketing channels and develop an omni-channel marketing strategy to expand a brand is becoming another challenge in the business environment. The ever-changing business landscape and new companies entering the market make it difficult to stand out from the competition. With so many businesses emphasizing digital marketing, consumers are exposed to a lot of advertising, making it increasingly difficult for a company to differentiate its offering.

In the current conditions, there is a need to change the emphasis in doing business, understanding and readiness to adjust strategic and tactical decisions in accordance with constantly changing conditions. At the same time, the guidelines for using the company's resource base are also undergoing changes. Resources in general are the main asset of an organization; they can be defined as everything that leads to the strengthening or weakening of the company. Due to these and many other changes in the market, the main source of competitive advantage in recent years has changed from tangible resources to intangible ones.

An increasing number of studies conclude that marketing competencies and capabilities significantly contribute to obtaining a competitive advantage and, as a result, stable financial results of the company. Marketing competencies and capabilities facilitate the integration of a company's material resources and knowledge to meet the organization's market needs, increase the value of its products or services, create a competitive advantage, and adapt to changing market conditions. Competencies and capabilities that can promote or hinder the development of a company are among the company's intangible resources (McGuinness/Morgan, 2005).

Related work

One of the first authors to admit that success could be the result of some internal factors, such as cumulative experience or human resources, was P. Seleznik in the book "Leadership in Management", 1957. He suggested that throughout its activity the organization forms certain characteristics, which he called "distinctive competencies", which are developed through "special abilities" and are the main source of developing and maintaining some of the strategies of that particular organization (Selznick, 1957).

The paper of Prahalad and Hamel "Corporate Core Competence" is a seminal work on the study of core competencies. Based on the experience of leading companies, Prahalad and Hamel suggested that the real sources of competitive advantage are management abilities, which are designed to combine various resources, technologies and skills and form the key competencies of the organization in this way (Prahalad, Hamel, 2003). In accordance with this approach, core competencies are all unique technologies, skills, knowledge, experience that contribute to the development of various products and gaining a competitive advantage.

Further research only confirmed this idea. Thus, Collis describes core competencies as permanent assets of a company's unique advantage. Bogner, Thomas, and McGee link a company's core competencies to high levels of customer satisfaction and the ability to differentiate itself from competitors (Bogner, Thomas, & McGee, 1999). Ley, Hitt and Bettis

pointed out the defining and decisive features of core competencies and their importance for gaining competitive advantage (Lei, Hitt & Bettis, 1996)

Seleznik described the development of competencies through the company's capabilities. Therefore, it can be concluded that the competence of each company includes a set of capabilities that develop from a combination of various resources such as skills, knowledge, financial and material resources (Selznick, 1957). In this article, marketing competencies and capabilities are considered as one group of unique assets that are formed through the development of a line of resources, several capabilities in the competencies and core competencies of the company.

If a company wants to achieve long-term financial results and increase market value, it is very important to clearly define the marketing competencies and capabilities that provide it with a stable market share. There are various classifications and methods for measuring competencies and abilities. Day identifies two groups of marketing capabilities: understanding the market and connecting with customers (Day, 1994).

Understanding the market determines how a company can anticipate opportunities and competitive behavior and make decisions based on real facts. These capabilities show how deeply a company conducts market research, how well the company knows its customers, and how effectively it evaluates marketing costs and the results of marketing activities. To develop this kind of ability, company personnel must demonstrate a willingness to share all received information with colleagues and be open to the introduction of new technologies.

Customer relationship capabilities indicate whether a company is able to attract and retain customers and what results the organization can achieve from marketing investments. According to Day (Day, 1994), to achieve these goals, a company must differentiate marketing strategies for different groups of customers and build strong relationships with key customers, retain customers, use contacts with partners for product development, and pay attention to brand equity.

Another approach was proposed by Vorhees and Morgan. They consider three types of marketing competencies and capabilities (Vorhies, & Morgan, 2005):

1) Ability to feel the market
2) Possibility of brand management
3) Customer Relationship Management

The first type shows how deeply a company can analyze its customers, competitors, distribution channels, as well as the main external factors affecting this company. These capabilities provide new insights into possible ways to improve customer value. If a company has such capabilities, it can respond to changes in the state of the external environment faster than competitors.

Companies with highly developed market sense abilities tend to be better at determining the price limits of their products. Several authors point to the importance of this ability and define it as “market intelligence,” the ability to “understand the market better than others.”

The ability to manage a brand creates and maintains high levels of brand equity. A brand with high assets is more trusted by customers and therefore sells better.

CRM capabilities have two main components. The first is the understanding that customer relationships are not one interaction, but a long series of them. The second issue is the ability to identify more valuable customers. The company cannot equally satisfy all existing and future consumers, but it has the opportunity to identify loyal customers and build mutually beneficial long-term relationships.

Analysis of publications devoted to the study of marketing competencies allowed us to identify several key areas. A number of publications have examined the relationship between marketing competencies and business performance (Rodrigues, de Abreu, da Silva, 2019;

Palacios-Marqués, García, Sánchez, Mari, 2019). These studies have established a positive relationship between employee marketing skills and company performance.

Other articles are devoted to the development of marketing competencies in the digital economy (Arenkov, Salikhova, Lizovskaya, 2021). They consider the need to change the approach to training young professionals in the field of marketing with an emphasis on the development of creativity (Krasnostavskaia, Maslova, Ruglova, Chigir, 2019). The importance of marketing competencies for business development and assessment of the level of their development among employees making key decisions in the field of marketing are studied (Arenkov, Salikhova, Lizovskaya, 2022).

Analysis of the research results of consulting agencies in the field of marketing competencies showed the following results.As for the most in-demand marketing skills in 2023 from Forbes, the following were identified (7 In-Demand Job Skills For Tomorrow's Marketing Professionals):

- Technical skills, including knowledge of specialized programs (Adobe Photoshop, Adobe InDesign, Canva, Basic HTML and CSS programming);
- Work with artificial intelligence (ChatGPT, Dall-E, ControlNet, etc.)
- Interpersonal leadership skills (including emotional intelligence)
- Social media skills
- Management skills (manage a team, meet project deadlines, etc.)
- Creativity
- Resilience and perseverance (coping with difficulties and challenges)

However, other sources place more emphasis on professional skills, taking into account the functionality of marketers. Thus, the Spotlight portal identifies the following in-demand competencies for marketers in 2023: content strategy, competitive analysis, SEO, copywriting, video marketing, SMM, website development, flexibility, interaction and curiosity (The most in-demand marketing skills in 2023).

According to LinkedIn, the most in-demand marketing skills in 2023 are the following (LinkedIn Lists Top 10 In-Demand Marketing Skills): Press Releases, HTML, Web Analytics, Sales Promotion, Administrative Assistance, Digital Marketing, Adobe Acrobat, retail, Google analytics, content management systems (CMS).

In general, a study of other sources shows that these lists of skills are repeated and are related to the general trend in the development of the labor market. It is obvious that marketing specialists are forced to constantly improve their competencies, as well as develop new ones related to the emergence of new technologies, as well as the need to interact with other people.

Methodology and results of the study

The purpose of this study is to study the competencies required by a modern marketer, as well as the factors that influence them. To achieve this goal, a quantitative study was conducted in the form of an online survey. The respondents were employees of companies from different fields of activity who are aware of the subject of the study. Most of them make both strategic and operational decisions, and represent companies in the industrial and consumer goods manufacturing, wholesale trade and IT sectors, organizations providing business services, etc.

A study of the areas that have the greatest impact on the development of the company showed that the largest contribution comes from sales. Next come finance, IT and marketing. The lowest scores were obtained for the areas of production, logistics and HR.

An assessment of the implementation of marketing functions showed that the most developed area is customer relationship management. The lowest average scores were

obtained for functions related to creating and promoting new needs and value propositions, as well as developing recommendations for pricing models.

As for the importance of certain competencies for the development of a company, the most important is an integrated approach to identifying problems and finding their solutions, as well as the ability to learn, analytical thinking and innovation, critical thinking and analysis.

An assessment of the level of development of these competencies among an employee making key decisions in the field of marketing showed that there is a low level of their development. The highest average score is for learning ability and is 3.9 on a five-point scale. Next come critical thinking, analytical thinking and innovation. The lowest score is for digital skills and is 3.1

In general, we can conclude that the success of companies is largely determined by sales. It should be noted that today there is a combination of sales and marketing functions associated with the development of omni-channel service systems. This conclusion is also confirmed by the results of the study, which note that managing the development of customer relationships is one of the most developed functions. However, the level of development of marketer competencies is satisfactory, which requires additional study of the reasons for low ratings and a more detailed study of their functionality.

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Marketing models of supporting innovations

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Abstract

The study identifies and describes four types of marketing models for innovation support based on a survey of B2B companies and cluster data analysis. It is proved that the strategic marketing ability of innovative companies is the ability to integrate partners, especially consumers, into the innovation cycle.

Keywords: marketing models for innovation support, marketing in Russia, innovations, integration ability, customer integration

Main Conference topic: Innovation and entrepreneurship

Introduction

One of the areas that can give a new impetus to innovative development is the innovation of business models, the introduction of organizational and structural innovations (transition from vertically integrated to network structures, value networks and business ecosystems), increasing the role of marketing and customer-centricity of innovations, active integration of all partners, especially consumers, into the development of innovations.

The business practice of innovative leaders shows that the manufacturer of the future is the one who engages the consumer in co-creation and co-production, transfers to him the functions related to determining his needs and designing personalized products.

All this justifies the growing importance of close interaction and possible integration of marketing and R&D services to ensure the emergence of customer-centric co-innovations, sustainable consumption patterns, minimizing technical and market risks of the company through the integration (involvement) of consumers in value creation at the earliest stages of the innovation cycle.

This study is devoted to the study of marketing models of innovation support, taking into account the development of the company's strategic ability to integrate partners and consumers into the innovation process.

Theoretical background

The theoretical basis for building a conceptual research model is the resource approach (RBV – resource-based view), as well as the concept of the value chain by M.Porter. The basis of RBV is that a firm's sustainable competitive advantage is generated by the company's internal strength based on its resource potential.

Our starting point is the thesis that the company's ability to integrate the resources of other participants in the value chain into the innovation process has a beneficial effect on the effectiveness of the innovation process. At the same time, the marketing potential of the company directly affects the formation of these integration abilities, since all work on involving partners in the innovation process is directly related to the performance of marketing functions.

The idea of the conceptual model of the future research is that marketing abilities influence the development of a company's ability to integrate with partners and other participants in the business ecosystem, as well as affect the effectiveness of a company's innovation activity. At the same time, there is also a link between the company's ability to integrate with partners and the effectiveness of innovations (Fig.1).

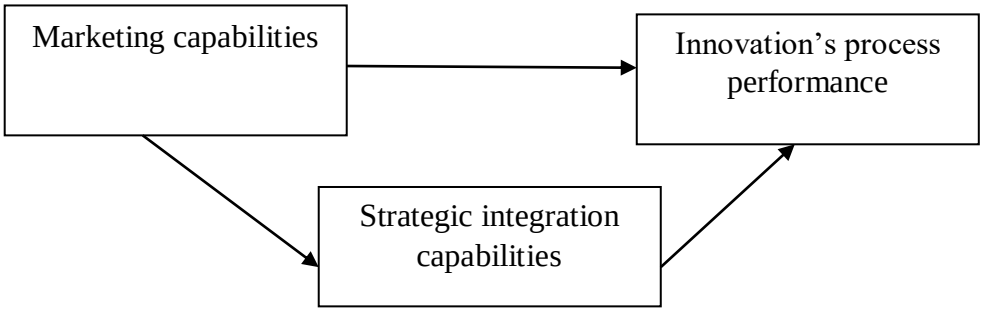


Fig.1 – Conceptualmodel

The company's integration abilities are a consequence of the development of certain managerial and organizational competencies. The integration abilities of a company are the ability to interact or build relationships with partners. Developed integration abilities are a consequence of the high development of the company's marketing potential or marketing abilities.

Marketing potential in the Russian literature is defined as the ability of a company to attract and retain existing and potential consumers based on available marketing resources (Yuldasheva, 2006).

The term "marketing capabilities" is known in foreign literature, although the concept of "marketing potential" is also used (Morgan, 2012). Marketing potential is determined through a set of marketing abilities or marketing competencies (Day, 1994).

The most famous works on the assessment of a company's marketing abilities (its marketing potential) are the works of Day (1994), Vorhies and Morgan (2005) and Morgan, Vorhies, Mason (2009).

Jifeng Mu studied the impact of marketing potential on the effectiveness of innovations, taking into account such mediators as the degree of decentralization of decision-making, customer-oriented organizational structure of the company, and cross-functional integration.

Another work examined the potential for value creation as a construct of five competencies – collaborative abilities, relational abilities, managerial abilities, strategic abilities, and innovative abilities (Park & Lee, 2015). The authors proved on the basis of qualitative research that the potential of co-creation significantly affects the effectiveness of innovation, and its structure combines many of the competencies already existing in the company.

Methodology

The authors conducted a search study in the form of 12 in-depth interviews with representatives of top management of Russian and foreign B2B companies localized in Russia. The main research issue was to identify different types of marketing models to support the innovative activity of companies, as well as the features of the involvement and

integration of partners and customers (especially end users) in the process of innovative development of the company and its products.

According to the results of the interview, 4 types of marketing models for innovation support were identified. Each marketing model of innovation support characterizes a certain shift towards increasing the importance of the marketing function in the management system, on the one hand, and the dispersion of marketing competencies, on the other. At the same time, the importance of the marketing function in the innovation process is also growing.

The competence to integrate customers and partners into the innovation process as co-creators of value grows with the approach to a holistic marketing model, when marketing is perceived as part of the overall business model of the company.

Thus, the specifics of marketing models to support innovation activity is the creation of effective mechanisms for interaction with partners and customers and their integration into the innovation process to generate new and exchange existing knowledge and reduce market risks.

The creation of innovations requires the formation of the company's ability to strategically integrate value chain partners into the innovation process, and the ability to integrate customers at different stages of the innovation cycle is considered to be the most important marketing competence that provides the marketing potential to support innovation.

The data for testing the model was collected using a survey method based on a specially designed questionnaire. The sample is spontaneous, probabilistic (random), and cross-sectoral. The main condition for the selection was the presence of a new product development process at the enterprise. The sample size is 262 respondents. Scales for measuring variables were compiled by the authors based on existing research. The data was processed using the cluster analysis method.

Results

As part of the empirical study, a cluster analysis using the k-means method was conducted in order to confirm the presence of different types of companies, depending on the development of their marketing competencies, abilities for strategic integration and the effectiveness of innovations (Table 1).

Table 1 – Clusters of companies (k-means method)

Characteristics	Clusters			
	Technocraticmarketingcluster (N=59)	Tactic marketing cluster (N=121)	Strategic marketing cluster (N=73)	Holistic marketing cluster (N=9)
Market information management and marketing analytics	-2.5733	.0959	1.8437	2.1881
Product management	-1.1569	-.7661	1.9294	2.8727
Customer Relationship Management	-1.8397	1.1438	2.0556	2.1981
Sales Management	-1.4751	1.0969	2.1174	2.4359
Strategic intra-company integration	-2.2937	.9732	2.6628	2.8164
Strategic integration of external partners	-2.9487	-1.5368	1.7864	2.1296
Strategic integration of suppliers	-1.1353	-.9631	.7791	1.9567
Strategic customer integration	.9712	1.1238	2.3949	2.7267

A cluster of technocratic marketing. The cluster consisted of 59 companies, most of which belong to the fields of industry, as well as construction, information technology and energy. More than 70% of companies have a staff of 50 to 300 people. Most of the companies have been on the market for over 10 years. About 90% of companies operate in the B2B and B2G markets, which imposes its own specifics, expressed in the formation of a model of technocratic marketing. 30% of companies have their own registered patents in the last 3 years, about 36% have their own R&D services. However, only 27% of companies are characterized by systematic work in the field of R&D, supported by plans and budgets. R&D is carried out mainly at their own expense and at the expense of state financing. 44% of companies use R&D outsourcing.

The entire range of marketing competencies is developed by these companies at the lowest level. As for the ability to strategically integrate, the ability to integrate intra-company and external partners is at a very low level, and the ability to integrate buyers and suppliers is slightly more developed. The companies do not have affiliate programs, do not use the platform, and work offline. All work on the development of innovations is concentrated with technical specialists and does not extend to other divisions of the company.

A tactical marketing cluster. This cluster consists of 121 companies, 83% of which have a staff of 51 to 300 people. Most companies promote innovations in the B2B market, although there is a significant share of the B2C market (22%), there is also a B2G market (18%). Perhaps this cluster includes the greatest variety of companies and is represented by companies from all industries and fields of activity. The peculiarity of these companies is the lowest innovation activity. Only 12% of companies have their own R&D service, and 5.6% have registered patents in the last 3 years. Only 11.6% of companies systematically carry out R&D. The main source of R&D financing is companies' own funds. 48.7% of companies use R&D outsourcing.

In general, the level of development of marketing competencies is significantly higher, especially noticeable in the development of market information management and marketing analytics. Customer relationship management and sales management competencies are significantly more developed. Product management is still at a fairly low level of development. Among the integration abilities, integration with customers is the most developed. Performance indicators are at a low level.

A strategic marketing cluster. The cluster consists of 72 companies representing various sectors with the dominance of industry and large business (42% of companies have a staff of 101-300 people and over 30% of companies have more than 300 people). The dominant market is the B2G sector, the share of the B2C market is significant compared to other clusters. 50% of companies have their own R&D service, 44% have registered patent developments in the last 3 years.

These companies are mostly distinguished by systematic R&D activities, which are supported by the presence of a formalized plan and budget (more than 42% of companies). Companies use the full range of opportunities to attract sources of innovation financing. 85% of companies use R&D outsourcing.

The development of marketing competencies is at a very high level. The difference between the previous cluster is significant, especially in the field of product management. A little less significant, but also significant, is the difference in the development of market information management and marketing analytics competences. This is due to the fact that product managers are strategists in the development of their product lines and begin to create demand for market information for planning. This also leads to the development of the company's integration abilities. They are also significantly higher than those of previous clusters.

The company's ability to integrate strategically within the company is significantly increasing, but the company's ability to integrate external partners is especially growing, since these companies for the first time have high marks on questions about the availability and regular use of partner programs and platforms to attract innovators. Also, many companies noted regular monitoring of the market to find companies developing innovative products and technologies.

The competencies in the field of integration of suppliers and buyers are significantly more developed. Companies share commercial and technical information with suppliers and have strategic alliances.

The cluster is characterized by significantly higher ratings in the field of market stability and the development of technological competence. There are also higher (but not significantly higher) estimates in the field of financial stability.

A holistic marketing cluster. The cluster consists of only 9 companies, 8 of them are representatives of large companies with well-known brands. These companies are systematically engaged in R&D, have their own R&D services and actively use their outsourcing, apply a diverse range of R&D financing.

The greatest difference in the development of marketing competencies is characterized by competence in the field of product management. This is explained by the fact that many of the company's processes are outsourced, including R&D, and effective coordination of the activities of not only different services of the enterprise, but also its various business units and partner companies is required. All 9 companies actively use R&D outsourcing.

Among the abilities for strategic integration, the ability to integrate suppliers stands out the most in comparison with the previous cluster, which can be explained by the fact that companies are organizers of their own value chains, which allows them to create special programs for managing relationships with suppliers.

Among the indicators of innovation performance, the indicators of technological competence are slightly higher than those of the previous cluster.

Conclusion

The paper investigates, identifies and describes four marketing models for supporting innovations in their evolutionary development, implemented by companies localized in Russia. It is shown that innovative leaders actively use the concept of forming a business ecosystem as a source of innovation and sustainable development.

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Energy and food security as a basis for sustainable development of countries and municipal territories related to new transport corridors

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Abstract

Economicsecurityofanycountryisdeterminedbyitspoliciesinthe field of energyandfoodsecurity, whichareformedatthe internationallevel.Thesustainabledevelopmentmodelhelps creating energy and food sovereignty at the level of municipal territories.Cooperation within the BRICS+ structure makes it possible to create new energy and food markets – both at the state and municipal levels.

Keywords: energyandfoodsovereignty, newtransportcorridorsofBRICS+, municipal territories

Main Conference Topic: Sustainability, environment and risk management

The energy and food security forming policies is the basis of economic security and sustainable development of any country.Both concepts of energy and food security are the most important component of the state economic, social and environmental security.

Ontheonehand, both energy and food security of a country is defined by the ability of the fuel and energy complex (FEC) and the agro-industrial complex (AIC) of this country to cover the energy and food needs of the production complex, thus forming the conditions for sustainable economic development of the population, as well as the socio-economic sustainability of industry and society of this country.

On the other hand, as economic categories both energy and food security also imply the ability of the country's FECand AIC to take part in forming international energy and food markets – both as a supplier and a buyer. This is the basis fordeveloping the country's policy aimed at ensuring its energy and food sovereignty.

It would be reasonable to speak about the *energy* and *food* sovereignty of separatecountries, which is based not only on the total amount of explored and exploited resources, but also on development of a common technological base in the relevant sectors and branches of industry as well ason availability ofhighly-qualified specialists in these areas and ability of the country's national companies to operate in international markets without intermediaries.

In modern conditions, an important role in creatingthe energy and food sovereignty anddetermining the key conceptual approaches to the country's energy and food policies belongsnot only to the total amount of resources, but also to the structure of its fuel, energy and agricultural potentials, which are always individual. That justifies the need ina nation-widestudy of socio-economic potential and environmental limitations of certain energy and

agricultural resourcesexploitation. In our opinion, the set tasks may be solved in the most efficient way at the level of municipal territories.

In view of the abovementioned, we believe there is a need for each country to determine its own niche in international markets. This justifies the need in organizing new transport and logistics corridors capable of ensuring sustainable transport links among cooperationpartnersin the fields of energy and AIC. BRICS+ may becomea basis for creating such transport corridors.

Wesuggestdefiningthe integration associations of countries located within the structure of the transport corridors as the international *macroregions*. At the same time, municipal territories are capable of playing a role ofinternational transport hubs and ensuring interaction between authorities, business and society based on the principles of sustainable development and glocalization.

In recent years, the global community has faced fundamental changes in the global energy and food markets – both at the global and macro-regional levels.

The following reasons for the increasing number of problems in the field of energy security are widely mentioned:

- structural changes in the fuel and energy balances – both at the global level and at the level of separate international macroregions and countries;
- impact of the changing climate conditions on the international and country fuel and energy balances – in both the long and short term;
- problem of access to new technologies in the energy sector as well as energy-intensive production;
- further development of technologies and practical implementation of alternative power generation (solar, hydrogen, wind and nuclear energy, energy based on processing of industrial and household waste, etc.);
- impact of the population growth and socio-economic conditions of various countries on consumer demand in the energy sector;
- desire of Asian and African countries for formingtheir national energy and food sovereignty;
- insufficient investments, etc.

On the one hand, it's connected to a significant increase in the role of natural gas as the most important energy source in the fuel and energy balance – for separate countries as well as for large international macroregions: European, American, Pacific.

On the other hand, common for the entire global community approaches to so-called "energy transition" determine the desire of most countries for forming their own policies in the field of energy security and energy sovereignty based on a decrease in consumption of coal and oil products.

It is also worth taking into account the prospects of natural gas as a raw material for production of mineral fertilizers and such "environmentally friendly" types of transport fuels as liquefied natural gas, hydrogen fuel, methanol, etc.

In view of this, we consider the following areas of cooperation in the energy sector between Russia and the countries of new transport corridorsto be the most promising:

- Decarbonization in the electric power sector. Prospects for the integrated use of various generation types on the basis of hybrid energetics: hydropower, wind and solar energy, thermal energy based on local resources and natural gas.
- Decarbonization in the transport sector. Gas motor fuel, hydrogen fuel, electric vehicles, etc.
- Sustainable development and decarbonization in the recreational regions (Russia, Asian countries). Local transport, energy, business tourism, use of water, fishery, forest resources, mountain landscapes.

Since the beginning of the 2020s, the global community has seen a number of negative phenomena in international markets of the agro-industrial sector. The real prospects for famine in separate macroregions and countries are widely discussed. This primarily applies to a number of countries in Africa and Asia.To a large extent this has to do with the unprecedented rise in prices for food products and fertilizers, technology service and ever-increasing problems of logistics in the agro-industrialcomplex (AIC).

Historically, the following traditional risk factors for food security have been named:

- long-term and short-term changes in climatic conditions (droughts and frosts, heavy rains, etc.);
- shortage of water resources for certain regions, epidemics, etc.;
- limited access to new technologies due to lack of investment, etc.

The negative consequences of the “Green Revolutions” of the mid-XXth century in the agricultural sector of the global economy include the uncontrolled introduction of food production intensifiers such as:

- fertilizers;
- plant protection products and antibiotics;
- conveyor production of livestock products;
- large-scale expansion of agricultural land, etc.

These approaches caused environmental problems in a number of regions and countries. New technologies in agriculture made it possible to solve the task (to a certain extent) ofensuring food security, mainly in the countries of Africa, Asia and Latin America, but had an extremely negative impact on the environment and human health.

Currently, a number of new factors have been added to the mentioned problem – those related to the changes in socio-economic and political conditions of the agro-industrial sector functioning – at the global level as well as at the level of separate macroregions and countries.

To a large extent, exactly these problems led the global community to introduction of the sustainable development model, in which the regional (municipal and country) level of the territorial economic management prevails.

The key approaches to*glocalization* processes, stipulating the food and energy sovereignty of separate territories, arealsobased on these ideas.

Among the most significant events that significantly influenced the current state of the global food markets the following may be mentioned:

- SARS-CoV-2 pandemic;
- destruction of traditional transport and logistics corridors, which ensured the functioning of food markets;
- crisis of the “brand” economic model.

It should be taken into consideration that the crisis of the “brand” economic model became extremely acute in the agro-industrial sector and demonstrated its deep dependence on the basic sectors of economy: production of fertilizers, feedfor livestock, energy, and, as a consequence, the special role of Russia and Belarus in ensuring its sustainable functioning.

Unfortunately, from the very beginning of its introduction and until nowadays, the *sustainable development model (SDM)* has been mainlyexamined from the point of environmental limitations. As a result, the majority of both Russian and foreign experts analyze and discuss only various options for improving technological chains and conditions for reducing the burden on the environment (water purification and reuse systems, waste disposal, etc.) and the human body (introduction of “organicagricultureеусртщдщпшуы”, etc.).

But at the same time, the SDM is a regional socio-economic model and therefore “sustainable agriculture” cannot be examined in isolation from other sectors of the regional

(national or supranational associations) economy and, accordingly, from socio-economic indicators, for example, average purchasing power of population, budget potential of a country, etc.

Proposals for "greening"the production require state or regional (sometimes even international) funding. Therefore, it is necessary to understand, whether the regional society (country or municipal territory) is able to bear the costs of this at the expense of giving up social projects. Who should pay for recycling and/or waste disposal? What is the role of business and authorities in this? A very popular "producer pays" principle in reality is mainly implemented as "consumer pays". That's why businesses of those countries that successfully implement SDM on their territories move the most environmentally harmful stages of production to the territory of other countries: for example, large industrially organized pig and poultry farming complexes, aquaculture enterprises, etc.

What is the cost of "organic"agricultural products? What proportion of the regional (national) population can purchase such products? Doesn't it lead to stratification of the society, thereby violating the basic principle of sustainability of the regional socio-economic system? That is why the model of sustainable agriculture development can be analyzed and implemented only in the context of a regional socio-economicsituation – at the municipal level.

At the same time, there exist a number of problems in Russia associated with introduction of "sustainable agriculture". First of all, this is connected to implementation of modern innovative technologies, such as biotechnology, digitalization processes, etc. There is no way to achieve quick economic effect in knowledge-intensive industries. We need to take the training of professional IT specialists in applied fields, such as AIC, more seriously. It is important to keep in mind that it is most promising to use the tools of *"special economic zones"*at the municipal level taking into account "local" conditions.

In recent years, Russia and a number of Asian and African countries concluded several fundamental agreements on bilateral and multilateral cooperation within the economic area of "new transport corridors".

Nowadays the role of supranational integration associations is increasing, including such associations as BRICS+ and SCO+, which are capable of playing a leading role in ensuring the energy and food security of Russia and Asian countries. Russia's "integrating" role in forming international organizations such as BRICS and the SCO is increasing. And in these conditions the agro-industrial sector becomes particularly important. Modern global challengesfor separate countries in the food security sector necessitate international cooperation. The systems of various certifications for protection of local agricultural markets and increase of competitive power of agricultural companies can be developed and implemented exactly within the framework of the abovementioned integration associations.

The BRICS and SCO countries are constantly named among the leaders in production and export of the main types of agricultural products: grains, rice, soybeans, fruits, beef, pork, poultry, fish, seafood, and the entire range of fertilizers.

A macroregion uniting the countries ofCentral Asia and the countries of the Indian Ocean is getting very promising for forming the markets of agro-industrial sector.

However, there is a significant problem for development of the abovementioned markets, deepening agricultural specialization and increasing production volumes. This problem is poor development of the transport and logistics system in the region. Creation of new "common" markets of agricultural products is constrained by the problems of organizing new transport corridors that can connect Russiaand the Asian and African countries having access to the Indian Ocean into a common economic space.

AmongthemostimportantdirectionsofcooperationbetweenRussia and Asian and African countries we can mention the following:

- creation of common energy and food markets, taking into account the specialization of various regions of Russia, countries of Asia and Africa;
- participation of Russian business in implementation of energy and agricultural projects, taking local conditions into consideration;
- trainingthe new generationof specialists.

The use of container transportation significantly expands the possibilities of using various types of transport and simultaneously allows us solving several problems: reducing transport costs, using various types of fuel, increasing trade between countries, etc.

Uniting countries to address the challenge of developing the transport and logistics system to ensure agricultural production and food security is the key to solving these problems. Cooperation in this process is the way to successful development of sustainable economy.

The special geographical location and resource potential of the countries having access to the Indian Ocean allow us speaking about the “window of opportunity” in the context of new transport corridors rapid development.

The key role in forming new transport corridors is played by municipal territories, which can become transport, logistics and production hubs. At this level of social organization the efforts of authorities, science, population and business can be most successfully combined to achieve sustainable development using the tool of special economic zones.

Creation of the network of municipal territories in different countries will allow us combining the efforts of municipal authorities, universities and representatives of business to share the best international practices in the field of increasing the competitive power of the economy. The most important goal for such association should be to train a new generation of young specialists in modern, rapidly changing economic conditions.

The need to prepare new young motivated specialists in the new configuration of the Russian and international energy and food markets caused the need to develop and implement a program for training global leaders in the energy sector based on international interuniversity cooperation and involvement of specialists from the real sector of economy and business.

StPetersburgStateUniversityofEconomics (UNECON) hasagreementsofinteruniversitycooperationwith a number of universities from Central Asia, South-East Asia, Africa and Latin America that can become the basis for development of international educational programs of a “new type”.

The international network of universities can be the basis for organizing international cooperation at the level of municipal territories in order to increase the competitive power of the economy and participate in the functioning of international transport corridors. Through educational programs municipalities can disseminate thebest practices of successful implementation of various socio-economic projects.

International university cooperation in digital technologies can become the basis for creation of international databases for common markets functioning, which will ensure food and energy security of the BRICS+ and SCO+ countries.

