CONSTRUCTION WASTE MANAGEMENT PRACTICES IN THE CONSTRUCTION INDUSTRY

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ABSTRACT

This article evaluated the knowledge of Construction Waste Management (CWM) among contractors in Gqeberha and establish what legislative shortcomings were there in terms of CWM regulations. The reduction in landfilling could decrease the waste management cost for construction companies, and reduce negative impacts on the environment. This article used a qualitative design approach. The primary data was obtained through structured interviews from a selected number of main contractors in Gqeberha. The study focused on on-site agents, contracts managers, and Health Safety and Envronment officers through a non-probability sampling technique. The study reveled that the lack of government legislation, to discourage the landfilling of waste, was the main catalyst. The primary data also stated that the lack of recycling facilities also contributed to the abundance of landfilling waste among contractors in Gqeberha. The research findings also showed that contractors in Gqeberha were knowledgeable on several construction waste management strategies. Future research will require contractors to research the potential economic benefits of CWM, as well as minimisation and recovery CWM strategies, and the local municipality to explore methods of discouraging landfilling waste, within the construction industry and in other sectors, as well as the economic and environmental benefits of CWM. The article provided insight concerning the CW and CWM practices among contractors in Gqeberha, including identifying the interventions required to address shortcomings.

Keywords: Construction Waste Management, Prevention, Recycling, Recovery, Reuse.

INTRODUCTION

The 2017 South Africans construction industry's contribution of 3.77 per cent towards the country's GDP and employment of about 609 000 people in the first quarter of 2018, respectively, indicates that the industry plays an important role for economies like the South African Economy (South Africa's GDP Page, 2020) and (Construction Industry Development Board, 2019). However, the generation of construction and demolition material is a reality for all construction sites, but the recycling and demolition waste generated is not. In 2017, construction and demolition waste

accounted for 13 per cent of South Africa's general waste, while 6 per cent of that waste was recycled (Department of Environmental Affairs, 2018). South Africa is undergoing potential economic and social benefits because the above figures suggest insufficient planning and management of construction waste (Richardson, 2013). Cost-saving is a favourable outcome that may be brought about by waste reuse, reduction, and recycling (Hwang and Yeo, 2011:396). They further stated that the result, as mentioned above, is a reduction of unnecessary material being purchased, reduction in disposal and landfill costs which eventually leads to reduced project costs and can lead to maximised profits.

Furthermore, construction waste disposal usually results in environmental and sustainability issues, including an imbalanced eco-system (Maruf, 2017). The process of collecting and reprocessing waste into a recycled product, reduces the diminishing of landfill space, saves natural resources, supplies products, and provides economic benefits like other waste management strategies (Roslan *et al.,*2016). Landfill waste may suggest a belated intervention in terms of waste management.

Construction activity changes the environment and landfilling its waste further pollutes the water, soil, and air beyond the construction site. Construction waste can be produced during the inception, design, and operation phase of the construction process, as Haile and Hartono (2017) indicated, implying that a holistic strategy is required to manage construction waste adequately. A study in Nigeria found that poor construction waste management was due to a deficient understanding of construction waste management among construction professionals Dania *et al.* (2007). The lack of sufficient space on the construction site, was a challenge in managing construction waste based on observations on a Swedish construction site (Haile and Hartono 2017). Additionally, Abukhader (2015) observed that the lack of eco-friendly waste management practices in Dubai could be due to the high number of ex-patriots that form roughly 90 per cent of the population. The differing backgrounds and beliefs can be tremendously influential in waste management behaviours. This research aimed to understand the present construction waste management practices in Gqeberha and propose solutions to improve the current situation.

LITERATURE REVIEW

Construction Waste Management

Construction Waste Management (CWM) is an aspect of waste management that ideals construction waste management through reducing, reusing, and recycling. It is also an aspect of sustainable development driven by the impact of humankind's activities on the environment (Dania *et al.,* 2007). Aleksanin (2019), states that the coordination of the methodical handling of construction waste is one of the most important resources and environmental saving factors. He further observed that waste management aligns itself with protecting the hydrosphere and atmosphere from pollution and correcting land and biological resources conservation issues. Fundamental waste management

steps have been integrated into various waste management hierarchies by different researchers, and they range from four to six strategies. For instance, Poon (2004) discussed a waste management hierarchy that contains four chronological steps to ensure the maximum conservation of resources to be avoiding waste, re-using materials, recycling materials, and finally waste disposal if the first three steps are not possible. Additionally, the hierarchy proposed by Nagapan (2012) is prevention, minimisation, reuse, recycling, recovery, and disposal.

