In: Waste Management: New Research
Editor: Ademir S. F. Araújo
ISBN 978-1-62081-995-1

Chapter 2

WASTE FOR LIFE (WFL): POVERTY REDUCING SOLUTIONS TO SUSTAINABLE WASTE MANAGEMENT

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ABSTRACT

This chapter highlights an innovative model of waste management combined with poverty reduction, which has been developed by the organisation Waste for Life (WfL). WfL is a loosely joined network of scientists, engineers, designers, architects, cooperatives, artists and students of different disciplines and countries working together to develop poverty reducing solutions to environmental and social problems. WfL uses low-cost technologies that can be sourced locally and add value to resources that are commonly considered as waste. WfL projects are centered on manufacturing waste based composite products from thermoplastics and natural fibre materials using a simple hot press method. WfL takes a social justice stance on waste management and looks at the social impact of the proposed system - particularly the impact on people who work with waste and live in socially deprived conditions. The intention is to reduce poverty by generating more stable income sources for marginalised groups who work with waste as well as providing a sustainable mechanism of waste management.

1. INTRODUCTION

Rapid urbanization coupled with increasing populations has brought in new socio-economic and environmental problems in the world, particularly for third world countries. One such issue that requires urgent attention is the mounting waste problem, which has grown from being an annoyance for regional and local governments to an issue of national importance in many developing countries. Huge tonnages of refuse are introduced daily in the

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urban areas of these countries. For example, the urban areas of Asia produce about 760,000 tonnes of municipal solid waste per day [1]. This waste need to be disposed of in a manner that is acceptable both socially and environmentally.

Waste is not only an environmental problem. It is a social dilemma throughout the world. According to Zurbrügg [2], the poor in the society suffer most from the unfavourable conditions deriving from disorganized waste management. He further states that local authorities allocate more resources to the affluent areas where citizens with more financial and political power reside and often ignore or pay less interest to clean the areas where majority of the poor people live [2]. The lack of environmentally acceptable solid waste management has created significant public health risks, particularly to the poor who live in close proximity to waste dumps and make their living through scavenging activities to supplement their unsatisfactory earnings [3].

Most waste management systems fail due to inadequate financial resources, lack of administrative and institutional management, improper distribution of resources and infrastructure and mostly lack of community support and public awareness [4]. Management of solid waste is not at all an easy task. However, it need not be made more difficult by unnecessarily using complex technology. Moreover, a technology that may be considered readily applicable in one country may be too sophisticated and otherwise unacceptable in another country [5]. Hence, using the appropriate technology is critical to successful solid waste management in the low technology economies of developing nations. This has raised a timely concern to adopt different strategies that will take a social justice stance on waste management focusing on low-cost technology and community participation.

Waste is a resource out of place. Many of us hardly recognize the value of waste as a resource. Being a potential source of valuable materials and renewable energy, reusing and recycling of waste can provide a definite economic advantage. This can also minimize the associated socio-environmental problems encountered by the haphazard waste disposal. To be both effective and sustainable in the long run, new methods of waste management in developing countries must be socially acceptable, technically viable, economically feasible, and environmentally sound. Keeping this in mind, the authors of this chapter focus on a novel waste management approach that values, not only the environment, but also the social aspect of waste management. This innovative waste management model coupled with poverty reducing strategies was developed by a not-for-profit organization called Waste for Life (WfL).

In the sections below, we will present the story of WfL. WfL has a different research direction that includes a socially and an environmentally just outcome. Section 1 provides a general introduction to the chapter. Section 2 describes the social justice perspective of WfL followed by an overview of natural fibre composites in section 3. Section 4 explains the research and technical approach taken by WfL. Section 5 presents case studies of Argentina and Lesotho and discusses WfL's experience of working with co-operatives and the informal sector in different parts of the world. WfL has initiated projects using thermoplastics and the plant Agave in Lesotho in Southern Africa and thermo plastics and paper materials in Buenos Aires in Argentina and demonstrates that viable products can be made using this method. Lastly, section 6 presents the final thoughts of the chapter.

WfL supports the autonomy of the participating cooperatives or community based organizations and facilitates the groups to take responsibility, carry out operation, manage, and maintain the project, which will ultimately benefit its members and the wider community.

This chapter will highlight the socially just approach developed by WfL and the methodologies followed to identify the needs of the community prior to a natural fibre composite project being implemented on the ground. WFL stresses the importance of conducting needs and feasibility studies, stakeholder analysis and Social Impact Assessments in different geo-political contexts to ensure community needs are taken into consideration. Lastly, the chapter will emphasize WfL's intention to reduce poverty by generating more stable income sources for marginalised groups who work with waste as well as providing a sustainable mechanism of waste management.

