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# Water resources management, climate change, food security and sustainable development

## ANALYSIS OF WASTE MINIMISATION STRATEGIES IN THE INFORMAL SECTOR OF GWERU, ZIMBABWE

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**Abstract**

The aim of this study was to analyse the solid waste minimisation strategies in the informal sector enterprises of Gweru, the third largest city in Zimbabwe. The study population for questionnaire surveys comprised all the 589 organised informal sector enterprises in the market areas and high density suburbs of the city. The questionnaire administered to the home industry operators aimed at collecting information on waste reduction and recycling practices. Interviews were also undertaken with key stakeholders concerned with waste management in Gweru. Results indicated that waste minimisation practices employed in the informal sector enterprises of Gweru involved re-use, recycling and sales as forms of waste management. The amount of solid waste disposed per enterprise far outweighs the amount of waste recycled and recycling is only undertaken by those enterprises that are willing to do so. Significantly more enterprises perceived recycling to be the friendliest method of managing the solid waste (almost 50% of the enterprises) and waste minimisation as the second friendliest method. Re-use of materials was the commonly employed strategy to source-reduce waste. Other methods involved in source reduction of waste considered attitudes of the operators in their decision to buy certain raw materials. These considerations included the durability of the raw materials, whether the products package could be re-used and possibility of re-using the products. The common reasons for the enterprises willing to recycle waste were perceived to be saving resources especially in Monomotapa and Shamrock Park and this was indicated by 81% and 76% of the operators in these areas respectively. These percentages are high showing that when given the opportunity and knowledge of recycling, most enterprises would do so keenly. At Kudzanai and in Mkoba the major reason that would drive the operators to prefer to recycle solid waste was the desire to avoid waste followed by the need to save resources. In conclusion, findings showed that people have a positive attitude

and think it is important to recycle waste as a way of preserving the environment. In order to encourage citizens to participate, they need to be convinced of the importance of the service they are providing. A waste management plan is also essential for any settlement because waste needs to be managed at all stages from its generation to disposal.

**Key words:** Waste minimisation, re-use, recycling, informal sector, Gweru, Zimbabwe.

## Introduction

The informal sector is recognised as part of a waste management system in an urban environment in terms of waste recycling. Studies in Zimbabwe have made preliminary assessments on the impact of domestic and formal waste on the environment (Tevera, 1991; Jerie, 1993; Jerie, 2005; Jerie, 2006; DNR, 1994 and MLGRUD, 1995), but no comprehensive study has been made to determine the effectiveness of waste minimisation strategies in reducing environmental pollution in the informal sector. Studies have not clearly articulated the issue of waste minimisation and recycling in the informal sector of Gweru as deserving investigation because some say it is difficult to study and probably the government does not directly generate any revenue from this sector. This is actually contradictory to the role the sector plays in reducing the amount of waste which in turn reduces the lifespan of the disposal sites (Tevera, 1993; Jerie, 2005).

There are three main components in an integrated municipal solid waste management system and these include waste minimisation, recycling (including composting) and combustion. When reviewing these components, five main activities can be analysed under the integrated solid waste management system and these include waste prevention, recycling, composting, combustion and landfilling. Source reduction is the most preferred management strategy in the hierarchy because it eradicates the necessity of handling, transportation and disposal of waste (Guerro et al., 2013; Lavagnolo et al., 2012; Ngo et al., 2011; Yan et al., 2010). Change in design, production, packaging, purchase and use of products or materials to reduce the toxicity and amount of waste generated at the source is referred to as source reduction (USEPA, 2008). Source reduction is regarded as the most environmentally sound method for minimising solid waste generation and therefore any method that assists in reducing waste, toxicity and focusing on re-use at the source is regarded as source reduction. Source reduction serves in conserving natural resources by producing and designing efficient products and minimises the quantity of waste as equal to the waste recycled or incinerated or landfilled (Mvuma, 2010; Tilaye et al., 2014; USEPA, 2008). Re-use involves materials or products which can be used more than once for the same or different activities without any upgrading and is an option for source reduction. Compared to recycling, re-use is preferred most since it does not undergo any upgrading and therefore no material and energy is used up and at the same time reduces the cost and need disposal. However, the demerits of re-use include cleaning the materials, transportation and time consumption for sorting the waste. Recycling is an activity of re-using materials that are of potential waste, but are rather turned into valuable resources and they may retain their original form or are turned into different products. The most important advantage of recycling is that it reduces the production of greenhouse gases

since there is diversion of waste from the landfills and also reduces the use of new resources in a way contributing to sustainable development.

## Literature review

Waste minimisation is a very crucial component of waste management. According to Ayres and Ayres (1996) 94%of the materials extracted for use in manufacturing become waste before the product is even made and 80 % of the products are discarded after a single use.

While it may be true that the principle of waste prevention is universally accepted, the practice has lagged behind (Pongracz, 2002). The OECD has even concluded that even when conventional environmental and waste policy approaches have succeeded in attaining their own specific objectives, they have not been sufficient toward overall waste management. Waste recycling has been increasing in the OECD, but without waste prevention efforts, a near doubling of municipal waste within the OECD area is expected within the next 20 years.

