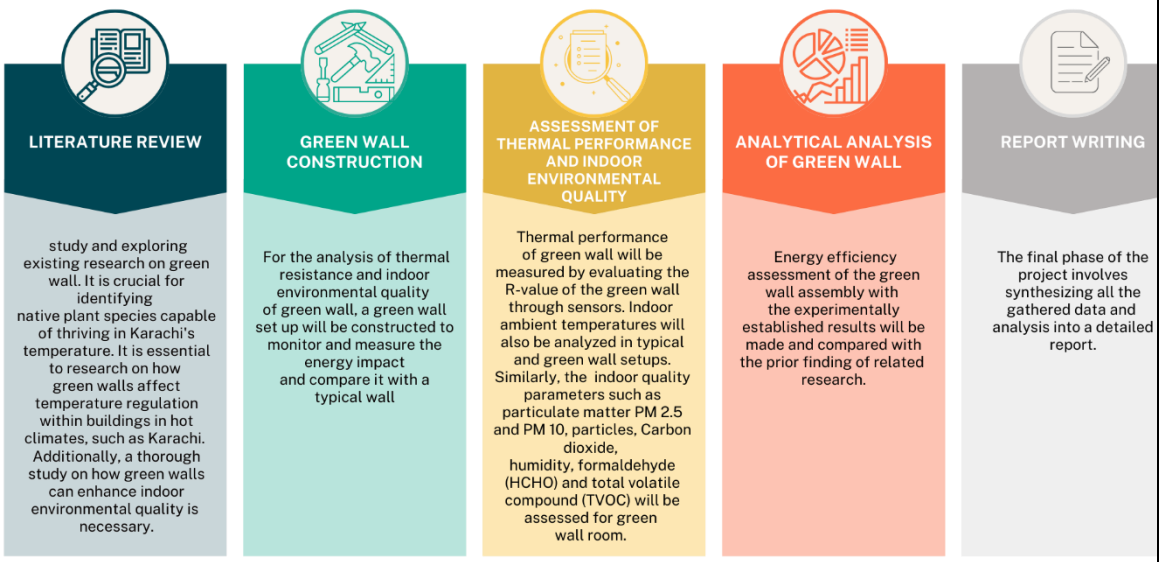
Final Year Project Showcase Batch 2020
Year 2024

Department: Urban & Infrastructure Engineering
Programme: Civil Engineering

1	**Project Title** **Thermal Performance and Indoor Environment Quality Assessment of Green Wall**
2	**Project Idea** This project aims to evaluate the feasibility and benefits of integrating green walls into buildings in Karachi's hot and humid climate. With rapid urbanization and increasing environmental challenges, such as heat, poor air quality, and high energy consumption, green walls offer a sustainable solution. By comparing the thermal performance and indoor environmental quality of green walls to traditional block masonry walls, the project seeks to provide insights into how these eco-friendly systems can reduce energy use, improve air quality, and contribute to the well-being of residents in a rapidly urbanizing city like Karachi.
3	**Process** The following figure depicts the methodology adopted to conduct this project. 
4	**Outcome** Thermal performance analysis shows that the green wall reduces the exterior wall's surface temperature by promoting plant evaporation and transpiration, compared to a standard block masonry wall. The installation of the green wall increases the thermal resistance of the wall, effectively reducing heat transfer and thus positively impacted on indoor temperature, In addition, it significantly reduces PM10 and PM2.5 levels, improving air quality. However, concentrations of TVOCs and HCHO remain largely unaffected, and humidity decreases in the room with the green wall
5	**Evidence (Theoretical Basis)**