The recovery of solid waste undoubtedly can contribute to alleviating problems such as poverty, unemployment and inadequate waste disposal. There is scope for implementation on a much broader scale than has been the case so far. If economically marginalised populations of developing countries are to benefit, the range of small-scale, low-cost and environmentally sound options needs to be developed and improved [6]. It is hoped that this chapter will contribute to these efforts.

2. WASTE FOR LIFE AND SOCIAL JUSTICE

Waste and poverty are two aspects that are closely interconnected. Waste often provides a livelihood through collection, reusing and/or recycling for the poorest members in the society. This is where WfL comes in to play. WfL is a loosely joined network of scientists, engineers, designers, architects, cooperatives, artists and students of different disciplines and countries working together to develop poverty reducing solutions to environmental and social problems [7]. As the name itself suggests, WfL works to improve the lives of marginalised groups in the community who usually earn their living by scavenging through waste. WfL uses low-cost technologies that can be sourced locally and add value to resources that are commonly considered as waste. Hence, WfL projects are centered on manufacturing waste based composite products from thermoplastics and natural fibre materials using a simple hot press method [8].

Waste management historically focused only on the environment. In many countries, this still remains unchanged. The traditional waste management system focuses on cleaning and preserving the environment, thus giving priority to government and private waste management companies, neglecting the services of informal sectors who play a vital role in managing waste. WfL has taken a different path to this traditional approach, making an effort to include the marginalised sectors who work with waste into the main system thereby focusing on the social in the foreground, with environmental benefits as background. This highlights a novel approach of integrating social and ecological justice perspectives.

WfL uses a different lens to look at waste management: a lens of social justice. Understanding what social justice means and how it relates to WfL is vital. It is much easier to talk about "justice" in social sciences or related studies. However, it is much more difficult to discuss the same in engineering practice. Engineers primarily focus on technical problems such as making stronger materials to build better structures or making technically advanced gadgets each day – at its worst these may be "designed for the dump" with no consideration of end of use. Recently, this practice of focusing only on materials and technical aspects of a

project is criticised heavily and there is much debate on giving priority to the environmental impact of a project. Social impact lags behind.

Ursula M. Franklin in her book, The real world of technology (1992) suggests that cost benefits of social, environmental and economic aspects of a project should be considered to understand "who benefits and who pays?" as a result of a project [9]. It is therefore important to study, what means by social and ecological justice within a context. The stakeholder analysis, Social Impact Assessment and the feasibility studies carried out prior to implementing a WfL project are directed to explore this idea of "who benefits and who pays?" and to examine the outcome of social and environmental justice in the community. In other words, integration of social justice raises concerns on who we are working for and who would ultimately benefit (or be harmed) by the results of a project.

WfL aims not only at a social just outcome, but also an environmental just outcome. According to Donna Riley (2008), the environmental justice movement highlights equity in terms of environmental pollution issues, transparency from the authorities and a participative community approach for addressing local environmental problems [10]. WfL projects increase access to income for marginalised communities while improving the environment by making use of waste materials for product manufacturing. This enhances equity, especially equity of access to income and the benefits it will provide [11]. George Catalano, a renowned social justice scholar states that, engineers should consider poverty and the planet together, so that economic justice and environmental justice are integrated [12]. This is exactly what WfL is trying to achieve; the potentiality of achieving socio-economic and environmental justice within the community through waste based composite projects.

WfL also looks at the social ecology of waste management, in which economic, social and political factors that play a fundamental role in creating environmental problems are considered. Murray Bookchin [13], a major figure in Social Ecology has stated that most of the current ecological problems arise from societal and social problems and argues that ecological problems cannot be understood or solved without understanding and dealing with the problems within the society. Bookchin has further said that, *"to separate ecological problems from social problems……would be to grossly misconstrue the sources of the growing environmental crisis."*[13, pg 1]

WfL continuously question their approach and research direction; Can WfL help cooperatives remain independent and economically self-sufficient? Will the project be sustainable and run without WfL's support? Can the research interest be directed towards achieving social and environmental just outcomes? Can WfL co-create solutions to reduce disparities between social groups and promote equity? Can WfL improve local empowerment through directly supporting local markets and local value involvement? [11]. In the subsequent sections, we have attempted to address some of these questions. Hence, it will be interesting to keep these questions in mind as you read through the chapter.