Re-use is considered the second preferred option after waste minimisation. Pongracz (2002) notes that re-use for the same **purpose** is part of the waste minimisation options, but re-use for another **purpose** is part of the waste management options. Re-use for the same **purpose** is use, for the second or other time, of an artefact for the same **purpose**, under the same form and with the same properties of the material as the first use, the material having constantly remained under the same form between several uses. Re-use for another **purpose** is use of an artefact for a different **purpose** as the original one, under the same form and with the same properties of the material as the first one, the material having constantly remained the same form between several uses. These propositions are in the main part and parcel of waste prevention options.

Recycling or material recovery has a very high priority amongst recovery options (Kadiri, 2010; Pongracz, 2002; Tchobanoglous et al., 1993). Recycling refers to the reprocessing in a production process of the waste materials for the original **purpose**, or for other purposes, including organic recyling, but excluding energy recovery. There are thus three forms of recycling. The first is closed-loop recycling which is a process in which waste material is used for the same **purpose** as the original one or for another **purpose** requiring at least as severe properties as the previous application so that after one or several uses this material can be used back again for the same **purpose**. Open-loop recycling is a recycling process in which material is used for another **purpose** than the original **purpose** and will never be used back again for the original **purpose**. Down-recycling is a process in which a fraction of a material from a used product is used to make a product that does not require as severe properties as the previous one. Pongracz (2002) observes that these definitions presuppose that the object regarded has had some useful life and turned into waste. By-products are not covered by these definitions since these have not had some previous use. Re-cycling and re-use therefore refer to things that have had a purpose and for some reason, ceased to be used for that purpose and to avoid being turned to waste it was re-used or re-cycled. Recycling as a method of waste recovery has been promoted since the 1960s. The role of

recycling has been not only a response to the environmental crisis, but has assumed the symbolic role in instigating a change to the nature of western societies and the culture of consumerism (Guerro et al., 2013; Pongracz, 2002; Tchobanoglous et al., 1993).There has been an assumption by environmentalists that there would be a shift from the 'throw away' society to a post-industrial recycling society.

The waste management hierarchy is a basic tool which is employed to make solid waste management as environmentally friendly as possible. It revolves round the 3R approach which is basically a precautionary principle that prioritises the prevention and reduction of waste, then its reuse and recycling, and last the optimisation of its final disposal. The 3R approach aims to establish a sound material cycle society on a global scale. It reflects the spirit of mottainai, a Japanese term referring to a sense of regret for something becoming waste without reaching its full utility (Ngo and Long, 2011). In order to achieve its aim, the 3 R approach envisages a much freer international trade in recyclable wastes and reduction of tariff and non-tariff barriers that currently inhibit the trade (Ngo and Long, 2011). International conventions have adopted important aspects of the hierarchy in dealing with the problems associated with the management of hazardous wastes. When the solid waste management hierarchy is adopted, air and water pollution problems can be minimized Tchobanoglous et al., (1993).

Integrated waste management is based on the idea that all aspects of the waste management system should be analysed together, since they are in fact interrelated and developments in one area frequently affect practices or activities in another (UNEP, 2010). The significance of an integrated approach is highlighted by the fact that certain problems can be more easily resolved in combination with other aspects of the waste management system rather than on their own. There is more economic use of resources as there are economies of scale for equipment or management infrastructure. The integrated approach allows for public participation and informal sectors in roles appropriate for each. Some waste management practices are more costly than others and integrated approaches facilitate identification and selection of low cost solutions (Tchobanoglous et al., 1993).

In implementing an integrated approach, contracting out may be undertaken with regard to collection of solid waste in some areas of the city (UNEP, 1996). The other areas would be under the jurisdiction of the local council or informal actors. The solid waste management operations would be cost effective allowing the private company the role of collecting and disposing of hazardous waste, while the municipality collects domestic waste and only part of the industrial waste (Afroz, et al., 2010; Brunner and Feller, 2007; Kadiri, 2010; Siddiqui, et al., 2006 ). According to studies in Bangkok, Thailand there is shared responsibility between the public sector and private sector in waste management (World Resources, 1996). The municipality maintains some form of public solid waste collection and the private sector collects in some areas and community programs take care of the remaining zones. The failure to implement an integrated system in waste management may mean that the revenue producing activities are "skimmed off" and are treated as profitable while activities in institutions and other sectors related to public health and safety fail to secure adequate funding and hence are operated at low or insufficient levels.

Another approach to waste management is decentralisation whereby waste management responsibilities are decentralised from the local councils to a number of groups which include non-governmental organizations (Rosario, 1994). This approach enables certain institutional sectors such as schools and hospitals to be given priority in waste management services. In Zimbabwe, a non-governmental organisation, Environment Africa, has spearheaded the decentralisation approach. Environment Africa has done this through the establishment of the Recycling and Anti - Litter Program (RAP). Schools act as centres where recyclable waste is recovered. This is an attempt to cultivate a recycling culture among school children. Under privatisation, private companies may be contracted by local councils to perform specified services in terms of waste management such as collection (Kwawe, 1995; UNEP 2010). In the developed world, the private company providing the services recovers the costs directly from the community being served. This is an approach, which has worked with success in Europe and North America. However, there is need to meet the required environmental standards in waste disposal or in the provision of standards of a high quality.

