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# 1 Introduction and Problem Statement

The growth of tourism in developing countries poses environmental concerns due to seasonal extremes, inadequate infrastructure, and interference with fragile ecosystems and protected areas (Geneletti and Dawa 2009, p. 229). In particular, the Union Territory of Ladakh, a picturesque region in India, witnessed a tripled amount of tourism arrivals between 2010 and 2021, bringing both economic benefits and environmental challenges (Dar et al. 2022; IBEF 2022). Especially, the urban areas of Ladakh face a multidimensional challenge. Firstly, the growing fast tourism of mainly national tourists brings an enormous plastic waste crisis (IBEF 2022; Padgelwar et al. 2021). Furthermore, the region is experiencing a high unemployment rate of 6.2% in 2023 due to rural-urban migration (Excelsior 2023; Goodall 2004). Moreover, there is an increasing demand for insulated houses due to the high altitude and cold of the region (Müller et al. 2020; IBEF 2022).

The EuroTeQ Collider Challenge of "Leave no waste behind" by several engineering universities recognizes the urgent need for an impactful solution, particularly to mitigate the toxic waste trail left behind by tourism activities. By addressing the waste management problem in Ladakh, we promote sustainability, preserve the region's natural beauty, foster regional employment and fulfill the demand for insulated housing materials.

This report aims to outline the results of a student project in which a business plan of the so-called "The Himalayan LEGOs" to reduce plastic waste in Ladakh was developed. First, we describe the method of how the solution was developed. Subsequently, the business concept is explained. Based on this, a market and stakeholder analysis will highlight the relevance and scope of the business concept. A financial analysis of the developed business plan illustrates the feasibility of the project. Finally, the results are summarized and an outlook on the next steps is given.

## 2 Methodology

Applying the design thinking approach at the beginning of the project, we, as an international students' team from the Technical University of Munich became aware of the Himalayan Waste Challenge and the urgent need for an impactful solution. Based on brainstorming ideas and an extensive literature review, we realized the lack of plastic waste management facilities in the Ladakh region. Realizing the importance of finding a technical solution that could be implemented in Ladakh as soon as possible and that would also be feasible, we decided to develop a business plan for Ladakh. We add value by using our time resources and expertise to develop a business concept that addresses the regional challenges of Ladakh, the inadequacy of financing in this relatively underdeveloped region, and the business's value proposition and sustainability to leave no waste behind. Based on this approach to the challenge, we define

the vision of our business concept as follows: "Our vision is to create a sustainable future for urban Ladakh by implementing circular business practices."

### **3 Results**

Our solution aims to address the significant environmental impact caused by the large amount of plastic waste in Ladakh. We propose a business concept for recycling plastic waste into construction bricks specifically for the urban areas of Ladakh, extending the use phase of plastic waste and reducing its negative impact.

While the technology of producing insulated plastic bricks from recycled plastic is known, it is an innovative concept for the Ladakh region, where there is currently no proven solution for plastic waste disposal (Awoyera and Adesina 2020). Our business model provides a solution to the growing plastic waste problem in the region. Furthermore, by supplying local construction companies with higher-quality housing insulation bricks, we meet the housing insulation needs of local residents. Our main competitors are local companies that produce traditional construction materials like concrete bricks.

Our solution primarily focuses on the engineering perspective, aiming to bring long-term environmental, social, and economic benefits to Ladakh through the innovative use of plastic waste.

#### **3.1 Manufacturing Process**

The process of converting plastic into bricks involves several scientific steps. Initially, plastic waste is collected and sorted based on its type and purity. The sorted plastic is then shredded into small pieces, increasing its surface area for subsequent processing. The shredded plastic undergoes thorough cleaning to remove impurities and is dried to eliminate moisture. Additives such as sand or fly ash or chemical agents may be mixed with the shredded plastic to enhance the final brick's properties. The plastic is melted at high temperatures and poured into brick-shaped molds or extruded to form continuous bricks. The molten plastic undergoes cooling and solidification within the molds, aided by cooling chambers or water baths. After solidification, the plastic bricks are demolded and may undergo finishing processes. Quality control measures are applied to ensure the strength, dimensional accuracy and other relevant properties of the bricks. The resulting plastic bricks can be utilized in various applications, offering advantages such as lightweight and thermal insulation compared to conventional bricks (H. T. Mohan et al. 2017).