3. NATURAL FIBRE COMPOSITES (NFCS)

Before moving onto the details of WfL's approach, methods used and success stories, it is important to focus on the material category developed by WfL, known as natural fibre composites (NFCs) or waste based composites. Rather than focusing only on material re-use,

WfL works with composite materials – which work by the principle that 'the whole is greater than the sum of the parts'. Reinforced plastics are stronger than the constituent plastic and tougher and more flexible than the constituent fibre. WfL has put years of research into the potential for adopting the concept of composites to develop usable and 'upcycled' materials from recycled plastics and natural fibre waste as materials. These have a higher potential for quality products than the waste materials recycled alone. The challenge, which WfL addresses is to develop manufacturing processes to create the composites, which use low cost technology. Due to the availability of waste materials and the low cost technology used, products made from waste-based materials offer great potential for poverty reduction, especially for marginalised communities who depend primarily on waste collection for their daily survival.

Plastics are used in our daily lives in a number of applications. The widespread use of plastics make plastic materials one of the major challenges in solid waste management [3]. Plastic wastes are especially cumbersome due to their potential environmental and human toxicity as well as their persistence [14]. This waste stream usually contains a substantial amount of polyethylene and other types of recyclable plastics, especially in packaging materials, which can potentially be recovered for recycling [15]. However, after use, most of the plastic waste usually ends up in landfills, open dumpsites, burnt, or buried, causing serious environmental problems [15]. This situation is further exacerbated in developing countries as proper regulations are not enforced and complied.

Recycling is considered the preferred method for plastic waste management of thermoplastics, which soften on heating and harden again when cooled; the property that makes them suitable for mechanical recycling [16]. Recycling of plastics can result in significant environmental benefits, particularly the conservation of fossil fuels, water, and energy used in the production of virgin plastics [16, 17]. Plastic recycling also plays an important role in diverting these materials from burning and haphazard dumping.

Several techniques, both chemical and thermal are used for recycling plastic waste. However, chemical techniques usually involve the use of hazardous solvents. Moreover, plastic recycling can be associated with some environmental costs such as the discharge of wastewater and effluents, and the release of toxic fumes [16]. In some developing countries plastic recycling is an environmentally hazardous industry due to the high usage of water for washing, rinsing, and cooling waste plastic and the discharge of polluted water to the environment [16].

Concerns over the environmental costs associated with improper recycling, waste production, green-house gas emissions and rising fossil fuels costs have encouraged academic and industrial research into alternative processes and products.

Some attempts at developing waste-based composites have been made, and in particular, there has been interest in replacing synthetic fibres with natural waste fibres in reinforced plastics. Reinforcing bio fibres such as cotton, jute, flax, hemp, sisal, kenaf and more recently corn and soy are increasingly replacing synthetic fibres [14] although frequently the matrix material (plastic) used is thermosetting, which cannot itself be recycled at the end of use.

Plastic waste represents a promising source of raw material for the development of thermoplastic composites with natural fibres, mainly due to availability of it in large volumes and low cost. In many countries, a large amount of natural fibre waste is generated from different processes and such waste is mainly disposed of in landfills, open dumpsites or burnt.

The addition of these natural fibre waste to recycled plastics renders the resulting composites viable from both the mechanical properties and the environmental point of view [18].

There are many advantages of waste based composites over conventional types of materials. Some of the advantages of NFCs include low density, low manufacturing energy, low CO_2 emission, renewability and a high level of biodegradability, compared to inorganic filler reinforced thermoplastic polymer composites [19]. Furthermore, a study carried out by Pervaiz and Sain [20] states that use of natural fibres in thermoplastics have great potential to act as sustainable 'sink' for atmospheric carbon dioxide and at the same time saving non-renewable resources. In addition, NFC production, in comparison with traditional glass fibre composites, can be created with potentially lower environmental impact as determined by Life Cycle Assessment [21]. Production methods developed by WfL can also use the raw materials without intensive cleaning as a preparation phase.

WfL works by coupling the knowledge and research from universities and experts and designing products together with partners on the ground [8]. WfL has developed different types of NFCs in different geo-political contexts. In Canada, bale wrap (High Density Polyethylene HDPE) was reinforced with flax and hemp, in Lesotho, corn, wheat and agave plant fibres were combined with plastic bags (Low Density Polyethylene LDPE), and in Buenos Aires NFCs were created using paper, card or textile, and plastic film [8]. These fibres were sourced from dedicated crops (agave, hemp, or flax), agricultural byproducts (corn stover or wheat straw), or post-consumer sources (cardboard, office paper, and newspaper) [8]. The next section discusses the simple hot pressed method used by WfL to manufacture NFCs.

4. PROJECT APPROACH

As discussed earlier, WfL takes a different direction for its research, which furthers the aims of social justice. It is a movement towards local empowerment. WfL has chosen to work with marginalised sectors in the society rather than with political parties, governments, and corporations. WfL continuously question its approach and why and what impact their actions might have on marginalised people with whom they are working. This novel project based on waste materials aims to integrate informal sectors into the formal waste management system. The intention is to reduce poverty by generating more stable income sources for marginalised groups who work with waste as well as providing a sustainable mechanism of waste management.