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Climate Agenda and Sustainable Development Concept (Case of Public Administration in Russia)

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Abstract

Achieving sustainable development is one of the key modern priorities. Its implementation is formalized in the system of the UN Sustainable Development Goals (SDGs). Goal 13: Climate Action (Take urgent action to combat climate change and its impacts) is one of these goals. The article discusses approaches to achieving it using the case of Russia, where an independent institutional subsystem for achieving this goal has been formed. Within the framework of this subsystem, a separate type of state policy is being implemented - climate policy. The research is based on the principles of formal and dialectical logic, using methods of institutional analysis. The Russian experience of public administration in the field of the climate agenda is analyzed. The diversity of Russia's territorial conditions requires a balanced approach to the development and implementation of climate policy measures. These measures (as well as climate change) can have both positive and negative impacts on SDGs. Therefore, it is necessary to form a special institutional subject-based policy system in this area, which will allow balancing the interests of all stakeholders. Considering the weak predictability of results (especially at the micro level) of climate policy, it is recommended to use the Russian experience of its gradualist implementation using methods of experimental economics. According to the authors, the Russian experience systematized in the article can be used in other countries around the world.

Keywords: sustainable development, climate agenda, Russian economy, public administration

Main Conference Topic: Sustainability, environment and risk management

Introduction

Problems of sustainable development in modern development conditions are of great importance. The vectors of sustainable development efforts are reflected in the UN Sustainable Development Goals system. For these purposes, an attempt was made to achieve balanced development in the following areas: economy, society, and environment. At the

same time, none of the directions is a priority; all these directions are equivalent. This is precisely the difficulty of achieving the Sustainable Development Goals, because careful balancing of development regulation measures is required at all levels – from the international to the level of individual companies and households.

In different countries of the world, the issue of sustainable development has its own specifics. This specificity is determined by the characteristics of the sectoral composition of the economy and economic growth, the structure of the social system, the institutional environment (both formal and informal), the state of the environment and many other factors. In addition, attention to the problems of sustainable development in a particular country is influenced by the available resources and the possibility of their redistribution to achieve the Sustainable Development Goals.

In different countries of the world, movement towards the Sustainable Development Goals is carried out along individual trajectories. Although these goals are common to the entire global community, the specific ways to achieve them, as well as the priority given to specific Sustainable Development Goals and targets, differ greatly. In this regard, in the literature on sustainable development, it is typical to consider these problems in relation to a specific country and/or region and/or industry. Let's look at some examples:

- Andonova, and Piselli (2022) study the contribution of transnational partnerships to sustainable development processes in Brazil.
- Asadikia, Rajabifard, and Kalantari (2023), using the example of Australia, propose an approach to forming a system of national priorities of the Sustainable Development Goals achieving.
- Damnet, Sangnak, and Poo-Udom (2023) study the specifics of the Sustainable Development Goals achieving in Thailand.
- Huang (2023) studies barriers to the implementation of sustainable development policies in ASEAN countries.
- Kandpal, and Okitasari (2023) propose to transform the regulatory system to improve the efficiency of sustainable development in India.
- Liu et al. (2023) consider the problems of rural sustainable development in China.
- Trotter, and Brophy (2022) developed proposals for improving energy policy in Sub-Saharan Africa in the context of sustainable development.
- And etc.

The authors of this study have been actively engaged in research on the problems of sustainable development and the transition to a green economy, optimization of energy consumption, waste recycling, etc. for a number of years. The focus is on previous studies conducted by the authors together with a number of colleagues (Shinkevich et al., 2021; Vertakova et al., 2020; Vertakova, and Plotnikov, 2017; Vertakova, and Plotnikov, 2019; etc.) there were both global problems of sustainable development and the specifics of achieving SDGs in Russia. This article examines the policy pursued in Russia within the framework of the Climate Agenda. This issue, according to the authors, remains insufficiently covered in publications.

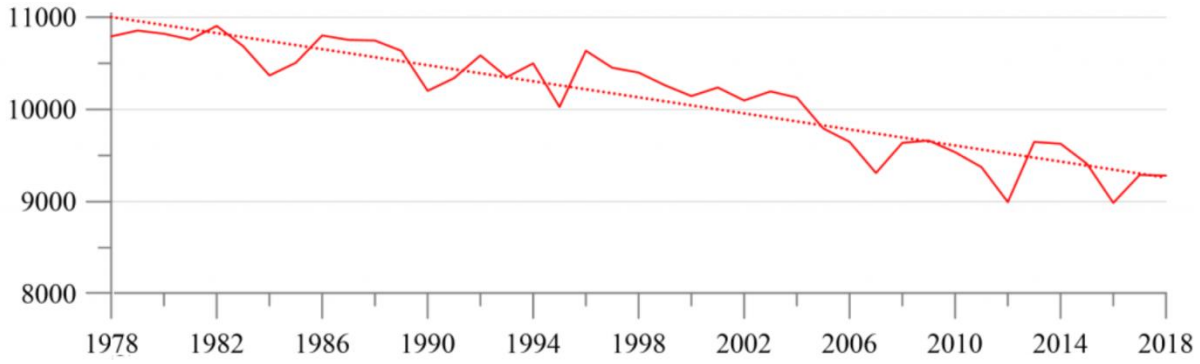
The essence of the Climate Agenda

Modern science has established the view that planet Earth is experiencing a process of global warming. According to current data from the World Meteorological Organization

(source: https://news.un.org/ru/story/2023/01/1436587), the last eight years have been the warmest in the world on record. Average global temperatures in 2022 were about 1.15°C above pre-industrial (1850-1900) levels. 2022 marked the eighth consecutive year in which annual global temperatures exceeded pre-industrial levels by at least one degree Celsius. The likelihood that the 1.5°C limit set by the Paris Climate Agreement (adopted December 12, 2015, entered into force November 4, 2016) will be exceeded is very high.

Global warming leads to changes in the life of the population, and also changes the structure of economic activity:

- *On the one hand*, these changes are evolutionary in nature. For example, there is a gradual melting of multi-year Arctic ocean ice (Figure 1). This can be considered in economic activities: it becomes possible to increase the duration of maritime navigation along the Northern Sea Route. This sea route between East Asia and Western Europe is significantly shorter than the traditional route through the Indian Ocean and the Suez Canal (Figure 2).



Source: Yulin, Vyazigina, and Egorova, 2019.

Figure 1: Average sea ice extent in the Arctic Ocean and Arctic seas, thousands sq. km

- *On the other hand*, dramatic changes are occurring. Due to the surprise factor, they can cause negative consequences. For example, "in 2023 (as of December 8), there have been 25 confirmed weather/climate disaster events with losses exceeding $1 billion each to affect the United States. These events included 1 drought event, 2 flooding events, 19 severe storm events, 1 tropical cyclone event, 1 wildfire event, and 1 winter storm event. Overall, these events resulted in the deaths of 482 people and had significant economic effects on the areas impacted. The 1980–2022 annual average is 8.1 events (CPI-adjusted); the annual average for the most recent 5 years (2018–2022) is 18.0 events (CPI-adjusted)" (NOAA, 2023).



Source: Kumari, 2023.

Figure 2: Northern Sea Route

The result of these changes, especially unexpected ones, is a decrease in the level of sustainable development. In this regard, within the framework of the Paris Climate Agreement, countries around the world are making consolidated efforts aimed at combating climate change. The effectiveness of these measures remains an open question. Despite the fact that many governments, international and national organizations, companies, politicians and civil activists support the relevance of the Climate Agenda, there are also more cautious positions.

For example, at the G20 nations summit (New Delhi, 2023), the famous entrepreneur Elon Musk said that "climate change will definitely not end the world as we know it." He previously stated that "farming has no major effect on the climate" (source: https://www.businessinsider.in/sustainability/news/climate-change-will-definitely-not-end-the-world-as-we-know-it-elon-musk-shares-views-on-climate-crisis/articleshow/103593171.cms). The basis for such judgments, which diverge from the mainstream Climate Agenda, is insufficient scientific knowledge of the climate problem, which probably requires further research.

However, as part of the Paris Climate Agreement, countries around the world have committed themselves to combating climate change. Controlling greenhouse gas emissions is a priority within these commitments. To limit global warming to 1.5°C, global greenhouse gas emissions must peak no later than 2025 and fall by 43% by 2030. The contribution of

different countries to achieving these goals varies. The purpose of this article is to review the efforts of the Russian Federation in the implementation of the Climate Agenda.

Russian experience in climate regulation

The Russian Federation pursues a responsible policy in the field of sustainable development. Despite the turbulence of development caused by various negative events (Covid-19 pandemic, anti-Russian sanctions, etc.), commitment to achieving the Sustainable Development Goals and the Climate Agenda. In particular, the Russian Federation signed the Paris Climate Agreement on April 22, 2016. As part of the implementation of its obligations, Russia developed and adopted the Climate Doctrine of the Russian Federation (approved by Decree of the President of Russia dated October 26, 2023 No. 812). The Climate Doctrine regulates the development and implementation of measures of a new type of public policy at the national level. This is climate policy.

As one of the goals of climate policy, introduced by Decree of the President of the Russian Federation of November 4, 2020 No. 666 "On the reduction of greenhouse gas emissions" in Russia, it is established: to limit greenhouse gas emissions to 70% of the 1990 level by 2030. They should be no more than 2162.4 million tons of CO2 equivalent. At the same time, for example, the volume of greenhouse gas emissions in 2020 amounted to 1482.2 million tons of CO2 equivalent (48% of the 1990 level). To achieve this goal, Russia is working to create a low-carbon economy through systemic decarbonization of its industries. Unfortunately, its results are still insignificant (Table 1).

Table 1: Greenhouse gas emissions in Russia, million tons of CO2 equivalent

Economic sector	**2017**	**2018**	**2019**	**2020**	**2020/2017, %**
Energy	1637.0	1688.7	1682.3	1597.7	97.6
Industry	230.9	240.2	233.6	241.7	104.7
Agriculture	113.2	112.8	114.0	116.6	103.0
Land use and forestry	-603.5	-584.5	-559.0	-569.2	94.3
Waste	89.1	91.0	92.9	95.4	107.1
Balance	1466.8	1548.2	1563.8	1482.2	101.0

Source: Rosstat, 2022.

Judging by the latest available official statistics (Rosstat, 2022), during the period from 2017 to 2020, the balance of greenhouse gas emissions remains approximately at the same level. Over four years, emissions increased by 1%. At the same time, significant progress in energy should be noted. This sector of the economy is the main source of greenhouse gas emissions, accounting for 77.9% of total emissions in 2020. In the energy sector over the past four years, a decrease of 2.4% has been achieved. This is a consequence of systematic work carried out by both the authorities and the management of industry companies.

As shown in Table 2, progress is not observed in all technological processes associated with greenhouse gas emissions in the energy sector. The greatest success has been achieved from reducing emissions associated with the combustion of fossil fuels (3.8%). This is the largest source of emissions. Therefore, it seems logical and correct to focus efforts to reduce emissions on this particular technological process. Progress has been achieved through changes in the mix of primary energy generation, mainly due to an increase in the proportion of greener natural gas used.

Table 2: Greenhouse gas emissions in the energy sector, million tons of CO2 equivalent

Economic sector: energy	**2017**	**2018**	**2019**	**2020**	**2020/2017, %**
Total	1637.0	1688.7	1682.3	1597.7	97.6
including:					
fossil fuel combustion	1435.0	1471.7	1450.7	1380.9	96.2
losses and process emissions	202.1	217.0	231.6	216.8	107.3
including:					
extraction of solid fuels	65.1	68.5	68.2	64.0	98.3
processes related to oil and gas	137.0	148.5	163.4	152.8	111.5

Source: Rosstat, 2022.

In Russia, when developing and implementing climate policy, an institutional system has been created for coordinating the interests of all its actors (Table 3). The multi-subjectivity of the policy being pursued makes it possible to achieve not only the general stated goals, but to involve all available resources in its implementation, as well as to form a new system of values in society. This value system takes into account the Sustainable Development Goals, the Climate Agenda, as well as the traditional Russian principles of social relations, including those taking into account the multi-religious composition of the country's population.

It should be noted that Russia is the largest country in the world by area, therefore its climate policy considers its geographical and natural features. This makes it possible to use Russian experience in many other countries that are more homogeneous in terms of climatic conditions. A balanced approach to assessing the consequences of climate change is recommended, which considers not only negative (for example, increased fire danger in forests, degradation of permafrost in Arctic regions), but also positive effects (for example, reduction of thermal energy consumption during the heating season, expansion of crop production areas in agriculture farm).

Based on this balanced approach to assessment, a more restrained approach to climate change processes than is often practiced today is required. Along with the challenges and risks in achieving the SDGs, they can contribute – on the contrary – to progress on these issues. But to do this, it is necessary to promptly identify these positive effects and the factors that determine them, as well as adapt the economy and society to the changed conditions. This

should be carried out on the basis of integrating climate policy with other types of policies (regional, structural, industrial, energy, food, scientific and technical, etc.).

Despite the importance of political measures, it should be noted the importance of economic (motivational) mechanisms for implementing climate policy. These economic mechanisms should stimulate the adaptation of economic activity to new realities, as well as help reduce the anthropogenic impact on the climate. These mechanisms, in particular those regulating greenhouse gas emissions, are based on the method of internalizing external costs (negative externalities) that accompany business activities. Implementing such institutional innovations requires care to balance benefits and costs.

Table 3: Main subjects of climate policy in Russia

Subject	**Interests**
Federal executive authorities	Effective public administration, successful development of infrastructure, legal regulation of public relations, consideration of weather and climate factors and related risks in policy
Regional government bodies, local self-government bodies	High-quality medium- and long-term planning of socio-economic development of territories, considering the consequences of climate change in policies, developing measures to adapt to climate change
National and international business community	Reducing investment risks, developing investment activity, accounting and managing climate risks
Population	Considering the social and economic consequences of climate change (comfortable living, choice of place of residence, changes in the labor market, etc.), changing behavior patterns in the interests of reducing anthropogenic impact on the climate

Source: compiled by the authors based on materials from the Climate Doctrine of the Russian Federation.

Guided by this principle, in Russia, from September 1, 2022, an experiment to limit greenhouse gas emissions was launched on the territory of one of the constituent entities of the federation - the Sakhalin region. The experimental mode of operation of the regional economy is established by Federal Law No. 34-FZ of March 6, 2022 “On conducting an experiment to limit greenhouse gas emissions in certain constituent entities of the Russian Federation.” The experiment will last until December 31, 2028. If it is successful, the new institutional regime will be extended to other regions and, in the future, to the entire country.

The goal of this experiment is to achieve carbon neutrality of the economy. Achieving this goal is expected through government incentives for the introduction of technologies to reduce greenhouse gas emissions and increase their absorption. For this purpose, it is planned to form a system of independent verification of greenhouse gas emissions/absorption. The economic mechanism of the experiment is based on the formation of a new specific market for the circulation of carbon units and quota fulfillment units. Monitoring under the experiment will be carried out on the basis of mandatory carbon reporting. It should be noted

that the measures taken within the framework of the experiment are systematic, which gives reason to hope that other regions of Russia (besides the Sakhalin region) will be included in it by the end of 2028.

Conclusion

The UN Sustainable Development Goals system sets long-term development guidelines for the international community, countries, regions, companies and people. These goals balance development in three important areas: economic, environmental and social. Of particular importance is Goal 13: Climate Action (Take urgent action to combat climate change and its impacts). Its difference is that it is comprehensive; this goal concerns economic, environmental, and social development. Therefore, efforts to achieve it are of particular importance.

The study examined the approach to implementing the Climate Agenda in Russia. The difference between the Russian experience is that the country has created a separate institutional subsystem, within the framework of which a separate type of state policy is implemented – climate policy. An analysis of the Russian experience of public administration in the field of climate change indicates the need to consider the diversity of territorial conditions for conducting climate policy.

It is noted that climate policy measures (like climate change) can have both positive and negative impacts on the SDGs and on development in general. Therefore, it is necessary to form a special institutional substantive policy system in this area, which will balance the interests of all stakeholders. Considering the weak predictability of the results (especially at the micro level) of climate policy, it is recommended to use the Russian experience of its gradual implementation using methods of experimental economics.

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Risk Assessment: Risk management of construction projects

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Abbreviations.

VE – Value Engineering

BOQ – Bill of Quantities

Executive summary.

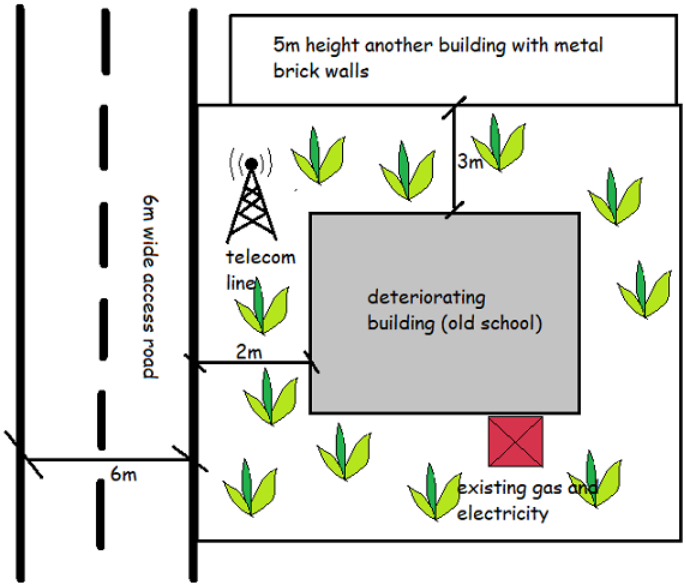
As cost consultants, our group was requested to evaluate the risk associated with a piece of property in the northern region of Sri Lanka. The landowner plans to create an apartment complex with internal roads, street lighting and a water supply. The historical information about the site was determined to be difficult to interpret since it was an old school building until the middle of 1988, the building that is currently on the plot is deteriorating, and the site is situated in an area where there are risks due to nearby buildings, telecom lines, underneath power and gas, and other hazards. All risks were identified during the brainstorming session in accordance with the brief, and additional risk diagrams were made. Although several other dangers are available in the risk register, our team only looked at the 13 linked risks.Task A gives a detailed explanation of each danger. One of the key components of the project was the risk register. Once every risk has been identified, the actions taken are examined, and the likelihood of residual risk is calculated. You may use the comparison diagram we provide as a resource for the developer of the property. After a risk probability analysis. Financial risk was determined to be the lowest recognized concern, while the oldest school building presented the most risk. The greatest percentage is permitted for physical and design risk later in the report. The contract amount is determined by comparing the scope of work to a previous project, and adjustments are made for quality, location, and time.The Sri Lankan sector is having difficulty with risk associated with material price. Our group used VE principles with one of these materials. Instead of using block walls for our proposed project, we intended to utilize ICC-ACOTEC wall panels since they are stronger, needless plastering, and can be installed more rapidly. it was believed that the ancient school was constructed with block walls.

Introduction.

Cost consultants' study on risk management is included in this paper. Numerous assessments are conducted about potential and hazards. A developer has acquired a block of land in Sri Lanka's north, as per the brief, with the intention of developing it with roads, street lights, and water supply tanks. The developer intended to create a 200-house apartment complex. The plot's historical information is as follows: up to the middle of the 1988s, the plot was a landfill (old school). The school building has been vacant and decaying for the last fifteen years; bushes and other plants around the property.

Task A – risks associated in the project.

Figure 01 – location of the proposed project



(Develop by author)

Above figure shows the exact location of the land that we are going to execute our proposed project. As you can see the area surrounding the current structure has a large portion of its surface covered with bushes and other plants. The property's north boundary is 3.0 metres away from the edge of another structure and has 5.0 meters-tall metal brick walls. A 6.0 m wide access road is located 2.0 m away from the west boundary. The current building is connected to outdated subterranean gas and electrical systems, and the location is used by telecom services to supply the building next door.Numerous dangers might arise during a construction job. Although there are risks associated with any project, the most important thing to remember is that risk management and identification are the keys to delivering projects successfully in terms of budget, schedule, quality, sustainability, and safety. Analyzing the primary risks associated with building projects and identifying their dangers are crucial. In the construction sector, risk assessment and management are essential actions to take before starting any project. Projects can be subject to a variety of risks, including those related to the environment, the economy, finances, sociopolitics, the law, planning or technical aspects, logistics, physical risk, management, contractual hazards, and managerial risk.

After reviewing historical data, our advisory team identified a number of significant impact concerns, including, financial risk, design and technical risk, environmental risk, social risk and physical risk, which might result from dangerous working conditions.Our team has analyzed the following risk in the preliminary stage of construction project.

Table 01 – risks identified at preliminary stage

Scenario	Type of risk	Risk associated
Used as old school until 1988's	**Physical risk**	Historical records of the land show that the building was used as an old school building until 1988. An old school building comes with challenges and risks inherent in both the physical structure (the building) and the land it sits on. Below are some common risks associated with old school buildings. **Structural Integrity** - This is an old building that may suffer from structural integrity, causing hazards such as collapsing walls, sagging roofs or weakened foundations. **Outdated infrastructure** – Older school buildings are vulnerable to having outdated electrical, plumbing and heating systems that are vulnerable to malfunctions, fires or other safety hazards. **Asbestos and Lead** – As this is an old building, it may contain materials such as asbestos and lead, which were widely used in construction but are now known to be hazardous to health. Exposure to these substances can eventually lead to serious health problems when inhaled. **Fire safety** - Aging wiring, lack of modern fire extinguishing systems or outdated fire exits can increase the risk of fire and make it difficult to evacuate the building safely. **Contamination** - The land may have been contaminated over the years, especially if there were previous industrial activities nearby, and this could pose a threat to the environment as well as the health of residents. **Pests, Rodents and Birds** – While bugs and rodents can be a problem in any structure, older buildings are prone to infestation. Poorly maintained structures have cracks and openings where rats and other small rodents can easily enter. **Infrastructural challenges** - Aging infrastructure in the surrounding area such as roads and utilities can affect the accessibility and functioning of the school.
Edge of building with metal brick walls	**Design and technical risk**	The design of the building should not cause any damage or demolition to the adjacent building. Technical risk is that vibration or movement of the site may cause **cracks and damage** to the adjacent building.
Access road hazards	**Logistics risk**	This land the west boundary is 2.0m offset from a 6.0m wide access road. here logistic risk.

		Traffic congestion: Risk: Limited access can cause traffic congestion, delaying the transportation of materials and personnel. **Limited Capacity:** Risk: Narrow or inadequate access roads may limit the size and type of vehicles that can be used, affecting the transport of large equipment. **Road maintenance and repair:** Risk: Regular maintenance or unexpected repairs on access roads can disrupt transportation. **Regulatory Compliance:** Risk: Failure to comply with local regulations related to transportation, road use and safety may result in delays or fines. **Community Relations:** Risk: Disruption due to construction traffic may lead to complaints from the local community.
Underground gas and electricity services	**Physical risk**	In this old building, the presence of old underground gas and electric services can pose various physical risks. **Corrosion and deterioration:** Underground pipes and cables can corrode and deteriorate over time, especially if they are made of materials such as iron or steel. It can cause leaks, ruptures or electrical faults leading to gas leaks, electrical fires or service interruptions. **Obsolete technology:** Outdated electric and gas systems may use technology that is no longer considered safe or efficient.Increased risk of electrical faults, equipment failure or outdated safety features. **Inadequate grounding:** Older electrical systems may lack proper grounding, increasing the risk of electric shock and equipment damage. Possibility of electrical accidents, especially malfunctions or malfunctions of equipment. **Material degradation:** Underground cables and pipes made of certain materials can degrade over time due to soil conditions, moisture or exposure to chemicals. Reduced infrastructure integrity leads to potential leaks, electrical shorts or failures.
Telecom line of adjoining building going through this building	**Social risk**	If there is any damage to the telecom line, the neighbouring building may lose some connectivity, which may disrupt the daily life of the residents or businesses of the other building. Be aware of cables passing through the site. As the land is surrounded by adjacent building and access road, proper communication should be maintained throughout the project. **Communication risk** exists on the site, the general public should monitor and be informed of updates.

(Develop by author)

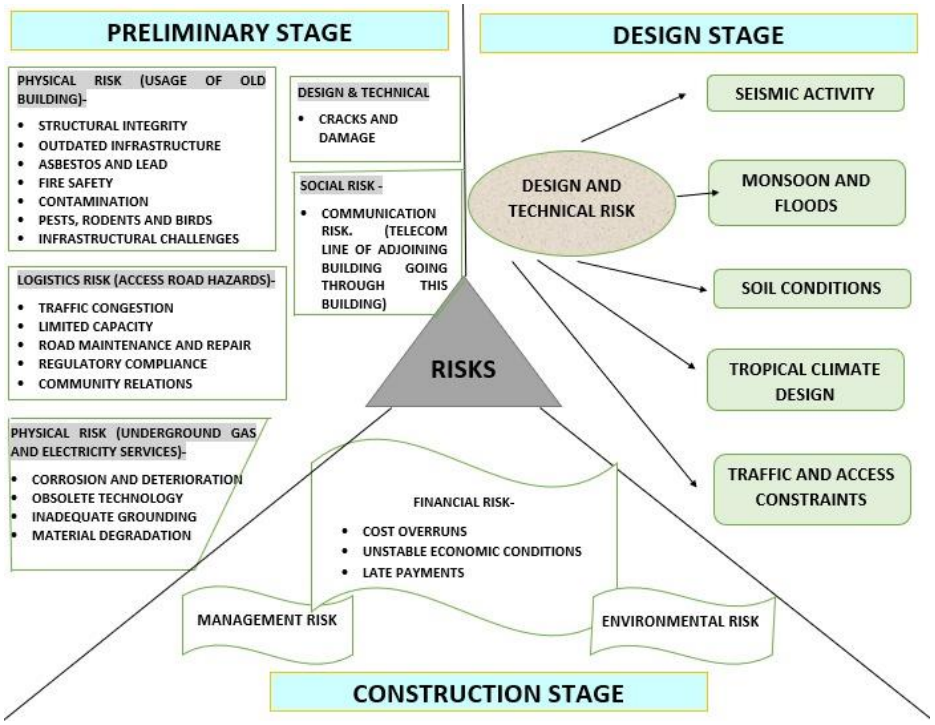
Table 02 – risks identified at design and construction stage

Stage	Type	Risk associated
Design	**Design and technical risk**	Construction is not just a small process to easily complete any project. There are many factors to consider and proper planning is critical to the success of any project. When constructing a building in a specific area such as northern part of Sri Lanka, there are planning and technical risks that may be more regionally specific. **Soil conditions:** A thorough geotechnical investigation should be carried out to understand the soil conditions. It is risky because different soil types may require different foundation designs. **Earthquake Risk:** Assessing the seismic risk of the region and designing the building to withstand potential earthquakes. **Availability of Utilities:** Ensuring the availability and reliability of essential utilities such as water, electricity and sewerage systems. In some areas, these services may not be well established, leading to potential challenges during construction and occupancy.
Construction	**Management Risk**	Improperly managed project scope changes can lead to cost overruns, delays, and potential conflicts. It is a risk in building construction.
	Financial risk	Financial risks in a construction project are the uncertainties and potential negative effects on the project's budget, cost and overall financial performance. These risks can arise from different sources and affect different aspects of the project. **Cost overruns** – Unexpected expenses or changes in project scope can result in costs exceeding the original budget. **Unstable economic conditions** – economic fluctuations, inflation or currency exchange rate changes can affect material, labor and finance costs. **Late Payments** – Late payments from clients, contractors or subcontractors can disrupt cash flow and affect project finances. There are also risks such as interest rate fluctuations, liquidity problems, contractual disputes, insurance coverage gaps, market fluctuations in material prices, supply chain disruptions, insufficient financial diligence, funding shortfalls, tax and regulatory changes.

	Environmental Risk	Demolition is a real risk. Of course, there are several major concerns for workers, including as noise, falling from a height, debris, mechanical failure, and structural collapse. Because of the aforementioned factors, there is a chance for serious harm. Death, broken bones, breathing issues, burns, and other accidents can result from working on demolitions.

The diagram below mentioned identifies all the risk involved in the project by our consultant team.

Figure 02 – illustration of risk identified



(Develop by author)

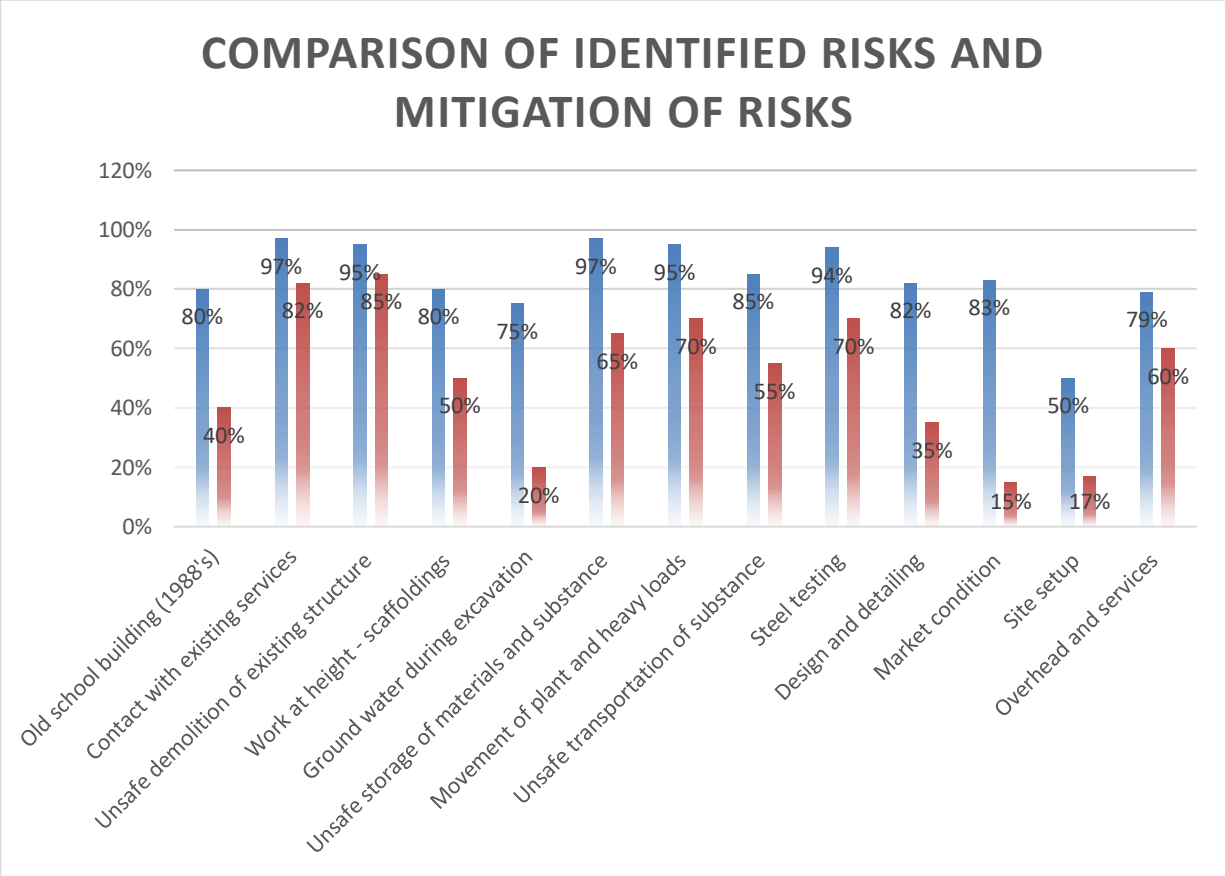
Task B – risk register.

Risk management is a crucial strategy that helps both the contractor and the client. Identifying risks at every stage of the agreement writing process and giving the right answers to each one will have a positive impact on the work's timeliness, quality, and cost.13 risks were discovered by our cost consultant team during this risk evaluation. Every risk has been identified by science and dealt with accordingly. The likelihood and effects of taking a risk, as well as the steps you're taking to lower those risks and their probability, are all described in a separate risk register worksheet that is attached to this report.We have included an additional document with the risk register that provides a numerical summary of the 13 hazards in the project together with their identified and residual risks.

Table 03 – table which elaborated the identified risk and residual risk in percentage.