	This project investigates the feasibility and benefits of integrating green walls into buildings in Karachi's hot and humid climate. As urbanization accelerates, the need for sustainable solutions to maintain indoor comfort and air quality becomes increasingly critical. Green walls, which are vertical gardens that incorporate living plants, offer a promising approach to mitigate the effects of heat retention and improve the overall environment of urban spaces. The research aims to enhance thermal performance and indoor environmental quality by comparing green walls with traditional block masonry walls. Initial findings indicate that green walls significantly improve thermal resistance, effectively reducing heat transfer and lowering energy consumption for cooling. The project utilizes thermal camera analysis to assess surface temperatures, revealing that the evaporation and transpiration of plants contribute to cooler exterior wall temperatures. In addition to thermal benefits, green walls play a vital role in enhancing indoor air quality. The project demonstrates that these installations can lower levels of particulate matter, such as PM10 and PM2.5, contributing to a healthier indoor environment. Although concentrations of total volatile organic compounds (TVOCs) and formaldehyde (HCHO) remain largely unchanged, the reduction in humidity levels presents further advantages for occupant comfort. While the initial costs of installing green walls may be higher than those of traditional options, the long-term savings in energy costs and the associated environmental benefits make them an economically viable solution. This project highlights the importance of considering both upfront investment and long-term returns when evaluating sustainable building practices. Ultimately, this research contributes to the broader goal of sustainable urban development, addressing pressing environmental issues in rapidly urbanizing regions like Karachi. By promoting green walls as a viable option, the project aims to foster a more resilient urban infrastructure and improve the quality of life for residents. The findings serve as a valuable resource for policymakers, architects, and developers seeking innovative strategies to combat climate challenges and enhance urban living conditions.
6	**Impact on Sustainability of Urban Regions or SDG-11 "Sustainable Cities and Communities"** The impact of this work aligns closely with Sustainable Development Goal (SDG) 11, "Sustainable Cities and Communities," by promoting environmentally friendly solutions in urban regions, specifically in the context of Karachi's hot and humid climate. The installation of green walls contributes to the sustainability of urban areas in several key ways: 1. Energy Efficiency and Reduced Consumption Green walls enhance the thermal performance of buildings, reducing the reliance on air conditioning and lowering overall energy consumption. This contributes to the goal of making cities more sustainable by cutting down energy use, which is a significant factor in urban carbon footprints. Reduced energy demand translates to lower greenhouse gas (GHG) emissions, which mitigates climate change, a key focus of SDG 11. 2. Mitigating the Urban Heat Island Effect Urban regions with dense concrete infrastructure trap heat, creating what is known as the Urban Heat Island (UHI) effect, which raises temperatures in cities, leading to increased energy use for cooling. Green walls, through natural processes like evapotranspiration, reduce the temperature of building surfaces and surrounding air, helping to combat the UHI effect. This aligns with SDG 11's aim to reduce the adverse environmental impacts of cities, particularly in terms of air quality and cooling needs. 3. Improved Air Quality Green walls filter air pollutants, absorbing particulate matter such as PM10 and PM2.5, which are harmful to human health and prevalent in densely populated urban areas. This enhances

	urban air quality, addressing one of the targets of SDG 11 to reduce the negative environmental impact of cities, including air pollution. 4. Support for Biodiversity and Ecosystem Services By incorporating plant life into urban settings, green walls promote biodiversity, attracting various species of birds and insects. This contributes to ecosystem services within cities, fostering a more balanced urban ecosystem. A healthier urban ecosystem is more resilient to environmental shocks, a key component of sustainable cities. 5. Contribution to Urban Resilience Green walls help enhance the resilience of urban areas by providing natural insulation and stormwater management. They reduce the strain on urban drainage systems by absorbing rainwater, which is crucial for cities facing challenges related to flooding and water management. These benefits support SDG 11's focus on making cities more resilient and adaptable to climate-related hazards and other shocks. 6. Human Well-being and Livability Green walls improve the quality of life for urban residents by creating healthier indoor environments. In addition to improving air quality, they reduce noise pollution and provide a visually pleasing natural element in otherwise concrete-dominated spaces. This enhances the overall well-being of city inhabitants, making cities more inclusive, safe, and healthy places to live, a core aim of SDG 11. 7. Scalability and Adaptability The use of green walls as a sustainable construction alternative can be scaled up in cities around the world, particularly in areas with similar climatic challenges. Their adaptability to existing structures makes them a viable solution for retrofitting older buildings, aligning with SDG 11's target of providing affordable and sustainable infrastructure that contributes to the revitalization of urban areas.
7	**Competitive Advantage or Unique Selling Proposition** 1. Attainment of SDG (Sustainable Development Goal) This project directly contributes to SDG-11: "Sustainable Cities and Communities." By incorporating green walls into urban environments, the project supports environmental sustainability, energy efficiency, and urban resilience. Green walls help reduce energy consumption by providing natural insulation, improving air quality, and mitigating the Urban Heat Island effect. In the context of rapid urbanization, particularly in cities like Karachi, this project provides a scalable solution to address climate change and enhance the livability of urban spaces. 2. Cost Reduction Green walls contribute to long-term cost savings by lowering energy consumption, especially in regions with hot and humid climates. While the initial investment in installing green walls may be higher, the reduced reliance on mechanical cooling systems results in significant savings over time 3. Superior Performance over Competitors Compared to traditional block masonry walls, green walls offer superior performance in terms of thermal regulation, air quality improvement, and environmental sustainability. The project demonstrates that green walls not only enhance building performance but also contribute to urban biodiversity and resilience.
a	**Attainment of any SDG** The project contributes to achieving SDG-11, "Sustainable Cities and Communities," by promoting urban sustainability through the integration of green walls. These installations