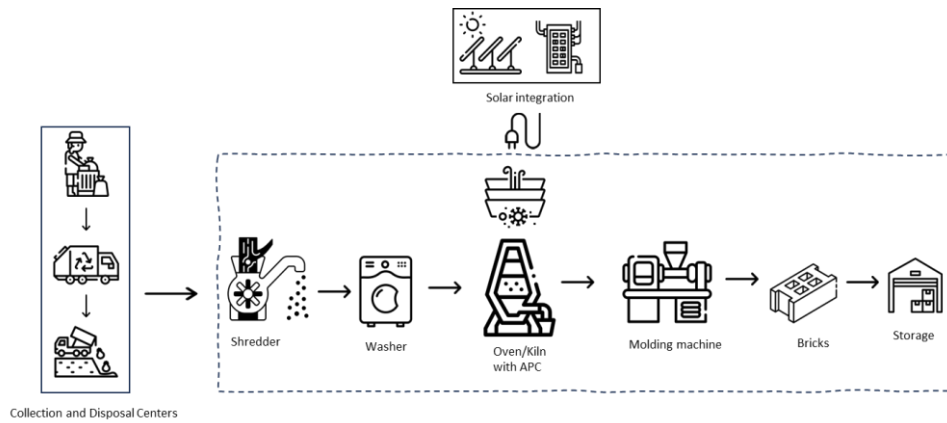


Figure 1: Manufacturing process of plastics bricks (own illustration)

### 3.2 Sustainability and Impact of the Business Plan

The business plan of “The Himalayan LEGOs” contributes to a more sustainable future by using and upcycling plastic waste, minimizing its impact on the environment. By using plastic waste as a construction material, our solution reduces waste incineration and limits the negative impact of landfills on water, soil, and air. The solution promotes closed-loop recycling, contributing to a circular economy within the framework of the Sustainable Development Goals (SDG 2015). Additionally, our project provides employment opportunities for the local population and improves economic and social conditions in Ladakh. The Himalayan LEGOs thus offer a sustainable business approach focusing on SDG 8 - Decent Work and Economic Growth, 9 - Industry, Innovation and Infrastructure, 11 - Sustainable Cities and Communities, 12 - Responsible Consumption and Production, 13 - Climate Action, and 15 - Life on Land.

Moreover, the sustainability of our project depends on factors such as the availability of plastic waste, demand for building materials from plastic waste, the cost-effectiveness of the process, and revenue generation from brick sales. If these factors are favorable, our project has the potential to be self-sustainable in the long run.

In the long term, The Himalayan LEGOs will have a positive impact at the regional level in India, focusing on the reduction of plastic waste and landfills in the urban areas of Ladakh, particularly Leh, and Kargil, which have experienced increasing rapid tourism in recent years.

### 3.3 Market Analysis

The Ladakh region currently offers two main types of bricks for construction purposes, namely adobe bricks and cement bricks. In terms of pricing, our plastic bricks are competitively priced, ranging from 0.30 to 0.33 euros per brick. When compared to alternative brick types, our plastic bricks exhibit superior insulation qualities, as evidenced by their thermal conductivity and thermal conductivity. According to Thermtest (2021), thermal conductivity refers to a material's ability to conduct heat. An ideal brick should have low thermal conductivity, ensuring optimal temperature regulation within a building, keeping it warm in winter and cool in summer. Our

plastic bricks demonstrate a thermal conductivity of 0.3W/mK and a thermal conductivity of 1.5W/m<sup>2</sup>K, outperforming adobe bricks (0.6W/mK and 3W/m<sup>2</sup>K) and cement bricks (1W/mK and 5W/m<sup>2</sup>K). In summary, there exists significant market potential for our plastic bricks in the local building market of Ladakh.

Moreover, we have assessed the potential market value of our plastic bricks by considering the estimated value of commercial investment opportunities for local stakeholders. This market value encompasses five distinct categories: commercial real estate, public space development, residential construction, affordable housing, and public works. During the initial stages of our business plan implementation, our primary target is the city of Leh, which possesses a market value of approximately €8.55 million. As our business continues to grow, we have strategic plans to expand our market presence throughout the entire Ladakh region, which boasts a market value of approximately €13.25 million (Invest India 2020).