No of Risks	Risks		Identified Risks		Residual Risk
1	Old school building (1988's)	H	80%	M	40%
2	Contact with existing services	E	97%	H	82%
3	Unsafe demolition of existing structure	E	95%	H	85%
4	Work at height - scaffoldings	H	80%	M	50%
5	Ground water during excavation	H	75%	L	20%
6	Unsafe storage of materials and substance	E	97%	H	65%
7	Movement of plant and heavy loads	E	95%	H	70%
8	Unsafe transportation of substance	H	85%	M	55%
9	Steel testing	E	94%	H	70%
10	Design and detailing	H	82%	M	35%
11	Market condition	H	83%	L	15%
12	Site setup	M	50%	L	17%
13	Overhead and services	H	79%	M	60%

Figure 03 – comparison chart of identified risk and mitigation of risk



(Develop by author)

Task C – risk allowance and application of value engineering concept.

As this is a Northern provincial council has allocated fund for constructing houses for people with middle range income. There 200 houses to be constructed Building. As this is an urban shipping project, there will be 5 similar apartments on the site. This medium-high rise building consists of 4 floors and is equipped with. Each apartment building has the same floor area.

Per one Building – 3521.03 m^2 (Total building area)

Figure 04 – front elevation of the proposed building



The medium high-rise building is built for residential purpose. Each floor comprises of 10 units, in total there will be 40 units. Our town ship project consists of 5 building with the total of 200 units with internal road development, supply of water with overhead tank and street lights. This information's are gathered from the outline Planning approval. Elemental cost planning is done referring to similar project at. In the below mentioned table we have included various adjustment to receive the contract sum. As cost consultants, we have assumed various percentage for the risks in the project.

Previous project data is given below. Summary of BOQ

Table 04 – previous project data

Project Name	Housing project in Rathnapura
Type of Project	Residential
Tender Date	2021.12.31
Documents based	BQ / Drawings etc.
Project Duration	16 months
GIFA	3,520.00

Table 05 – previous project elemental rate

		Element			
	Description	**Total Cost**	**Unit QTY**	**Unit**	**Unit Rate**
	Previous Housing Project in Rathnapura	592,965,162.27	3520.00	m^2	168,456.012

Elemental cost plan is done for the develop city project Northern provincial council has allocated 200 Housing scheme by referring to previous Housing Project in Rathnapura.

Table 06 – details for the develop city project at Jaffna

Project Name	NPC proposed 200 houses for people with middle range income.
Type of Project	Residential
Tender Date	2023.12.31
Documents based	BQ / Drawings etc.
Project Duration	24 months
GIFA	3,521.03

Table 07 – element cost plan of Jaffna Project

Time Index 1 (Previous Project): Base (December 2021):	947.30
Time Index 2 (New Project): Project (April, 2024):	1364.0
Location Index 1 (Previous Project): Base (Rathnapura)	0.582
Location Index 2 (New Project): Project (Jaffna)	0.866

item	**Description**	**Total Cost**	**Unit QTY**	**Element Unit Rate**	**Base Cost**	**Time adjustment**	**Location Adjustment**	**Quality Adjustment**
01	Block- 01	592,965,162.27	3521.03	168,456.012	593,138,671.93	854,049,560.34	1,270,802,266.76	1,270,802,266.76
02	Block- 02	592,965,162.27	3521.03	168,456.012	593,138,671.93	854,049,560.34	1,270,802,266.76	1,270,802,266.76
03	Block- 03	592,965,162.27	3521.03	168,456.012	593,138,671.93	854,049,560.34	1,270,802,266.76	1,270,802,266.76
04	Block- 04	592,965,162.27	3521.03	168,456.012	593,138,671.93	854,049,560.34	1,270,802,266.76	1,270,802,266.7

								6
05	Block- 05	592,965,162.27	3521.03	168,456.012	593,138,671.93	854,049,560.34	1,270,802,266.76	1,270,802,266.76
06	Internal Roads	**Lump SUM**						23,404,702.00
07	Water supply with overhead tank	**Lump SUM**						1,000,000.00
08	Internal Street Light	**Lump SUM**						750,000.00
09.	**Contract SUM**							**6,379,166,035.82**

Table 08 – cost of other services

Cost of other services							
Internal Road access	Length (m)	Width (m)	Thickness (m)	QTY	unit	Rate	Amount
Concrete	1000	6.00	0.15	900.00	M3	23,000.00	20,700,000.00
Road Side curb	1.00	0.25	0.25	2002.00	Nrs	1,351.00	2,704,702.00
	Total Amount of Internal Road Access						23,404,702.00
Water Supply							
Deep Well with overhead Tank	**Lump Sum**						1,000,000.00
Street Light							
Solar Street Lights	**Lump Sum**						750,000.00

Table 2: Allocation of risk is elaborated in the table.

Risk Allowance		
Contract Sum: - **6,379,166,035.82**		
Construction Risks	**Allocated percentage from contract sum**	**Risk allowance**
Physical Risk	1.87%	119,290,404.86
Design and technical Risk	1.60%	102,066,656.57
Logistics Risk	0.30%	19,137,498.11
Social Risk	0.36%	22,964,997.73
Management Risk	0.50%	31,895,830.18
Financial Risk	0.78%	49,757,495.08
Environment Risk	0.60%	38,274,996.21
Total amount of Risk allowances		**383,387,848.74**

Determine the necessary risk allowances based on the risks and opportunities found in the group project. Then, choose at least one opportunity and use value engineering to support it.

Selected Risk

The risk of large projects is affected by import bans as they can interrupt the flow of materials, equipment and other need, which then effect project execution. The regulatory environment around imports of some goods (such as, to prevent illegal logging or importation), may mean supply chain disruption and delay due to regulatory controls imposed upon them. In sensitively timed projects, this can be a risk, slowing progress and pushing up costs. The risk thus necessitates a robust risk management plan, including diversification of suppliers, robust compliance assessments of the importing environment and, most importantly, robust contingency plans for import bans. Succinct project description that includes, proactive engagement with the regulatory, monitoring of the policy environment, and that do meet this risk head-to-head will demonstrate that the bidder fully understands the nature of large project execution and care of cost, time and stakeholder impact.

Large scale projects that involve major capital investment are at risk from inflation because inflation can seriously affect both cost estimates and project budgets. Inflation can increase costs of labor, materials, and all other things the construction project involves. It therefore also erodes the budgeted purchasing power by contractor's project. This change in contractors initial staffing plan which could lead to unscheduled budget overrun. Carefully structure your contract, include inflation indices, incorporate cost escalation clauses and try to check or review periodically your budget estimates.

Minimizing the risk with value Engineering.

We recommend using ICC-ACOTEC Pre-cast panels as an alternative to Block work in this project in order to control the aforementioned high risk.

Method of reducing the risk associated with this value engineering suggestion.

ICC-ACOTEC precast panels to traditional blockwork, construction times are shortened due to their rapid installation and more dependable schedule is produced by faster construction, which reduces the possibility of project delays.

When installing precast panels, less effort is needed by hand than when putting individual blocks,by doing this, the project's reliance on a big labor force is reduced, lessening the possibility of labor shortages or delays.

Precast panel utilization could result in financial savings on the purchase of materials, handling, and shipping. To measure these advantages and illustrate the overall economic value, a thorough cost analysis ought to be carried out.

Long-term energy savings are possible because precast panels frequently offer better thermal insulation. Since the building's life-cycle performance is taken into account in addition to initial expenses, this is consistent with value engineering principles.

In conclusion, using ICC-ACOTEC precast panels is advised since it not only mitigates high risks that have been identified but also results in cost savings through value engineering. This method provides a well-rounded solution that is in line with efficiency, dependability, and cost-effectiveness by optimizing both the construction process and project economics.

Task D – limitation of methodology applied by the team members.

Table 10 – limitation of members

Member	Limitation
Deheme Dulanjee 1020577	Assembling team members for risk management during the construction of apartment buildings was a challenge. I did a thorough investigation and study of the complex nature of the topic. It took me a lot of time and effort to research the various hazards and risks posed by buildings. To my credit, I finished on time. In addition, working cooperatively with other team members, maintaining effective mutual communication was able to maintain rapport and trust among the team. Sources including books and journal articles needed to be used to gather essential information and data. Despite these challenges, our team maintained and completed a thorough operation that revealed our knowledge of risk management in residential buildings. This led to an increase in our knowledge.
Mohan Rumeshinee 1022651	For this group work, we arranged group meetings. During the brainstorming sessions, we divided the tasks among each and every one. I prepared the task “identifying the potential risks that could impact the project's delivery’. I noted down all the details we discussed during the brainstorming sessions and researched the risks according to the land area which located in north side. So I analyzed according to the weather condition, soil type, transport, storage and etc. It was really challenging and took some time to analyze. And we analyzed under three topics- preliminary, design and construction stage. Utilizing these details, I prepared a risk diagram. However, I encountered some issues inserting a lot of details into specific boxes and shapes.
Chathura Rangana 1029216	It has been difficult to form a task group for risk management during the construction of apartment buildings. Due to the topic's complexity, a thorough inquiry and analysis were required. I had to invest a lot of time and energy researching the different risks associated with construction, such as those related to labor, design, selection, environment, and so on. I've included an example drawing of the planned building and an efficient bar chart to help clarify the client consultation. Working with the other members of the group also presented a unique set of challenges, such as deciding who would be best to offer good reciprocal communication, which is an essential part of collaboration.
Rayees Akthar	I think a lot of coordination, trust, and communication skills

1023539	are necessary for good cooperation. Understanding the job and making a mental map to complete the assignment are the most crucial steps. It was my responsibility to enumerate certain risks and categories them in the project in compliance with the project brief. During the brainstorming session, all of the identified hazards were examined, with the most promising ones being selected for more discussion. But it soon became clear that it was challenging to arrange meetings with other team members. After that, the group was able to collaborate to its full potential as ideas were exchanged. Another important task I worked on was risk allocation; getting a contract amount through qualitative analysis was essential.
Mohamed Reznie 1029145	Furthermore, it was challenging to collect data using a qualitative research approach because of the conditions. Based on the given objective, our group was able to identify a few independent variables that affect risk in risk assessment. However, it was challenging to determine the relevance of the connection between theory and real events in the Sri Lankan setting. I was assigned the responsibility of evaluating the risks related to the current building loss effects on this property development. It is necessary to look into the reasons behind this building's deterioration in the specified area. As a result, I had to look for any projects with the same risk analysis in order to get the information I needed.
Janidu Thathsara 1019751	During our collaborative brainstorming session, we precisely defined the assignment and distributed it among the team members to ensure the report's success. The technical data needed to reach a judgement made it difficult to analyse the control mechanisms over the risk reduction process. I was forced to consider the project's actual circumstances in light of possible risk after entering the risk with probability in the risk matrix. In this case, my job was to pinpoint any potential issues that may come up during development as well as the risks connected to the building's immediate perimeter. Our team's research led to the identification of a few independent variables that affect risk in risk assessment.

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Exploring the impact of yoga interventions on the psychological health of student Athletes: A comprehensive research investigation.

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ABSTRACT

Yoga, recognized as a complementary or alternative approach to medical treatment, holds significant potential in addressing stress, anxiety, depression, and various mood disorders. Its manifold benefits encompass fostering a heightened sense of well-being, promoting relaxation, boosting self-confidence and body image, improving efficiency, nurturing better interpersonal relationships, enhancing attentiveness, reducing irritability, and cultivating an optimistic outlook. Acknowledging the traditionally observed high-stress levels among student-athletes attributed to the simultaneous demands of academics and athletics, a randomized controlled trial (RCT) was conducted to explore yoga's impact on psychological health, specifically stress management and well-being within this population. The study enrolled 40 student-athletes, with half (n=20) assigned to the control group and the remaining 20 forming the experimental group. The experimental group engaged in a structured 60-minute yoga session involving asanas and pranayama six days a week for eight weeks. To evaluate the psychological impact, the researchers employed the Psychological Well-being Scale (Ryff, C. D.,1989), focusing on dimensions such as Self-Acceptance, Positive Relations with Others, Autonomy, Environmental Mastery, Purpose in Life, and Personal Growth. Results from the study indicated a noteworthy enhancement in psychological health within the experimental group compared to the control group. This research provides valuable insights, suggesting that incorporating yoga into student-athletes routines positively influences their psychological well-being. The observed improvements have the potential to contribute to an overall enhancement in the performance of these athletes. As a holistic approach, yoga addresses the physical demands of sports and attends to the mental and emotional aspects, creating a comprehensive framework for improving the overall health and well-being of individuals engaged in rigorous athletic pursuits.

Keywords: Asanas, pranayamas, stress management, psychological well-being, psychological health

1. Introduction

Exploring positive aspects of psychological functioning within the social sciences unveiled a need for a more profound comprehension and research focus. A pivotal step in systematically investigating these positive dimensions was establishing an operational definition of psychological well-being. This task, however, posed a significant challenge due

to the inherently multifaceted nature of psychological well-being, as elucidated by Ryff'stheory (Ryff, C. D., & Singer, B., 1996). Ryff's theory encompasses Autonomy, Environmental Mastery, Personal Growth, Positive Relations with Others, Purpose in Life, and Self-Acceptance.

Yoga transcends its physical well-being benefits, encompassing stress reduction, anxiety management, depression mitigation, and improved mood regulation. Beyond physiological effects, studies underscore positive impacts on self-confidence, body image, interpersonal relationships, and overall outlook on life. Yoga induces notable structural and functional changes in the brain, akin to "weightlifting for the brain" (Harvard Health Publishing, n.d.). Harvard Health Publishing notes the holistic impact of yoga and meditation, emphasizing its positive effects on executive functions, including reasoning, decision-making, memory, learning, reaction time, and accuracy on mental acuity tests.

Within the clinical landscape endorsing exercise for Parkinson's disease (PD), a noticeable gap exists in randomized clinical trials comparing yoga to conventional physical exercises for stress and symptom management in PD patients. Notably, Kwok et al.'s (2019) study provided valuable insights, revealing that a mindfulness yoga program demonstrated comparable effectiveness to standard rehabilitation and exercise (SRTE). The mindfulness yoga program additionally yielded benefits, including a reduction in anxiety and depressive symptoms and improvements in spiritual well-being and health-related quality of life (HRQOL).

Mind-body interventions, with yoga at the forefront, have become prevalent in managing depression. Cramer et al.'s (2013) review not only emphasizes the popularity of yoga in this context but also suggests its potential as a supplementary treatment for depressive disorders. Building upon this, de Manincor et al. (2016) demonstrated the efficacy of combining yoga with regular care in reducing symptoms of depression. Supporting the therapeutic role of yoga, Maddux et al. (2018) reported significant reductions in stress and improvements in psychological health measures among participants engaging in 8- and 16-week gym yoga programs. Additionally, Hagen et al. (2023) shed light on the impact of yoga on young individuals' awareness and mental well-being, suggesting its potential to empower healthier lifestyle choices. This collective body of research underscores yoga's multifaceted and profound impact on various dimensions of well-being, making it a promising avenue for enhancing mental health and overall quality of life.

Amidst the extensive exploration of the positive impact of yoga interventions on psychological well-being, a discernible research gap exists, particularly in the context of student-athletes. Despite the burgeoning evidence supporting the efficacy of yoga in diverse populations, there is a scarcity of comprehensive studies specifically investigating its effects on the psychological well-being of student-athletes. This gap is notable in the literature, especially concerning the nuanced challenges and stressors unique to this demographic.The present study aims to bridge this research gap by focusing on the psychological well-being of student-athletes enrolled in affiliated colleges of MG University, Kottayam. Student-athletes experience distinctive pressures arising from both academic and athletic commitments, necessitating tailored interventions that address their specific needs. While existing research provides valuable insights into the general population's response to yoga, a dedicated investigation into the impact on student-athletes is imperative.

2. Materials and Methods

Adhering to predetermined inclusion and exclusion criteria, we initially recruited 40 participants for this study. However, attrition during the later stages reduced the final sample size to 40 participants (N=40) for data collection. We specifically focused on recruiting student-athletes at the main campus of MG University, Kottayam. The university ethics committee approved the study after a comprehensive overview. All study participants provided explicit and informed consent.

2.1 Experimental Design and Participants

Utilizing a randomized controlled trial (RCT) design, the study employed convenience sampling to allocate participants into two groups after the initial screening process. Specifically, the experimental group, comprised of 20 volunteers for a yoga exercise program, contrasted with the control group, which included 20 participants maintaining their daily routines without intervention. The final statistical analysis encompassed 40 student-athlete participants, evenly distributed between the experimental and control groups.

2.2 Yoga Wellness Programme

Implemented over twelve weeks, the ongoing yoga program, occurring thrice weekly, sought to furnish participants with complimentary equipment. Each 60-minute session adhered to a curriculum accentuating the physical facets of yoga practice. This curriculum, tailored for achieving an aerobic workout and optimizing energy metabolism processes, emphasized continuous yoga—a cyclic practice allowing minimal rest periods. The selected asanas aim to fortify and align the trunk and lower extremities. Validated by experts in yoga and sports science teachers, the yoga sessions entailed instructional demonstrations followed by participant practice, encompassing three phases within the 60-minute timeframe. The program spanned five days a week, excluding Saturdays and Sundays, for twelve weeks.

In response to the unique needs of student-athletes, the curriculum incorporated continuous yoga practices, integrating stretching techniques, sun salutations, and mindful meditation and breathing exercises. This comprehensive approach received validation from university yoga instructors and involved 20 student-athletes in the intervention group.

2.3 Testing of Psychological Well-being

The Psychological Well-being Scale (SPWB), developed by Ryff in 1989 and Ryff et al. (2010), is a self-report instrument designed to assess psychological well-being with 18 items. The scale encompasses six subscales: Autonomy, Environmental Mastery, Personal Growth, Positive Relationships with Others, Purpose in Life, and Self-Acceptance. Each subscale consists of three items evenly distributed between positive and negative statements.

This research focuses on assessing psychological well-being using the Ryff Inventory across various dimensions. Autonomy, reflecting independence and the ability to regulate behavior despite social pressures, is measured through statements like "I have confidence in my opinions, even if they are contrary to the consensus." Environmental Mastery assesses an individual's effectiveness in managing ecological factors and activities, with statements such as "In general, I feel I am in charge of the situation in which I live." Personal Growth explores

one's receptiveness to new experiences and recognition of self-improvement over time, captured by statements like "I think it is important to have new experiences that challenge how you think about yourself and the world." Positive Relations with Others gauge meaningful connections, empathy, and affection, with an example statement being, "People would describe me as a giving person, willing to share my time with others" (Seifert, T. A., 2005). This comprehensive evaluation aims to provide insights into the psychological well-being of individuals across diverse dimensions.

Participants express their responses on 7 points Likert scale from 1 = strongly agree; 2 = somewhat agree; 3 = a little agree; 4 = neither agree nor disagree; 5 = a little disagree; 6 = somewhat disagree; to 7 = strongly disagree, with certain items being reverse-coded. Subscale scores are obtained by summing the responses. The total score, derived from the sum of the 18 items, reflects higher psychological well-being within the respective dimension. Completion of the SPWB takes approximately ten minutes.

2.4. Analytical Approach and Statistical Methods

The statistical analysis for this study was conducted using IBM SPSS® Statistics version 25, employing a comprehensive approach that integrated Descriptive Statistics, Univariate Analysis of Covariance (ANCOVA), and Multivariate Analysis of Covariance (MANCOVA). Our aim was to thoroughly evaluate the impact of the 12-week yoga intervention program on the psychological well-being of student-athletes, measured using the Psychological Well-being Scale (SPWB).

ANCOVA and MANCOVA were selected as our primary analytical methods, designed to improve the precision of detecting treatment effects by adjusting observed values of the response variable (Y) for the influence of concomitant variables (X). ANCOVA specifically focused on univariate analysis, comparing intervention groups before and after the yoga program. This approach considered covariates, ensuring a more accurate detection of treatment effects. A significance level of $p < 0.05$ was deemed indicative of statistical significance in ANCOVA.

Additionally, MANCOVA expanded the analysis to multiple dependent variables simultaneously, providing a comprehensive understanding of the treatment's impact across various dimensions of psychological well-being. The inclusion of covariates in both ANCOVA and MANCOVA was deemed essential to minimize errors in identifying actual differences in response due to treatments, ensuring a robust and standardized assessment of psychological well-being.

This meticulous analytical approach was adopted to enhance the reliability and validity of our findings, contributing to a nuanced evaluation of the effectiveness of the yoga intervention program in fostering positive psychological well-being among student-athletes.**3.**

Results

Table 1. Adjusted marginal means of post-test of control and experimental groups of Psychological Well-being Scale (SPWB)

Dependent Variable		Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Autonomy Post	Control	12.904[a]	0.469	11.948	13.860
	Experimental	15.546[a]	0.469	14.590	16.502
Environmental Mastery Post	Control	14.112[a]	0.170	13.766	14.457
	Experimental	15.038[a]	0.170	14.693	15.384
Personal Growth Post	Control	13.479[a]	0.371	12.723	14.235
	Experimental	14.421[a]	0.371	13.665	15.177
Positive Relations with Others Post	Control	12.332[a]	0.210	11.904	12.759
	Experimental	13.018[a]	0.210	12.591	13.446
Purpose in Life Post	Control	12.334[a]	0.243	11.839	12.828
	Experimental	13.616[a]	0.243	13.122	14.111
Self-Acceptance Post	Control	15.940[a]	0.160	15.613	16.267
	Experimental	16.960[a]	0.160	16.633	17.287
Psychological Well-being Post	Control	81.100[a]	0.761	79.549	82.650
	Experimental	88.600[a]	0.761	87.050	90.151

a. Covariates appearing in the model are evaluated at the following values: Autonomy Pre = 12.85, Environmental Mastery Pre = 14.25, Personal Growth Pre = 13.92, Positive Relation with Others Pre = 12.50, Purpose in Life Pre = 12.65, Self-Acceptance Pre = 16.05, Psychological Well-being Pre = 82.23.

Table 1 presents the adjusted marginal means of post-test scores for the control and experimental groups on the Psychological Well-being Scale (SPWB). The analysis encompassed key dimensions of psychological well-being, including Autonomy,

Environmental Mastery, Personal Growth, Positive Relations with Others, and Purpose in Life, Self-Acceptance, and the overall Psychological Well-being score.

The results exhibit noteworthy differences between the control and experimental groups across various dimensions of psychological well-being. For instance, the experimental group demonstrated higher mean scores in Autonomy, Environmental Mastery, Personal Growth, Positive Relations with Others, and Purpose in Life, Self-Acceptance, and the total Psychological Well-being score compared to the control group. The confidence intervals further underscore the robustness of these differences.

To delve deeper into the impact of the treatment, a multivariate analysis of variance (MANOVA) was conducted on the combined dependent variables. The results, considering Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root, indicated statistical significance, with Wilks' Lambda = 0.263, F (6, 27) = 12.607, $p < .001$, and a substantial partial eta squared of 0.737. This signifies a significant effect of the treatment on the set of dependent variables, emphasizing the effectiveness of the yoga intervention program in influencing psychological well-being.

To ensure the robustness of the analysis, Levene's Test was applied to examine the assumption of homogeneity of variances for each dependent variable. While significant differences were observed for Autonomy Post and Psychological Well-being Post, the majority of dimensions, including Environmental Mastery, Personal Growth, Positive Relation with Others, Purpose in Life, and Self-Acceptance, exhibited homogeneity of variances.

These findings contribute to the existing literature by highlighting the positive impact of yoga interventions on various facets of psychological well-being among student-athletes. The observed differences align with and extend previous studies, affirming the potential of yoga as a holistic approach to enhance overall mental well-being.

Table 2. ANCOVA Results for Post-test Dependent Variables between Control and Experimental Groups

Tests of Between-Subjects Effects							
Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Treatment	Autonomy Post	61.419	1	61.419	14.892	0.001	0.318
	Environmental Mastery Post	7.561	1	7.561	14.003	0.001	0.304
	Personal Growth Pre	7.804	1	7.804	3.027	0.092	0.086
	Positive Relations with Others Post	4.146	1	4.146	5.032	0.032	0.136
	Purpose in Life Post	14.476	1	14.476	13.125	0.001	0.291
	Self-Acceptance Post	9.169	1	9.169	19.013	0.000	0.373
	Psychological Well-being Post	495.024	1	495.024	45.628	0.000	0.588

Table 2 presents the results of the Analysis of Covariance (ANCOVA) conducted on post-test dependent variables, comparing the control and experimental groups across various dimensions of psychological well-being.

Significant differences were identified between treatment groups for Autonomy Post ($F(1, df) = 14.892$, $p = 0.001$, partial eta squared = 0.318), Environmental Mastery Post ($F(1, df) = 14.003$, $p = 0.001$, partial eta squared = 0.304), Positive Relations with Others Post ($F(1, df) = 5.032$, $p = 0.032$, partial eta squared = 0.136), Purpose in Life Post ($F(1, df) = 13.125$, $p = 0.001$, partial eta squared = 0.291), Self-Acceptance Post ($F(1, df) = 19.013$, $p < 0.001$, partial eta squared = 0.373), and Psychological Well-being Post ($F(1, df) = 45.628$, $p < 0.001$, partial eta squared = 0.588). These findings, with p-values below the conventional threshold of 0.05, indicate substantial differences between the treatment groups in these post-test dependent variables, leading to the rejection of the null hypothesis.

Effect sizes, as measured by Partial Eta Squared, were also assessed. Psychological Well-being Post exhibited a substantial effect size with a Partial Eta Squared value of 0.588, indicating a large impact associated with the treatment. Conversely, Personal Growth Pre yielded a p-value of 0.092, exceeding the 0.05 threshold. In this instance, the null hypothesis would not be rejected, suggesting insufficient evidence to conclude a significant difference between treatment groups for Personal Growth Pre.

These outcomes align with previous studies emphasizing the positive impact of yoga interventions on psychological well-being. The substantial effect sizes underscore the robustness and clinical significance of these differences, contributing valuable insights to the existing literature and affirming the efficacy of the yoga intervention program in enhancing diverse dimensions of psychological well-being among student-athletes.

Table. 3 Pairwise comparison between treatments

Dependent Variable			Mean Difference (I-J)	Std. Error	Sig.[b]
Autonomy Post	Control	Experimental	-2.642*	0.685	0.001
	Experimental	Control	2.642*	0.685	0.001
Environmental Mastery Post	Control	Experimental	-.927*	0.248	0.001
	Experimental	Control	.927*	0.248	0.001
Personal Growth Post	Control	Experimental	-0.942	0.541	0.092
	Experimental	Control	0.942	0.541	0.092
Positive Relation with Others Post	Control	Experimental	-.686*	0.306	0.032
	Experimental	Control	.686*	0.306	0.032
Purpose in Life Post	Control	Experimental	-1.283*	0.354	0.001
	Experimental	Control	1.283*	0.354	0.001
Self-Acceptance Post	Control	Experimental	-1.021*	0.234	0.000
	Experimental	Control	1.021*	0.234	0.000
Psychological Well-being Post	Control	Experimental	-7.501*	1.110	0.000
	Experimental	Control	7.501*	1.110	0.000

Significant at the .05 level.

Table 3 presents the pairwise comparisons between the control and experimental groups for various dependent variables, shedding light on the nuanced distinctions in psychological well-being following the yoga intervention program.

Significant mean differences were observed in Autonomy Post, indicating a substantial distinction between the control and experimental groups (Mean Difference = -

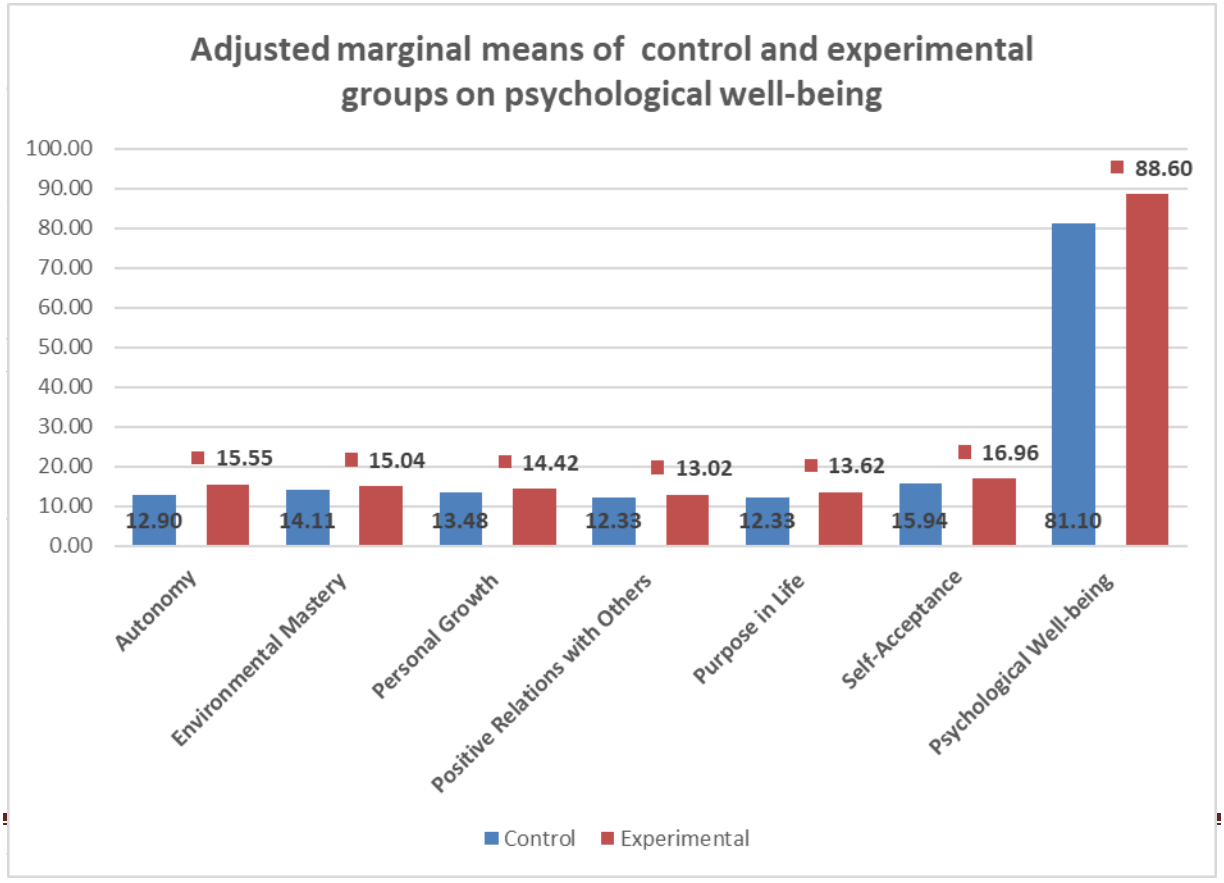
2.642, Std. Error = 0.685, p = 0.001). This finding suggests a notable impact of the intervention on autonomy levels. The converse comparison, from experimental to control, also yielded a statistically significant mean difference (Mean Difference = 2.642, Std. Error = 0.685, p = 0.001), reinforcing the robustness of the observed effect.

Consistent patterns of significant mean differences were evident across other dependent variables, including Environmental Mastery Post, Positive Relation with Others Post, and Purpose in Life Post, Self-Acceptance Post, and Psychological Well-being Post. Each pairwise comparison demonstrated statistically significant differences at the 0.05 significance level, emphasizing meaningful distinctions in scores between the experimental and control groups on these post-test variables.

However, for the dependent variable Personal Growth Post, the observed mean difference did not reach statistical significance (Mean Difference = -0.942, Std. Error = 0.541, p = 0.092). This result suggests insufficient evidence to assert a substantial difference between the treatment groups concerning personal growth.