## Methodology

The study population for questionnaire surveys comprised all the 589 organised informal sector enterprises in Monomotapa high density suburb, Shamrock Park medium density suburb, Mkoba high density Suburb, Ascot high Density Suburb, Kudzanai market and Kombayi market. The location of these enterprises in Gweru is shown in Figure 1. Focus was on these areas because of the large concentrations of informal enterprises characterised by a diverse range of enterprises that include retail, service, repair, manufacturing and construction activities. In Monomotapa 47 out of 51 enterprises agreed to participate in the survey. At Shamrock Park there was a combination of informal sector enterprises and small-scale and medium scale enterprises. All the 57 informal sector enterprises were selected to participate in the survey and these were those with less than 10 employees and the small scale and medium scale enterprises were left out since they did not meet the criteria for defining informal sector enterprises.

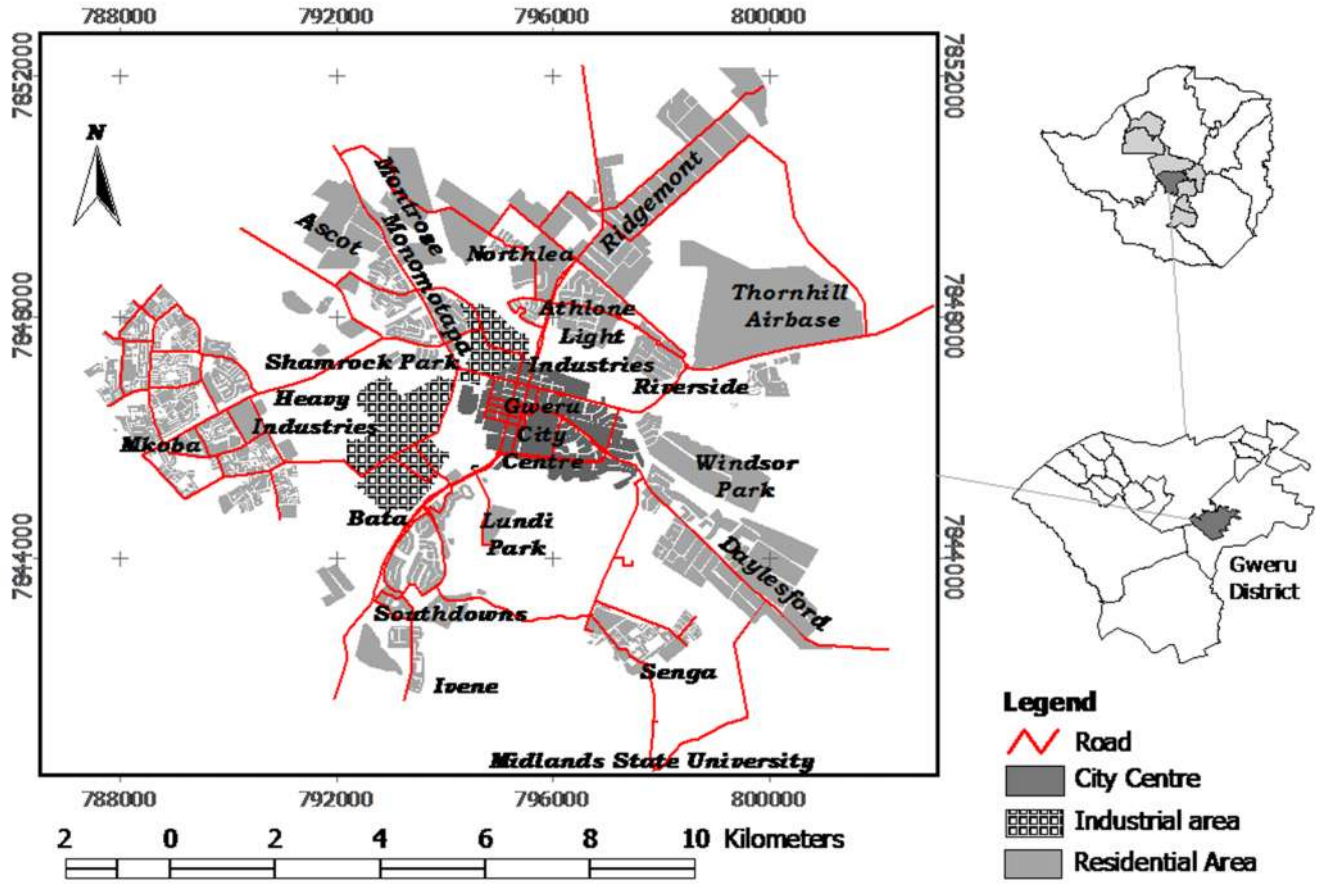


**Figure 1: Location of informal sector enterprises in the city of Gweru**

All the 182 enterprises at Kudzanai who were allocated with stalls from which they operated were involved in this study and participated with keen interest and the majority are retailers of food and clothing. The other market area near the city centre is at Kombayi and all the 29 informal enterprises who were allocated stalls participated in the study and as at Kudzanai these are mainly food and clothing retailers. In Mkoba and Ascot High density suburbs the majority of enterprise operators participated in the survey and the very few who declined to participate were either suspicious or simply uncooperative. Out of a total of 229 enterprises in Mkoba, 224 participated from the sections of Mkoba 6, Mkoba 14 and Mkoba 16 and in Ascot a total of 50 out of 53 enterprises participated in the study. All in all 589 enterprises participated in the questionnaire survey. Questionnaire surveys were used to realise the immediate objectives of the research as well as to gather data on the informal sector of Gweru. To gather data on critical areas of solid waste minimisation in the informal sector, the design as recommended by Oppenheim (1992), De Vaus (2007) and Baker (2003) was used so as to reduce ambiguity or bias. The questionnaire was developed to cover aspects of the objectives to investigate issues concerning informal sector enterprise waste generation and disposal practices and waste minimisation strategies. The instrument was divided into appropriate sections to allow for the systematic collection of data from the enterprises in the different spatial locations of Monomotapa, Shamrock Park, Mkoba, Kudzanai, Kombayi Market and Ascot. The survey questionnaire

was semi-structured, containing both open-ended and closed-ended questions. Interviews were for the purpose of gathering information on waste minimisation practices. The interviews targeted policy makers and planners in the organisations dealing with waste management.

## Results and discussion

### Analysis of waste minimisation and recycling behaviour

The extent to which solid wastes can be reduced, recovered and recycled needs to be an integral part of any solid waste management system. The first step needs to be the reduction of waste at the point of generation. Included here are returnable bottle deposits and containers such as glass, metal and plastic and not food jars, plastic and paper cups**,** liquor bottles etc. In the informal enterprises significantly more enterprises ($P<0.05$) [Pearson's Chi-Square value of 0.000 and likelihood Ratio of 0.000] reported recycling as the most friendly method of managing solid waste with waste minimisation (waste prevention/source reduction) (waste prevention/source reduction) as the second most preferred option (Table 1).

**Table 1: Environmentally friendly methods of managing waste in the enterprises**

| | Environmentally friendly way to manage waste | | | | | |
