

Reflection Paper

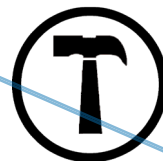
Circular Communities

For Housing

Transforming waste plastic and glass into building blocks making housing construction simpler, cheaper, faster and more sustainable



FLOW



MAKE

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This reflection paper delineates the research, design process as well as the result of the graduation project. The paper begins with a short introduction of the studio structure. The paper also discusses the relationship between the research and design, as well as between the research methodology and the methodical line of inquiry within the graduation studio. The broader goal and the wider social, environmental and economic impact is described as well.

Introduction :

In the Graduation Studio 'Intecture' of Architectural Engineering, each student has the possibility to define their own graduation project, which should relate to the different selected contexts and the main studio topics of Flow, Make and Stock. In the first Semester (MSc3) each student formulated research studies in the technical topic of their preference within Architecture, which resulted into a research paper. The first studio presentation was a short design assignment, where each student had to design a pavilion within a week based on their fascination, which gave the tutors an idea, in which of the three main studio topics could the project incline towards, this helped to assign our tutors. For my graduation project, I decided to choose Cigondewah, in Bandung, Indonesia as the location. The reason for which being, the similarity of the context to the cities in India, from where I belong, while also being a completely new challenge to understand the social and cultural aspects of a place which I didn't know much about.

Research and Design:

In the beginning of the studio, I was very interested to explore the use of bamboo as a building material, due to its low ecological footprint, the context of Indonesia would give me the opportunity to explore it. After doing further research about the location, studying the problems associated with housing provision and the major issue regarding plastic pollution, I decided to change my idea to using waste plastic as a resource for providing affordable housing.

The project is located next to a major textile factory 'PT Kahatex', in an urban Kampung (village) called Cigondewah, near the southern border of the City of Bandung. Around 45% of the population living here, have migrated from other parts of the country in search for jobs, increasing the burden on the already insufficient housing stock. During the field visit and while conducting interviews of the local residents, it was understood that there exists a local informal building industry which constructs most of the houses in the Kampung, this is a cheap way of getting a house built. Unfortunately, due to their low technical skills, the quality of construction is substandard, which was evident in many structures there.

When asked if they would like to live in a house that is built from waste plastic, a local resident from Cigondewah said that, as long as the material is cheap, durable, easy to use and looks good, they will readily accept it. But, to persuade the people of the Kampung, they would like to see a pilot house constructed with the material. This is how I arrived at my Design and research question.

Design Question:

How do we solve the affordable housing crisis in the Kampung of Indonesia using a 'Decentral' Circular Economy system?

Research Question:

How to develop low-tech prefabricated building elements using waste plastic?

Further, research was done in understanding the chemical composition of plastics, ways of manufacturing plastic and requirements as a building material, to create a hybrid material which is a mix of different plastics (which are usually immiscible, but under favorable conditions become miscible) and powdered waste glass, this is done to improve the compressive strength, fire-resistance and to give the material a rough texture.