To address the risk of inflated Type I errors due to multiple comparisons, the Sidak method was employed for adjustment, setting the significance level at 0.05. This approach ensures rigorous control for the overall experiment-wise error rate. These findings align with the broader body of research, showcasing the positive impact of yoga interventions on various dimensions of psychological well-being, while also highlighting the need for nuanced interpretation and consideration of specific variables.

Fig.1 Adjusted Marginal means of control and experimental groups on psychological wellbeing



The physical exercises (asanas) in yoga enhanced physical flexibility, coordination, and strength, while breathing practices and meditation were associated with calming and focusing the mind, reducing anxiety, and potentially leading to a higher quality of life (Kirkwood et al., 2005). Other benefits encompassed reduced distress and blood pressure, along with improved resilience, mood, and metabolic regulation (Yang, 2007).

Psychological well-being, a crucial aspect of overall health and happiness, encapsulates subjective experiences such as happiness, life satisfaction, and a sense of purpose. Its components, including positive and negative emotions, autonomy, positive relationships, purpose in life, and personal growth, are interconnected, contributing to an enhanced overall well-being. Sustaining high levels of psychological well-being is vital for leading a fulfilling life.

According to Dhanabhakyam and Sarath (2023), psychological well-being requires continuous attention and care. Individuals can nurture their psychological well-being through activities that foster personal growth, positive relationships, and a sense of purpose and meaning in life. This study sheds light on the potential of yoga interventions in enhancing the psychological well-being of student-athletes, emphasizing the importance of holistic approaches in promoting mental and emotional health. These findings contribute to the broader literature, reinforcing the positive impact of mindfulness-based practices on psychological well-being, while also underscoring the need for tailored interventions to address specific dimensions of well-being.

5. Conclusions

In conclusion, the study has provided valuable insights into the impact of an ongoing yoga intervention on the psychological well-being of student-athletes affiliated with MG University, Kottayam. The results indicate that the experimental group, exposed to the yoga training program, exhibited significantly higher psychological well-being levels than the control group. This was evident across various dependent variables, including Autonomy Post, Environmental Mastery Post, and Positive Relations with Others Post, Purpose in Life Post, Self-Acceptance Post, and Psychological Well-being Post.

The multivariate analysis of variance (MANOVA) revealed a significant effect of the treatment on the set of dependent variables, with Wilks' Lambda reaching statistical significance. Additionally, pairwise comparisons further highlighted substantial mean differences, emphasizing the effectiveness of the yoga intervention in enhancing specific aspects of psychological well-being among student-athletes.

However, it is crucial to note that not all dependent variables showed significant differences, particularly in the case of Personal Growth Pre. This nuance suggests the need for a more nuanced understanding of the intervention's impact on various dimensions of psychological well-being.

6. Future Research Directions

Long-term Effects: Investigate the long-term effects of the yoga intervention on the sustained psychological well-being of student-athletes. This could involve follow-up assessments over an extended period.

Individual Differences: Explore potential moderating factors or individual differences that may influence the effectiveness of the yoga intervention on psychological well-being. Consider demographic, personality, or lifestyle variables.

Dose-Response Relationship: Examine the dose-response relationship between the frequency and duration of yoga sessions and the resulting psychological well-being outcomes. This could provide insights into optimizing intervention protocols.

Comparison with Other Interventions: Compare the effectiveness of yoga interventions with other well-being interventions, such as mindfulness-based practices or cognitive-behavioral therapies, to identify the most suitable approach for student-athletes.

Contextual Factors: Investigate contextual factors, such as the presence of a supportive environment or the role of peer influence, that may enhance or impede the impact of yoga interventions on psychological well-being.

In conclusion, while the current study provides promising evidence of the positive effects of yoga on psychological well-being among student-athletes, ongoing research is necessary to deepen our understanding of the mechanisms and optimize intervention strategies for sustained and comprehensive mental and emotional health benefits.

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Cannabis sativa as a therapeutic agent towards breast cancer

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Abstract

Cannabis Sativa is a herbaceous, dioecious and an annual plant with a height of 1-2m growing predominantly in central Asia. Cannabis has a rich profile of active phytochemicals. Plant extracts of cannabishave shown more than 545 active compounds in cannabis. The primary metabolites include amino acids, sugars, fatty acids, and vitamins. Therefore, primary metabolites are used for its nutritional value. Secondary metabolites include cannabinoids, terpenoids (monoterpenoids, sesquiterpenoids, triterpenoids), sterol and flavonoids. Cannabinoids and other isolated secondary metabolites of cannabishave antimicrobial effects and vast number of therapeutic effects in alleviating side effects associated with chemotherapy, chronic pain and cytotoxic effects in cancer cells exhibiting anti-cancerous effect. The key pharmacological properties displayed by the bioactive compounds are anti-inflammatory, anti-tumor, antioxidant, antinociceptive, antidepressant, antimicrobial, neuroprotective, analgesic, anticonvulsant, anti-pruritic and lowers blood pressure. The anticancer properties of secondary metabolites such as phytocannabinoids, terpenes and flavonoids have been discussed in this study against various breast cancer cell lines. Alterations to key cell signaling pathways, genes, transcription factors, enzymes and interaction with the endocannabinoid receptors were evident in breast cancer cell lines treated with cannabisbioactive compounds. Additionally, synthetic analogs of cannabinoids have been found to exhibit anti-cancer effects in breast cancer cell line.

Keywords: Phytocannabinoids, Terpenes and Flavonoids, breast cancer cell line, synthetic cannabinoids

Main Conference Topic : Sustainability

Introduction

Cannabisis a herbaceous, dioecious and an annual plant with a height of 1-2m growing predominantly in Central Asia. The plant belonging to the *Cannabaceae*family grows in a temperate and tropical climate(Gonçalves et al., 2019;Breijyeh et al., 2021). Cannabis has three main species as *Cannabis sativa*, *Cannabis indica* and*Cannabis ruderalis*(Solymosi &Kofalvi, 2017). Cannabisis termed as marijuana, hashish and as hemp inpublic. Accordingto UNODC(United Nations Office on Drug and Crime), *Cannabis* was the most consumed drug in the world as of 2022 (UNODC, 2022). The herb is built across many controversies due to its rich chemical profile and for its psychoactive nature. Essentially, in the past cannabiswas considered as a drug by many but now the focus has turned towards its therapeutic benefits due to advanced scientific research(de A. Leite et al., 2018). Few countries that have allowed the use of cannabisfor medical purpose are Australia, Canada, Cyprus, Chile, Croatia, Czech Republic, Germany, Israel, Italy, Puerto Rico, and the USA(Solymosi &Kofalvi, 2017).

Cannabishas a rich profile of active phytochemicals. Plant extracts of cannabishave shown more than 545 active compounds. These active compounds contain primary metabolites and secondary metabolites which are synthesized through cellular metabolism of cannabis(Lowe et al., 2020). The primary metabolites include amino acids, sugars, fatty acids, and vitamins. Therefore, primary metabolites are used for its nutritional value. Secondary metabolites include cannabinoids, terpenoids (monoterpenoids, sesquiterpenoids, triterpenoids), sterols and flavonoids(Jin et al., 2020). The secondary metabolite of highest concentration is cannabinoids. There are over 120 varieties of cannabinoids identified(Breijyeh et al., 2021). Cannabinoids and other isolated secondary metabolites of cannabishave antimicrobial effects and vastnumber of therapeutic effects in alleviating side effects associated with chemotherapy, chronic pain and cytotoxic effects in cancer cells exhibiting anti-cancerous effects(Verma et al., 2021).

2.0 Hallmarks of cancer cellsand keyfactors involved in carcinogenesis

Cancer is a chronic disease caused by abnormal multiplication of cells due to alterations in the cellular processes. Genetic alterations such as mutations, epigenetic alterations, hypoxia, and dysregulated autophagy are some factors that could potentiallylead to cancer(Rankin et al., 2016). Cancer is the second most leading cause of death and as of 2018, the disease has killed more than 9.6 million lives (Verma et al., 2021). Cancer cells are quite unique due to their key characteristics. The key characteristics are called the Hallmarks of Cancer cells. A cancer cell has a total of eight hallmark characteristics which are sustaining proliferative signaling, evading growth suppressors, resisting apoptosis, cell immortality, inducing angiogenesis, induction of metastasis, deregulated cellular energetics and metabolism, and hijacking the immune system (Hanahan & Weinberg, 2011; Zhou et al., 2020).Furthermore,new hallmarks of cancer cells arededifferentiation/transdifferentiation, epigenetic dysregulation, altered microbiome and altered neuronal signaling (Senga & Grose, 2021).

Cancer cells survive past a cells' normal life span causing uncontrollable proliferation. Proper regulation of cell cycle is lost in cancer cells. The changes in a cancer cell include phenotypic changes that cause epithelial to mesenchymal transition (EMT) and cell migration, hypoxia of localized

cellular regions that contributes to cell survival and proliferation and angiogenesis(Feitelson et al., 2015; Harris, 2002).

Genetic alterations induced by chemical mutagens like Ethidium Bromide (EtBr) and physical mutagens like ultra-violet (UV) radiation and gamma (ɣ) radiation induces damages to the DNA structure. Mutations in deoxyribonucleic acid(DNA), specifically in oncogenes, tumor suppressor genes or cell cycle regulatory genes could cause accelerated DNA replication surpassing the DNA repairing mechanism leading to tumor formation (Basu, 2018).

According to biologist Conrad H. Waddington, the initial description of epigenetics means 'the study of heritable changes in gene expression mediated by mechanisms other than alterations in primary nucleotide sequence of a gene'. Epigenetic regulations that include abnormal DNA methylation, deregulated microRNA (miRNA) and non-coding RNA and variations in histone modification have been evidently observed in cancer cells. Epigenetic alterations in key tumor suppressors and oncogenes have been directly associated with cases of colorectal cancer cells (Bird, 2002; Okugawa et al., 2015).

Autophagy, which is a highly regulated mechanism to recycle any cytoplasmic constituents, is a key factor in cancer cell proliferation. Autophagy has dual effects as it can promote both cancer cell survival and cancer cell death(Rosenfeldt & Ryan, 2011). Additionally, the basal level of autophagy increases in cancer cells due to cells being exposed to stressful conditions such as dysregulated proliferative signal, enhanced glycolysis, hypoxia and to maintain prolonged quiescence(Lu et al., 2008). Autophagy promotes tumorigenesis by increased cellular plasticity and metabolic adaptations in cancer stem cells. Autophagy also can cause the cancer cells to metastasize, by being dormant and unresponsive to medical therapies. Additionally, autophagy involves tumor suppressor genes and oncogenes which are stringently regulated by epigenetic modification. Pathological epigenetic modifications like DNA hypomethylation triggers autophagy associated genes to express oncogenic traits that could lead to cancer (Mandhair et al., 2021). Meanwhile, autophagy can inhibit Natural Killer (NK) cell mediated lysis of cancer cells in hypoxic tumor cells(Baginska et al., 2013).

Hypoxia, which also means low oxygen levels in body tissues, is a key molecular feature of tumor microenvironment (TME) that elicits metastatic character of tumors(Rankin et al., 2016). Hypoxia develops due to an imbalance in oxygen levels caused by inefficient oxygen exchange in cells. The Hypoxic state of cells activates the hypoxia inducible factor -1 (HIF-1) and hypoxia inducible factor – 2 (HIF-2) dependent system. HIF-1 and HIF-2 together aid the cells to adapt to hypoxic environment by stimulating angiogenesis, glycolysis, invasion, migration, and erythropoiesis in cells(Semenza, 2012).

HIF 1 and 2 are clinically proven to be associated with metastasis and vigorous forms of cancers(Jin et al., 2015).

Hypoxic TME can suppress the immune responses by being resistant to cytotoxic CD8+ T cell (CTL) mediated killing. Routinely, CTL release granzymes and perforins targeting cancer cells to induce apoptosis. In Contrast, Antiapoptotic responses are activated by HIF in cancer cells. HIF signalingupregulates CD38/CD73 enzymes that can inhibit lymphocyte cytolytic function by accumulating adenosine in extra cellular matrix. Additionally, hypoxia provides an ideal environment for the generation and maintenance of Cancer Stem Cell (CSC) by activating genes such as OCT4, SOX2, NANOG,KLF4 and C-MYC which pushes the cell towards cell division(Zhang et al., 2016;Barnhart & Simon, 2007).

2.1Currently used chemotherapeutic agents and the necessity for novel drugs

Many decades ago, there were only limited treatments for cancer patients. Invasive treatments such as surgeries and non – invasive, radiation therapy and chemotherapy were the treatments available for patients. Cancer treatment is administered to patients in two ways. The most common treatment is the conventional (traditional) treatment and the novel treatments(Roy & Li, 2016).Conventional treatment is when the tumor is excised from the body surgically followed with radiotherapy or chemotherapy(Abbas & Rehman, 2018). Chemotherapy and radiotherapy usually levy genotoxicity in cancer cells by producing reactive oxygen species (ROS) to destroy the tumors(El-Hussein, 2021).

Currently, the majority of the clinical trials are focused on finding novel cancer therapeutics. The ongoing clinical trials are updated in www.ClinicalTrials.gov database, mainly focusing on the efficacy of modern therapies like stem cell therapy, targeted drug delivery using nanomedicine, immunotherapy, and gene therapy(Debela et al., 2021).Additionally, natural bioactive compounds like vitamins, polyphenols, flavonoids, curcumin, quercetin are few of the therapeutic compounds studied due to anti-apoptotic and anti-proliferative nature exhibited in vitro and in vivo(Chikara et al., 2018).Additionally, chemotherapy involves drugs that target cells with higher basal level of proliferation and a short span of cellular regeneration time. The therapy is not targeted towards carcinogenic cells. Therefore, healthy non-tumor cells like skin, hair, epithelial cells of the gastro-intestinal (GI) tract which have shorter cell cycle can get affected(Feitelson et al., 2015).

The focus on this study is to discuss the action of *Cannabissativa* bioactive compounds towards cancer cells.

2.2 Bioactive compounds of Cannabis

The potent bioactive molecule of *C. Sativa*is known to bephytocannabinoids. The chemical analysis of *C. sativa* extract has isolated more than 100 varieties of cannabinoids. Cannabinoids such as tetrahydrocannabinol (Δ^9 -THC/THC) and cannabidiol (CBD) are the predominant variety of cannabinoids available in *C. sativa* in high concentrations(Bonini et al., 2018).

There are possibly about 4 species of cannabisplant existence as *C. sativa, C. indica*, *C.ruderalis* and *C. afghanica*(Amin & Ali, 2019). Although the predominant species of the Cannabisis *C.sativa*, subsequently chemotypes of the *C. sativa* were found due to the difference in concentration of bioactive compounds. Some chemotypes had Δ^9 -THC as the predominant cannabinoid while some plants had CBD at the highest concentration. Rare chemotypes also express other lesser-known cannabinoids such as cannabidivarin (CBDV) or Δ^9–tetrahydrocannabivarin (Δ^9–THCV) (Bonini et al., 2018). Generally, phytocannabinoids are neutral molecules with a lipid backbone. Additionally, alkyl resorcinol and monoterpene are present in the molecular structure(Bonini et al., 2018;Amin & Ali, 2019).

Furthermore, there are acidic phytocannabinoids such as Δ^9– tetrahydrocannabinolic acid (Δ^9–THCA),cannabidiolic acid(CBDA), cannabigerolic acid(CBGA),cannabichromenic acid(CBCA) and less concentrated forms of phytocannabinoids such ascannabigerol(CBG), cannabinol (CBN) andcannabichromene(CBC). Other rare forms of cannabinoids such asΔ^9– THCV,CBDV andcannabigerovarin(CBGV) are found as bioactive compounds of *C.sativa*(Bowen et al., 2021).

Referring to other in vitro and in vivo studies conducted, most of the above mentioned phytocannabinoids have therapeutic effects in various human health conditions(Franco et al., 2020). In addition to phytocannabinoids there are other multiple bioactive compounds such as terpenes,

terpenoids,bibenzyls, flavonoids, stilbenoids, alkaloids and hydroxycinnamic acid(Andrade-Ochoa et al., 2018; Allegrone et al., 2017;Candy et al., 2017).

Additionally, a study conducted by Francisco et al., using Deep Eutectic Solvents (DES) quantified the total phenolic content (TPC), total flavonoid content (TFC), total terpenoid content (TTP) and total antioxidant activity (TAC) using the stable 1,1- diphenyl-2-picrylhyroxyl (DPPH) free radical, suggesting the presence of potent phytochemicals in cannabis(Tiago et al., 2022).

Cannabis bioactive compounds have a multifaceted function. The key pharmacological properties displayed by the bioactive compounds are anti-inflammatory, anti-tumor, antioxidant, antinociceptive, antidepressant, antimicrobial, neuroprotective, analgesic, anticonvulsant, anti-pruritic and lowers blood pressure(Kumar et al., 2021).

Figure 2 : Cannabidiol (Breijyeh et al., 2021)

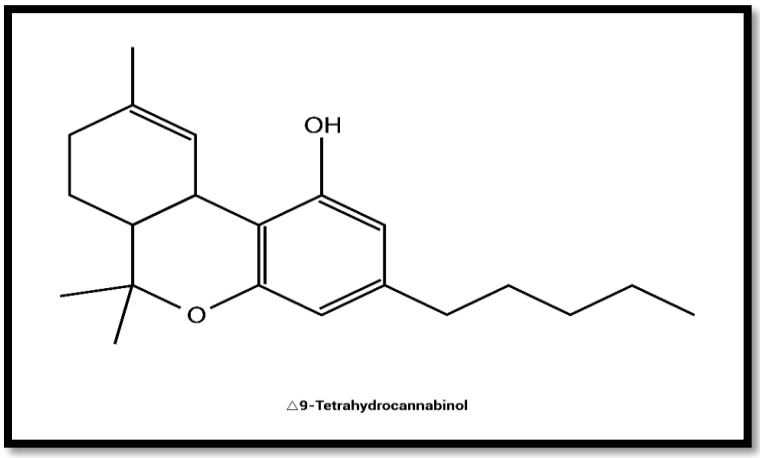
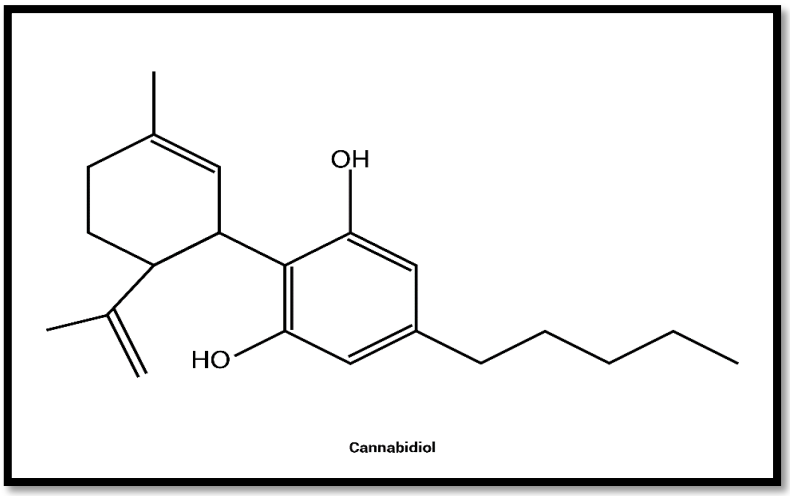


Figure 1 : Δ9 -Tetrahydrocannabinol(Breijyeh et al., 2021)



2.3 The Entourage effect

The entourage effect was first explained by Mechoulam and Shimon Ben- Shabat in a cannabinoid study conducted in 1998. The study suggested that the entourage effects mean, the entire spectrum of bioactive compounds found in *Cannabis* extract was more effective as a therapeutic agent than an individual active component (Ben-Shabat et al., 1998).

Evidence based studies suggested that administering 2:1 CBD to THC alleviates the psychoactive high conferred by THC. CBD was also able to reduce the anxiety caused by THC as well (Bhattacharyya et al., 2015). Additionally, antitumor effects of botanical drug preparation (BDP)were able to produce more antitumor response in breast cancer cells compared to pure THC (Blasco-Benito et al., 2018).

Meanwhile, a study conducted in 2013 by Dr. Margaret Haney of Columbia University concluded that THC administered in the form of dronabinol was a better compound in acting as an analgesic relief compared to the whole plant being used. Due to the contradictory conclusions of different studies, entourage effect of cannabisis still under research (Cooper et al., 2013).

2.4 Biosynthesis pathway of bioactive molecules in Cannabis

2.4.1 Biosynthesis pathway of predominant cannabinoids THC and CBD

Cannabinoids are predominantly biosynthesized in glandular trichomes of female flowers(Tahir et al., 2021).The biosynthesis pathway of cannabinoids has been studied using engineered *S. cerevisiae* (Yeast). Geranyl pyrophosphate (GPP) was produced in yeast cells when genes such as EfmvaS (HMG-coA synthase) and EfmvaE (HMG-coA reductase) from *Enterococcus faecalis* were introduced, and by overexpressing native mevalonate pathway genes such as *ERG12, ERG8, ID11* and a mutated *ERG20* gene.

Additionally, hexanoyl- coA was synthesized using genes Re*bktB*which is natively found in *Ralstoniaeutropha* and other genes Cn*paaH1*, Ca*crt* and Td*ter*from *Cupriavidusnecator,Clostridium acetobutylicum* and *Treponema denticola* respectively. Meanwhile, hexanoyl-coA was produced by providing hexanoic acid as a substrate for acyl-activating enzyme(AAE) expressed by the gene Cs*AAE1* from *Cannabis.*

Hexanoyl coA is converted to olivetolic acid which is then converted to a prenylated form. Genes such as *Cs*TKS and *Cs*OAChelp with the convertion of hexanoyl coA to olivetolic acid while prenylation was done by *Cs*PT4. GPP and prenylated olivetolic acid produces cannabigerolic acid (CBGA). Cannabinoid synthases such as THCAS and CBDAS convert CBGA to Δ^9-tetrahydrocannabinolic acid(THCA) andcannabidiolic acid(CBDA)respectively. Upon being heat treated THCA and CBDA convert to THC and CBD respectively due to decarboxylation(Luo et al., 2020;SupaartSirikantaramas et al., 2007).

Additionally, CBGA is the precursor for most of the cannabinoids as well. Chemical processes like oxidation, irradiation, decarboxylation, isomerization leads to the production of other cannabinoids like CBL, CBN, CBL and so forth (Desaulniers Brousseau et al., 2021).

2.4.2 Biosynthesis of Terpenes

Cannabis plants have varied terpene composition among its different chemotypes available. Enzymes such as terpene synthase (TPS) producethe majority of the terpenes based structurally on hydrocarbons(Chen et al., 2011;Booth et al., 2017). Complex terpenes are modified using additional enzymes such as cytochrome P450s. The isoprenoid moiety of cannabinoids and the terpenes found in *Cannabis* resin is formed through the isoprenoid biosynthetic pathway (IBP). IBP is carried out in the cytosol utilizing the mevalonic acid pathway (MEV). GPP and farnesyl pyrophosphate (FPP) are the substrates used by monoterpene synthases and sesquiterpene synthases to produce different varieties of mono- and sesquiterpenes in cannabisrespectively(Booth & Bohlmann, 2019). A study conducted on purple Kush cannabisidentified more than 30 *Cannabis* terpene synthase (CsTPS) by analyzing the genome and transcriptome sequences (Booth et al., 2017).

Due to vast differences in the composition of terpenes in the plant a proper biosynthetic pathway has still not been elucidated (Booth & Bohlmann, 2019).

2.4.3Biosynthesis pathway of *Cannabis* specific Flavonoids

Flavonoids are a large group of phenolic compounds found in plants. Flavonoids help the plants to respond to stimuli such as sunlight and UV radiation (Warner et al., 2021).

Flavonoid compounds of more than 20 types have been identified. Some flavonoids such as quercetin and kaempferol are generally found in other plants as well(Brenneisen, 2007). Meanwhile, cannflavins A and B are unique to cannabis(Radwan et al., 2008). Flavonoids specific to *Cannabis*are studied due to strong anti-inflammatory properties.

The flavonoid biosynthesis pathway is still under further studies. Two pathways were proposed by Rea *et al* and Flores-Sanchez and Verpoorte, highlighting different biosynthetic pathways.

2.4.3.1Flores-Sanchez pathway -2008

This pathway suggests that phenylalanine as the precursor, a series of enzymatic reactions convert phenylalanine to *p*- coumaroyl -coA.

Coumaroyl - CoA is converted to caffeoyl-coA. Caffeoyl coA reacts with malonyl coA. This reaction proceeds to produce luteolin. It is proposed that luteolin is converted to cannflavins A and B.

Alternately another pathway suggests, Caffeoyl-coA is converted to feruloyl-coA. Feruloyl-coA reacts with malonyl coA and proceeds to form cannflavins A and B. This enzyme derived reaction is still a proposed pathway as well(Flores-Sanchez &Verpoorte, 2008).

2.4.3.2Rea *et al*– 2019

Meanwhile Rea et al., suggests a different biosynthetic route. This pathway suggests that p-coumaroyl-coA reacts with malonyl-coA which proceeds to form naringenin that can be converted to chrysoeriol. Chrysoeriol is then converted to cannflavins A and B. This is a proposed reaction still

under study. Alternately, naringenin can get converted to eriodictyol which could proceed to form cannflavins A and B. This is a proposed reaction as well(Rea et al., 2019).

Therefore, both the biosynthetic pathways are still under studies to outline an accurate pathway.

2.5 Biosynthetic pathway of Bibenzyl

The therapeutic benefit of *Cannabis* is not limited to its cannabinoids, flavonoids or terpenes. Other compounds belonging to the category of bibenzyls are equally important as well(Vitalini et al., 2018). Bibenzyls, also known as dihydrostilbenes are derivatives of phenyl propanoid(Vitalini et al., 2018).

The biosynthetic pathway of bibenzyls is not yet clearly understood, but the proposed pathway is condensed to have three main steps.

Step 1 – esterification of hydroxycinnamic acid by a member of 4- coumarate – coA ligase to form acyl co-enzyme A (coA).

Step 2 – acyl co-enzyme A esters are converted to different derivatives of dihydro-coA by reductases. A few reductases studied are CsDBR2 and CsDBR3.

Step 3 – these dihydro- coA also referred to as dihydro-hydroxycinnamoyl-coA condenses with malonyl-coA to produce the bibenzyls such as dihydropiceatannol (DHP) and dihydroresveratrol (DHR). This is an enzyme derived reaction carried out by polyketide synthase (Boddington et al., 2021).

2.6 Endocannabinoid system

The endocannabinoid system (ECS) was first discovered in 1988 by Allyn Howlett and W.A. Devane(Kalant, 2001; Devane et al.,1988). ECS is the pathway via which cannabinoids exert their effects on the cells of mammals (Lal et al., 2021).

It is a complex biological system consisting of many proteins-based components. The ECS comprises the enzymes that control activation and deactivation of the receptors, membranal receptors, the ligands that interact with the system. The ECS is prevalent throughout the mammalian system including central nervous system (CNS) and peripheral tissues as well (Di Marzo, 2009).

ECS contains three main types of cellular receptors such as cannabinoid receptor type – 1 (CBR-1), cannabinoid receptor type – 2 (CBR-2) and G- coupled protein receptors (GPCR), ligand sensitive membranal ion channels and nuclear receptors(Marzo et al., 2004;Dariš et al., 2019).

Additionally, endocannabinoids which are naturally found in mammals like anandamide (ANA) and 2-arachidonylglyverol (2-AG) interact with the ECS in a similar manner to phytocannabinoids. The enzymes responsible for the synthesis of endocannabinoids are also a key component in ECS. Some of the enzymes involved in the process are isoenzymes α and β of diacylglycerol lipase, fatty acid amide hydrolase, monoacyl glycerol lipase are few to be mentioned (Lowe et al., 2021).

The ECS modulates many physiological and immunological roles in mammals such as homeostasis, emotional behaviour, protection to neurons and the nervous system, reproductive health, in cognition and intellectual abilities are few of the roles to mention. The components of ECS are modulated and targeted due to its involvement in multiple cellular processes in both CNS and peripheral tissues. ECS plays a crucial role in the etiology of multiple pathophysiological processes. Therefore, ECS are

targeted with the help of phytocannabinoids from cannabisto impact therapeutic benefits into diseased tissues by targeting cell- signaling pathways of ECS(Lowe et al., 2021;Lal et al., 2021).

Therefore, the bioactive compound of *Cannabis* imparts the therapeutic benefits on diseased tissues through the ECS.

2.7 Role of cannabinoids in cancer

In this section, therapeutic benefits of cannabinoids such as THC, CBD, and other cannabinoids are discussed involving many different types of cancers.

Advancements in scientific research have evidently shown the therapeutic benefits of cannabisin cancer. Traditional cancer therapy is quite unspecific and can cause cellular toxicity in healthy cells. In contrast, cannabinoids are well tolerated by healthy cells and cellular toxicity is specific to cancer cells. Cannabinoids have proven evidence to show anti-cancer and anti-tumor activities in both in-vitro and in-vivo experiments (Lal et al., 2021). Cannabinoids have exclusively been shown to inhibit growth and survival of cancerous cells.

The efficacy of a cannabinoid changes depending on the type of cancer, the affinity of the cannabinoid towards the cannabinoid receptor and the location of the tumor. Additionally, cannabinoids impart cellular toxicity specifically to tumor cells by altering the signaling and cellular pathways sparing the healthy cells due to an upregulation of CB1 and CB2 receptors in cancer cells (Dariš et al., 2019).

Cannabinoids have contributed to its anticancer properties by inhibiting cell proliferation, inducing apoptosis, inhibiting angiogenesis, cellular metastasis and by decreasing the size of solid tumors (Malhotra et al., 2021).

One of the most common cellular stresses that could lead to cancer is inflammation. Chronic inflammation is the key reason in about 20% of all human cancers. Pro-inflammatory pathways like nuclear factor kappa B (NF-κB) pathway and over expression and deregulation of the epidermal growth factor/ epidermal growth factor receptor (EGF/EGFR) are some of the cellular aberrations that could lead to cause a cancer. Cannabinoids such as CBD have been shown to suppress the EGF signaling pathway so that proinflammatory cellular cascades are inhibited (Kopustinskiene et al., 2022).

Cannabinoids were able to inhibit telomerase activity in dimethyl nitrosamine (DMNA) induced liver cancers by inhibiting the catalytic subunittelomerase reverse transcriptase (TERT) of telomerase and thereby inducing apoptosis(Dratwa et al., 2020).

In liver cancer cells of line Hep3B, small hemp peptides have caused apoptosis by masking the antiapoptotic protein B-cell lymphoma -2 (Bcl-2). Additionally, cellular migration and cell viability have been inhibited without interfering with the overexpressed cleaved caspase-3 andBcl-2 associated death promoter (BAD). Moreover, β-catenin signaling pathway was downregulated proving that β-catenin pathway is having a significant contribution in controlling cancer formation (Wei et al., 2021).

A study conducted by Munson *et al*, in 1975 showcased the anti-cancer potential of cannabinoids for the first time in mouse models with Lewis lung carcinoma. In this study the mice were given an oral suspension of agents delta-8-tetrahydrocannabinol(Δ^8 -THC), Δ^9 -THC and Cannabinol(CBN)which retarded the growth of tumor. In here, Δ^8 THC was used instead of Δ^9 THC due its reduced hydrophobicity and lack of psychoactive effects. Eventually, Δ^9 THC was studied to be more efficient than Δ^8 THC in exhibiting specific anti-cancerous effects(Woodcock, 2006).