Manzo [22, pg 288] states "Community development projects should be driven by the present needs and problems of the community targeted, not by an abstract or universal conception of basic human need." This statement reflects the importance of addressing the needs of the intended beneficiaries of a project. Many organizations who work in developing countries have their own standards and criteria to measure the impact of the projects they implement. These organizations often forget that the results of the project must be considered "improvement" or "development" not by them but primarily by the targeted community. According to Manzo (2000), this means that development projects should primarily address the "basic needs felt by local populations" [22, pg 297]. WfL follows this model, working

towards local empowerment and trying to make marginalised groups autonomous and self-sufficient.

4.1. Background Research

Before implementing a project on the ground, much background research needs to be carried out. WFL conducts needs assessments, feasibility studies, stakeholder analysis and Social Impact Assessments (SIA) before any development work is implemented. This helps to work in a participatory way with local residents, the ultimate project beneficiaries. These initial studies give insight into the realities of the local environment and what may expected from a successful project. The preliminary studies investigate the present resources that could be used for making NFCs and analyses the results of interviews with the likely stakeholders in such a project, including householders, members of cooperatives and CBOs, NGOs, local authorities etc [23]. Hence, it is important to briefly discuss the above methods as they make the backbone of WfL projects.

4.1.1. Scoping and Needs Assessment

A needs assessment is important prior to the actual project being implemented on the ground. It will provide details on the initial planning of the project with the help of the project beneficiaries and will investigate the present resources that could be used for the project. The initial scoping and the needs assessment for WfL projects are carried out through interviews with the prospective stakeholders of the projects, including waste pickers, members of community based organizations/ co-operatives, householders, Government officials, NGO representatives and other interested parties.

The first step is to carry out a survey in the local community and with people who work with waste to determine if there is any viability in a WFL collaboration to create natural fibre composites from waste. The needs analysis will help to understand the perceptions and views of relevant organizations, communities, cooperative members and individuals concerning the project and the availability of natural and the other fibre sources, availability of waste plastics and potential products that can be made from NFCs [23].

4.1.2. Feasibility Study

A feasibility study is carried out to explore the socio-economic, environmental, and technical feasibility of the project. This provides an understanding of whether the project will be practicable to carry out in the current socio-economic situation of the local context. The project should be able to utilize the local materials and knowledge to be technically feasible and should not hinder any environmental aspects in which it operates.

A feasibility study is carried out in line with the Needs assessment through a detailed analysis of the current socio-economic and environmental status of the country. Interviews with experts, community based questionnaire surveys, country reports etc is utilised to gather data for a feasibility study. Moreover, small scale recycling companies and cooperatives that work with waste should be visited and their processes should be observed. Technical capability of the local workshops to manufacture the machinery and the availability of the required parts for the machines is also an important aspect to assess. Most importantly,

funding sources should be approached and the feasibility of funding a waste based composite project should be evaluated.

4.1.3. Stakeholder Analysis

According to the Overseas Development Administration of US, Stakeholder analysis is the *"identification of a project's key stakeholders, an assessment of their interests, and the ways in which these interests affect project riskiness and viability"* [24, pg 1]. Stakeholder analysis contributes to project design by providing the rationale for the project and by helping to identify how stakeholders' will contribute to the project [24].

The stakeholder analysis is carried out through personal interviews with the stakeholders identified in the study. A summarised procedure taken from WfL projects and the "Guidance note on How to do stakeholder analysis of aid projects and programmes" [24] is given below.

1. Identification all potential stakeholders.
2. Identification their interests in relation to the problems being addressed by the project.
3. A rough assessment of the probable impact of the project on each of these interests (positive, negative, or unknown). Baillie et al (2010) suggest approaches for this.
4. An assessment of each stakeholder's importance to project success and the relative influence they have on the project.
5. Identification the priority the project should assign to each stakeholder in meeting his or her interests.
6. Identification risks and assumptions, which will affect project design and success.

4.1.4. Social Impact Assessment (SIA)

Burdge and Vanclay [25] define Social Impact Assessment as an earlier process of assessing or estimating the social consequences that are probable to occur from specific policy actions or project development. This includes all social and cultural impacts on human populations, which can alter the ways and means that they used to live in the society.

A summarised version of a SIA taken from the SIA carried out for the Buenos Aires Project by Michelle Kent [26, pg 25-26] and the principles and guidelines for Social Impact Assessment outlined by the Interorganizational Committee on Principles and Guidelines for Social Impact Assessment [27] is given below.