Prevention of Waste

Prevention of waste is the most important aspect of the waste management hierarchy as it achieves the highest sustainability of the environment. Nagapan (2012), avers that studies have shown frequent design errors and changes will always lead to waste generation. Hence designers need to consider technical information, at the pre-construction phase, to prevent waste through good communication amongst the professional team of a construction project to curb waste.

Minimisation or Reduction of Waste

Waste minimisation or reduction, is the second-best strategy to reduce the impact of waste on the environment. As a reduction in the amount of waste generated, enhanced economic savings can reduce the amount of raw material consumed and the transportation cost of material and waste (Chikezirim and Mwanaumo, 2013). Contractors need to set out waste reduction programmes and targets and a planned waste management approach, part of an overall environmental management plan and good housekeeping practice. They are also advised to establish waste management monitoring and audit programmes, utilised throughout the construction process, as stated by Solehah (2015).

Reuse of Waste

Reuse of waste is the next strategy, and it has many techniques for construction waste. Reuse is an important approach to rerouting construction waste away from landfills, according to Ajayi *et al.* (2015), who state that reuse involves a minimal alteration to the materials, either in their chemical or physical state. This strategy uses the same construction material more than once (Yuan and Shen, 2011). At times, construction waste materials that cannot be reused directly can be converted to new products through recycling (Roslan *et al.,* 2016). This is the process of collecting, reprocessing, and manufacturing the waste into a recycled product and putting it to use again. Like other waste management strategies, this phase reduces landfilling of waste, saves natural resources, supplies products, and provides economic benefits.

Recycling of Waste

Recycling waste is fourth in the hierarchy, and it is the most preferred method to use when the material is used within the construction sector. Mulders (2013) asserts that recycled material lowers the overall embodied energy as such materials have a lower embodied energy than virgin materials. It should be noted that without significant economic incentives directing waste management towards recycling, it will be difficult to get the desired behavioural change. The advantages of recycling construction waste are extensive but have been summarised as; the conservation of precious land areas, the extension of the lifespan of landfills, the cost-effectiveness of recycled products, improvement of the general environmental status in terms of energy and pollution, the minimisation of resource consumption, the utilisation of waste which would be lost to landfills, and job creation.

Recovery of Waste

As the fifth strategy, recovery of waste can be defined as the reuse of waste materials that allows them to maintain their original form to be re-used in a similar state (Nagapan, 2012). An example is the incineration technology utilised in Germany to assist in the recovery of metal waste. The incineration process eliminates harmful metal from the waste, and the gases produced from the incineration are used to produce electricity, thus reducing landfill waste. This strategy requires extensive governmental support, because the establishment of an incineration facility requires a substantial financial contribution.

Disposal of Waste

Disposal of waste is the final option in the hierarchy, and the most common disposal method is landfilling. This is the least favourable strategy as it goes against sustainable waste management, which reduces the amount of waste disposed into the environment (Nagapan, 2012). It is concluded that the waste management hierarchy should be implemented in all construction sites. Waste management strategies, such as those mentioned above, can effectively integrate sustainability while managing waste. If combined with the correct legislation/policy, it can help reduce the negative issues related to construction waste.

Benefits of Construction Waste Management

Proper implementation of construction waste management can provide various benefits, across the lifecycle of the material from its generation to its conclusive disposal. According to Hwang and Yeo (2011), apart from economic advantages, construction waste management may have a positive input in the following aspects: cost-saving and profit maximisation, reduced demand for landfill spaces, improved resource management, image improvement, productivity, and quality improvement.