|---|---|---|---|---|---|---|
| | | Waste minimisation | Recycling | Energy generation | Landfilling | Total |
| Retail | 0 | 99 | 125 | 15 | 40 | 279 |
| Service | 2 | 31 | 11 | 2 | 8 | 54 |
| Repair | 0 | 17 | 57 | 2 | 8 | 84 |
| Manufacturing | 1 | 29 | 62 | 5 | 16 | 113 |
| Construction | 0 | 15 | 41 | 0 | 3 | 59 |
| Total | 3 | 191 | 296 | 24 | 75 | 589 |

In the informal sector enterprises, 191(32%) respondents indicated they would source-reduce waste and 296(50%) would prefer to recycle waste and hence a total of 487(82%) respondents were considered the potential 'reducers-recyclers' in the informal sector of

Gweru. Waste minimisation is the most dominantly preferred in the service sector (57%) and it is the second most dominant way of managing waste in the retail enterprises (35%), the repair (20%), the manufacturing (26%) and the construction (25%) enterprises. On the other hand recycling dominates as a preferred method of waste management in construction (70%), repair (68%) manufacturing and retail enterprises (45%).

The most common methods for the source reduction of solid waste unknowingly employed by the informal operators were the re-use of waste materials (as well as the repair and re-use of things that had been damaged (Table 2). The other methods involved in source reduction take into account the attitudes of the enterprise operators in their decision whether to buy particular raw materials. The most important aspects considered include the durability of the raw materials, whether the products' package can be re-used, possibilities for re-using the products, amount of packaging included with the raw materials, and whether the raw materials are from renewable resources. With the exception of the third, fourth and fifth methods discussed above, percentages of enterprise operators for all other methods differed significantly among the enterprises. As an example, among all the methods, re-using waste materials was greatest with the same importance in Monomotapa, Shamrock Park and Mkoba and least in Ascot.

**Table 2: Enterprises' actual methods (as percentages) to source reduce waste**

| **Method** | **Monomotapa** | **Shamrock Park** | **Kudzanai / Kombayi** | **Mkoba** | **Ascot** |
|---|---|---|---|---|---|
| Re-use waste materials | 59 | 31 | 33 | 39 | 17 |
| When buying, consider packaging | 5 | 12 | 4 | 3 | 3 |
| When buying, consider durability of product | 46 | 49 | 27 | 36 | 13 |
| When buying, consider possibilities for re-use | 33 | 47 | 14 | 29 | 13 |

| | | | | | |
|---|---|---|---|---|---|
| of product | | | | | |
| When buying, consider whether product is made from renewable resources | 15 | 17 | 9 | 6 | 12 |
| When buying, consider whether its package can be re-used | 12 | 21 | 11 | 7 | 14 |
| Repair things that have been damaged and re-use them | 47 | 52 | 8 | 26 | 33 |

Table 3 shows reasons why enterprises choose to collect and recycle waste in the informal sector of Gweru and the reasons for recycling differed significantly among the spatial areas and types of enterprises. The most common reasons for enterprises recycling waste were perceived to be saving resources in Monomotapa and Shamrock Park (by 81% and 76% of the operators respectively) followed by the desire to reduce costs of waste collection and disposal since Council would charge for any waste more than could be held by the standard bins or skips provided. In Monomotapa and Mkoba on the other hand the major reason that was perceived important for recycling was the desire to avoid waste and saving resources was the second reason for choosing recycling as a method of managing waste. However, improving the appearance of the areas was the least important reason for choosing to recycle in four of the five spatial areas indicating that recycling was mainly viewed in terms of converting waste into valuable materials rather than in terms of environmental aesthetics.