Cannabinoids can induce apoptosis by binding to receptors CB1 and CB2. Binding of cannabinoid upregulates pro-apoptotic molecules like sphingolipid ceramide. Sphingolipid ceramide inhibits the activity of mitogen- activated protein kinases (MAPKs) and in contrast activates the stress activated protein kinases (SAPKs) that could lead the cell towards apoptosis. The apoptosis is induced via the mitochondrial pathway due to phosphatidylinositol 3-kinase(PI3K) protein kinase B (AKT) pathway being downregulated. This downregulation dephosphorylates BAD and led the cells to apoptosis (Woodcock, 2006).

Additionally, each of the cancer cells has been induced with a different mode of apoptosis when treated with cannabinoids. As mentioned previously, leukemia cells when exposed to cannabinoids have undergone apoptosis due to accumulation of sphingolipid ceramide which caused the modulation of MAPKs leading to apoptosis. Furthermore, upregulation of endoplasmic reticulum (ER) stress related genes led to apoptosis in glioma cells (Hinz & Ramer, 2018).

Specifically, Δ^9 THC and its synthetic analog HU-210 induce apoptosis by upregulating the tribbles homolog 3 (TRB3) protein which was evident in rhabdomyosarcoma cells. Furthermore, cannabinoid also modulates specific cell cycle checkpoints. In melanoma cell lines,cannabinoids hypo-phosphorylate and activate the tumor suppressor protein retinoblastoma – associated protein (pRB) and inhibit the activity of Akt thereby causing cell arrest (Blázquez et al., 2006).

Cannabinoid also arrests the cell cycle at G1-S transition phase and G2-M transition phase by down regulating the cyclin-dependent kinase – 1 (CDK-1), alternately cannabinoids also induce p21, a CDK-1 inhibitor which inhibits cell division. This was evident in breast cancer cell lines (Caffarel et al., 2006).

THC and its synthetic analog JWH-133 inhibited the growth of aggressive human epidermal growth factor receptor 2-positive ($ErbB2^+$) breast cancer by inhibiting the Akt pathway (Caffarel et al., 2010). Cannabinoids such as CBD have shown growth inhibition of glioma cells by negatively affecting enzymes like 5- lipoxygenase (5-LOX) and its end product such as leukotriene B4(LTB_4). Additionally, CBD also induced the toxicity to lung carcinoma cells by upregulating cyclooxygenase-2 (COX-2) dependent prostaglandins (PGs) of D and I series (Ramer et al., 2013). CBD is also termed as a potential therapeutic agent exhibiting redox mode of actions to impart toxicity to glioma stem cells. The molecular interaction consists of multiple pathways which are activation of p38- MAPK pathway, reducing the expression of stem cell marker protein SRY-box transcription factor-2 (SOX-2), and inhibition of inhibitor of differentiation/DNA binding(ID-1) which is a DNA binding transcription factor (Singer et al., 2015).

Furthermore, CBD has shown to reduce the growth of cancer cells by producing ROS. A study conducted by McAllister *et al*, in 2011 exhibited that CBD also curbs the spread of cancer cells by initiating mitochondrial damage, production of ROS and inhibiting the binding of transcription factors with DNA. Meanwhile CBD can elicit apoptosis by upregulating autophagy through hypo-phosphorylation of mammalian target of rapamycin (mTOR) and eukaryotic translation factors (Shrivastava et al., 2011). Furthermore, a different molecular pathway can induce autophagy in cancer cells, and this utilizes calmodulin-activated kinase subtype, which can phosphorylate adenosine monophosphate (AMP) activated- kinase inducing autophagy when treated by cannabinoids (Vara et al., 2011).

Recent studies have also authenticated that G-protein coupled receptor (GPR55) expression is upregulated in cancer cells compared to healthy tissues. Cannabinoids have the potential to target GPR55 and can levy antagonistic effects thereby curbing carcinogenesis. However, further studies are underway(Pérez-Gómez et al., 2012).

Metabolic reactions like glycolysis are impeded by cannabinoids causing the cancer cells to undergo cell death. Glycolysis is usually altered and reprogrammed by cancer cells in order to survive in

hypoxic environments. THC can also bind to non-cannabinoid receptors like transient receptor potential vanilloid receptor 2 (TRPV2) causing influx of Ca^{2+}into the cancer cells thereby deregulating the transmembrane potential of mitochondria and inducing apoptosis. Ca^{2+}can also mediate autophagy and production of ROS causing cancer cell death (Hinz & Ramer, 2018).

Cannabigerol (CBG) is a non – toxic cannabinoid which also confers anti-tumor properties in cancers. Studies have also confirmed that CBG was more robust in exhibiting anti-tumor behaviour than THC. A study conducted by Tamarah *et al*, in 2021 confirmed that CBG induced caspase-3-dependent apoptosis. Additionally, combination of CBD and CBG in a 1:4 molar concentration ratio reduced the viability of glioma cells.Furthermore, CBG was able to arrest the glioma cells in the G1 phase and curbed the progression to S1 and G2/M phase. CBG also worked as an antagonist to the transient receptor potential melastatin 8(TRPM8) receptor, thereby inducing intrinsic apoptosis pathway in prostate cancer. Production of ROS in colorectal cancer cells was evident when CBG was used (Lah et al., 2021).

Overall anticancer effects of cannabinoids are due to the molecules being able to modulate CB1 and CB2 receptors. Meanwhile, cannabinoids such as CBD mediated anti-cancer actions on MDA-MB-231 breast cancer cell line by inducing apoptosis and autophagy by upregulating ER related stress genes and by inhibition of Akt and mTOR signaling pathway (Dariš et al., 2019). Moreover, CBD has curbed cell proliferation and invasion of U87-MG and T98G human glioma cell lines by downregulating the extracellular signal-regulated kinase(ERK) and Akt signaling pathway and has inhibited HIF -1α which could lead the cell to survive in hypoxic conditions. THC and CBD have synergistically inhibited cell proliferation of human glioma cell line through cell cycle arrest, induction of ROS, inducing apoptosis, modulation of ERK and through caspase activities (Marcu et al., 2010). In pancreatic cancer cell lines of Capan-2, PANC-1,MIA PaCa-2 and BXPC-3, THC decreased cell viability by inducing p8-ATF-4-TRIB3 pro-apoptotic pathway (Carracedo et al., 2006).

Two neuroblastoma cell lines such as IMR-5 expressing wildtype p53 and SK-N-AS expressing mutant p53 were used to study the effects of cannabinol (CBN). CBN was able to curb cell proliferation, cellular angiogenesis and metastasis through various cellular pathway modulations. In the cancer cells, the Akt pathway was inhibited and upregulation of microRNA-34a (miR-34a) targeted the cell proliferation promoter protein E2F1 which led to the suppression of cancer proliferation. A cleaved fragment of miR-34a, 31 -nttRNA$_i^{met}$functions as a tumor suppressor and played an anti-angiogenic role by targeting 6-phosphofructo-2-kinase(PFKFB3)(Wang et al., 2022).

Cannabinoids can normalize abnormal vascular tissues formation that leads to angiogenesis in tumor cells. Cannabinoids can specifically inhibit vascular endothelial growth factor (VEGF). VEGF/VEGF-receptors are activated and over expressed in many malignancies. The activation of the pathway triggers endothelial cell growth, cell migration and independent survival of migrated cells at the new site. VEGF also induces blood vessel permeability causing malignant effusion. Meanwhile, another well-known function of VEGF is tumor angiogenesis which causes successful tumorigenesis(Hicklin & Ellis, 2005). Aggressive forms of cancers can metastasize into distant cells causing poor prognosis in patients. Cannabinoids can modulate extracellular proteases and protease inhibitors to enhance the antimetastatic activity (Velasco et al., 2016).

Further analysis of molecular changes induced by bioactive molecules of *Cannabis* in breast canceris explored in detail.

2.8Cannabinoids and its effects in Breast cancer

Statistically, at least 12% of women will get diagnosed with breast cancer in their lifetime. The disease itself is heterogenous due to various molecular aberrations, varied prognosis in patients and contrasting responses to the current therapies available, some patients respond quite well for the treatment while some others respond well initially but get a relapse due to resistance for the therapies. The treatment for breast cancer is targeted on molecular markers on the cancer cells, such as estrogenic and progesterone receptors (ER and PR) and the HER-2 Oncogene. Currently, therapies like modulators of ER receptors and monoclonal antibodies are utilized as a successful method of treatment.Additionally, another subtype of breast cancer which doesn't exhibit any molecular marker is known as the triple negative(-ve) breast cancer (TNBC) which is the most aggressive form of breast cancer. This form of breast cancer is treated with traditional chemotherapeutic agents which not only target cancer cells but also all the fast-dividing cells of the body(Blasco-Benito et al., 2018). Many studies conducted on breast cancer cell lines using cannabis based cannabinoids have evidently displayed anti-cancer activities in both in vitro and in vivo conditions.

THC and cannabisdrug preparation (CDP) were confirmed as potent anti-cancer agents on pre-clinical models of hormone – sensitive breast cancer cell lines like T47D and MCF-7. Both THC and CDP were able to reduce cell viability. CDP was more potent compared to pure THC. CDP was a combination of Δ^9 – tetrahydrocannabinol acid (THCA),THC, Δ^9 – tetrahydrocannabivarin (THCV), CBD, cannabidiolic acid (CBDA), CBG, CBN and cannabichromene (CBC) with 21 additional terpenes. The mode of action carried out by THC was by the activation of CB2 receptors and production of ROS(Blasco-Benito et al., 2018).Meanwhile, CDP still was able to actively curb the proliferation of the cells even after blocking the CBVB2 receptors confirming that CDP was altogether implying different cellular mechanisms. This still needs further research.

Similarly, human breast cancer cell lines of HER2+ such as HCCY954 and BT474 also was significantly affected by THC and CDP in similar pattern. Additionally, TNBC cell line such as MDA-MB-231 was also affected by THC and CPD. As seen in other cell lines CDP was more potent in arresting the cell proliferation as well. It was also simultaneously confirmed that terpenes were not responsible to this effect, further studies are needed to find the active molecule of CDP extract (Blasco-Benito et al., 2018).

Furthermore, THC was known to be an antiproliferative agent due to its ability to modify JunD, a transcription factor. Breast cancer cell lines with knocked out JunD coding gene were not suppressed by THC. Furthermore, human epidermal growth factor receptor 2 (HER2) and CB2 forms heteromers that have caused aggressive breast cancers to form. THC is capable of disrupting the heteromer by binding to CB2 receptors causing the cells to be less proliferative (Tomko et al., 2019).

Additionally, whenTNBC cell line MDA-MB-231 were used to study the effects of THC, it led to an upregulation of fatty acid-2-hydroxylase (FA2H) which catalyzes the 2-hydroxylation of fatty acid. Studies have suggested that FA2H expression has increased the efficacy of anti-cancer agents like PM02734. Upon exposure of cancer cell line to THC, proliferator-activated receptor alpha(PPAR-α) which is usually expressed in lower levels, was significantly upregulated in MDA-MB-231. This was evidently analysed using DNA micro-array and RT-PCR analysis.THC application on MDA-MB-231 induced PPAR-α which in return also induced the expression of FA2H in a positively correlated manner. Additionally, THC can protect a cell from palmitic acid (PA) lipotoxicity by inducing the cells' defense machinery. PPAR- α also inhibited the transcription of NF-κB and activator protein -1 (AP-1) signaling pathways. NF-κB also increases the expression of the chemokine receptor cxcr4 which causes cancer cell metastasis. The inhibition of aforementioned signaling pathways such as NF-

κB and AP-1 also down-regulates COX-2, which is a key component of carcinogenesis (Takeda et al., 2014).

A silico study conducted using THC demonstrated that THC was able to bind to estrogen receptor β (Erβ). This binding of THC to Erβ activates the receptor to impart anti-tumor effects on ER^+ breast cancer tumors by arresting cells at G2 phase. THC was also evidently demonstrated to prevent estradiol- induced proliferation of MCF-7 cells. Erβ, upregulates the expression of the genes p21Cip1 and p27kip1. p21Cip1 promotes cell cycle arrest while p27kip1 is a tumor suppressor gene and a promoter of apoptosis(Pellati et al., 2018; Jo et al., 2021) and down-regulates the expressions of the genes c-Myc, Cyclin-D1 and Cyclin A. Cell cycle regulators like Cyclin-D1 plays a significant role in oncogene-induced tumorigenesis in breast cancer. Cyclin-D1 also inhibits the expression of Bcl-2 associated X protein (BAX) which is a pro-apoptotic protein. Therefore, lowering of Cyclin D1 expression in MDA-MB-231 cells establishes the apoptosis mediated by THC(Sultan et al., 2018).

Additionally, Erβ is able to form heterodimer with androgen receptors thereby curbing the PI3K/AKT signaling pathway of the MDA-MB 453 cell line. PI3K/AKT intracellular signal transduction is necessary for metabolic activity, proliferation, growth, and angiogenesis. A novel ligand named Cannabinoid A which is a structural analog of Delta-4-Isotetrahydrocannabinol (Del4isoTHC) and Δ^{8-} THC elicited the upregulation of Erβ (Bhattacharjee et al., 2020)

In addition to the activities of THC, CBD has been shown to downregulate proteins that impart resistance to treatments and made the 6D breast cancer cells line sensitive to anticancer agents like doxorubicin and cisplatin (García-Morales et al., 2020). MCF-7 breast cancer cell line were transformed by EMT to acquire the invasive malignant phenotype of 6D cells and CBD was evidently able to inhibit the EMT and was able to downregulate the invasiveness of the cancer cell line. Molecular changes like masking the CB1 receptor led to increased cancer cell mortality. Generally, interleukin-1beta (IL-1β) cytokine is the key inducer of IL-1β/IL-1RI/β-catenin signaling pathway which has a major contribution in the EMT. Meanwhile, treatment of these cells with CBD relocalised E-cadherin and β-catenin at the adherent junctions thereby inhibiting metastasis. Additionally, translocation of β-catenin was prevented by CBD which downregulated the expression of ΔNp63α, BIRC3 and ID1 proteins which are few of the key factors that induce malignant features. Moreover, inhibition of AKT which is usually activated in cancerous cells was evident when CBD was used. Inactivation of AKT resulted in downregulation of IL-1β/IL-1RI/β-catenin signaling pathway (García-Morales et al., 2020).

The major form of breast cancers affecting both pre-menopausal and post-menopausal women is the estrogen receptor – positive [ER^{+}] subtype. ER^+ breast cancer cells proliferate and form a turnover when exposed to the hormone estrogen. HER^+ breast cancer cell line MCF-7aro with higher levels of aromatase expression was used in addressing the anti-cancer benefits of cannabinoids. Aromatase is an enzyme which usually converts androgens to estrogen thereby increasing the estrogen concentration in cells. CBD is a potential inhibitor of the enzyme aromatase which was observed in MCF-7aro cells. Moreover, CBD was able to decrease the level of CYP19A1 gene transcription which is transcribed and translated to produce aromatase (Amaral et al., 2021). The molecular investigations convey that cannabinoids such as THC and CBD activate caspase-7 and caspase-9 which caused a downregulation in the levels of mitochondrial transmembrane potential and increased the concentration of cleaved poly (ADP-ribose) polymerase (PARP) which collectively programmed the cell towards apoptosis(Amaral et al., 2021).

Furthermore, according to a study by Mohamed Elbaz *et al,* CBD elevated the downstream inhibition of the Raf-1/MEK/ERK, NF-κB and AKT signaling pathways (Elbaz et al., 2015). Inter and intra cellular communication of the cell is mediated by the Raf-1/MEK/ERK signaling cascade, which regulates key functions such as cell growth, survival, and cellular differentiation. Mutations in Raf-1/MEK/ERK are evident in most cancers. Hyperactivity of Raf-1/MEK/ERK has been shown for the

progression of cancers. Therefore, inhibition of the signaling pathway due to CBD establishes the anti-cancer activity of phytocannabinoid(Degirmenci et al., 2020).

Additionally, CBD acting on the cellular receptors can modulate cytokine secretion of cancer cells. Cytokines such as chemokine ligand-3 (CCL-3), granulocyte-macrophage colony-stimulating factor (GM-CSF) and macrophage inflammatory protein-2 (MIP-2) released by the 4T1.2 mouse breast tumor cells were inhibited by CBD. Therefore, polymorphonuclear cells like neutrophils and other white cells such as macrophages were prevented from entering the TME. This resulted in the downregulation of angiogenesis and metastatic ability of the tumor. Interaction of CBD with GPR55 receptor mediated anti-angiogenic activity by inhibiting the expression of matrix metallopeptidase 9 (MMP9), tissue inhibitor of metalloproteinase 1 (TIMP1), serpin E1, plasminogen activator inhibitor type-1 (PAI-1),chemokine (C-X-C motif) ligand 16 (CXCL16), endothelin-1 (ET-1), platelet derived growth factor -AA (PDGF-AA) and interleukin-8 (IL-8) which are all necessary for angiogenesis of tumors (Pellati et al., 2018).

Further studies also suggests that CBD plays a crucial role in preventing angiogenesis in ER^+ breast cancer cells by downregulating many pro-angiogenic factors like integrins or angiopoietins, matrix metalloproteinase 2/9 (MMP-2/9), urokinase -type plasminogen activator (UPA), ET-1 and PDGF-AA. Additionally, factors like thrombospondins or interferons are activated due to the anti-angiogenic property. Additionally, MMP-2/9 are involved in cancer metastasis, CBD plays an anti-metastatic role as well (Bhattacharjee et al., 2020). Furthermore, CBD reduces the stemness of breast cancer stem cells. This was studied using the mammospheres derived from MCF-7 cells. Reduction of stemness was confirmed through reduced expression of stem cell markers such as HIF-α/Src/VHL (Jo et al., 2021).

Additionally, CBD has significantly increased or decreased the expression of 1204 genes that is involved in Zinc (Zn) homeostasis. Zn levels significantly increase the antioxidant and anti-inflammatory effects which increases the anti-cancer benefits (Nahler, 2022).

Furthermore, CBD and CBG have reduced the tumor proliferation and metastasis by activating CB2 and transient receptor potential vanilloid receptor 1 (TRPV1) receptors in breast cancer cells thereby upregulating oxidative stress and apoptosis (Lal et al., 2021). Another study conducted using human breast adenocarcinoma cell lines MDA-MB-231 and MCF-7 which are resistant to paclitaxel were treated with O-1602 which is a synthetic molecule similar in structure to abnormal cannabidiol and more distantly related in structure to THC. The cell lines used in the study were overexpressing cellular receptors like GPR55 and treatment of these cells with O-1602 reduced the proliferation of aggressive cancer cells. Moreover, O-1602 was able to reduce the metastasizing capacity of the cancer as well (Tomko et al., 2019). CBD use also evidently induced apoptosis in TNBC cell lines causing an interaction between peroxisome proliferator-activated receptor gamma (PPARɣ), mTOR and cyclin D1(Kis et al., 2019). Furthermore, mTOR is a kinase that is involved in the activation of growth factor receptors and involves in the maintenance of cell metabolism, cell division and cell survival. Usually, mTOR is deregulated in most of the human cancers including breast cancer. When cells of T-47 D and MDA – MB-231 cells were treated with CBD, CBD inhibited the phosphorylation of mTOR which caused apoptosis in cancer cells(Sultan et al., 2018).

Meanwhile, CBC also has acted as a potent inhibitor of cell survival in cancer cells of MDA-MB-231 and MCF-7 breast cancer cell line (Ligresti et al., 2006). Additionally, CBN causes intracellular accumulation of the substrate mitoxantrone by blocking the multidrug transporter breast cancer resistance protein(BCRP) which confers drug resistance (Holland et al., 2007).

Cannabidiolic acid (CBDA), is known to inhibit the expression of COX-2 which is usually expressed in high levels of cancer cells (Hirao-Suzuki et al., 2022). COX-2 is also known to initiate the development and progression of cancer cells for further development. Inhibition of COX-2 also leads

to lowered levels of cellular DNA replication (Cai et al., 2020). In this study, breast cancer cell line MDA-MB-231 was used as these cells express higher levels of PPAR β/δ. PPAR β/δ is a nuclear receptor which regulates the expression of multiple genes. Proteins like angiopoietin like4 coded by ANGPTL4 gene are enhanced when MDA-MB-231 was treated with CBDA. ANGPTL4 is known to inhibit the cell migration and adhesion of triple-negative breast cancer cells. Additionally, ANGPTL4 expression also establishes better prognosis and disease-free survival in breast cancer patients (Cai et al., 2020). Furthermore, ANGPTL4 is suggested to be a tumor suppressor. Meanwhile CBDA also activated adipose differentiation related protein(ADRP) via PPAR β/δ, and ADRP plays a significant role in re-differentiating breast cancer cells to inhibit cancer progression (Hirao-Suzuki et al., 2022). The anti-cancer effects of CBDA on MDA-MB-231 were imparted by reducing the expression of the proto-oncogene *c*-fos and COX-2 (Jo et al., 2021).

Furthermore,CBN which is produced due to long term storage of Cannabis, is formed from the precursor THC. CBN potentially inhibits a family of cytochrome p450 enzymes such as CYPA1, CYP1A2 and CYP1B1. Meanwhile, other actions are mediated by desensitizing the cation channel TRPA1 and by blocking the TRPM8 cation channel(Almeida et al., 2021). The enzymes CYPA1, CYP1A2 and CYP1B1 are involved in the process of carcinogenesis. These enzymes oxidize pro-carcinogenic compounds to produce active carcinogenic metabolites (Androutsopoulos et al., 2013).

The cation channel permeable for Ca^{2+}, TRPM8 is upregulated in various types of cancers, and it is evidently upregulated in breast cancer as well. It up-regulates the levels of autophagy in breast cancer cells. AMP- activated protein kinase (AMP-K) generates nutrientsthrough breakdown of intracellular structures which feeds the growth of tumor. The activation of AMP-K is intracellular Ca^{2+} dependent. Therefore, inhibition of TRPM8 causes a reduction in the basal level autophagy of breast cancer which inhibited the growth and migration of breast cancer (Huang et al., 2020).

Lesser known phytocannabinoids such as O-methylphytocannabinoid,cannabicyclol, cannabicitran, Iso-THC, cannabielsoin, anhydrocannabimovone and cannabioxepane are yet to be studied as an anti-cancer agent (Caprioglio et al., 2022).

2.9Anti-cancer role of Terpenes in Breast Cancer

Myrcene is the most abundant terpene found in Cannabis. Few terpenes found in Cannabis like nerolidol, β-caryophyllene, ocimene, terpinolene and β-myrcene were used to find their cytotoxic effects in a taxol-resistant model of breast cancer. A significant cytotoxic effect was imparted by nerolidol and β-caryophyllene. Simultaneously, the two terpenes also activated the apoptotic cascade and reduced the cellular metastasis (Tomko et al., 2022). Anti-tumor agent 1,4 naphthohydroquinone is synthesized via the Diels-Alder cycloaddition between myrcene and 1,4-benzoquinone and the anti-tumor activities were studied on MCF-7 cell line. The GI_{50} value of 1,4-naphthohydroquinone was comparable to the GI_{50} value of the reference drug doxorubicin (Molinari et al., 2013).

Friedelin is a triterpenoid which is largely present in the roots of *Cannabis sativa*. About 12.8 mg/kg of friedelin was isolated from cannabisroots (Ryz et al., 2017). Friedelin is a molecule with potent anti-cancer activity when exposed to breast cancer cell lines. Treatment of MCF-7 cell line with friedelin, produced cytotoxic effects on the cells with an IC_{50} value at 1.2 µM. Friedelin increased the ROS production and increased the molecular variations that could lead to apoptosis. Molecular changes in cancer cells like condensation of chromatin, irreversible nuclear compaction or nuclear pyknosis was evident and fragmentation of the nuclei body were some events linked to the apoptosis.Molecular changes like upregulation of Cdkn2A, pRb1, p53 and downregulation of mouse double minute 2 homolog (mdm2) was evident in friedelin treated MCF-7 cells. Upregulated pRb1 and Cdkn2A act as tumor suppressors(Subash-Babu et al., 2017). Meanwhile, Mdm2 is a primary

negative regulator of the p53 protein. E3 ubiquitin ligase of mdm2 can ligate and ubiquitinate p53 which can get degraded by proteosomes. Simultaneously, friedelin also suppressed the expression of Bcl-2. Bcl-2 inhibits the pro-apoptotic signals which increase the chance of cancer cell survival (Um, 2015). Additionally, cytokines like tumor necrosis factor-alpha(TNF-α),Fas ligand and its adaptor proteinfas-associated protein with death domain (FADD) has been upregulated in death receptor-dependent pathways. Friedelin also up-regulates the BAX protein which causes cytochrome C to be released, thereby activating apoptosis. A significant increase in the expression of caspase proteases like casapase-3,8,9 and PARP was evident upon friedelin treatment of MCF-7 cells. Activation of caspase- 3 causes the cleavage of PARP which starts the cascade of apoptosis. In contrast down regulation of proliferating cell nuclear antigen(PCNA) prevents DNA replication(Subash-Babu et al., 2017).

Limonene is one of the most abundant terpenes found in Cannabis. Limonene is a monoterpene, and perillyl alcohol is a hydroxylated limonene analog. A lab analysis of limonene and perillyl alcohol on T-47D, MCF-7 and MDA-MB-231breast cancer cell lines decreased the expression of Cyclin D1 mRNA levels, causing the cells to be arrested in the G1 phase, thereby contributing as a cell growth suppressor (Bardon et al., 1998).

Sesquiterpene extract containing β-caryophyllene, β-caryophyllene oxide and α-humulene collected from Felina 32 hemp showed antitumor effects on MDA-MB-231 breast cancer cell line. Sesquiterpenes were able to downregulate P-glycoprotein (Pgp) and multi drug resistance-associated proteins 1 and 2 (MRP1 AND MRP2). The above mentioned three sesquiterpenes also downregulated the Janus kinase (JAK1)-signal transducer and activator of transcription (STAT3), NF-κB and PI3K/AkT/mTOR/S6K1 signaling pathways thereby inhibiting cancer progression and inducing apoptosis (Di Giacomo et al., 2021).

2.10Anti-cancer role of Flavonoids in Breast Cancer

Flavonoids make up a fraction of bioactive compounds in *Cannabis sativa*extract. There are more than 20 flavonoids identified in *C.sativa.* Predominant flavonoids in cannabisare quercetin, apigenin, luteolin and kaempferol. Flavonoids unique to cannabisare cannflavins A, B and C (Bautista et al., 2021). Cannflavins A and B exhibit anti-inflammatory properties. The anti-inflammatory reactions are exhibited by inhibiting microsomal prostaglandin E synthase-1(mPGES- 1) and 5-LOX which are two important enzymes needed for the biosynthesis of pro-inflammatory factors like prostaglandin E2(PGE_2) and leukotrienes(LTs) respectively (Werz et al., 2014). Over expression of mPGES-1 is usually coupled with increased COX-2 production, which results in high levels of PGE_2. Therefore, suppression of mPGES-1 reduces the levels of PGE_2 which usually inhibits tumorigenesis(Nakanishi et al., 2010). High levels of PGE_2 cause increased tumor growth with well-established vascularization resulting in worse prognosis. The enzyme 5-LOX is a necessary enzyme for the synthesis of lipid pro-inflammatory factor LTs which again could increase cellular stress to proceed with tumorigenesis (Ringleb et al., 2017).

Quercetin is a flavonoid providing antioxidant properties to cannabis. The chemical structure of quercetin is 3,3',4',5,7-pentahydroxyflavonol belonging to the aglycone class of flavonoids. A study was conducted on breast cancer cell line MCF-7 and CAL51 using nanoparticles encapsulated with quercetin. Upon treatment of cells with quercetin nanoparticles both MCF-7 and CAL51 cells showed cytotoxic effects like disintegrated cell membrane, swelling of the cells, vacuolization of cytoplasm and condensation of chromatin which were all the features of a pro-apoptotic cell. Molecular effects like downregulation of PI3K,MAPK and Wnt signaling pathway led the cells to apoptosis was a key

feature of quercetin treatment. These keys signaling pathways inhibit many proteins like MEK1, PI3K,Akt,mTOR, glycogen synthase kinase-3 alpha(GSK3α) and β-Catenin. In cancer cells, overexpression of the abovementioned proteins helps the cell survival and causes progressive oncogenesis. Increased expression of pro-apoptotic proteins like caspase-3,p53 and BAX were evident which induced DNA fragmentation in MCF-7 and CAL51 cell line. The cells were also arrested in the transient M phase which curbed the cell division. Meanwhile apoptosis was also induced via activation of intrinsic and extrinsic pathways of cell cycle by regulating gene-encoded proteins such as p53,p21,p27 and by modulating the cell cycle regulatory proteins like cyclin B, cyclin D and CDKs. Simultaneously, induction of p73 and p21 proteins and inhibition of cyclin B, cyclin B1 and CDK-1 also mediated cell cycle arrest at G2/M phase (Mohammed et al., 2021).

Additionally, HER2 breast cancer cell line was induced to undergo apoptosis through activation of multiple caspases such as caspase-3 and caspase -8 whereas in contrast STAT3 signaling pathway was downregulated. A study conducted in targeted delivery of quercetin using pH sensitivezinc oxide nanoparticles for breast cancer caused increased apoptotic cell death in MCF-7 cells due to enhanced oxidative stress and mitochondrial membranal disruption on the cancer cells (Sadhukhan et al., 2019).

To increase the cytotoxic effects of quercetin, it was coupled with another flavonoid naringenin. Synergistic cytotoxic effects on breast cancer cell lines were evaluated. Treating breast cancer cell lines in vitro with both the flavonoids had a synergistic effect. Naringenin and quercetin had significantly higher caspase-3 and 7 activations leading to a more robust apoptosis induction and disrupted cell proliferation. Furthermore, downregulation of Bcl-2 and Bcl-2 family proteins such as BAX and B-cell lymphoma-extra large(Bcl-xL) was evident in MCF-7 cell upon being treated with the duo naringenin and quercetin (Rhman et al., 2022). When considering a malignant cell, the lack of antioxidant enzymes such as catalase confer the cells to lack the ability to neutralize free radicals. Flavonoids are also considered to be pro-oxidants, as these flavonoids can bind with metal cations to produce superoxides which lead to apoptosis. Furthermore, Quercetin-O, is a radical formed through auto-oxidation of quercetin. Quercetin-O can act as a free radical and can inhibit the action of enzymatic antioxidant thioredoxin reductase. Additionally, naringenin also acts as a pro-oxidant that can inhibit glutathione peroxidase and the ROS- dependent activation of extracellular signal-regulated kinase 1/2 (ERK1/2). Therefore, ultimately the increase of ROS caused lipid peroxidation and lead to apoptosis (Niazvand et al., 2019). Expression of MMPwas downregulated upon the cells were treated with naringenin and quercetin leading to apoptosis (Niazvand et al., 2019).

Another study investigated the gene ‘twist’ which is essential in the development of cells in embryonic stage. The twist gene alsodownregulates E-cadherin, which causes cells to move and become invasive. Twist is overexpressed in breast cancer cells leading to form metastatic invasive cancers. Quercetin decreases the regulatory enzyme of the twist gene, phosphor p38MAPK. Phospho-p38MAPK is a vital enzyme necessary for cell proliferation in various cancers, including breast cancer. Phospho-p38MAPK phosphorylates the twist gene causing the gene to be activated. Therefore, downregulation of phospho-p38MAPK inhibits the function of twist gene as well (Ranganathan et al., 2015).

Apigenin is chemically known as 4’,5,7- trihydroxyflavone. Apigenin promotes anti-cancer effects by upregulating apoptosis, autophagy and regulating the aberrant cell cycle. Furthermore, invasiveness and migration of the cancer cells are reduced as well. Modulation of key signaling pathways regulates multiple processes in curbing the growth of cancer. Breast cancer cell line BT-474, upon being treated by apigenin inhibited cell proliferation and induced apoptosis by downregulating P-JAK1,P-JAK2 and PSTAT3 (Yan et al., 2017). JAK-STAT pathways are involved in cell growth, survival and development of cells (Ghoreschi et al., 2009). In MDA-MB-231 cell line, apigenin caused cell cycle arrest, by downregulating cyclin A, cyclin B and CDK1 whereas p21 was upregulated. Additionally, histone deacetylase (HDAC) activity was inhibited. Inhibition of HDAC can induce cell cycle arrest

and inhibit tumor angiogenesis and invasion and induced the acetylation of histone H3 protein(Eckschlager et al., 2017).