(Source : Interorganizational Committee on Principles and Guidelines for Social Impact Assessment and Development of a Social Impact Assessment methodology and its application to Waste for Life in Buenos Aires)

1. Development of a public involvement program
2. Identification of proposed action and alternatives
3. Community profiling
4. Identification of possible impacts
5. Investigation of probable impacts
6. Determining probable response of affected parties
7. Estimation of secondary & cumulative impacts
8. Impact Assessment
9. Recommend changes in proposed action or alternatives

10. Mitigation, remediation and enhancement plan
11. Development of a monitoring program

4.2. Technical Process

This section highlights some of the technical aspects of waste based composite projects facilitated by WfL. Firstly, materials and designs are co-created by the research team in collaboration with local communities. Secondly, Waste for Life members develop simple production methods that can be locally manufactured and maintained such as the hot press method, which can be built using local machinery. Thirdly, appropriate products are designed as candidates for production in the same context [8].

4.2.1. Materials Development

Different pathways of fibre/plastics composite production, examined by WfL are given in figure 1 [8]. The various processing stages can be classified into four stages: (i) selection of fibre material; (ii) fibre material preparation; (iii) primary fibre/plastics bonding and (iv) production of final products. The method used for fibre material preparation depends upon the raw material type and the processing facilities available for production. These processes produce different fibrous intermediaries such as fibre, flour, paste, flakes or modified sheets. Primary fibre/plastics bonding is achieved by pressing these materials into thin layers using a simple hot press which uses only heat and pressure. This process does not encourage addition of any chemical, which add to environmental, health and safety concerns and cost. The thin hot-pressed laminates are then shredded, or shredded, extruded and pelletized to enhance the properties. Finally, the composite material is subject to final press moulding to produce the desired end product [8].

4.2.2. Production Method – The Hot Press

The second challenge for WfL was to create a low cost hot press (compression mould), which could be manufactured locally. The hot presses designed by WfL for its Argentinean and Lesotho projects are based upon the first model developed by the organization, the "Kingston hot press. This was designed at Queen's University in Canada by Darko Matovich [8]. Key design parameters for the hot press were to allow moulds up to 60x60 cm size to be pressed (with minimal deflection of the pressing pads) while maintaining a pressure of up to 6 MPa and a temperature of up to 200°C [8]. The hot press cost less than $3000 and utilised standard 220 V circuits for heating, as opposed to industrial presses, which are typically between $50,000 and $100,000 and require industrial electrical circuitry [8].

The prototype shown in figure 2 was mainly made with the help of graduate students who were trained in basic machining (drilling, cutting) on the spot. The welding was done partly by a professional welder and partly by an apprentice who had undergone one hour of welding instruction [8]. The process of hot press prototype manufacturing provided real life experience indicating that similar work can be done by workers with various skill levels in machining, although the welding and electrical work should best be left to the (local) qualified staff. The press in Buenos Aires was produced by a local design engineer using these designs with changes to suit locally available materials. Four prototypes have been built

in different research labs around the world and a final production press has been in use by a cooperative in Buenos Aires for a year.

4.2.3. Product Development

Students and professionals in the WfL network work together in creating new product designs based on the needs assessment of the local context. Engineering students from many Universities around the world have joined this effort. Engineering students at Queens University were among the first to join the effort. During the 2009-2010 academic year the Rhode Island School of Design (RISD) joined the WFL effort through a number of on-campus initiatives. These included an industrial design studio that built the Kingston Press at RISD, a school-wide design competition sponsored by the student group "Respond Design" and the Office of Public Engagement, and an integration of the project into the "Industrial Design and Furniture" courses in the Spring 2010 semester [8]. Also, students of the University of Buenos Aires have designed products for the co-ops to make with the materials. Recently, in 2011, Faculty of Engineering in University of Western Australia introduced a design component for WfL project in Buenos Aires in its first year Engineering module "Introduction to professional engineering".