**Table 3: Reasons why enterprises choose to collect and recycle waste materials (%)**

| Possible reason | Monomotapa | Shamrock Park | Kudzanai | Mkoba | Ascot |
|---|---|---|---|---|---|
| Protect the environment | 34 | 35 | 21 | 24 | 26 |
| Protect human health | 44 | 47 | 36 | 39 | 41 |
| Avoid waste | 66 | 69 | 51 | 42 | 53 |
| Improve appearance of area | 7 | 11 | 13 | 21 | 32 |
| Save resources | 81 | 76 | 42 | 40 | 39 |
| Reduce amount of waste to be burned or placed in dumpsites | 58 | 66 | 17 | 24 | 29 |
| Reduce costs of waste collection and disposal | 71 | 72 | 34 | 26 | 24 |
| Receive payment for materials being recycled | 56 | 49 | 33 | 32 | 34 |

Most of the enterprise operators revealed lack of adequate room within their premises to store materials and the lack of time and zeal to sort, save and transport materials as the reasons why they would not recycle waste (Table 4). At Kudzanai, in Mkoba and Ascot some of the important reasons indicated for not recycling included not having buyers for the waste and the absence of recycling programmes. These responses would really be expected from such enterprises where the bulk of solid waste generated is vegetable and food waste that could not be easily recycled nor composted due to the lack of a composting culture in the enterprises.

**Table 4: Reasons for enterprises not collecting and recycling waste materials (as percentages)**

| **Possible reason** | Monomotapa | Shamrock Park | Kudzanai | Mkoba | Ascot |
|---|---|---|---|---|---|
| Do not know about recycling | 11 | 8 | 31 | 22 | 21 |
| No recycling programs here | 36 | 29 | 51 | 60 | 55 |
| Not interested in recycling | 12 | 11 | 56 | 44 | 39 |
| No enough time to sort, save and transport materials | 63 | 56 | 61 | 59 | 56 |
| No enough room in enterprise to store materials | 71 | 67 | 83 | 74 | 68 |
| No buyer or place to sell recycled materials | | | | | |
| Recycling is not mandatory | 13 | 11 | 56 | 43 | 41 |
| | 17 | 9 | 47 | 44 | 37 |

Enterprise operators in repairs such as mechanics suggested elimination of old car bodies as a major method of improving aesthetic value of the landscape. The other common waste reduction methods included removal of litter, debris and illegal dumps as well as public education to reduce waste.

**Motivation to recycle: Factor analysis and multiple regression of recycling behaviour**

The informal enterprise operators regarded recycling as the best way to manage solid waste hence it was important to undertake further statistical analysis of the factors motivating this recycling behaviour. A factor analysis was performed to group the variables (attitude, subjective norm and perceived control) into constructs or factors which represent separate and independent underlying dimensions of recycling behaviour. The variables within each independent factor were then summed to form a measure of that factor, and reliability analysis used to test the reliability of each measure. The factor analysis grouped the variables contained within the questionnaire into eight independent factors, these factors and their corresponding reliability coefficients are shown in Table 5. A reliability coefficient of greater than 0.7 indicates the measure has achieved acceptable reliability. The factor analysis grouped the variables as expected, with the exception of variables relating to the moral norm and the consequences of recycling. The factor analysis indicated that two variables which had originally been included within the moral norm measure, 'I am concerned with maintaining a good place to live' and ' I have a strong interest in the health and well-being of the community I work in' represented a different recycling behaviour, accordingly theses two variables were grouped together and named Concern for the Community.

**Table 5: Factor Analysis and factor reliability in recycling behaviour**

| **Factor** | **Variables** | **Reliability co-efficient** |
|---|---|---|
| Attitude | Recycling is good/ bad; recycling is useful/ a waste of time Recycling is rewarding/ unrewarding; recycling is sensible/not sensible | 0.86 |
| Subjective norm | Most people think I should recycle; most people approve me recycling | 0.91 |
| Perceived control | I have plenty of opportunities to recycle<br>Recycling is inconvenient<br>Recycling is easy/difficult<br>The local council provides satisfactory resources | 0.72 |