In T47-D and MDA-MB-45 upregulation of cleaved caspases and PARP was evident. Meanwhile in MDA-MB-468 and 4TI cell line, apigenin caused enhanced immune response. Inhibition of interferon-gamma(IFN-ɣ) induced programmed death ligand -1 (PD-L1) expression. Additionally, In SKBR3 cell line, apoptosis was established due to reduced expression of P-JAK2, PSTAT-3 and inhibition of VEGF(Yan et al., 2017). Furthermore, apigenin also down-regulates MMP-2/9 and transcription factors Snail and Slug. Snail family transcription factors increases the EMT that induces tumor progression whereas both Snail and Slug transcription factors increases the production of transforming growth factor – β3 (TGF-β3) which can then subsequently increase EMT as well (Ghoreschi et al., 2009). Additionally, reduced PI3K/Akt pathway increased the expression of the transcription factor FOXO3a, which can cause cell cycle arrest (Eckschlager et al., 2017).

Additionally, luteolin referred with its chemical name as 3',4',5,7- tetrahydroxy flavone is a common flavonoid found in cannabisin high concentration. Luteolin also displays pro-oxidant activity to produce ROS. Similarly, to previously discussed flavonoids, luteolin induces apoptosis by inhibiting anti-apoptotic pathways such as PI3K/Akt, NF-κB, X-linked inhibitor of apoptosis protein(XIAP) and inducing p53 to stimulate pro-apoptosis pathway. Suppressing NF-κB levels also increase cell sensitivity to TRAILproteins causing apoptosis. Luteolin decreases XIAP inducing proteasomal degradation by inhibiting protein kinase C(PKC) activity. The anti-metastatic actions are mediated by suppressing the secretion of cytokines such as TNF-α and IL-6. Overproduction of TNF-α and interleukin-6(IL-6) cause cancer cell migration. IL-6 levels are known to positively increase MMP-1 which causes cell metastasis. Simultaneously, inhibition of EGFR decreases cell metastasis as well. Meanwhile, Focal adhesion kinase (FAK) causes invasiveness of cancer cells. Inhibition of FAK by luteolin reduces cell invasiveness. Luteolin activated caspase cascade and enhanced the expression of death receptor -5 (DR5), which arrested the cancer cells in subG1 and G1 phase(Lin et al., 2008).

Luteolin regulates multiple estrogen signaling pathway genes such as NCOR1, GTF2H2,NRAS,TAF9,DDX5,NRIP1,POLR2A, NCOA3 and cell division controlling genes like CDKN1A, CCNA2, PCNA, PLK1 and CCND1. Luteolin also promotes H4 histone acetylation to stop tumorigenesis (Imran et al., 2019).

Furthermore, kaempferol, is chemically known as 3,5,7,4'-tetrahydroxyflavone. Anti-cancer effects of kaempferol were studied using breast cancer cell line MDA-MB-231 and T47D. The sensitivities of the cell lines to kaempferol were different. TNBC cell line MDA-MB-231 was the most sensitive to kaempferol than T47D. Kaempferol induced cell cycle arrest at G2/M transition phase of the cell. Molecular changes in the cells such as increased release of cytochrome C, condensation and fragmentation of chromosomes and membranes blebbing proceeds the cell to apoptosis. As mentioned in previous flavonoids, cleavage of caspase 3 and 9 was induced after kaempferol treatment. Kaempferol enhanced activation of p53 through ATM kinase which also upregulated death receptor and mitochondrial apoptosis. Kaempferol also increased the levels of phosphorylated H2AX and ɣH2AX which positively induces DNA repairing checkpoint proteins to cause cell cycle arrest in MDA-MB-231(Zhu & Xue, 2019).

Additionally, kaempferol caused the downregulation of anti-apoptotic proteins Bcl-2,polo-like kinase I (PLK-1), pAKT, phosphorylated insulin receptor substrate 1 (PIRS-1),pMEK1/2,CDK1,cyclins A, B,D1 and E and Cathepsin D (Zhu & Xue, 2019).

Meanwhile, reduced cell migration and invasiveness due to downregulation of GTPases RhoA and Rac1 in TNBC cell line was evident(Imran et al., 2019). Hyperactive RhoA and Rac1GTPasescause increased cell migration and cancer progression (Haga & Ridley, 2016). Kaempferol also reduces the expression of glucose transporter-1 (GLUT1) proteins causing accumulation of extracellular

lactate(Imran et al., 2019). Further anti-metastatic activity by kaempferol was established by blocking PKCδ/MAPK/activator protein -1 (AP-1) signaling cascade which blocked MMP-9. Kaempferol also positively induced transcription factor NRF2 and its regulatory enzyme NQOC1to produce an array of antioxidant proteins in MCF-7 cell line thereby blocking the transformation of oncogenes (Wang et al., 2019).

2.11Synthetic drugs based on bioactive compounds of *Cannabis* used in breast cancer

WIN-55,212-2, JWH-133 and JWH-015 have shown potent anti-cancer activity on breast cancer cells. Further analysis on these drugs is necessary to increase the robustness (Chakravarti et al., 2014).

3.0 Conclusion

Cannabis s. contains many bioactive compounds which can be extracted from the herb and analysed to innovate new treatments for breast cancer. Bioactive compounds such as phyto-cannabinoids, terpenes and flavonoids have shown evident results in laboratory analysis in conferring anti-cancer activity on breast cancer cell line. The mechanism of action and interaction with cell signaling pathways were evident as well. This study gives an in depth understanding in the usage of *Cannabis. s*in the field of medicine to treat breast cancer. Although, natural phytocannabinoids and cannabis based bioactive compounds were potent against breast cancer cell lines, further molecular analysis is needed to target breast cancer cells by cannabis bioactive compounds.

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Educational Technology Management Framework

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Abstract:

Technology is a driving change catalyst in education and has traditionally followed a standard business implementation approach. While many business IT concepts can be directly overlayed and applied when implementing technology in education, a different branched approach is needed to ensure the educational technology is implemented to focus on key educational concepts that business IT strategy does not address. This framework model aims to create a workable and recurring process of how educational institutions should manage and implement technology.

Keywords: Educational Technology, Technology Framework, Lifecycle Management, REACT
Main Conference Topic: Education

Introduction:

The need for a set framework in educational technology is prevalent as current frameworks are not suitable to the unique needs of the educational industry. Most educational institutions do not have a dedicated framework or dedicated strategic plan for managing their technology. Many educational institutions rely on standard business technology implementation practices and not notice any major flaws all while missing key areas specific to education that business technology implementation does not address. There is a need for a set framework for technology in education to ensure alignment of technology management and implementation with the strategic goals of the institution. The purpose of the Educational Technology Management Framework is to allow new and existing educational institutions to apply this framework to align technology with the strategic educational goals of the institution. This framework utilizes five business technology COBIT principles and aligns them with five key Northwestern Information Design and Strategy program frameworks to produce a complete framework suited for educational technology implementation and management.

Problem Statement:

Currently, there is no set framework for educational technology implementation and management. The most commonly used IT management framework is the Control Objectives for Information Technologies (COBIT) framework, created by the Information Systems Audit and Control Association (ISACA). The COBIT IT principles do not address some of educational technology's unique and challenging aspects that are specific to the industry.

Framework:

The educational technology management framework combines a COBIT principle with an IDS program framework to develop each framework branch of the REACT (Review, Examine, Adjust, Consolidate, and Test) model.

Figure 1.

Framework Creation

COBIT Principle —>	**IDS Framework —>**	**ETMF - REACT Model**
Meeting stakeholder needs	User research	Review
Covering the enterprise end-to-end	Data management	Examine
Applying a single integrated framework	Design thinking	Adjust
Enabling a holistic approach	UI/UX Design	Consolidate
Separating governance from management	Constructivist learning theory	Test

- Review critical IT systems and day-to-day operations.
- Examine processes and identify critical areas of improvement.
- Adjust IT systems and processes to best serve the educational institution.
- Consolidate systems and processes focusing on uniformity.
- Test the framework and repeat the REACT model.

Literature Review:

A primary building block for the educational technology management framework is how technology must focus on the end-user and their user experience. Observing the user experience states, “Our philosophy is not about following strict procedures to predictable solutions. It’s about defining (and redefining) specific problems and opportunities - and then creatively responding to them. The ultimate goal of these tools is not merely to make people happy; it’s to make successful products and services by making people happy.”(Goodman et al., 2012). Throughout each step of the framework, it is necessary to continue to reiterate the importance of how a successful implementation of technology, in the end, must provide a service that makes the end-user happy. End-user satisfaction can easily get lost during technology implementation and management with strict procedures and predictable

solutions that ignore the underlying factors of implementing and technology management. Without the end-user focus of the framework, the technology becomes an item rather than a tool.

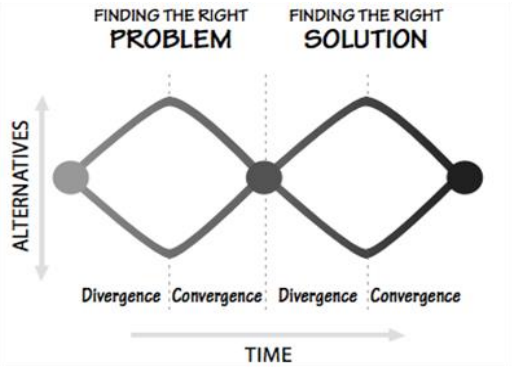
Focusing on the end-user is an important factor, more importantly, there needs to be a focus on the leaders in the organization. Merely accepting a technology change will lead to a failed future technological process adoption across the organization. Organizational leaders need to have an all-in approach to backing the technology framework and clearly understand the rationale behind significant milestones. Kim Erwin states, "We need more than buy-in; we need leaders to fully join our idea - to be involved in integrating it - not merely to accept it. If the idea is big enough and bold enough to disrupt the standard order of things, then "buy in" is no longer enough. It has to be all-in."(Erwin, 2014). The Educational Technology Management Framework aims to think outside the box of standard technology implementation and management and view educational technology through a new lens. Following the framework's five branches without the all-in approach will lead to subpar results. This framework will still produce positive results if leaders do not fully engage with an all-in mentality but the overall change catalyst of the framework will not be as impactful.

Educational institutions are, in essence, the original learning organization and need to approach the framework with the same learning organization approach. Often technology is approached as a separate entity from the educational institution and focused on a problem-solution system rather than a transfer of knowledge system. The problem-solution approach will work for educational technology departments but will unnecessarily overuse resources, create unnecessary dependencies, and not fully utilize the full potential of the technology. In the Harvard Business Review article Building a Learning Organization, David Garvin states, "A learning organization is an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights."(Erwin, 2014). This framework is focused on modifying an organization's technology approach and utilization, and must be continually reiterated that the educational technology should change to reflect new knowledge and insights of the learning organization.

In The Design of Everyday Things, Don Norman states, "Designers often start by questioning the problem given to them; they expand the scope of the problem, diverging to examine all the fundamental issues that underlie it. Then they converge upon a single problem statement. During the solution phase of their studies, they first expand the space of possible solutions, the divergence phase. Finally, they converge upon a proposed solution (Figure 6.1)."(Norman, 2013). Information technology can be approached as a binary problem to solution thinking but will surely miss the mark on all the fundamental issues underlying the problem. This framework takes a unique approach to think about branches of the framework as a designer rather than an IT professional or educational leader. This method of thinking is critical to ensure that an organization does not fall into the traditional process of addressing one single issue and not looking at the underlying problems.

Figure 2.

Double Diamond Model



(Norman, 2013 Figure 6.1)

Taking the double diamond approach will ensure that all the underlying issues are examined and not just look for quick solutions. This double-diamond approach has the start, middle, and end as three significant milestones that can be used as engagement markers for the team working on technology change or implementation. Having both the technical team and managerial team go through the divergence and convergence phases together will work to build team comradery and explore unique solutions. The double diamond approach also is a catalyst to ensure that all voices are heard during the process as each divergence and convergence opens up and explores new opportunities and solutions regarding the single problem. The conversation behind the divergence and convergence phases can lead to increased buy-in by the leadership and implementation team as they have stepped through and understand the process from problem to solution.

Research Methodology:

The concept for this framework was seen as a need to address the lack of any notable management framework aimed at educational technology. This framework could be developed and implemented to not only improve the general structure and workflow of the department, but more importantly, focus on how technology can be applied and managed to reach the district's mission and vision. All elements of this framework were fully implemented and studied over a two year long period. The initial groundwork for the framework generated feedback and allowed for adjustment and reconsideration of certain aspects that would not have been possible without this real-time implementation.

While the primary research focuses on boots-on-the-ground case study research, another secondary research methodology used in this framework was to review and assess previous case study research. The case study Optimal Pathways for Technology Integration towards Blended Learning -

Case Study of a Non-Traditional School in Illinois, United States did not address the technology management and overall framework this technology integration would impact. While it would seem

standard to start with a broad framework and strategic plan and then work towards project-based case studies, it was very informative and impactful to do the opposite. As this framework was implemented in real-time, and had direct involvement and oversight of the case study project, it created a deeper understanding of the steps needed to not only successfully implement technology towards blended learning but also all the underlying steps that make up a single technology implementation project. Many of the same smaller project-based concepts apply to a more extensive educational technology management framework.

Research Findings:

Two key elements were identified that continued to surface for technology management in education throughout my research.

- Technology management and integration are not differentiated by industry.
- Educational institutions often do not develop strategic technology plans.

Very few technology implementation and management frameworks are applicable directly to education. The most common framework is the COBIT framework created by ISACA for information technology management and IT governance. COBIT has excellent principles that overlap with educational technology management and implementation but should not be strictly adhered to as educational technology should have an academic approach and not a business approach. While a business approach to educational technology will ensure technically correct implementation and management, it will not correctly align technology management and implementation with the district's strategic plan, mission, and vision as closely as an educational technology management framework. While technology has some standard aspects across the industry, it is a disservice not to approach technology through adirected lens, especially in education.

The second research finding is the lack of strategic technology plans across most educational institutions. Educational institutions commonly have a strategic plan that aligns the district with critical goals and milestones to better the school. Looking at predominant school districts in the area, many had strategic plans, but with little to no reference to technology and the district's technology plan. Technology undoubtedly has impacted our educational institutions in massive ways, and not having a plan for one of the most valuable assets is not the correct approach. A primary example of a strong strategic plan with technology was Lake County Tech Campus, which had a key technology area in their strategic plan with specific action items, timeline, measures, and results. This strategic area of Lake County Tech Campus is a comprehensive technology plan example.

Figure 3.

Lake County Tech Campus Technology Strategic Area

Lake County Tech Campus — 2020-2025 Strategic Plan

Strategic Area: Programming/Technology/Curriculum

Goal Statement: Equip students and teachers with access to the most relevant technology in order to interact confidently with those technologies.

Key Area	Action	Action Manager	Timeline	Measures	Results	2020-2021	2021-2022
Technology	Work with member schools to integrate technology resources and provide equitable access to all students	Lake County Tech Campus Principal Team and Technology Team	2020-2025	Technology usage report	Equitable access for all	Splashtop Remote Access to computer labs to access software and hardware demands of computing courses. Checked-out laptops and Chromebooks for students in need of a device. Updated Tech Academy website with student-friendly tutorials.	All Special Education teachers, case managers, counselors, and liaisons to Tech Campus have access and recieved training for the Schoology gradebooks of their students to track their progress.
	Research shareable collection system for all components of ESSA	Lake County Tech Campus Principal Team and Technology Team	2020-2025	Technology needs assessment	Increased number of students meeting ESSA goals		Purchases Transeo work based learning software that will provide detailed student data to all member districts regarding ESSA opportunities.
	Recognize and implement the needs of programs through industrial and educational technology	Lake County Tech Campus Principal Team	2020-2025	Annual program reviews	Current programmatic and educational technology throughout the building	Fully remote learning environment specific to programming which helps equate to remote working environment	
	Refine the development of e-Learning and blended learning opportunities and an effective delivery system	Lake CountyTech Campus Principal Team and Technology Team	2020-2025	Student and staff surveys, lesson plans and assessment data	Effective e-Learning opportunities	Integrated Schoology LMS into teaching to manage, provide, & assess student work in an equitable fashion. Provided Remote Access via Splashtop Buisness for students to gain access to computer lab resources. Additionally, instructors live-stream daily lessons.	Continued support of previous year integration.

(Kapala, 2020)

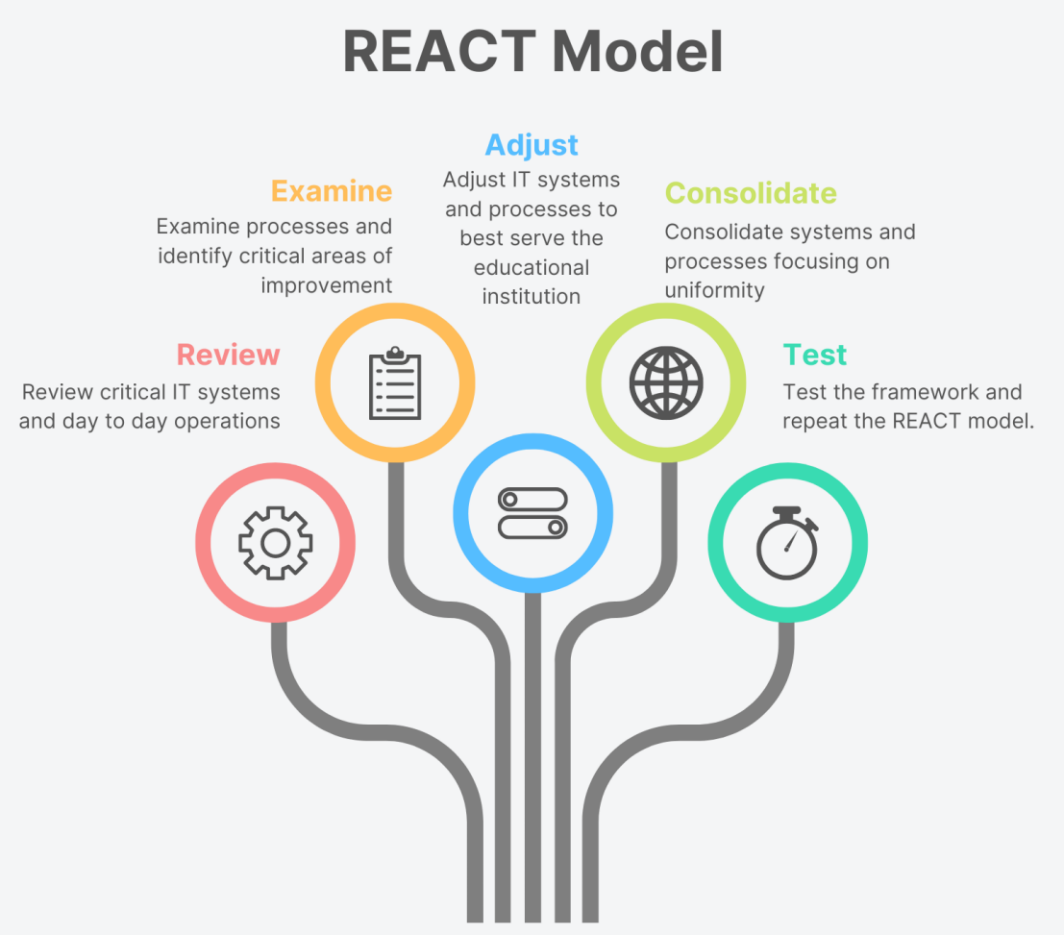
Looking at Chicago Public Schools, the largest school district in Illinois, it was discovered that their strategic plan only had one initiative for technology. Their strategic plan stated one technology goal "Provide a classroom device for every student and teacher. Our students deserve modern technology at their fingertips to support their learning. Within the next five years, every student will be equipped with a device, such as a tablet or laptop, for digital learning in the classroom. These devices will be used at the direction of teachers and educators, who will also be provided a device with classroom management tools to enhance student learning and collaboration. To support that goal, we will also double the internet bandwidth at every one of our schools. This strategy directly addresses the digital divide to ensure that every student, regardless of income or access to technology at home, has the tools and resources needed to benefit from a 21st century education" (Valle et al., 2019). While providing a classroom device for every student and teacher is a great milestone, this goal is not specific or encompassing all major educational technology elements. Knowing that technology plays such an important role in educational experience and growth, one strategic goal of providing a device to every student and teacher cannot cover all elements of technology and properly work towards the district's mission "To provide a high-quality public education for every child, in every neighborhood, that prepares each for success in college, career, and civic life" (Valle et al., 2019).

Solution or Treatment:

The solution was the creation of the Educational Technology Management Framework. This framework combines the five core COBIT principles with IDS program frameworks to develop the five framework branches of the REACT (Review, Examine, Adjust, Consolidate, and Test) model. The core concept of the REACT model is to directly review and develop an IT strategy and management plan that aligns technology with the educational institution's mission and vision. This framework can be applied in a narrow or broad approach depending on the depth of strategic plan elements you would like to include and analyze.

Figure 4.

REACT Model



- Review critical IT systems and day-to-day operations. This can consist of internal and external technology network and infrastructure assessments and an in-depth look at day-to-day operations and processes. The primary key is to understand the educational technology environment at this moment and to perform user research. At this point, you want to get a general baseline of how the IT department functions and how the end-users use the technology during day-to-day operations. Observation is a crucial component to begin this, as you should not send out a survey regarding user research if you do not have a general understanding of the environment that you are surveying.

- Examine processes and identify critical areas of improvement. Look at the pain points and opportunities of what needs improvement and what is working well. Starting the REACT model, must not get too granular as the first few iterations of the model must be broad and then focus on granular elements later on after the first few iterations of the model. This is also an excellent time to start developing the educational technology strategic plan and align it with the institution's strategic plan. What do you see as areas of improvement in the next year, two years, and five years?
- Adjust IT systems and processes to best serve the educational institution. Now it is time for you to grab that strategic plan (if available) and see the critical educational goals for the institution. How will IT have to adjust to assist the institution in meeting and exceeding these goals? This is an important time to sit down with key stakeholders in the institution and take a deep dive into how IT plays a role in the strategic plan. You want to ensure that IT is not overlooked when dissecting the goals of the institution, as many backend changes are needed by IT to support the strategic goals. This is a pivotal time to make personnel changes and overall process adjustments. You want to directly involve the IT team throughout this framework, so they understand the goals and the reasoning behind the changes.
- Consolidate systems and processes focusing on uniformity. Now it is time for management simplification. What are the primary areas of time spent by both users and IT personnel that can be consolidated or removed with system-wide change? Many educational institutions started with very little technology, then expanded to have too much technology, and now are trying to reduce for management purposes and have a set and manageable technology baseline. Again, this process can start as a broad scope for the first few iterations of the REACT model and then work to become more granular as you continue the model. Now is a great time to consider bringing in a consultant or managed service provider to take a look at best practices and, more importantly, gain insight from an external perspective. Would outsourcing some of your IT services and management be a viable option and the best fiscally responsible approach? Now is the time to sit down and determine what path you want to take to ensure you can best serve the educational institution's needs.
- Test the framework and repeat the REACT model. Now that you have worked through the first four branches of the model, it is time to take a step back and see if all of the adjustments are working to reach the educational institution's strategic plan and the strategic technology plan (if applicable). How have you implemented the technical training to ensure that all stakeholders have the appropriate strategy to work through the new technology changes? Constructivist learning theory is an excellent way to approach technology training and implementation. You want to work to create an environment where the end-users are progressing as much as the technology changes. If you implement technology without the constructivist learning approach, the end-users will quickly become dependent on IT support

rather than working through problems independently. While it is vital to provide technical support, it is imperative that a dependent relationship with IT is not needed to solve every problem. The IT department should focus on supporting systems to run correctly and not need to be the expert in every system. Now is a great time to engage with your technology trainers or coaches to have them give feedback on the changes.

Implementation and Timeline:

The REACT model timeline to fully process should not be greater than six months. You should be able to go through all five branches of the model in six months before starting the next iteration. The reason for the six-month deadline is that organizations and technology within the organizations are very fluid and need to be analyzed within six months so that you are not performing steps in the framework that are no longer applicable. This six-month deadline would allow you to work through the Educational Technology Management Framework twice a year to ensure that you are on top of new emergent technologies and working for continuous improvement in the institution. At minimum, the REACT model can be an annual process for an institution depending on the size and overall time allocated to work through this model. You want to ensure that the following criteria are adhered to regardless of the situation, so the model produces optimal results.

- A complete cycle of the REACT model is done prior to restarting another cycle.
- The initial processes of the REACT model start broad and then eventually can work to a more granular focus after the model has been completed multiple times.
- The REACT model should be performed **at a minimum** once a year.

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ABSTRACTS

The Impact of the Work Environment on Employees' Mental Satisfaction in Green and Non–Green Apparel Factories in Sri Lanka

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Abstract

The establishment of green apparel buildings is an efficient method of minimizing the negative impacts of industrial development. As a result of the insufficient knowledge of potential benefits and disadvantages, apparel factories in Sri Lanka are not very likely to take on such an approach. This study aims to identify the factors that affect employees' mental satisfaction in the industry as well as the impact on environmental benefits, employee perception and performance, and economic impact through Indoor Environmental Quality (IEQ) and its' maintenance cost to the apparel factory. The mixed method is the approach which is used. A green factory building and a non-green factory building were selected as the sample for the study. Using questionnaires, data was gathered from 90 randomly selected apparel sector employees in two different factories. In addition, semi-structured interviews were conducted with fifteen professionals with knowledge in the green building construction and apparel industry. The results demonstrated that the environment and the company's employees stand to benefit greatly from the green apparel industry. Every employee in the green apparel buildings benefits from better lighting, fresh air, cosy surroundings, and beautiful views of the natural outside. Employee productivity, mental satisfaction, and health are all improved. IEQ is not apparent in non-green buildings; rather, it can be developed psychologically by promoting worker productivity and quality of work. Maintenance cost is closely related to how much attention is put on various design components, demonstrating a sophisticated strategy for balancing the project's architectural demands with its financial constraints. Finding solutions to close the gap between green and non-green factories and achieving a balance that combines the best features of both strategies to improve overall employee productivity and well-being in the apparel industry requires an understanding of these limitations. Green apparel buildings are required to improve brand equity and lower employee turnover and absenteeism rates by improving strategies which can enhance productivity through mainly awareness programs regarding the green building concept.

Keywords: IEQ, employees' mental satisfaction, green apparel buildings, non–green apparel building, maintenance cost, productivity

Sri Lanka's Path to Sustainable Energy: A Hybrid System with Integrated Pumped Hydro Storage (PHS) as an Energy Demand Management System (EDMS)

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ABSTRACT

Sri Lanka's current energy landscape has major challenges to come across in order to achieve proposed sustainability goals by 2050. More than 50% of energy requirement is depend on fossil fuels, and price fluctuation due to unstable economic situation in the country are among major challenges. A paradigm shift towards a sustainable energy mix is imperative to address these challenges. The main objective of the study is to proposes Energy Management System (EMS), integrating renewable energy sources such as solar and wind coupled with energy storage system. A comprehensive literature review was carried out and analyzed the modern energy infrastructure models that are been successfully implemented in globally. In order to find the gap in existing energy system, KII were carried out in different stakeholders in energy sectors. The study findings revealed that the existing energy transmission system is entirely controlled and regulated by system control center by Ceylon Electricity Board (CEB). This system is unable to provide continuous power supply at full operation if there is a major failure in a plant or transmission line. Moreover, the frequency controlling machine has been designed to shut down to avoid any damage to the central control system. This occur mainly as a safety protocol inbuilt in the frequency synchronous system. This phenomenon lead to intermittent power cut during peak hours. Moreover, the existing EMS is able to present only the demand management schedule (power-cut schedule) instead of meet the total energy requirement of the country. This study is proposed a hybrid energy management system(HEMS) which could leverage Sri Lanka's abundant renewable energy sources (RES), primarily solar and hydro power. RES will be acting as primary energy contributors, while a dedicated pumped hydro storage (PHS) facility will utilize off-peak surplus energy from RES to pump water uphill to a reservoir. During peak demand hours this stored water will be released back down, driving turbines and generate electricity to meet peak demand. This PHS system is also coupled with a smaller scale battery backup system to provide additional peak power and startup power to support and enhance system flexibility at critical grid nodes. The latest smart grid technologies will optimize the process of this demand management system leveraging advanced data analysis, forecasting algorithms and intelligent control system. By adopting a hybrid energy system with integrated PHS, solar, and grid modernization, Sri Lanka can become a role model towards a clean, resilient, and prosperous energy future. This approach tackles the nation's energy challenges head-on, explore the way for economic growth, environmental protection, and improved quality of life for citizens. The time to act is now, and Sri Lanka has the potential to become a leader of sustainable energy development in the region.

Keywords: hybrid energy management system (HEMS), renewable energy, pumped hydro storage (PHS), solar power, grid modernization.

Effectiveness of Organic fertilizers as a Sustainable Waste Management for Small-Scale Gardening: A Case Study using Chilli, (Capsicum annum L.)

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Abstract

Composting is an environmentally friendly method of re-purposing organic waste and it supports the United Nations' Sustainable Development Goals (SDGs) such as SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land), improving composting techniques may also help us accomplish a number of other targets listed in other SDGs. Sri Lanka has decided to shift from commercial agriculture to organic agriculture by using compost and eco-friendly fertilizers and pesticides in 2020. With the current demand for compost fertilizer requirements in the country, researching on the effectiveness of the production and filling the research gaps is timely. Thus, this research was conducted to determine the optimum rate of compost application of commercially developed compost product by measuring soil characteristics (soil pH, soil temperature, water holding capacity, and microbial activity), growth parameters (plant height, diameter of the stem, total number of leaves, total number of flowers, total number of pods), and crop yield. The research was conducted from April 08, 2022 to May 27, 2022 in the greenhouse of the University of Colombo, Faculty of Science, Sri Lanka. The chili pepper was utilized as the experimental crop and the variety used in this research was MI 2. The Chili plants were cultivated in greenhouse at different rates [Control: No compost; T1: 5 MT/ha; T2: 10 MT/ha; T3: 15 MT/ha; T4: 20 MT/ha; T5: 25 MT/ha; T6: 30 MT/ha] of compost application for 8 weeks. One-way Analysis of Variance (ANOVA) with p value < 0.05 was used to check for significant differences in the calculated mean values of all parameters. Based on the results, the treatment T1 (rate of compost application at 5 MT/ha) displayed the most suitable compost-soil combination and more effectiveness than other treatments in terms of soil characteristics, growth parameters, and crop yield among the studied chili plants. The results revealed that it was more effective to utilize an optimal rate rather than using a higher rate of compost application in vain. This approach will be an effective way of sustainable waste management for a sustainable future.

Key words: Effectiveness of organic fertilizers, Compost application, Soil characteristics, Sustainable Waste Management, Sustainable Development Goals

Heritage Mural Conservation and Digital Restoration of Thaliyil Mahadeva Temple, Kerala, India.