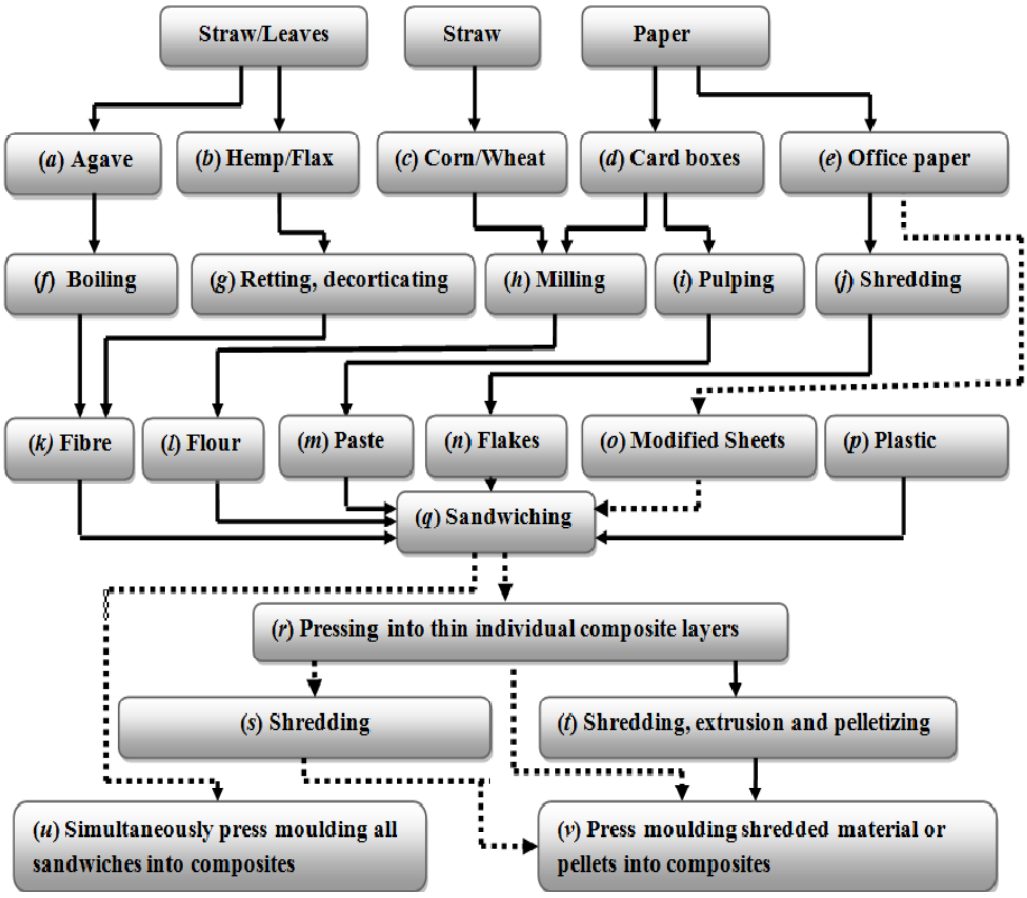

Figure 1. NFC production processes employed by WfL (Source: Baillie et al., 2011).

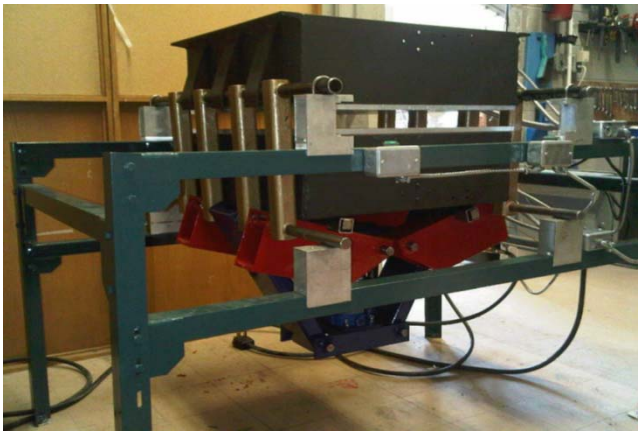

Figure 2. Kingston Hot press (Source: Baillie et al., 2011).

The WfL network of voluntary support is continuously growing with many students and professionals getting involved in the project through carrying out research, materials and product development and designing and improving the machinery required by the people on the ground.

Figure 3. Products designed by students for WfL (Source: Baillie et al., 2010).

5. IMPLEMENTATION ON THE GROUND

This section presents two specific implementation cases of Natural Fibre Composite (NFC) projects run by local cooperatives in Lesotho and in Argentina facilitated by Waste for Life. The background of each context and the challenges of initiating such a project are discussed. More details are published in Baillie et al, 2010 but a synopsis will be presented here.

5.1. Lesotho

The Kingdom of Lesotho is a landlocked country and enclave, surrounded by its only neighbouring country, the Republic of South Africa. Lesotho gained independence from the United Kingdom on the 4th October 1966 [28]. It is just over 30,000 km2 in size with a population of approximately 2,067,000 [29]. Lesotho's population is in decline, and has decreased from a high of 2.2 million in 2002 to 1.8 million in 2005. Estimates for this country explicitly take into account the effects of excess mortality due to AIDS; this can result in lower life expectancy, higher infant mortality and death rates, lower population and growth rates, and changes in the distribution of population by age and sex than would otherwise be expected [28]. The United Nations projects that the death rate will continue to exceed the birth rate for the next forty-five years.

Lesotho's economy is based on diamonds exported all over the world and water sold to South Africa, manufacturing, agriculture, livestock, and to some extent the earnings of labourers employed in South Africa. However, about 40% of the population live below the international poverty line of US$ 1.25 a day [30]. Agriculture is the key sector in Lesotho, which is mostly a subsistence economy. Major crops include corn, wheat, sorghum, beans and peas.