| | | |
|---|---|---|
| | for recycling<br>I know what items can be recycled<br>I know where to take my waste for recycling<br>I know how to recycle my enterprise waste | |
| Moral norm | I feel I should not waste anything if it could be used again It would be wrong of me not to recycle my waste<br>I would feel guilty if I did not recycle my waste<br>Not recycling goes against my principles<br>Everybody should share the responsibility to recycle waste | 0.74 |
| Situational factors | Recycling takes up too much time<br>Recycling takes up too much room<br>Recycling is too complicated<br>Recycling programmes are a waste of money | 0.9 |
| Outcomes | Recycling helps to protect the environment<br>Recycling reduces the amount of waste that goes into the landfill<br>Recycling preserves natural resources<br>Recycling helps to protect the environment<br>Recycling reduces the amount of waste that goes into the landfill<br>Recycling preserves natural resources | 0.73 |
| Consequences | Recycling saves energy<br>Recycling saves money<br>Recycling creates a better environment for future generations | 0.75 |

| | | |
|---|---|---|
| Concern for the community | I am concerned with maintain a good place to live<br><br>I have a strong interest in the health and well-being of the community in which I live | 0.78 |

Multiple regression with recycling intentions as the dependent variable was used to determine which of the eight factors identified in the factor analysis exerted the greatest influence on recycling. The components of the TPB (attitude, subjective norm and perceived control) were first entered. These three components collectively explained 29.4% of the variance in recycling intentions, with attitude being the only statistically significant predictor ($P < 0.05$). When the additional components to the model were entered into the multiple regression, the percentage of variance explained increased to 41.5%, with attitude, past recycling behaviour, consequences of recycling and concern for the community being statistically significant. In the enterprises all individual components were significantly correlated with recycling attitudes, with perceived control and situational factors being the most strongly correlated measures. This is confirmed by examining the frequencies of the variables contained within these measures. Over 66% of the respondents indicated that they knew what to recycle, how to recycle and where to take their waste for recycling. In addition, 78% of the respondents agreed that recycling takes up too much time and room, and is too complicated and a waste of time. The strong and significant correlations between attitude, perceived control and the situational factors suggest that access to the factors which make recycling easier may have influenced their positive recycling attitudes.

Stepwise multiple regression was used to determine which individual variables exerted the greatest influence on recycling intentions. The results are shown in Table 6, together with the six individual variables which correlated the most strongly with recycling intentions. Together, the individual variables explained 67.3% of the variance intentions. It can be noted that variables from the attitude measure were the most significant predictors in the multiple regression and exhibited the strongest correlations with intentions, opportunities for recycling, knowledge of hoe to recycle, concern for maintaining a good place to live and concern about waste were also important.

**Table 6: Correlation between intentions, attitudes and the individual components of the model**

| Stepwise multiple regression of the individual variables on recycling intentions | Correlation with intentions |
|---|---|
| Significant variables: | |
| Recycling is responsible (attitude) | Recycling is responsible(attitude) significant at P<0.05 |
| Recycling is useful (attitude) | Recycling is sensible (attitude) Significant at P< 0.05 |
| Recycling is good (attitude) | Recycling is good (attitude) Significant at P< 0.05 |
| I feel I should not waste anything if it can be used again (moral norm) | I have plenty of opportunities to recycle (perceived control) Significant at < 0.05 |
| I know how to recycle (perceived control) | Recycling is rewarding (attitude) Significant at P< 0.05 |
| | I am concerned with maintaining a good place to work in (concern for the community) Significant at P< 0.05 |
| I am concerned with maintaining a good place to work in (concern for the community) | |

Attitudes to recycling dominated as the predictors of recycling intentions. Enterprises would not engage in recycling schemes unless they view these schemes and outcomes resulting from them, positively. Perceived control and the situational factors were strongly correlated with recycling attitudes suggesting that having the appropriate skills, resources and opportunities to recycle contributes towards positive recycling attitudes. Recyclers in this study do not feel that recycling causes them inconvenience, takes up too much time or room, is too complicated or a waste of money and hence view the behaviour positively.

This means that recycling schemes need to be designed with convenience in mind, based on the needs of today's entrepreneurs for time and space and this need was emphasised by Mac Donald and Oates (2003).

There were attitudes that specifically correlated strongly with recycling behaviour and these were: recycling is responsible, rewarding, sensible and good and in addition the respondents demonstrated a concern for maintaining a good environment to work in. According to Emery et al., (2003) and Evison and Read (2001), campaigns which aim at reinforcing the positive attitudes of recyclers and changing the negative attitudes of non-recyclers need to focus on these aspects of recycling behaviour.

**Products from the recycling of solid waste**

Out of the 296 enterprise operators who preferred recycle solid waste, 63% indicated that they have been doing so for more than 12 months, 22% for 6 months to a year, 8% for 1 to 6 months and 7 % did not remember the length of time they have been recycling materials. However, the length of time of recycling differed significantly among the spatial areas ($P<0.01$) with the enterprise operators in Monomotapa and Shamrock Park being the leading recyclers and those at Kudzanai and Kombayi being the least recyclers. The most commonly recycled materials at Monomotapa and Shamrock Park include ferrous metal from tin cans and scrap metal from old vehicles and non-ferrous metals such as aluminium, copper and lead. Heavy metals such as zinc, mercury and silver are also recovered from vehicle and household batteries while automobile and truck tyres and road building materials are recovered from tyres for recycling. Recyclable construction and demolition wastes in Monomotapa and Shamrock Park have been a source of soil, asphalt, concrete, wood, dry wall, shingles and metals for builders and have in some cases constituted up to 25% of the building and construction material. The materials recovered from recycling differ significantly between the enterprises mainly involved with manufacturing and construction (Monomotapa and Shamrock Park) and those mainly concerned with retailing, repair and service functions at Kudzanai market, Kombayi market, Ascot and Mkoba.