Prof. Dr. Robinet Jacob, Dr. Toney K Thomas & Miriam Najjim
Mahatma Gandhi University, India

Murals are considered as an art form. It is not only an artifact but also a mentifact which is seen in the walls, ceilings and in large spaces. They bring past cultural life of a society in a certain time period into the public arena. The Indian subcontinent has witnessed the dawn and dusk of several religious philosophies under different rulers from time to time (from prehistoric to late medieval period such as Shungas, Kanvas, Satvahanas, Kushans and Thekkumkoor etc). Their socio-cultural, political, economic, religious activities are narrated as facts and stories with the help of mural painting in places of mass gathering. They are the religious institutions such as temples, caves, tombs, mosques, viharas and churches. Ajanta, Ellora and Badami caves, Brihadeshwara temples, Lapakshi etc set an example. Regional styles have been created to show uniqueness to the rule by artists. Analysis of styles of brush stroking, pigment and binding content are studied using Chromatographic techniques. Thaliyil Sree Mahadeva Temple sets an example for this by using organic and inorganic materials and its unique Vembanad style. This paper focuses on analyzing and studying murals by adopting scientific techniques from interdisciplinary fields, thus by safeguarding one of the oldest murals of the 7th Century A.D seen in the walls on Sreekovil. The main aim of this study is to characterize the figurative elements, analyze the constituent materials which were used and thus take necessary courses of action for chemical conservation. Step by step structural and chemical conservation processes and Digital restoration of the murals using scientific techniques and artificial intelligence for sustainable promotion.

Keywords : Murals, Heritage structural preservation, Chemical conservation, Digital Restoration, Artificial Intelligence

Assessing the Ecological and Societal Impacts of Sea Level Rise on the Negombo Stretch in Sri Lanka

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ABSTRACT

This study delves into the profound impacts of sea level rise and erosion on the Negombo-Colombo stretch in Sri Lanka, employing Google Earth images, Landsat 5 and 7 images, and in-situ data for analysis. The overarching objective is to understand the consequences of sea level rise on mangrove ecosystems, particularly the threat posed by sediment erosion, inundation stress, and heightened salinity at landward zones. The study identifies the significant challenge of 'coastal squeeze,' restricting landward migration of mangrove stands due to topography or human development, particularly impacting the mangrove islets at the Negombo Lagoon sea entrance. This phenomenon not only poses an ecological threat but also directly affects the Kuttiduwa islet, transforming it from a mangrove-covered area to a densely populated region since 1993. The islet has evolved into a semi-urbanized fishing community, featuring essential infrastructure facilities and serving as a commercial hub for marine and lagoon fishery. This transformation underscores the dynamic interaction between sea level rise, environmental changes, and human activities, emphasizing the need for proactive measures to mitigate the adverse effects on coastal ecosystems and communities.

The challenge of entropy

Dr/Prof. Suresh Balraj,
Professor Emeritus, India

ABSTRACT

The progressive degradation of the biosphere which we are witnessing today cannot be attributed to technical deficiencies in the implementation of our socio-economic policies. It is the policies themselves that, by their very nature, are causing the destruction. What is more, they are difficult to reverse for two basic reasons : The first is that we have all become dependent on the proper functioning of commercial, bureaucratic and political institutions which employ the bulk of us, and which are committed to - and dependent on - the perpetuation of precisely those policies that are causing the destruction. The second reason is that we are imbued with a worldview - modernism - which rationalizes and legitimizes these policies and the destruction which they bring about.

The basic tenet of the worldview of modernism is that the world is imperfect, random, chaotic, atomized and aggressive. In fact, to use Lord Tennyson's well known phrase, nature is seen as 'red in tooth and claw', while the life of man (as opposed to modern man) is seen, in Hobbes's equally famous phrase, as 'nasty, brutish and short'. In effect, evolution or ecology is thought to have done a bad job. According to conventional wisdom, it has produced a lousy world which is why we undo its work and change the world as radically as possible. This transformation is be achieved by means of economics, science and technology, and the various institutions of the state which together will perform the miracle called 'economic growth/development', thus, creating a veritable paradise on earth - one that is incomparably superior to the evolutionary process or the natural world. This is unquestionably the most pernicious myth ever entertained by the human race, for it is the policies which it serves to rationalize that are leading to inexorable destruction of the ecosphere, which, in turn, must inevitably spell the eventual extinction of our/all species.

The reason is clear : economic growth involves methodically substituting the technosphere (the surrogate world of human artefacts) for the biosphere (the real world of living things) from which the former derives its resources and to which it consigns its ever increasing toxic wastes. In other words, economic growth, to which our society is totally committed, inevitably means ecological degradation and, ultimately economic contraction. The two are inseparable - they are but different sides of the same coin. Ecological degradation and economic contraction finally give rise to a host of problems, each one of which is interpreted in such a way as to make it appear amenable to a solution that involves further economic growth. Such an interpretation is categorically and summarily consistent with the worldview of modernism.

Thus, we are told that, for example, population explosion is caused by poverty and insecurity in the 'underdeveloped' countries, and the only solution, therefore, is further or more economic growth which will, indeed, make the poor rich and secure, and thereby, give rise to the 'much-needed', so-called demographic transition with birth rates falling as material prosperity rises. Similarly, malnutrition and famine are blamed on 'primitive' agricultural techniques : again, economic growth is seen as the way out by making available heavy machinery, HYVs, and synthetic or artificial fertilizers and pesticides. And, so it is for each of the ever intractable problems that we face today which are nothing but, in reality, the

symptoms or manifestations of ecological degradation being caused by the very same policies that are actually meant to solve them.

As a result, the market-backed juggernaut of destruction continues unabated with impunity. We are, in fact, caught in a vicious cycle of ever greater ecospheric destruction and eventual extinction. Indeed, if are to survive on Earth for more than a few decades, then humankind must not only be restructured into socio-economic groupings that are capable of sustaining themselves without annihilating the world of living things, but also reject the worldview of the military-industrial base - led by markets and PR - in all its ramifications, thereafter, replacing it with a worldview that validates the different socio-economic structures and their ecologically benign policies. Hence, the unenviable task of discrediting the present or existing worldview is well under way, but to persuade the 'whole' of humanity to reject it outright will only be possible if an integrated and cohesive ecological worldview replaces it.

Exploring Customer Citizenship Behaviour in Tourism and Hospitality: An In-Depth Analysis and Conceptual Framework

Dr Toney K Thomas, Mohammed Niyas KK, Noufal Naheem Kottekkadan & Rigin Sebastian, Mahatma Gandhi University, India

ABSTRACT

The concept of citizenship behaviour within the tourism and hospitality industry is experiencing rapid transformations. However, most studies in this field tend to concentrate on the perspective of employees, often neglecting the crucial viewpoint of tourists. This study addresses this gap by expanding the scope of customer citizenship behaviour (CCB) within tourism and hospitality. This study seeks to broaden the scope of customer citizenship behaviour (CCB) within tourism and hospitality. In the customer context, CCB aims to conceptualise voluntary and self-directed behaviours that contribute positively to the tourism enterprise. Exploring an additional, voluntary role is envisioned to yield substantial benefits for the organisation. Through a systematic literature review employing the TCCM (Theory, Context, Characteristics and Methodology) approach, this research seeks to analyse the historical expansion of CCB over time thoroughly. Further, this study endeavours to construct a comprehensive conceptual framework by synthesising insights derived from existing literature.

Metaverse Nexus: Transforming Digital Heritage Recreation through Virtual Reality, Augmented Reality and Mixed Reality for Sustainable Tourism Development

Joseph S Raju, Dr Robinet Jacob & Vishnu Saju
Mahatma Gandhi University, India

ABSTRACT

In the contemporary landscape of tourist destinations, the synergy between sustainability and digitalization takes center stage. This paper offers a comprehensive exploration of the nexus between these two critical facets, leveraging the transformative capabilities of the metaverse. Serving as an expansive interconnected virtual realm, the metaverse seamlessly integrates digital and real-world experiences, allowing users to engage in diverse activities such as gaming, socializing, working, and exploring new places. Within this digital space, individuals can fashion their digital avatars and interact across a spectrum of virtual environments, mirroring real-world scenarios in a digital context. It investigates various ways in which digitalization contributes to sustainability, encompassing the adoption of smart technologies, the application of the metaverse, engagement through virtual reality and augmented reality, and the integration of digital heritage recreation. Successfully navigating challenges is crucial for fostering a balanced coexistence between sustainability goals and the continued surge of digitalization in the ever-evolving landscape of tourist destinations.

In the Metaverse, interactive and immersive experience with others in a variety of virtual environments. It's a bit like living in a huge, shared online space where you can do all sorts of activities and experiences, similar to the real world but in a digital form.Virtual Travel allows users to virtual replicas of real-world destinations, allowing them to "visit" and experience different places without physically traveling there. This can provide a preview of travel destinations and help in trip planning.Metaverse systems are used for tourism destinations and stakeholders to showcase their attractions, history, and culture through immersive storytelling and virtual experiences. This can promote destinations and engage potential travelers.Metaverse revolutionizes the travel industry by offering pre-experience services, allowing users to virtually explore hotels, restaurants, and other amenities before making travel decisions. This innovative approach alleviates travel anxiety and provides realistic previews of options. Additionally, the Metaverse enables highly personalized travel experiences, allowing users to customize virtual journeys, interact with locals or experts, and engage in immersive conversations for a more engaging and tailored exploration.

Keywords: Metaverse, Virtual Reality, Augmented Reality, Mixed Reality, Digital Heritage Recreation, Sustainable tourism Industry 4.0

U.S. Household's Awareness of Emerging Contaminants in Drinking Water and the Influence on Consumer-Decision Process in the Adoption of Residential Filtration Systems

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In-house water treatment systems is expected to grow globally in market value from US$19.9 billion in 2018 to an estimated value of US$34.6 billion by year 2026 (Reports and Data, 2019). Despite such global market presence, there is not much empirical studies dealing with in-house water treatment systems in developed countries. Furthermore, there are no studies till date that performed comprehensive analysis on consumer awareness of emerging water contaminants and multiple POU and/or POE in-house water treatment systems. To gauge the public's knowledge of emerging contaminants and their interest and willingness to pay for Point-of-Use (POU)/Point-of-Entry (POE) home water filtration devices, we performed a nationwide, online consumer survey covering 18 years or older from all fifty (50) US states. Our nationwide survey also explored how the messaging of a Point of Use (POU)/ Point of Entry (POE) product influences the public's decision to treat their drinking water by dividing the randomly selected survey respondents into a target (with benefit information) and a control (without benefit information) group. Survey findings reveal that about 20% of the respondents from combined target and control groups are unaware of any of the emerging contaminants. Out of the top five well known emerging contaminants in the United States (*Pesticides/herbicides*, *Pharmaceuticals*, *Microplastics*, *Personal Care Products* and *Antimicrobial Resistant Bacteria* and *PFAS* and *Pathogenic Mycobacteria*), three of them show up as the top five emerging contaminants that respondents showed the highest level of concern in relation to negative health impacts, which are *Pesticides/herbicides*, *Antimicrobial Resistant Bacteria*, and *Microplastics*. The survey respondents reveal that they find local or state government announcements/ directives as the most impactful source of information on water pollutants. Local state or government announcements are also the most impactful source of information for those aware of at least one of the top five most known emerging contaminants.

Keywords: Emerging contaminants; Drinking water; Consumer-decision making process; Residential water filtration systems; U.S. Households

JEL classification: D12, Q25, Q52, Q56

The role of the traditional social norms in crime prevention in Sri Lanka

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ABSTRACT

Society has benefited greatly from traditional social norms by sharpening every aspect. The community in Sri Lanka has been practicing social norms to perform in many traditions among the day-to-day life. Therefore, this study seeks to identify prevailing values, beliefs and practices among the people and to assess the role and impact of traditional roles in preventing crime. The sample consisted of 75 data contributors, including police officers, university students, lawyers, and the general public aligned with the convenience sampling technique. Google questionnaire was used as a tool for the data collection. As the results, it was found that 80% of respondents believed several norms were most important, and those are taking care of parents and respecting elders, and women. Most respondents (97.33%) believe social norms and values dramatically have changed over the past few decades. According to the sample, 86.67 % believed that Sri Lankan social norms can be used effectively to prevent crimes. further 36% of the data contributors point out that traditional social norms such as various Sri Lankan customs, practices, restrictions related to elder females, marriage caste customs, and belief about supernatural power provide the background to prevent those tendencies of criminalizing people. In relation to this, some examples shown by the data contributors can also be shown below. That is, Various legends found in the rural societies of Sri Lanka related to Mohini, Various beliefs that it is not appropriate for women to hang out in deserted places such as bathing places at night, Kalu Kumara Distiya, Adherence to Panchasheela etc. Many people (74.6 %) thought that the opportunities to commit crimes are prevented in some way through Buddhist beliefs such as Pancha Sheela. In conclusion majority of people believe value of social norms in crime prevention but it's awareness among modern people is not sufficient to practice them. Inculcation of such morels and norms within society based on school and education institution, are vital. Further media propaganda and launching awareness programs on morals and values are essential to make the crime free society.

Key Words: Crime Prevention, Crimes, Cultural Norms, Social Norms, Social customs

Breaking Barriers

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ABSTRACT

This research aims to investigate the intricate dynamics of gender roles and stereotypes impacting women's participation in STEM (Science, Technology, Engineering, and Mathematics) education. Through an extensive literature review and empirical analysis, the study seeks to identify societal influences shaping women's career choices in STEM fields. By examining educational experiences, societal expectations, and the representation of women in STEM, this research aims to provide valuable insights to inform strategies that promote gender inclusivity and diversity in STEM education. The findings are anticipated to contribute to the ongoing discourse on breaking gender barriers in STEM and fostering an environment that encourages women's active engagement in these critical fields.

The Transformative Role of Innovative Museum Design in Heritage Tourism

Ar. Raji Vipin & Dr. Robinet Jacob
Mahatma Gandhi University, India

The essence of heritage tourism lies in preserving and showcasing the rich culture of a heritage city, and a museum is the heart. Modern museum design in heritage tourism goes beyond the traditional realm of exhibition spaces, that engage visitors in immersive and interactive experiences through an amalgamation of technology, storytelling, and cultural authenticity to redefine the way visitors perceive, engage with the rich cultural heritage and enhance the museum experience. The advancing museum paradigm underlines the importance of visitor engagement, by encouraging participatory and memorable encounters with heritage artifacts. In this digital age, museum design involves planned and designed integration of immersive technologies such as virtual reality (VR), augmented reality (AR), and AI-driven interactive exhibits. Incorporating such digital elements can create enriched and dynamic environments that upstage traditional stationary displays, providing visitors with an immersive journey through time and history. Through a comprehensive analysis of recent developments in museum designs, this paper explores the technological aspects of Innovative design principles in creating a museum experience. The museum's spatial zoning and planning are very critical to guide visitors and their movement inside the building, unfolding the narrative in chronological or thematic order. This attracts a diverse audience, irrespective of language or culture, and fosters a deeper connection between visitors and the heritage they see. This evolution in design will help bridge the gap between the past and present, making heritage more accessible, engaging, and educational. This paper highlights the integral role of museum design in shaping the narrative of heritage tourism through the balance between preservation and innovation to create a space that preserves cultural artifacts, with minimal ecological footprint, making it a more sustainable museum experience and thus, leading to responsible tourism. Heritage museum planning demands a holistic approach, addressing architectural, curatorial, conservation, educational, community, and technological features, to preserve and present heritage in a way that nurtures appreciation and educates future generations.

Keywords: heritage, museum, innovation, technology, visitor engagement, design

Persistence and Student Success in Higher Education - Introducing Academic Safe Spaces in Online Courses

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ABSTRACT

This study discusses experiences with design and implementation of safe spaces for students in online courses. The classroom, in-person or virtual, is one of the places where issues of struggling students manifest. The goal of safe spaces in the virtual classroom is to promote student communication, connect them with academic and non-academic resources to create pathways that help overcome barriers to learning. The need for academic safe spaces (ASF) in online courses will be discussed along with how it can complement other strategies to support student success. A few different design strategies to implement ASF in the learning management system will be presented with supporting data on the implementation of ASF. Though there is no common design strategy for safe spaces in the virtual classroom, a consistent safe space module in every online classroom can help strengthen the communities of inquiry and improve online course persistence.

Digital Storytelling and Tourism Engagement: A Comprehensive Analysis of representations in the Tourism industry.

Joseph S Raju, Vishnu Saju & Dr Robinet Jacob
Mahatma Gandhi University, India

ABSTRACT

Storytelling is a narrative paradigm of using words and actions that have a profound impact on tourist perceptions. It has the ability to influence on cognitive, affective and emotional level of the tourists. Any element of storytelling such as images, narratives or audi-video is disseminating meanings to destinations. The elements of digitalization have the ability to transform the material world into digital contents. Integrating the digital attributes in storytelling promotes sustainability and increases the engagement of tourists. The study delves into the dynamic intersection of technology to understand the impact of digital storytelling in the tourism industry. This research methodology involves systematic literature synthesis of the existing research and case analysis of digital storytelling in the tourism industry. The technological assessment delves into the tools and platforms employed in virtual tours, examining their contribution to the immersive and interactive nature of the experiences. Visitor engagement and feedback analysis provide insights into the effectiveness of these digital narratives. The implications of the findings extend to the broader tourism industry, offering recommendations for practitioners, policymakers, and technology developers seeking to harness the potential of digital storytelling for cultural exchange. The study concludes with reflections on the limitations of the current research and suggests avenues for future exploration, encouraging continued innovation in the realm of digital storytelling.To substantiate the findings, the paper incorporates a series of regional and international case studies. These case studies showcase diverse applications of digital storytelling in tourism, highlighting the ways in which technology enables the creation of immersive narratives that resonate with visitors. The analysis encompasses an assessment of the technological tools and platforms employed in these storytelling initiatives, with a focus on their role in enhancing user engagement.

Keywords: Digitalstorytelling,tourism,technology,destination,Visitor engagement, narratives

Incorporating Sustainability Studies into the Curriculum of Undergraduates: A Comprehensive Evaluation

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2. Mahatma Gandhi University, India

ABSTRACT

This research investigates the influence of seamlessly integrating sustainability education into the undergraduate curriculum, focusing on student engagement, environmental literacy, and adopting sustainable practices. Employing a mixed-methods approach, the study aims to achieve four primary objectives. Firstly, the research assesses student engagement by gauging their interest and active participation in sustainability studies. Secondly, it quantitatively measures the impact of sustainability education on students' environmental literacy, evaluating the effectiveness of educational interventions. Thirdly, the study explores the enduring influence on students' behavioral patterns, particularly their incorporation of sustainable practices in daily life. Lastly, the research identifies challenges and proposes solutions associated with integrating sustainability studies into the curriculum. This study seeks to contribute to the existing literature by providing a comprehensive examination of the impact of sustainability education within the academic framework, shedding light on how educational institutions can play a crucial role in fostering environmentally conscious citizens.

Key words : Sustainability education, environmental literacy, sustainable practices

Marketing is Economic Development

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ABSTRACT

RCEDC is a Non-Profit organization, whose mission is focused on spurring economic development in Racine County, WI. Our staff provides businesses with services needed to complete **expansion**, **relocation**, **financing**, and **talent recruitment** projects.

Historically, Non-profits have to account for every penny and report back to a board with expense justifications, where Marketing is often regarded as a frivolous activity that should be minimized. But, what if you could convince them otherwise?

Teaching case on work/life balance titled: " No dad joke – The apparent dilemma for a dad, his mistress, and his kiddos. Side hustle or side hassle? Dad attempts to balance extra income with family time".

Dr. Terry McGovern[1], Dr. Abey Kuruvilla [1]& Dr. Danielle Clark1[2]
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This case is about a father, Abey Kuruvilla, who works full time as a college professor but has a side gig as an Airbnb host. The design of his mid-century home included a one-bedroom apartment on the lower level with its own entrance and a full kitchen. Due to this design, and at the encouragement of a friend, he turned the lower-level unit into an Airbnb rental in 2017. His Airbnb, located in Racine, Wisconsin, was featured on TimeOut magazie and several other media outlets and is now considered one of the top properties in the state due to its tree-house like setting. Racine lies in between the metro areas of Milwaukee and Chicago within a one hour drive of Chicago's O'Hare international airport. This location coupled with a park like setting and a creek has resulted in high occupancy rates for most of the year. The father refers to the Airbnb as his mistress because he spends so much of his free time maintaining the space and working to meet the needs of his guests so it stays competitive. The income from his Airbnb is intended as college funds for his twins. Although his wife supports the endeavor, his 8-year-old twin children are not fans. When guests stay in the lower level of the home, the kids are required to remain quiet on the upper level. The side hustle is causing Kuruvilla to miss out on some of his children's natural playful activities. In the fall of 2023, Kuruvilla saw a rare two-week window with no bookings. He felt this might be a good time to end his side gig and focus more on his children. With concerns about a pending recession and a recent pay cut due to budget problems at his university however, Kuruvilla worried about losing the extra income brought in by the Airbnb.

This case touches on gig workers, the shared economy, and work-life balance. It presents a dilemma faced by many working Americans in the 21st century economy.

Innovating Eco-Friendly Practices in Additive Manufacturing for Aquarium and Reptile Products.

James Morelan
University of Wisconsin Parkside, United States

ABSTRACT

The intersection of passion and innovation often leads to remarkable outcomes. My journey began with a deep-rooted fascination for aquariums and reptiles, which in 2021, evolved into a thriving business venture. Harnessing the potential of 3D printing, I have created unique products that reflect my creative style. This business quickly grew, amassing over 10,000 customers across the world.

After shipping thousands of orders I realized the impact my small business could have on the planet, so I embarked on a new project in late 2023 to integrate solar power as a renewable energy source for operating my farm of 23 3D printers. This endeavor was not just an exploration but a personal commitment to sustainability.

Complementing this green initiative, I transformed our packaging approach by switching to curbside recyclable paper for internal packaging as an alterative to bubble wrap. This not only allows for easier disposal for customers but also aligns with greater environmental goals. I have also meticulously designed my products to fit standard box sizes like 4-inch cube boxes and 6x4x4 boxes. This decision minimizes wasted space and reduces the need for excess packages, further reinforcing our commitment to ecological responsibility.

My submission for the ICSG program highlights this journey of integrating eco-friendly practices in additive manufacturing. It showcases how businesses, especially in niche markets like aquarium and reptile products, can significantly contribute to environmental conservation without compromising on efficiency or customer satisfaction. This initiative serves as a testament to the potential of combining innovative technology with sustainable practices, paving the way for a greener future in the manufacturing sector.

Global Logistics Strategy of a Multinational Corporation

Pasquale D Frankoviglia & Dr. Abey Kuruvilla
University of Wisconsin – Parkside, United States

ABSTRACT

This paper describes the Corporate Logistics work related to Modine's Global Logistics Strategy. The paper illustrates the Value Chain Model and defines Modine North America's Value Web. Partnering with DSV leads to enhanced data analytics and better landed cost metrics. The resulting enhanced data strategy will yield opportunities for robust 80/20 projects and significantly improve Modine's ability to forecast freight costs and manage freight accruals. The paper provides context for future discussion and research in the area.

Once implemented, the complete PO Management and IT solutions in North America we will have established the best practices that can be used to create a "Blueprint" for use in other regions of the world.

Thrifting - 'less is more"

Ananya Sriram & Dishita Golchha
JS Global School, India

ABSTRACT

Thrifting involves Purchasing gently used goods at garage sales and thrift stores with the principle that “less is more” smaller quantities often yield higher quality.Thrifting is the exchange of various items such as appliances, books, media, clothing, cooking accessories, electronics, furniture, games, household goods, musical instruments, shoes, and sports equipment[4]. It brings solutions to social problems such as fast fashion, unemployment, clothing affordability for low-income households. Saving a lot of money is one of the key advantages of thrifting, especially when it comes to clothing from thrift stores[1].Thrifting is a growing trend in the apparel industry, as it helps preserve environmental sustainability and personal style[3]. Every country spends at least $311.97 million annually on apparel, and reducing this expense can significantly increase a country's GDP. The fashion industry contributes to global emissions at 8-10%[5],which is more than the emissions released by shipping and aviation combined. An antique store buying used goods that are in good quality is a way to reduce the amount of waste that ends up in landfills. Sustainable clothing and recycling practices benefit the environment and communities, as thrift stores, operated by non-profit organizations, provide jobs and affordable clothing options, especially for those with modest incomes.[2]

Thrifting has become a popular solution to combat climate change and preserve clothing quality. It fosters and ignites youth enthusiasm in spreading awareness of sustainable development through thrifting, and building a better society[3]. JSGS actively encourages students to contribute clothing from home including worn out jeans and shirts for creative daily use products. Our goal is to raise awareness of the benefits and drawbacks of thrifting and repurposing from an environmental, social, and economic standpoint.

Keywords: Sustainability, GDP, Thrifting

Main conference topic: Thrifting

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Hiawatha: Generations to Generations

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ABSTRACT

Hiawatha Bar and Grill located in Sturtevant, Wisconsin is a bar that has been passed down through generations of family and has struggled to keep up with modern business practices. Our group worked with them to help implement a inventory management system as well as detailed training to improve overall accuracy in daily operations. We achieved this through meeting with both the owner and employees to find pain points.

Sustainability Initiatives in a Midwestern City - Racine on the Great Lakes

Ellery Pleier
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ABSTRACT

Racine is a city in southeastern Wisconsin, home to over 200,000 across the county. While not a large city, Racine is in between major cities such as Milwaukee to the north, and Chicago to the south, both within 80 miles. As a result of this, many of those in Racine commute to work, and in recent years especially, companies have begun to establish headquarters nearby. With a location on Lake Michigan, being close to major cities, and companies building facilities, how is the city of Racine furthering its sustainability initiatives for such an important location with strong economic implications in the future? Through interviews with city officials and other public figures, with the addition of research on general trends within the area, the city of Racine is setting itself up to become more sustainable in the short and long term.

Data collection will be conducted through publicly available information and databases and research will be completed through interviews with multiple public officials.

Acceptance of e-learning among professional students in Chennai city, India

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ABSTRACT

E-learning is a vital technology for higher education institutions, especially in the COVID-19 pandemic that has disrupted face-to-face education. However, the success of e-learning depends on the acceptance and satisfaction of the students who use it. This study examines the factors that influence the acceptance of e-learning among professional students in Chennai, India. A survey was conducted among 531 MBA, MCA, and BE students from various colleges and the data was analyzed using SPSS and PLS-SEM. The results show system and information quality, perceived enjoyment, technology characteristics, and task characteristics had positive and significant effects on the perceived ease of use, usefulness, system use, and task-technology fit of e-learning.

Moreover, the task-technology fit and the information system success model positively impact the benefits of e-learning for the student's academic performance and satisfaction. The study suggests that higher education institutions should adopt e-learning systems that are user-friendly, informative, enjoyable, and compatible with the student's needs and tasks. It also recommends that lecturers motivate and guide the students to use e-learning effectively.

Keywords: E-learning, professional students, system quality, information quality, perceived enjoyment, technology characteristics, task-technology fit, information system success model.

Sustainable Agriculture: Past, Present, and Future

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ABSTRACT

The United States Department of Agriculture defines sustainable agriculture as "farming in such a way to protect the environment, aid and expand natural resources and to make the best use of nonrenewable resources". The World Bank defines Climate-smart agriculture (CSA) as "an integrated approach to managing landscapes - cropland, livestock, forests and fisheries--that address the interlinked challenges of food security and climate change". The Food and Agricultural Organization of the United Nations reports that "Land conversion from natural ecosystems to agriculture has historically been the largest cause of greenhouse gas emissions), linked to loss of biomass and carbon in biomass above and below ground." The United Nation estimates that global population will increase from the current 8 billion to 9.7 billion in 2050. These factors highlight the important role of sustainable agriculture with respect to sustainable globalization. Recognition of historical and current agricultural habits is vital in formulating future sustainable best practices.

The Union of Concerned Scientists outline facets of agricultural good stewardship from environmental sustainability based on: healthy soils and erosion prevention, wise water management, minimizing air and water pollution, carbon storage on farms, climate change resiliency, and promoting biodiversity. Economic and social sustainability ensures that farms of any size are profitable and contribute to the local economy, promote equity and justice among workers, generate health food, and priorities people and community over corporate profits. Best practices include: crop rotation and diversity, reduced- or no-tilling methods, cover crop planting, livestock and crop integration, integrated pest management, adopting agroforestry practices, and implement systems approach suited to the landscape.

The details of sustainable agriculture are highly dependent on the geographic and economic fabric of the producing and consuming communities. The challenge for agriculture remains in balancing the sustainability tenets (people, planet, and profit) that equates to survival of our species.

Keywords: Agriculture, Climate Change, Food, Soil, Water

POSTER PRESENTATIONS

Empowering Language Learners through Sustainable Learning: A Project-Based Approach

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Abstract

The increasing global awareness of environmental issues necessitates an educational shift towards fostering environmental consciousness. This paper explores the integration of environmental awareness into English Language Teaching (ELT). Inspired by the British Council's Primary Plus magazine "My Music," the project tasked students with designing soundproof ear mufflers, aligning with the principles of project-based learning (PBL).

Keywords: Project-Based Learning, environmental awareness, language learning, 21st-century skills, formative assessment, real-world problem-solving.

Main Conference Topic: Education

1. Introduction

The central inquiry question driving the project was, "How can we assess primary learners using PBL applicable across all contexts?"

PBL sessions not only address language learning but also nurture crucial 21st-century skills: critical thinking, problem-solving, communication, collaboration, digital proficiency, creativity, imagination, and leadership. The project exemplifies how language learning extends beyond the classroom, empowering students to contribute to real-world environmental challenges.

By sharing this experience, I aim to inspire fellow educators to enrich their ELT curriculum, integrating meaningful environmental content and fostering a generation of language learners with a heightened sense of environmental responsibility.

2. Literature Review

2.1 British Council's Statement of Approach

The British Council's Statement of Approach emphasizes learner-centered methodologies, realistic goal-setting, reflection, constructive feedback, and assessment strategies. This aligns seamlessly with the project's framework, providing a solid foundation for meaningful learning experiences.

2.2 Project-Based Learning in Language Teaching

The focus on preparing students for college and careers extends beyond traditional academic subjects, emphasizing attitudes, habits, and skills crucial for success. A significant study (Conley, 2005) identified key "habits of mind," including critical and analytical thinking, problem-solving, openness to feedback and failure, effective communication, source evaluation, independent reasoning, and time management. Employers similarly emphasize critical thinking, problem-solving, effective communication, real-world application of knowledge, information handling, innovation, and teamwork. These collectively known as "success skills" go beyond basic subject knowledge, highlighting the need for a comprehensive educational approach that instills these competencies(Larmer et al, 2015). Project-Based Learning (PBL) encourages students to explore real-world problems, promoting active engagement, critical thinking, and collaboration. The integration of PBL in language teaching has shown promising results in enhancing language skills and fostering 21st-century competencies.

2.3 Seymour Papert's Pedagogical Principles

Seymour Papert's pedagogical approach, built on Piaget's theory of constructivism with a learning theory of his own: constructionism proposes that the best way to ensure that knowledge is built in the learner is through the active construction of something shareable — a poem, program, model or idea. In other words, hands-on experiences and problem-solving (Stager, 2016). The project draws inspiration from Papert's principles by engaging students as active participants in solving real-world environmental challenges.

3. Methodology

3.1 Project Design

The project methodology followed a systematic approach to address the challenge of sound pollution in Colombo, the commercial capital of Sri Lanka. Initially, the challenge was presented and defined, framing students as sound engineers. This introduction was facilitated through a YouTube video and subsequent person-aligned discussions to create a context for engagement.

Following that, the project emphasized teamwork by assigning roles within the team, promoting collaboration, negotiation, and boosting confidence as students stepped into the shoes of sound engineers. The research phase employed a KWL grid (What I Know, What I Want to Know, What I Learned) to guide students in exploring their existing knowledge, identifying gaps, and documenting new insights.

"My World" activities followed, aimed at raising awareness of the students' surroundings based on the research findings, including aspects such as decibel levels and conductors of sound. The design and testing phase involved the creation and evaluation of prototypes, followed by an iterative process of improvement based on feedback. This cycle repeated to enhance the prototype further and ultimately produce the final product, which was then retested for effectiveness.