	improve energy efficiency by reducing heat gain and reliance on artificial cooling, which helps to lower carbon emissions. Additionally, green walls enhance air quality by filtering pollutants like PM2.5 and PM10, creating healthier environments for city dwellers. In a rapidly urbanizing city like Karachi, where the challenges of climate change, air pollution, and energy demand are pressing, green walls offer a sustainable and resilient solution. By mitigating the urban heat island effect and supporting energy-efficient infrastructure, the project aligns with the goal of developing sustainable and resilient cities, which is crucial for Karachi's long-term environmental and public health needs.
b	**Environmental Aspect** This project focuses on environmental sustainability by incorporating green walls, which significantly reduce energy consumption and carbon emissions. Green walls help lower indoor temperatures, reducing the need for air conditioning and thus conserving energy. They also absorb carbon dioxide and filter harmful pollutants, improving air quality. By mitigating the urban heat island effect and promoting natural cooling, the project contributes to a more energy-efficient and eco-friendly urban environment.
c	**Cost Reduction of Existing Product** While the initial cost of installing green walls is higher than traditional block masonry walls, the long-term savings make them a cost-effective solution. Green walls reduce energy consumption by improving thermal insulation, leading to lower cooling costs, especially in hot climates like Karachi. Over time, the energy savings offset the initial investment, making green walls a financially viable option that not only reduces operational costs but also contributes to environmental sustainability.
d	**Process Improvement which Leads to Superior Product or Cost Reduction, Efficiency Improvement of the Whole Process** The current process of using traditional block masonry walls in urban environments is inefficient in terms of energy consumption and thermal insulation. These walls allow for significant heat transfer, leading to increased energy usage for cooling in hot climates. The introduction of green walls improves this process by providing superior thermal insulation through natural plant-based cooling. This reduces the reliance on air conditioning, cuts down energy consumption, and lowers operational costs over time. Additionally, green walls enhance indoor air quality and contribute to environmental sustainability, making the overall building process more efficient and eco-friendlier.
e	**Expanding of Market share** The current market for traditional building materials, such as block masonry walls, is limited by its inefficiency in addressing modern environmental and energy concerns. With increasing global focus on sustainability and energy efficiency, green walls represent a significant opportunity to expand market share. They cater to the growing demand for eco-friendly construction solutions that reduce energy consumption, improve indoor environmental quality, and contribute to carbon reduction. As awareness of climate change and energy efficiency grows, green walls can capture new market segments, particularly in regions with hot climates, like Karachi, where sustainable solutions are essential for reducing energy costs and improving living conditions. This expansion taps into the need for greener, more efficient building technologies, which are increasingly prioritized by governments, developers, and consumers.
f	**Capture New Market** The introduction of green walls presents a unique opportunity to capture new markets, particularly in urban areas facing environmental challenges. There is a growing niche market

	for sustainable building solutions that are currently unaddressed, especially in regions like Karachi, where the demand for effective cooling and air purification systems is high. Traditional construction methods often overlook the integration of greenery, leaving a gap for innovative solutions. Green walls not only enhance building aesthetics but also offer practical benefits, such as improved air quality and thermal comfort, appealing to environmentally conscious consumers and developers. By targeting this unaddressed segment, the project can position itself as a leader in sustainable construction, attracting investments and partnerships with organizations focused on green technologies and urban resilience.	
8	**Target Market** The target market for green walls includes urban developers, architects, building owners, and environmentally conscious families. Developers can enhance property appeal and meet sustainability regulations, while families in densely populated areas seek solutions for better air quality and reduced energy use. Educational institutions can also integrate green walls to promote sustainability and environmental education. This diverse audience highlights the increasing demand for eco-friendly solutions in urban environments.	
9	**Team Members** (Names along with email address	Yusra Shuaib (shuaib4305150@cloud.neduet.edu.pk) Syeda Maryam Wafa Khani (khani4305961@cloud.neduet.edu.pk) Anshara Zahid (anshara4301288@cloud.neduet.edu.pk) Ali Umer Shaikh (shaikh4300089@cloud.neduet.edu.pk)
10	**Supervisor Name** (along with email address)	Dr. Nida Azhar (nazhar@cloud.neduet.edu.pk) Dr. Farrukh Arif (farrukh@cloud.neduet.edu.pk)