The methods of disposal of e-waste generated in the informal enterprises were influenced by the objective factors that included both the characteristics of the waste such as type of waste stream and the different types of recycling channels. Methods of disposal of large household e-waste items such as televisions, refrigerators, washing machines, air conditioners and computers and small items such as cell phones were quite different. Selling to scrap merchants is the main way of discarding e-waste in Monomotapa, Mkoba, Shamrock Park and Ascot. It was established that 46% of the enterprise operators chose this method, while trade-in or selling directly to companies accounted for another 19% of the disposals. The major reasons for disposing the larger appliances included the inconvenience of storing such large items within the not-so-large enterprise premises as well as the economic benefit of recouping some salvage value. Indeed 16% of the discarded appliances had not completely lost their original function and hence could be sold as second hand products (hence could serve the same **purpose**). Some of the discarded appliances could also enter the secondary market after being repaired i.e. a change of **state** after **structure** reformation and hence performance is improved to serve the same or sometimes different **purpose**.

In the enterprises located at Kudzanai market, Kombayi market, Mkoba and Ascot the most commonly recovered materials for recycling from open dumping and other disposal receptacles are plastics, paper and cardboard, glass, aluminium, food and vegetable waste, textiles and wood. The paper that is recovered for recycling comprises packaging material, old newspapers, corrugated cardboard in the form of bulk packaging paper (which is a major source of paper for recycling) and mixed paper derived from various mixtures of white ledger paper including newsprint, magazines and white coloured long fibre paper. The plastic recovered for recycling includes polyethylene terephthalate (PETE/1) and is recovered by scavengers and sold those who process it to produce soft drink bottles, salad dressing and vegetable oil bottles as well as photographic film. High density polyethylene (HDPE/2) is recyclable material that is derived from water containers, milk jugs, detergent and cooking oil bottles. Another common type of plastic that is recovered from recycling is low density polyethylene (LDPE/4). This comprises thin film packaging wrap that is discarded by customers who purchase items from the markets and nearby shops. In the enterprises located in the high density areas of Mkoba and Ascot and the Kudzanai market, closures and labels of bottles and containers as well as cereal box liners are sources of Polypropylene (PP/5) when recycled. Polystyrene (PS/6) is derived from packaging for electrons and electronic components, foam cups, fast food containers, tableware and microwave plates. In the market areas located at Kudzanai, Kombayi, Ascot and Mkoba the organic component of the solid waste is dominant and is derived from food and vegetable waste. Some of the organic waste is recovered by farmers prepare compost for soil enrichment.

Observations in the enterprises at Monomotapa, Mkoba and Ascot revealed that scrap metal recovered from the solid waste is used in the production of poultry feeding trays, pots, dishes, metal buckets, window and door frames, dust bins and scotch carts. The waste materials derived from carpentry enterprises such as planks and chipped wood are used in the production of lounge suites, kitchen chairs, stools, benches and tables and bed mattresses. Waste rubber material is derived from conveyer belts and old tyres and this is an important input for the shoe making and repair enterprises and is used in the production of sandals and shoes. These products are affordable and hence their market not only comprises residents of the high density suburbs in which they are located, but also customers from other parts of the city of Gweru where such products cannot be readily obtained. At Kudzanai market, Kombayi market, in Ascot and in Mkoba informal activities involving the retailing of spare parts, tyre tubes, bolts and fasteners were also observed selling reused mended second hand tyre tubes, damaged tubes, car bearings, bolts, nuts, washers, empty cardboard boxes that were used as table mats, waste timber planks used as flooring or working area.

**Table 7: Products made from recovered waste in various enterprises**

| **Enterprise** | **Product** |
|---|---|
| Scrap metal recovery | Poultry feeding trays |
| | Pots and dishes |
| | Metal buckets |
| | Window and door frames |
| | Dust bins |
| | Scotch carts etc |
| Carpentry | Sofas |
| | Bed mattresses |
| | Kitchen chairs |
| Shoe making and repairs | Sandals |
| | Shoe soles and repairs |
| Garage and mechanics | Repair battery cells |
| | Repair tubes |