### 3.4 Stakeholder Analysis

Stakeholder analysis is a vital tool for comprehending the diverse individuals, groups, and organizations that can influence or be impacted by our business endeavors. Our stakeholder analysis identifies six key elements: the local government and regulators, local NGOs, plastic waste recycling companies or organizations (specifically Waste Wise, a team of TUM students working on the Ladakh Waste Challenge), investors, and our primary customers, the construction companies operating within the region.

First and foremost, addressing the issue of plastic waste in the local landfill aligns with the Ladakh Vision 2025, which outlines the government's roadmap (Dawa 2005). Therefore, supporting our production of plastic bricks will be highly advantageous to the local government in realizing a circular economy and maintaining a clean Ladakh.

Furthermore, we are actively engaging with local NGOs, including the HIAL Institute, 3D Waste Management, ZERO Waste, and Saahas Zero Waste. These organizations can help us raise awareness about our plastic bricks in the region and provide valuable technical support for future product expansion and overall business development. Additionally, we have the potential opportunity to establish our plant on the land of the HIAL Institute.

Our current investors consist of RecycleX, the local government, and various NGOs. RecycleX, an India-based company specializing in recyclable, sustainable, and innovative building products, has expressed its willingness to assist us with the necessary production machinery. Moreover, we have the potential to secure financial investments from the government and NGOs, further strengthening our operational capabilities.

WasteWise or other local recycling institutes will serve as our primary suppliers of the most essential production material, namely plastic waste. By collaborating with these organizations, we can ensure a consistent and reliable supply chain.

Last but certainly not least, local construction companies will serve as our primary customer base. In India, it is common for local citizens to enlist the help of construction companies when building their own living spaces, rather than undertaking the construction themselves. Consequently, establishing strong partnerships with these construction companies will be pivotal to the success of our venture.

By effectively engaging with our diverse stakeholder groups, we can leverage their support, expertise, and resources to drive the growth and sustainability of our plastic brick manufacturing business in the local market.

### 3.5 Financial Analysis

The core motivation of our start-up is to generate a positive impact on Ladakh's environment. Nevertheless, a business is only successful and impactful in the long run when it is profitable. Therefore, a business plan along with an in-depth cost analysis was set up to have a base for further decisions, such as capacity planning, factory size, number of employees, and the price of bricks. This section presents the key financial figures and forecasts.

Starting from the ground up, market research was conducted to determine the availability and cost of the various machines needed for the production line setup. Once a certain model of the machine was chosen, further machines were assessed based on their area, energy, and output. After completing those activities, the total estimated amount of land needed for the factory setup was calculated, and quotes for the installation of solar units were requested after determining the expected total amount of electricity needed for the plant. Following easy navigation, the project's financials were estimated using the aforementioned figures. The overall cost of building up the plant with all the machinery needed, equipment, and solar panels is €78,000. In the first year, the projected revenue is €180,000, which contrasts with the yearly running costs of €185,400. However, the sales amount will increase in the following years, leading to higher revenue. Although the first year is expected to operate at a loss, profitability is anticipated within the second year, leading to a reasonable payback period of 3.5 years, which can be seen in Figure 2.