Lesotho's urban centres had no well-established waste programs and the lack of such programs resulted in much of the waste being dumped and burned in open spaces, especially in Maseru, Lesotho's main urban centre. Plastic wastes as well as crop residues comprised a large share of waste generated in Maseru. These were potential materials for the composites. WfL identified that providing alternative uses for agricultural residues may not only increase the farmers' income but may also boost agricultural production and multiply job opportunities. WfL received funding to go ahead with the initial studies and began the exploratory phase of WfL Lesotho in 2005.

WfL's first action was to survey local communities to determine if there was any viability in a WfL collaboration to create NFCs from waste in Lesotho. Maseru district was selected as the main focus for the project due to its suitability for producing both the waste plastic and fibre needed for the composites. Two visits were made to Lesotho, in 2005 and 2006. During the first visit, data was collected in two parts. The first part was obtained from published documents found in various institutions in Maseru city. The second part of the data was obtained from personal interviews with representatives of relevant institutions. All interviews were conducted in the local language, Sesotho by WfL's key researcher on the project, Thimothy Thamae.

To find out from the local villagers what they thought the composite materials produced from waste could be made into, they were shown a piece of previously produced Agave/plastic bag composite and asked to consider possible applications. Most of them stated floor or roof tiles.

Nearly two thirds of the houses used corrugated iron as roofs in Lesotho. Lesotho's hot summer months and exceptionally cold winters make the use of insulating ceiling panels below poorly insulating iron roofs a requirement. However, only a few people can afford to purchase these insulating ceiling panels. The studies indicated that cheap ceiling panels were among the most desirable products to be made from natural fibre composites in the country.

It was clear from the initial studies that WFL technology was welcome by many different groups in Maseru. Plastics companies and local government agencies were interested in the project, but the most interesting group to WfL was the Cooperative College – a Govt. supported entity to train local people to work in cooperatives. It was deemed better to focus on cooperatives, which would benefit a broader spectrum of people. The college provides training and technical equipment for many groups including Maseru Aloe, an umbrella cooperative whose members come to the college to process Agave gel from local Agave plants.

During interviews and workshops, all representatives and workers of the cooperatives agreed that the plant fibre waste plastic composites would be an excellent additional product to create within their groups. They had access to waste plastic, straw and Agave fibre, and they were able to learn the manufacturing techniques and house the necessary equipment at the cooperatives training centre.

One of the major barriers to implement a composite manufacturing facility in Lesotho was deemed to be the high cost of equipment. Low cost manufacturing was a priority if composite projects were to succeed. Seeking low-cost alternatives, the Department of Mechanical Engineering at Queen's University worked collaboratively with the University of Napoli, Italy, Lerotholi Polytechnic in Lesotho, Department of Cooperatives, and Maseru Aloe Cooperatives in Lesotho, to design the compression moulder or 'hot press' prototype. The hot press is designed to be manufactured from inexpensive materials that can be purchased locally or in neighbouring South Africa. Like any other hot press, the materials to be made are placed in a mould between two heated plates and compressed to desired shapes. Lerothli Polytechnic expressed an interest in developing a business side to their educational profile and manufacture the hot presses on demand.

Results of the interviews revealed that the local people would prefer ceiling panels as a product as these would moderate otherwise extreme winter and summer temperatures aggravated by iron roofs. Providing cheap panels, easy to mount to the existing houses could be a relief for the householders. With farmers willing to sell their straw for composites and cooperatives willing to take up the challenge of making composites, an NFC project in Lesotho was successfully implemented.

Funding for the project was awarded from the United Nations Development Program Global Environment Facility to support Maseru Aloe in the development of the business. Thimothy Thamae returned to Lesotho and started to work at the University of Lesotho and supported the work from there together with an international team of volunteers. Students and academics who are working with WfL will continue to feed into the ongoing development of this project in Lesotho.

5.2. Argentina

Argentina is the eighth largest country in the world, with a population of 41,769,726, as of July 2011, spanning an area of 2,780,400 square kilometres [28]. At the end of 2001, Buenos Aires in Argentina experienced an economic crisis, which led to a large growth in unemployment rates. Before the economic crisis, Argentina's export industry thrived with some of the major exports including agricultural products such as beef, maize and wheat, and mining including lead, tin, zinc, copper, iron ore, manganese, petroleum, and uranium [28]. However, the export sector too was hit by the 2001 economic crisis, which led to massive overnight unemployment.