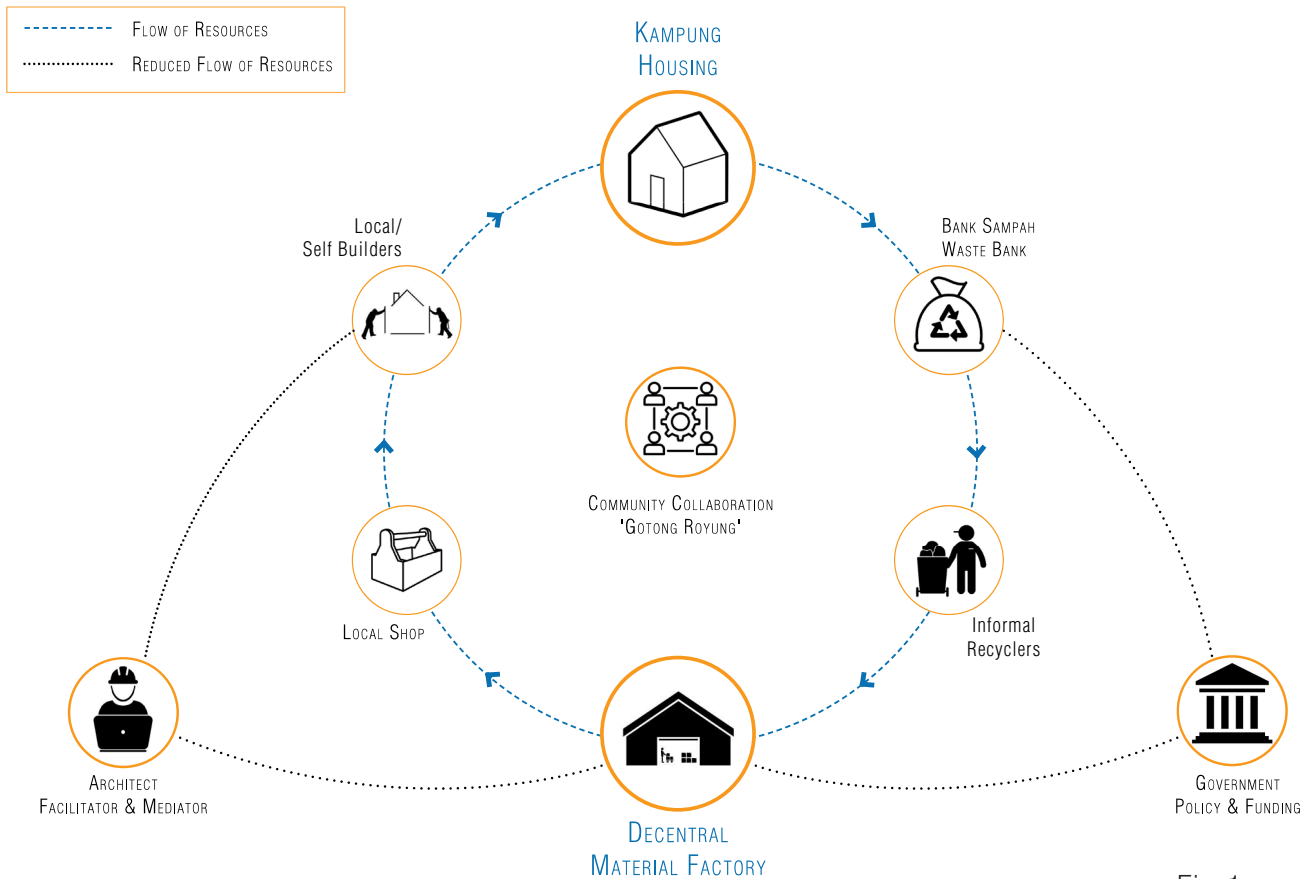


Fig 1.

Graduation Project and the Studio theme:

The reason for me deciding to do my graduation project in Architectural Engineering, is because the thinking and the approach of the studio falls in line with what I see myself doing in the future. The studio defines architecture and engineering to be irreversibly connected and that technological advancements in design help directly to improve efficiency in Architecture. The studio strives to bring social, spatial, functional and technical developments together to achieve integrated design solutions to solve the environmental and social challenges that we face currently.

In the studio framework, this project falls under the topics of make and flow, designing new construction elements using waste by creating a decentral circular economy for housing provision. The tutors assigned by the studio were a perfect fit for the project, Mo Smit as my main design mentor, with her experience

of working in Indonesia, David Peck as my research mentor, who is a specialist in circular economy principles and Engbert Van Der Zaag for building technology, were very instrumental in helping shape the project.

The graduation project deals with providing affordable housing solutions for the low-income individuals living in the Kampung of Indonesia, while also helping reducing environmental pollution. The strategy is to create a decentral circular system (Fig 1.), where a network of small manufacturing facilities could be set up at a neighborhood scale, for the local people to micro manage their waste and produce these elements on their own, resulting in the empowerment of vulnerable communities, who can then assemble their own houses.

It's about helping people help themselves.

Method and Process:

In the graduation studio each student focuses on their individual technical research topics related to the overall design question for their project. Design by research is the main focal point of the studio. The design program is formed by concluding the research conducted during the first semester of the studio, to create a strong argumentation for proposing design-based solutions. This process of reaching a self-formulated design brief, gave me the flexibility of researching ideas of my interest, creating more opportunities for exploration within the overall wider studio goals.

A two-week field trip to Indonesia during the first semester was organized, where we visited the site in the Kampung of Cigondewah, conducting interviews of the residents, including the people who are living in rental units within the Kampung, to understand the socio-economic and the cultural structures within these communities. This also gave us the opportunity to study housing typologies and understand the existing network of the informal building industry and the recycling industry. Data regarding the demographics, government programs, income structure, cost of construction, the current waste management system was collected and analyzed.

During the second semester (MSc4), the first step was to design the building elements. After studying case studies, using the previous research conducted, getting inspired by Lego building blocks and similar interlocking blocks, I created a total system of elements, with a simple stackable technique of construction and a self-locking design (Fig.2), that can be used to construct the foundation, walls, openings and the roof tiles of a house. The next step was to contextualize the design of the housing. As noticed during the site visit, an outdoor extension such as a front porch, balcony or a courtyard are an important part of the daily life. The idea is to create a very adaptable plan layout, and based on the type of occupants and/or size of the family, 14 unique layout typologies are designed to show the flexibility of the building system. The roof is also designed to be adaptable to the changing layouts.

I have managed to acquire research funding through the Science Center Delft and the 'Change Maker Challenge' by the Dopper Foundation, simultaneously, collaborative talks are underway with a manufacturer in India to understand the production aspect of the products.. The next step will be prototype testing and to try create a startup company with the help of 'YES! Delft'.



Fig 3.

Wider social, economic and ecological impact:

One of the biggest challenges facing climate change and poverty is indifference. Over 1.5 billion people today do not have access to adequate housing, a billion of those people live in slums, in unsafe conditions.

Indonesia is one of the 5 countries in the world that contribute to up to 60% of the total ocean plastic pollution. With the global plastic production estimated to increase to 1,124 million metric tonnes by 2050, compared to 311 million metric tonnes in 2014, if we continue to practice current waste management systems, by 2050 there will be more plastic than fish in the ocean. On the other hand, demand for affordable social housing for the lower income groups in the cities is growing, due to the rapid increase in the urban migration, population growth and the inefficiency of governments in many developing countries to provide housing. It is estimated that by 2050, around 70% of the total population in Indonesia will reside in the urban areas. In Indonesia, there is a current housing shortage of over 11.5 million houses which is estimated to grow as more people move to the cities.

The problem is, the negative impact of plastic in the environment and the existence of fragile housing in vulnerable communities, which accelerates global warming and the inequality gap.

In Cigondewah, a neighborhood of 3000 people, possibly generates enough plastic waste in 4-6 weeks to construct a house for a family, that comes up to 10 - 12 houses per year.

The broader goal is to reduce environmental pollution and to reduce the global housing shortage with a solution that has a high social, environmental and economic impact. With this approach, the designed system aims to tackle 10 of the 17 United Nations Sustainable Development Goals. (Fig 3.)