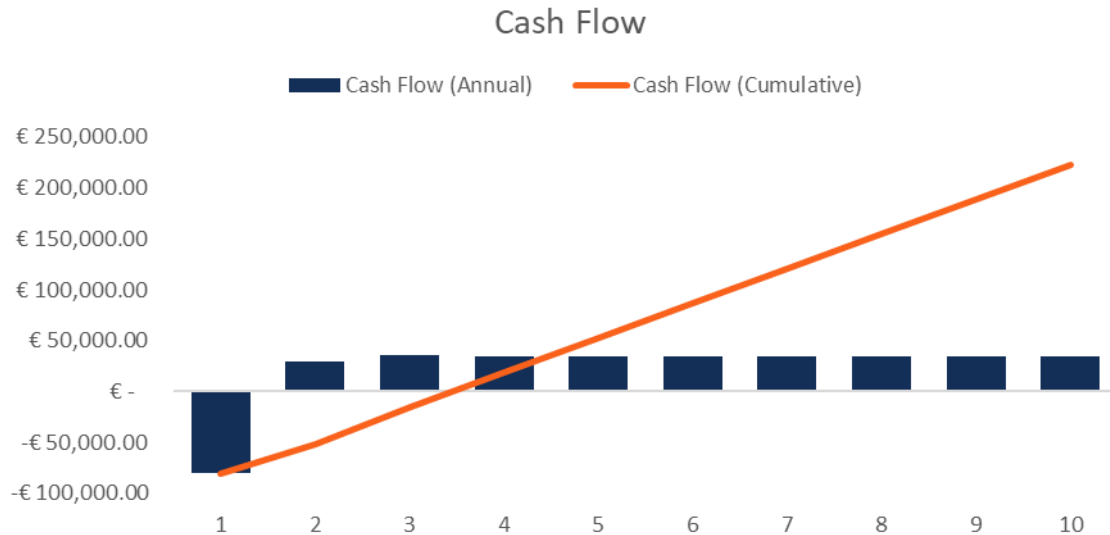


Figure 2: Cash Flow Calculation (own illustration based on CFI (2019))

Based on calculations, the business will result in a profit margin of 12.37% over the first five years. To gain market traction, the project will employ a penetration pricing strategy, starting with a low price of €0.30 per brick and gradually increasing it to €0.33 per brick. While the cost analysis is subject to assumptions, efforts have been made to incorporate local information and figures for realistic projections. The detailed financial plan can be seen in the following table.

Capital Investment Model						
		1	2	3	4	5
Price per brick	€	0.30	0.31	0.32	0.33	0.33
Sales		609,400	692,500	692,500	664,800	664,800
Revenues	€	182,820	214,675	221,600	219,384	219,384
Expenses (total)	€	185,400	185,400	185,400	185,400	185,400
Salaries	€	60,000	60,000	60,000	60,000	60,000
Operating costs (water, maintenance, filters, transport, ...)	€	67,200	67,200	67,200	67,200	67,200
Raw materials (fly ash, sand)	€	55,200	55,200	55,200	55,200	55,200
Advertisement	€	1,000	1,000	1,000	1,000	1,000
Others (insurance, fees, ...)	€	2,000	2,000	2,000	2,000	2,000
Profit	-€	2,580.00	29,275.00	36,200.00	33,984.00	33,984.00
	-€	78,000.00				
<b>Capital Investment (total)</b>	€	78,000.00	-		-	-
Machineries	€	20,000.00				
Purchase of land	€	-				
Construction of factory	€	33,000.00				
Installation of solar panels	€	20,000.00				
Office equipment, furniture	€	5,000.00				

Figure 3: Financial plan based on CFI (2019)

## 4 Conclusions and Outlook

Our business idea of transforming plastic waste into valuable resources and producing high-quality construction materials holds great potential for a sustainable and prosperous future. By focusing on recycling High-Density Polyethylene (HDPE), Low-Density Polyethylene (LDPE), and Polyethylene Terephthalate (PET) waste, we aim to significantly reduce the amount of plastic waste occupying landfills, ultimately leading to a decrease in landfill sites.

Through proactive stakeholder engagement, we have garnered considerable interest in our business idea. The next phase involves detailed negotiations to secure additional funding from stakeholders, enabling us to proceed with the implementation of our plan. The construction of the factory is scheduled to commence at the beginning of next year, with the goal of developing a prototype within nine months and initiating full-scale production by 2025.

Once production is underway, our future goals include establishing a net-zero factory by compensating for minimized emissions, thus contributing to a more sustainable environment overall. As production stabilizes, we intend to expand our operations beyond the city of Leh, utilizing plastic waste from Kargil, the second-largest city in Ladakh, and forging partnerships with local construction companies to actively participate in the building process. Additionally, we envision diversifying our product portfolio by introducing additional offerings, such as tiles, to cater to evolving market demands.

We strive to create a sustainable and vibrant future for Ladakh, where waste is minimized, resources are maximized, and the beauty of the region is preserved for generations to come. Our vision extends far beyond simply producing bricks from Leh's waste. The Himalayan LEGOS aspire to transform harmful waste into valuable resources, working in close collaboration with the "Waste Wise Initiative" to systematically clean up the beautiful Ladakh, brick by brick.



## **5 Distribution of Work within “The Himalayan LEGOs”**

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## **Declaration**

We hereby declare that the report submitted is our own unaided work. All direct or indirect sources used are acknowledged as references.

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