Throughout the course of the project, a record was maintained to capture the new language learned as students engaged in various aspects of the project. Finally, the methodology included a reflective component, allowing students to contemplate and analyze their experiences, learning, and contributions to the project, fostering a holistic understanding and application of the language and skills.

3.2 Formative Assessment Techniques

Various formative assessment techniques, including peer-feedback, self-assessment, exit tickets, and KWL grids, are employed to gauge language proficiency and measure students' understanding of environmental issues. These techniques assess the students' ability to propose sustainable solutions effectively.

4. Results and Conclusion

The project's culmination involves valuable feedback and reflection, emphasizing the inquiry process. Student testimonials highlight increased awareness of sound-related environmental issues, new vocabulary acquisition, and the collaborative nature of the project. These reflections serve as evidence of the successful integration of environmental themes into the ELT curriculum.

Furthermore, the project's portfolios provide exemplary models for teacher training. Educators attending sessions on this project report feeling inspired, recognizing the potential of integrating environmental issues into their language teaching practices.

This holistic learning approach showcases that students can autonomously address environmental challenges when provided opportunities tapping into their creativity and interests.

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Biography of the Author

Ahisha Haneef is a highly qualified and experienced educator holding certifications in Cambridge CELTA, DELTA, and Trinity TYLEC. She has been actively involved in teaching since 2017. Her teaching portfolio includes a diverse range of learners, spanning various backgrounds, nationalities, and age groups. Her expertise extends to preparing students for Cambridge IGCSE examinations.

Passionate about creating dynamic and meaningful learning experiences, she is dedicated to engaging her students through interactive lessons tailored to their everyday lives. Ahisha's innovative teaching approach contribute to a positive and empoweri

An analysis on CO_2 emissions from aircraft ground operations at Colombo (CMB) airport with reference to a specific air carrier of Sri Lanka

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ABSTRACT

Aviation is a globally expanded industry in the transportation sector which consists of several operations and activities on both air and ground levels. Among the environmental impacts, the atmosphere bears a substantial influence, as air operations and related activities rely heavily on fossil fuel which ultimately emit combustion by-products into the atmosphere. Pertaining to atmospheric impacts, the increasing demand and stipulations from the global agreements have directed this industry to become carbon neutral in near future with technological and operational advancements. The atmospheric impacts of aircraft operations are widely addressed at higher altitudes whereas the ground emissions are sparsely discussed due to their relative insignificance. Therefore with the existing studies on ground-level emissions, this study also supports to underline the importance of emission inventories for aircraft ground operations. This specifically focuses on the evaluation of carbon dioxide emissions by aircraft operations on ground. The study has been confined to the taxi phase and the aircraft APU usage after arrivals and before departures, at Colombo (CMB) airport with special reference to the flights of a specific air carrier of Sri Lanka. A fleet of 24 with narrow-body and wide-body aircraft was used to collect the data. The carbon dioxide emission calculation methodology for the taxi phase of narrow and wide bodied aircraft uses the actual operational taxi times from industrial data, rather than internationally recognized TIM (Time in Mode) values, followed by statistical inferences which depicted a significant difference ($p = 0.000$) from TIM values at 5% significance level. APU emissions have been evaluated based on the APU/GPU policy of the airline. The average carbon dioxide emissions have been calculated under 5 types of operated aircraft, separately for taxi out, taxi in and APU usage for the airborne flights from and to CMB airport during the mentioned period. Thus, the findings reveal that the cumulative estimated emissions of the total taxi phase contribute around 9 958 metric tonnes of CO2 while the APU usage contributes around 5 064 metric tonnes of CO2 by both arrivals (11,031) and departures (11,031) for the year 2022. This forewarns that the aggregated emissions of the aforementioned operations have a considerable impact on the local air quality as well as on climate change despite the less significance compared to cruise level emissions, and necessitates proactive measures to mitigate the repercussions.

Keywords: Air Carrier, Aircraft ground operations, APU, CMB Airport, CO2 emissions, Taxi

Community perception on Environmental Sustainability in Mass and Medium Scale Composting Production Facilities in Western Province, Sri Lanka.

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ABSTRACT

Municipal Solid Waste (MSW) is becoming a universal problem. World generated 2.24 billion tons of MSW in 2020. MSW composting is a 'win-win' solution when managed effectively. According to the literature most appropriate method of treatment of MSW in Asian developing countries is composting. The composting technology transfer organic fraction of municipal waste into a reusable and marketable humus substance called "COMPOST". This method has both positive and negative impacts on environment depending on the sustainability of compost generating method. Reduction of waste sent to unsustainable landfills. Nutrient recycling and improving soil structure are some positive impacts while Greenhouse Gas (GHG) emissions. Soil, surface water and ground water contaminations, Offensive odors emission and breeding vectors are negative impacts. Therefore this study aims to analyze the community perception on impacts of compost production facilities to suitability in environment. The study areas were Pohorawatta, Karadiyana, Wagawatta and Ranpalassa Waste Management Center. Structured questionnaire was used to analyze community perception with total sample size of 60 families with in 500 meter radius area at each production plant. Community perception on possible contaminations, due to leachate, unpleasant odor, benefits from facility, health impacts, availability of vectors were examined. Results were analyzed using basic statistics. The results indicated that Wagawatta facility has the minimum impact due to offensive odor whereas all four facilities indicated concerns due to dust production (over 50% responses). Respondents from Wagawatta facility indicated minimum contamination of ground water whereas Pohorawatta had the largest contamination (50%) according to community. Highest health risk was caused by Pohorawatta facility and lowest is Wagawatta according to the community. Considering the benefits to surrounding community Karadiyana and Ranpassala facilities had provided job opportunities to surrounding community and Pohrawatta and Wagawatta have not provided such opportunities. Therefore these results indicated that Wagawatta facility had more sustainable procedure according to community than other facilities. Including socio economic benefits to the community is recommended for further enhancement of the sustainability in Wagawatta facility. While controlling the negative impacts increasing socio economic benefits to the community is crucial for maintaining a sustainable environment in compost production facility.

Molecularly imprinted polymer based on polyaniline for sensitive and selective electrochemical detection of cadmium

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ABSTRACT

An electrochemical sensor based on molecularly imprinted polyaniline has been synthesized and tested for the electrochemical sensing of cadmium in aqueous solution. The synthesis was started by copolymerizing anthranilic acid and 2-(1H-benzimidazol-2-yl) aniline in the presence of Cd2+ ions as the target analyte and followed by acid leaching of the target analyte to obtain the molecularly imprinted polymer (MIP). The synthesized MIP was examined for its structural, crystallographic and morphological characteristics using Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction analysis (XRD) and field-emission scanning electron microscopy (FESEM). The MIP has been used to modify a carbon paste electrode (CPE), and the MIP-modified CPE was tested for the sensitive and selective detection of Cd2+ ions in aqueous solution. Various electrode preparation parameters, i.e., Cd deposition potential, pH of deposition solution, deposition time, and thickness of active layer, were optimized using pulse voltammetric stripping analysis to achieve maximum performance. Electrochemical investigations with the optimized MIP-modified CPE revealed a high sensitivity for Cd2+ ions as well as a high selectivity in the presence of potentially interfering ions. Finally, reproducibility and repeatability of the electrode were assessed and found to be satisfactory.

“Nourishing Kerala's traditional recipes with integration of pumpkin seeds”

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ABSTRACT

Pumpkin seeds are one of the most underexploited seeds, which is generally considered as agro-waste. Pumpkin seeds are rich in macro and micronutrients, which can ensure nutritional security for the public. Incorporating pumpkin seeds into traditional Kerala cuisines will increase their nutritive value. Traditional Kerala food items such as Dosa, Coconut Chutney, Aviyal, Rasam, and Chapatti were enriched with pumpkin seeds. The primary objective is to determine if such integration can enhance the sensory attributes of traditional Kerala Cuisines. Sensory analyses were conducted to determine the overall acceptability using a 9-point hedonic scale. It was found that overall acceptability is good for pumpkin-incorporated food items. Thus, pumpkin seeds could be incorporated into traditional Kerala cuisine to increase their nutritive value, especially in diets that are deficient in macro and micronutrients. Incorporation of pumpkin seed in traditional cuisines increases about 57.4 Kcals of Energy, 2.98 g of Protein, 4.91g of Fat, .81mg of iron, vitamin C of .18 mg respectively in each traditional dishes. This study, therefore, not only provides empirical evidence supporting the nutritive benefits of pumpkin seed integration but also advocates for a practical and sustainable approach to enhancing the nutritional value of traditional Kerala cuisine. The findings presented herein offer a compelling argument for the broader adoption of pumpkin seeds as a culinary supplement, presenting an opportunity to bridge nutritional gaps and promote health within the context of traditional dietary practices.

Keywords: Pumpkin seed, Traditional Kerala Cuisine, Nutrition Security, Sensory Analysis, Culinary Sustainability

Metagenomic insights into the microbial community structure and functional potentials in the rice rhizosphere influenced by acid sulphate soil of Kuttanad

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ABSTRACT

The diversity of rhizosphere microbes is thought to be essential for maintaining the health and quality of the soil. Additionally, it aids in the growth of plants and their ability to flourish in adverse conditions. We used metagenomic investigations to explore the microbial community and its potential in the rice rhizosphere soils of the Kuttanad area in Kerala, which is the only place in India where rice cultivation has been practiced below sea level. The three landscape aspects of Kuttanad rice production include Karapadam, which are upland rice fields; Kayal, which are wetland rice fields developed from reclaimed lake beds, such as the Vembanad Lake; and Kari, which is land buried with minerals that resemble black coal. Furthermore, with a pH of 2.5 to 5.2, the acid-sulfate soils of the Kuttanad region are exceptionally acidic. Acid-sulfate soils occupy a significant area of the alluvial coastal swamps, especially in the tropics. The extreme acidity caused plant damage and retarded growth. The bacterial and fungal species identified were found to be acid- and salt-tolerant. Furthermore, the majority of the microorganisms that were found were Sulphur-mining and phosphate-solubilizers. Pseudomonas, Azospirillum, and certain Bacillus species are most frequently found, which suggests stronger PGPR activities and biocontrol qualities. The taxonomic composition of bacteria and fungi, as well as their functional groups, varied significantly between the various locations. A true understanding of the native microorganisms in the soil can aid in the comprehension of potential organisms for sustainable and environment friendly crop enhancement through the creation of improved microbial strains or synthetic consortia.

Fabrication of Sustainable Lanthanum-mediated Carbon Quantum Dots for the Fluorescent Detection of Aniline and Enhancement in Photocatalytic Degradation Efficiency of Zirconium Oxide Nanoparticles

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ABSTRACT

A unique and efficient fluorescent sensor was developed by doping carbon quantum dots (CQDs) with La(III) ions by microwave treatment. The La-CQDs exhibited an average particle size of 4.8 nm, a quantum yield of 16 %, and blue fluorescence emission when excited at 360 nm. Furthermore, the La-CQDs were successfully incorporated into zirconium oxide nanoparticles (La-CQD-ZrO2) and designed as a superior photocatalyst for the degradation of refractory pollutants. Both the sensor and photocatalyst were characterized by Fourier transform infrared (FT-IR) spectroscopy, X-ray photoelectron spectroscopy (XPS), transmission electron microscopy (TEM), X-ray diffraction (XRD), Field emission scanning electron microscopy (FE-SEM), Raman analysis, ultraviolet-visible (UV-vis.) spectroscopy, photoluminescence (PL) spectroscopy, zeta potential analysis, dynamic light scattering (DLS), cyclic voltammetry (CV), differential pulse voltammetry (DPV), and amperometry analysis. As a PL-based sensor, the La-CQDs displayed outstanding selectivity towards toxic chemical aniline with a limit of detection (LOD) of 10 nM within the linear range of 0-2 μM. The excellent results obtained in real sample analysis promise the use of La-CQDs as an aniline sensor in industrial level applications. The photocatalytic performance of La-CQD-ZrO2 was superior to that of pure ZrO2 and CQD-ZrO2 with more than 90 % degradation efficiency towards rhodamine B (Rh B), sunset yellow (SY), methyl orange (MO), 2,4-dichloro phenoxy acetic acid (2,4-D), and cefalexin. The synthesized composite showed excellent promise as a quick and affordable solution for removing industrial dye from wastewater.

A Novel SGO-Ag_2S Catalyst for the Photodegradation of Organic Pollutants: A Sustainable Approach

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ABSTRACT

Photocatalysis is an efficient method for the elimination of dyes from wastewater. The presence of dyes causes many severe issues to aquatic life and human health. So the removal of dyes from water is very essential for human safety. Silver-based photocatalysts are capable for degrading almost all organic dyes. In this work , silver sulfide (Ag2S) coupled with sulphur-doped graphene-oxide composites were prepared by a one-pot microwave-assisted method. The fabricated photocatalyst is characterized by scanning electron microscopy (SEM), energy dispersive spectrometer (EDS), transmission electron microscopy (TEM), X-ray diffraction (XRD), UV-vis. DRS Spectroscopy, and fourier transform infrared (FT-IR) spectroscopy. The as-prepared sulphur-doped graphene-oxide/Ag2S (SGO/Ag2S) exhibited universally high photocatalytic activity towards typical organic dyes in aqueous solution. Another important result of this work is that, hole scavenger EDTA acted as a sacrificial agent which will enhance the activity of the SGO-Ag2S photocatalytic system.

A Novel MWCNT Supported Ag_3AsO_4 Catalyst for the Photodegradation of Organic Pollutants

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Contamination of the environment due to the accumulation of organic pollutants is a serious concern. Silver based semiconducting materials has proved to be stable photocatalysts than conventional TiO2 or ZnO catalysts for organic toxin degradation. Ag3AsO4 is a photocatalyst with higher activity than Ag3PO4 or AgI for photocatalytic degradation of organic dyes. Here in, we have prepared a novel MWCNT Supported Ag3AsO4 binary photocatalytic system (MWCNT/Ag3AsO4) by a facile precipitation strategy. XRD, FT-IR, SEM, TEM, UV-vis. DRS, and PL studies were carried out for characterizing the chemical, physical, and optical properties of the modified photocatalyst. The MWCNT/Ag3AsO4 hybrid exhibit enhancement in the visible light assisted photodegradation of various organic pollutants compared to pristine MWCNT or Ag3AsO4 catalysts. The fabricated MWCNT/Ag3AsO4 composite degraded different organic toxins like rhodamine B (RhB), methyl orange (MO), methylene blue (MB), levofloxacin, and thiram with more than 90% mineralization within a short time. The photocatalytic degradation of organic compounds were monitored using UV-vis. spectroscopy and HPLC analysis. The modification of Ag3AsO4 with 2% MWCNT by weight exhibited improved photocatalytic degradation and followed pseudo-first-order kinetics. The MWCNT/Ag3AsO4 heterostructure with enhanced activity can be used as a promising photocatalyst for waste water treatment with future industrial applications.

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Lysinibacillus sphaericus- a sustainable biocontrol approach towards Banana Pseudostem Weevil

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Odoiporus longicollis Olivier (Coleoptera: Curculionidae), commonly called as banana stem weevil (BSW) or banana pseudostem borer, has been designated a notorious and monophagous pest of bananas and plantains globally. Bananas, along with plantains, are the fourth most important staple crop worldwide and are essential to maintaining food and nutritional security among 400 million people in producing countries. The infestation starts normally from five months old plant and it has been estimated that the stem weevil causes 90 percent of yield loss depending on the growth stages of the crop and management efficiency. The loss is more when the infestation occurs in the early vegetative stage i.e., within five months. The current research attempts to find sustainable *solution using Lysinibacillus sphaericus based* biopesticide. *Lysinibacillus sphaericus – a diazotrophic endophytic bacterium was found to be effective against this pest. The present study cracks the mode of action of the bacterium against the weevil by identifying the compounds responsible for the insecticidal activity, binary toxins actions against the pest, and antioxidant stress involved in control of banana pseudostem weevil larvae. The biocontrol aspects of Lysinibacillus sphaericus over the insect grubs were analysed by Scanning Electron Microscopy and COMET assay.* Use of *Lysinibacillus sphaericus* against the banana pseudostem weevil significantly contributes to sustainable ecosystems by minimizing the risks associated with synthetic insecticides.

Novel insight on the utility of thermotolerant phytases in developing sustainable solutions to agriculture and global warming

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Phytases- the primary phytate breaking enzymes have gained significant ecological as well as industrial significance due to its role in hydrolysis of antinutrient factors; thereby promoting better utilisation of nutrients both by plants and animals. The current paper explores the potential of phytases from thermotolerant *Pencillium decumbens* in better utility of nutrients. Phytases from *Pencillium decumbens* were purified, characterised and verified for its phytate degradation properties. Solid state fermentation of phytases using different agrowaste residues were statistically optimised following the principles of response surface methodology using rice bran and coconut cake extracts. The current paper also verified the different aspects of plant growth promotion induced by phytases on wheat seeds by evaluating its germination rate, shoot and root length and phosphate release. Finally the role of phytase supplementation in augmenting the role of carbon dioxide fixation in plants were analysed to get positive results. This is the first report on use of phytase to improve carbon dioxide sequestration. The utility of phytases in overcoming desiccation and inducing drought resistance characteristics has also been noted.

Aluminium and Iron toxicity mitigating effects of plant growth promoting rhizobacteria isolated from rice plants of kari lands of Kerala, India facilitating sustainable rice cultivation in acid sulphate soils

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Rice is the second most widely cultivated crop worldwide and major staple food crop for majority of the population in India. The state of Kerala is also known for its paddy cultivation and the major share comes from Kuttanad, the 'Rice Bowl of Kerala'. The *kari* soils of Kuttanad are characterised by high acidity and are commonly known as acid sulphate soils due to the presence of iron pyrites. The cultivation of paddy in such soils is difficult due to iron (Fe) toxicity, aluminium (Al) toxicity and poor soil health. Acid sulphate soils occupy about 24 Mha of the global land area covering Asia (6.5 Mha), Africa (4.5 Mha), Latin America (3 Mha), Australia (3 Mha), Europe (435,000 ha), North America (100,000 ha). Such vast area cannot be ignored due to the increasing global demand for rice and hence sustainable cultivation of the crop is essential. Plant growth promoting rhizobacteria (PGPR) are group of microorganisms which promote growth of plants by different mechanisms. Rhizosphere is the narrow zone of soil surrounding the root surface where diverse group of plant growth promoting rhizobacteria (PGPR) are seen. The current study assessed the effect of four plant growth promoting rhizobacteria *viz.* TKI4 (*Bacillus licheniformis*), PRKD4 (*Bacillus velezensis*), PRKD5 (*Mammaliicoccus vitulinus*) and APA5 (*Bacillus altitudinis*) isolated from the acid sulphate (*kari*) soils of Kuttanad to improve rice growth in acid sulphate stress conditions. The influence of these bacterial isolates on rice seed germination under high Al (600 ppm), Fe (700 ppm) and low pH (3.5) were evaluated. Higher germination percentage and seedling vigor were recorded with bacterial isolates treated seeds. A 14-day hydroponic experiment on rice seedlings was conducted using nutrient solutions supplemented with high Al and Fe concentrations in acidic conditions. The plant growth parameters were seen higher in bacterial isolates treated seedlings. The hematoxylin staining score was higher in uninoculated seedlings denoting lesser Al root uptake in isolates treated seedlings. Similarly, chlorophyll content was greater in seedlings treated with PGPR compared to control indicating iron toxicity tolerance. Scanning electron microscopy of the seedling roots revealed the colonization of bacterial isolates under high Al and Fe concentrations. Among the isolates, TKI4 and PRKD4 were found to be effective in imparting Al and Fe toxicity tolerance in rice seedlings under acid sulphate conditions.

Sustainable Globalisation

Himasha Samath

ecole international, Sri Lanka

Sustainable Globalisation is the act of fulfilling human needs without compromising the ability of the future generation's to do the same. It can have benefits such as a good quality of life and water, energy and food security enhanced globally. Globalisation can have consequences if it's not sustainable. While trying to fix a problem, the effects it could have on other situations must be considered. This is why we need to have sustainable globalisation.

Sustainable Business Excellence Award - Hospitality & Tourism

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ABSTRACT

DT Travels (Pvt) Ltd, a 2022 & 2023 South Asian Travel Awards winning company in the tourism industry. It has been a great privilege that a Sri Lankan Company has won this prestigious award among the 16 international Competitive Travel Agents in 05 South Asian Countries (India, Maldives, Bangladesh, Nepal & Sri Lanka) solidifying the reputation as a trustworthy brand that delivers. The experienced, energetic young group of DT Travels – Sri Lanka excels professionally planned tailor-made packages for inbound & outbound tour arrangements with World-recognized Accommodation, Sports Travel, Luxury Leisure Travel, VIP Tours, Trekking & Hiking Tours, Adventure, Food Tours, Student & Corporate Tours, MICE and Event Planking, Transportation of any means | Professional guiding service with international language speaking skills. DT Travels (Pvt) Ltd is looking forward to continuing its successful journey in the Sri Lankan travel industry as it moves dynamically into the future, setting as its goal the development of its network and the expansion of activities.

Barriers to Adopting and Implementing Green Practices: A Study of Small and Medium-Sized Enterprises (SMEs) in Sri Lanka

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Abstract

Small and medium-sized enterprises (SMEs) play an important role in sustainable development, but they often face barriers in adopting and implementing green practices. This research aimed at identifying the key barriers that prevent small and medium-sized enterprises (SMEs) in Sri Lanka from adopting and implementing green practices. A quantitative research approach was used, and data was gathered from 114 SMEs in Sri Lanka. The study found that limited finance and poor environmental awareness were the most significant barriers to the adoption and implementation of green practices among SMEs in Sri Lanka. Through the findings of this study, recommendations were made to policymakers and relevant institutions in Sri Lanka to develop effective strategies to help SMEs overcome the identified barriers and encourage the adoption of green practices among SMEs.

Review of Graphene Concrete from an Environmental Perspective

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Abstract

Concrete is the most widely used material in the world. Concrete has the advantage of considerable compressive strength, water flow resistance, ease in placement, and lower production price. However, conventional concrete is brittle and can break under heavy loads. Also, traditional cement is blameworthy for sharing about 8% of greenhouse gases (GHGs) in the atmosphere. So, this is a critical issue in the current scenario for the atmospheric conditions, resource scarcity, economic drawbacks, etc. Then, researchers became more concerned about nanomaterials (NM), and in the last decades, concrete-based NM publications have increased rapidly. So, graphene and its derivatives have become the most popular nano-additives due to their excellent mechanical, thermal, and electrical properties. Studies have shown that using less material, energy, and water and increasing compressive strength, tensile strength, flexural strength, and durability can lower GHG emissions. They have also shown that producing 1 kg of Graphene nanoplate (GNP) emits 0.17 kg of CO2, while producing 1 kg of Portland cement emits 0.86 kg of CO2, proving the environmental advantage. However, the production of graphene and its derivatives is highly costly, and cost benefits will take a long time to show. So, regarding large-scale production, chemicals should be selected cost-effectively. Meanwhile, scientists have developed a method to turn rubber tire waste into graphene, which can be used to reinforce concrete. Similarly, more affordable and recyclable methods need to be discovered in the future. Graphene-enhanced concrete has excellent potential to help achieve the SDGs, especially SDG 9: Industry, Innovation, and Infrastructure, and SDG 12: Responsible consumption and production. There is a need for a safe, comfortable survival environment for future sustainability in concrete technology.

Keywords: Graphene Concrete, nanomaterials, compressive strength, tensile strength, flexural strength, cost-benefit, sustainable development goals

Assessing Environmental Impacts and Awareness in Agricultural Supply Chains: A Study of a Supermarket Supply Chain in Welimada, Sri Lanka

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ABSTRACT

The agricultural industry has been striving to ensure food security amidst a growing population by relying on ecosystem services provided by the natural environment. However, these efforts have resulted in adverse effects on the environment. In light of the global shift towards sustainable agriculture, it is entrusted upon Sri Lankan citizens to ensure the sustainability of our agricultural supply chains. The agricultural supply chain encompasses multiple stages that may potentially result in detrimental environmental effects. This study focuses on the impacts on the environment at the farm stage of a famous supermarket supply chain in the Welimada Divisional Secretariat, Badulla District. The main objective of the study was to analyse the impacts and dependencies on natural resources while assessing the level of awareness among farmers regarding the environmental implications of their agricultural practices, including their understanding of the concept of Sustainable Development Goals. The primary data collection methods involved physical visits to the agricultural lands. To assess the correlation between farmers and the impact on natural capital, as well as to measure their comprehension of natural capital, a questionnaire survey was devised. The survey was conducted to gather insights from farmers within the Welimada Divisional Secretariat (N=72). During field visits, data was obtained through process observations and semi-structured interviews with farmers. The heavy usage of water by farmers for agricultural needs poses a potential risk to nearby aquatic ecosystems. Findings from the survey indicate that most farmers rely on water from nearby canals (branches of Uma Oya) and wells/groundwater, though the exact quantities remain unknown. However, farmers report using a substantial amount of water for crop cultivation. Addressing the volume of water used by farmers is crucial to ensure sustainable water resource management. Regarding non-biodegradable waste on agricultural lands, the primary sources identified by survey respondents were polyethene bags from fertilizer use and plastic/glass bottles from pesticide application. Polyethene bags are often disposed of through incineration, emitting carbon dioxide and contributing to greenhouse gas emissions in the supply chain. While some farmers (20 out of 72) reported reusing polyethene bags until the end of their useful life, disposal of glass and plastic bottles primarily involves burial, significantly adding to waste landfilling. Survey results show that a notable portion (67%) of participants understood the environmental implications of agricultural practices. However, a majority (78%) lacked familiarity with the concept of "Sustainable Development Goals." The study employed Fisher's exact test to explore correlations between age, education level, and awareness of environmental impacts from agriculture and the concept of sustainable development. Results highlighted significant associations between both age and education level with awareness of environmental impacts and understanding the sustainable development concept.

Keywords: Sustainable Agriculture, Environmental Impacts, Supermarket supply chain, Farm stage, Sustainable Development Goals

Parental knowledge on Epilepsy and its correlates. A study based on neurology clinic at Lady Ridgeway hospital, Sri Lanka

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ABSTRACT

Epilepsy, a complex neurological disorder, has a profound impact on individuals and their families. Continued support and resources are crucial to maintain stable epilepsy control.

A limitation in information and research on the real degree of knowledge of Sri Lankan parents with children diagnosed epilepsy. The main research objective was to assess the level of parental knowledge regarding epilepsy and its management among parents with diagnosed children at Lady Ridgeway Hospital's neurology clinic in Sri Lanka, which was guided by three specific objectives.

This was conducted based on quantitative research methods collecting primary data. The sample was chosen as 200 parents with children who diagnosed epilepsy seeking medical care at Lady Ridgeway Hospital's neurology clinic.

A structured questionnaire was distributed among the sample. Convenience sampling method was used as the sampling technique. The main three aspects analyzed through the analysis were the evaluation of the Socio-Demographic factors, analyzing information related to the child and the assessment of knowledge on Epilepsy utilizing SPSS software.

Parents' highest education level and the parents' employment status were related with the indicators used to measure the knowledge level of the parents.

Majority among the children diagnosed epilepsy were males, which was 50%. According to the analysis of the knowledge level of the parents' majority of the respondents have scored Good level score for their knowledge on epilepsy because when focusing the research sample, highest number (57) of the respondents have scored 13 out of 18. Second highest number (52) of the respondents have scored 14 out of 18. Third highest number (49) of the respondents have scored 15 out of 18. Fourth highest number (43) of the respondents have scored 16 out of 18.

Key words: Children diagnosed epilepsy, Lady Ridgeway Hospital's neurology clinic, Parents knowledge level.

Does digital infrastructure help to save energy? An insight to IT industry in Sri Lanka

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Abstract

Most industries now turn to digitalized versions in their activities for better expansion. Meantime, higher technology requirements consume a large amount of energy to keep the required level of power that of need. Furthermore, that effects of global energy consumption, greenhouse gas emissions, and environmental impacts as well. In fact, energy requirement of data centres could lead to energy crises that must be addressed using renewable energy. However, to address future requirements for energy, renewable energy sources such as solar would not be a practical solution. Therefore, introducing digital infrastructures like green coding to minimize CPU usage and reduce energy consumption of software products is vital to growth of IT industry in Sri Lanka. In considering a single device, the energy consumption reduction can be less. However, when it comes to the national level, energy consumption reduction would significantly affect the total energy demand specially during peak hours. Introduction of digital infrastructures to software development could have multiple benefits such as data load minimization, equipment that reduce energy consumption, and minimized e-waste through the increasing life span of the product. It makes a solution for rare earth material and toxic material problems as well. Also, there are limitations and barriers to addressing the complexity of the measurement, and specific practices like cryptography and scientific simulation cannot be addressed in this practice. However, there is future potential to work in the software industry to make significant energy optimization using green coding practices. For that, there is a need for awareness about software engineers in Sri Lanka to get involved in better practices in coding.

Keywords – Carbon emission, Carbon aware software, Energy saving, Green coding , Sustainable software engineering

Anxiety and increased Para-social Interactions in Females during and due to the Pandemic

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ABSTRACT

Para-social behavior has seen a surge in recent years, with the development of new social media platforms and the erasure of older, more conservative social rules. Anxiety has also been at an all-time high, especially after the global Pandemic caused by the Covid-19 virus. This study aims

to look at the roles played by anxiety and the pandemic in the development and possible increase in Para-Social Interactions exhibited by Females in the South Asian region. Research in this particular area is still insufficient and this study attempts to open doors for further research. This

is an Interpretive Phenomenological Analysis that provides unique insight into the human experience of engaging in Para-Social Behavior. Results suggest a positive relationship between anxiety and Para-Social interactions and are reflective of research literature.

Keywords: Para-Social Interactions, Anxiety, Covid-19, Pandemic, Celebrities

A Study on the Applicability of BIM to Reduce Building Services Maintenance Costs of the Hotel Building Projects in Sri Lanka

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ABSTRACT

This study aims to explore the potential of Building Information Modeling (BIM) in reducing building services maintenance costs for hotel projects in Sri Lanka. The importance of maintenance in ensuring customer satisfaction and the challenges faced by the hospitality sector due to cost overruns have been recognized. This research addresses common issues such as inadequate coordination, quality control lapses, and communication gaps between construction and maintenance teams. The study focuses on identifying and reducing factors influencing maintenance costs in Sri Lankan hotels, with an emphasis on the impact of building services. Objectives include identifying maintenance costs, minimizing these costs, exploring digital representation and management systems for building services, and providing recommendations for Quantity Surveying and Facility Management.

The literature review reveals that hotel facility operation and maintenance costs are influenced by diverse factors such as building characteristics, material availability, managerial factors, energy consumption, and customer satisfaction. Maintenance officers play a crucial role in maintaining indoor air quality. Therefore, the study emphasizes the need for a holistic approach to building projects, advocating for early investments in quality construction and design to yield long-term savings. The research identifies building services, particularly HVAC systems, as a significant contributor to maintenance costs. Using a mixed approach involving quantitative data analysis through the Relative Importance Index (RI) Method and qualitative data analysis through content analysis, the study recommends the use of BIM software for digital representation to enhance cost-effectiveness, efficiency, and productivity in building maintenance.

In conclusion, the findings highlight the importance of addressing building services, leveraging BIM technology, and adopting value engineering and a comprehensive approach to minimize maintenance costs in hotel projects. The study contributes valuable insights and recommendations for stakeholders in Quantity Surveying and Facility Management, emphasizing the need for proactive measures to ensure sustainable and cost-effective hotel maintenance practices.

Key Words: Maintenance Cost, BIM, Hotel Projects, Building, Life Cycle

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