Waste recyclers within the different home-based enterprises in the high density suburbs of Gweru have filled the market with different valuable products. Table 7 shows that waste materials can be sustainably utilized to make durable products that are marketable and hence enhance socio-economic development in the City of Gweru. There is also a relationship between types of product made and levels of education and experience of the enterprise operators. Most operators who produce lounge suites had received some form of formal education while operators who produced pots and dishes had no schooling at all. About 85% of carpentry and works operators had attained formal education while only 42% of the scrap metal operators had formal education and the rest (58%) had no schooling at all. This is because the nature of some recycling activities requires knowledge attained from some

formal forms of schooling. For instance the designing of lounge suites requires woodworking background while garage works require some background knowledge of motor mechanics. This therefore influences the nature and products made by different operators through recovery and recycling. It was also observed during the survey that there was no uniformity in products made per enterprise. For instance, at Monomotapa it was observed that only one individual in the scrap metal recovery enterprise had a finished scotch cart while the rest had pots, poultry feeding tins as well as dishes and door frames. Only two operators in the shoe repairs enterprises were observed having well made sandals while the rest specialized with shoe repairs. Though the shoe repairs operators reported making shoe soles there was no evidence of such works since they had no rubber in possession to make soles rather they had strings to help the sewing of shoes. The carpentry enterprises produce affordable mattresses and lounge suites for the local market. Observations revealed that only five respondents had made lounge suites from old lounge suite material while the rest had kitchen chairs and bed mattresses. Therefore waste recovery for recycling in different home based enterprises contributes in sustainable utilization of resources and provide with valuable products for urban dwellers to enhance their standards of living.

**Conclusion and recommendations**

Findings show that informal sector enterprise operators have a positive attitude and think it is important to recycle as a way of preserving the environment. In order to encourage citizens to participate, they need to be convinced of the importance of the service they are providing. Gonzalez-Torre and Adenso-Diaz (2005) carried out a study in the city of Gijon where he concluded that the nearer containers are to citizens, the more they recycle waste. There are basically two ways of encouraging citizens to fulfil their role in solid waste management. Firstly, they can be obliged by law to take part in an economically and environmentally feasible programme and secondly, by adding the social factor to the environmental and economic aspects of selective collection. This option involves studying under what circumstances society is willing to accept certain aspects or not.

Another way of increasing rate of participation is to stimulate separation through measures such as offering refunds on returnable bottles, kindling public interest in consuming fewer packaged products, lowering the amounts paid for waste collection, investing in advertising campaigns or stimulating participation by implementing tax benefits. A study undertaken in Spain by Gallardo et al. (2010) compared the different selective collection systems in use in that country. One of the conclusions reached was that the quality and quantity of the recyclable materials was better when they were collected at the kerbside. Furthermore, this work shows how a weight-based billing system can reduce the amount of residual waste but can also lead to citizens being tempted to burn waste in fireplaces or leave residual waste in inappropriate places. The biodegradable material waste collected in essence contained 12% impurities (Gallardo et al., 2010).

A waste management plan is also essential for any town because waste needs to be managed at all stages from its generation to disposal. The decisions, which are made about one aspect affect other aspects, e.g. the amount of waste reduction carried out affects the rate at which landfill space is filled up. The long term plan would be based on developing base line data on

waste generation rates in the informal sector, the characteristics of the solid waste in terms of composition so as to identify the appropriate management practices that would minimise waste; the socio-economic characteristics of the informal sector operators and the current institutional and legal framework. Recycling as a recovery option needs to be encouraged in as much as composting should be considered as a waste diversion option especially for the huge amounts of waste generated in the market places of Gweru. In all these efforts the successful development of the plan would be enhanced by the active participation of the informal sector, the private sector, residents, other institutions and NGOs in the decision making process (Table 8).

**Table 8: A stakeholder driven waste management plan for the informal sector of Gweru**

| **OBJECTIVES** | | **Gweru City Council** | **Informal Sector** | **Other service users: Business, SMEs, residents** | **NGOs/ other organisations** |
|---|---|---|---|---|---|
| Planning and management | Strategic planning | Develop plan with assistance of the stakeholders | Is involved in all stages of planning | Are involved in all stages of planning | Provides backup and support and monitors the whole process. |
| | Legal and regulatory framework | To be developed by city council | Participates and shares ideas | Participate and share ideas | Provides inputs and monitors process |
| | Public Participation | Involves all stakeholders | Participates willingly | Participate willingly | Assist in sensitisation on plan and monitoring |
| | Financial management | Guides in the management of funds | Actively participates | Actively participates | Monitor the whole process |
| | Institutional arrangement | Facilitates and provides specialists and support | Involved in decision making | Involved in decision making | Facilitation and coordination |
| Waste generation | Waste characterisation | Promotes three waste stream characterisation | Segregation of waste into degradable, recyclables | Segregation of waste into degradable, recyclables and garbage | Promotion of waste segregation and monitoring of the |

| | | | | | |
|---|---|---|---|---|---|
| | | | and garbage | | process |
| | Waste minimisation | Promotion of reduction, re-use and recycling | Segregation of waste into degradable and non-degradable waste | Segregation into degradable and non-degradable waste | Promote reduction, reuse, recycling and monitor process |
| Waste handling | Overall responsibility for collection and transfer of non-degradable, non-recyclable and hazardous waste | | Disposes waste after thorough segregation | Dispose after thorough segregation | Assists in marketing of compost and recycling with the informal and private sectors |

There is need to set targets in as far as developing a sustainable waste management system is concerned and these targets would need to involve the informal sector enterprises and other stake holders. Such targets also include waste minimisation so as to divert waste from the landfill. Solid waste segregation needs to be encouraged at the source and this would involve separating the waste into bio-degradable, recyclable and non-degradable waste so as not to waste resources.

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