Amidst a lack of any regulated recycling system, thousands turned to the informal occupation of recovering recyclable materials from waste to be sold for an income. This "waste picking" work is a common survival strategy of people in regions of poverty [17]. These people are known in Buenos Aires as cartoneros and work in a variety of situations, from individuals, to families and larger groups known as cooperatives. Over 80% of the world's population live off less than $10 USD a day, making poverty a very serious global issue. The cartoneros and cooperatives in Buenos Aires are a part of this percentage, with the income earned by members of the cooperatives approximately $5.3 USD a day. Hence, these cooperatives have been identified as the key stakeholder for the WfL project.

Waste for Life Buenos Aires project took a different path than WFL Lesotho. However, the needs assessment activities of Lesotho work framed WFL's approach in BsAs. WfL had no direct contacts in Argentina. Two WFL team members visited Buenos Aires (BsAs) for six months in 2007 and again in 2008. They observed that in Buenos Aires the cartoneros collect waste paper and plastic, which can be used to make natural fibre composite material products, far more valuable to them than the waste alone. For the most part, these unpaid informal workers live in outlying shantytowns but come into the city with their carts at all times of the day to collect waste that can be recycled or sold. Most of the recycling waste that is collected is sold directly to middlemen, though the more organised cooperatives separate, sort, and sell the materials directly to industry.

The team spent six months with the cooperatives and other stakeholders contacting them through meetings, workshops, and video and audio interviews. In addition to the above, the team toured around the facilities at the CEAMSE landfill site, the social factories, the private sorting units, and the new Chinese run sorting and recycling centre. After the initial needs assessments and stakeholder analysis, WfL had identified potentially interested cartonero cooperatives, university and other research partners, and a microcredit organisation interested in developing a 'hot press loan' scheme. Student involvement in the project was identified as materials and machine development, and product development and marketing. A local industrial designer built the first experimental hot press in Buenos Aires, which was housed at the University of Buenos Aires.

Much work was done to consider the sustainability of the WFL project, after withdrawal of the team. WFL explored micro loans as an option and worked with a locally based organisation 'The Working World' to create a loan fund for hotpresses, which would be funded in turn by donations to WFL. The Working World has great experience in supporting cooperatives and help them manage projects so that ultimately they can pay back the interest free loan. They will forgive loans and maintain the equipment if necessary but this does not usually occur. WfL worked with the Working World to consider the first cooperative that

they might work with, and that was most likely to benefit from the project, as well as to succeed.

The press in this case was manufactured locally by a 'recovered' factory – a socially just enterprise in and of itself. These recovered enterprises emerged after the economic crisis as a means for local workers to support themselves and continue working. They formed cooperatives and took over the factories they worked in and which had been abandoned by the owners at the time of the economic crash. In many cases the groups gained the legal right to work in the factory and to appropriate the means of production, even though they were not the legal owners. One of these factories, which produces automotive parts, '19th December', agreed to manufacture the hotpresses on demand at a reasonable price, thereby creating a local source of the equipment and an income stream for themselves.

Selecting an appropriate product and marketing the products was another serious concern for WfL. With no sales experience, the cooperatives would not be able to simply walk into this new domain. WfL spent two years, with locally based volunteers exploring various possibilities, following design ideas created by the international student support team. Ultimately, a local designer helping WFL created the idea for a trash can which was commissioned by the local authorities as a source of bins for a local ecopark (this may be viewed on www.wasteforlife.org). This was followed by a commission for book covers. The selected cooperative is now in production and is beginning to pay back the loan.

CONCLUSION

"We must listen, we must observe and we must learn to see what our technical knowledge can bring to the community, in ways that will support positive, life-giving structures as well as independence from unsympathetic political systems." [23, pg 109]

This chapter summarises the story of Waste for Life, its socially and environmentally just approach and its emergence in two very different contexts. NFC production in a developing context presents many challenges and opportunities and much further work needs to be done. However, it offers great potential to improve the current waste management practices, whilst creating an income stream for marginalised communities.

Most wastes can be considered as "resources out of place". If managed properly it can provide material or energy in useful forms. A better system would incorporate reduction of waste to be disposed at the source, recovery of energy or material and safe disposal of what is left causing minimum risk to the environment and to the society. Waste management is not a mere technical challenge. The environmental impact, socio-cultural, economic, institutional, policy, legal and political aspects are fundamental in planning, designing and maintaining a sustainable waste management system in any context. Hence, it is crucial to integrate the perspectives of stakeholders, waste system elements and sustainability aspects in designing proper waste management systems [31]. We might not be able to predict all possible effects that can arise by implementation of a project. But if all projects undergo in-depth background research such as needs assessments, Social Impact Assessments and stakeholder analysis before implementation, lot of problems will be avoided.

We hope that this chapter will provide the guidance and a framework for planning socially just waste management projects, for engaging with communities and mostly, an understanding of the social and environmental justice perspectives of waste management.

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