Barriers to Construction Waste Management

A study on overcoming the barriers to construction waste reuse in Australia, noted that the key barrier in promoting construction waste management was the additional cost of processing, recycling, or reuse and the quality of the recycled or reused waste materials (Park and Tucker, 2016). Park and Tucker (2016), state that the lack of information is said to contribute as the main cause of the limited effectiveness of construction waste management, particularly the conflicting interests and differing perspectives of key stakeholders involved in the management of construction waste. Internal stakeholders, such as contractors and project clients, tend to emphasise the monetary aspects of construction waste management. In contrast, the external stakeholders, such as the general public, non-state organisations, and legislative authorities, are more concerned with minimising the quantities of waste entering the landfills and the environmental impacts (Park and Tucker, 2016). The lack of information stance is further corroborated by Abarca-Guerrero *et al.* (2017), who cited inadequate knowledge about implementing eco-technologies and the insufficient training of workers on waste management issues, as some of the barriers to implementing the reduction of construction waste.

Alternative uses for Construction Waste Materials

The rapid growth in construction, has led to the creation construction and demolition waste (Shahidan *et al.,* 2017). This section of the research elaborated on waste management solutions for such waste(s) that have been produced through various stages of a typical construction project. Such waste is discussed hereunder.

Concrete Waste as Recycled Concrete Aggregate

The depletion of natural aggregates, globally, can be attributed to rapid industrial development, which creates an enormous amount of construction and demolition waste. This problem can be reduced by using recycled aggregates sourced from demolished concrete to reduce environmental pollution and protect. This will help reduce environmental pollution and protect naturally occurring resources (Shahidan *et al.,* 2017).

Reuse and Recycling of Masonry Waste

Waste masonry bricks, from demolition work, can be reused for their original purpose once the bedding mortar is removed manually or through temperature treatment (Mulders, 2013). Temperature treatment strains the bond between the mortar and the brick surface interface, causing shear stress, setting the brick free of the bedding mortar. After the treatment, the brick retains the quality it had before its initial construction use. Waste masonry bricks may also be recycled into a fine grain with or without

removing the bedding mortar, and are formed when the masonry is crushed to a fine grain smaller than 0.5mm and mixed with clay in a fired kiln to produce clay bricks (Mulders, 2013).

Elongating the Lifetime of Timber Waste

Timber waste can be re-used, then recycled or recycled after its intended use on site. Mulders (2013) suggested that timber can be used for various functions once its initial intended use is obsolete, and this process can be repeated every time the new use for the timber waste becomes obsolete once again. For example, a timber beam can be processed into a floorboard once it is no longer needed as a beam. After that, it can be made into a window frame. Once the window frame is no longer needed, the timber can be processed into an oriented strand board which can be used for loadbearing applications in construction.

Environmental Impact of Landfills

The landfilling of construction waste results in a wide range of environmental costs, including the use and degradation of land, the release of methane gas, the destruction of habitats, and the contamination of soil and groundwater. The manufacture of construction materials involves the extraction, processing, and transportation of natural resources, resulting in pollution and greenhouse gases. The disposal of these construction materials at landfills results in the loss of useful materials (Crawford *et al.,* 2017).

How Government Discourages Landfilling

According to Ajayi *et al.* (2015), several legislatures, together with tax measures, have been made obligatory by governments to diverge waste away from landfills. An example of such measures is the "Pay as You Throw" (PAYT) system, where a polluter pays fees to dispose of waste at a landfill, through which governments have diverted substantial volumes of waste from landfills. PAYT charges are paid per unit volume or weight of all waste that is landfilled. It has the final aim of discouraging waste landfilling while encouraging alternative waste management solutions. The latest Nelson Mandela Bay Municipality Integrated Waste Management Plan, highlighted that the municipality does not operate any formal recycling system. However, it does facilitate recycling through other initiatives that target only domestic household waste and not commercial construction waste (Nelson Mandela Bay Municipality, 2016).

RESEARCH METHODOLOGY

Research Method

Data collection is the process of collecting and measuring information on variables of interest. It is established systematically, enabling the researcher to answer stated research questions, test the hypotheses, and evaluate outcomes (Leedy and Ormrod,

2015). Methods vary by discipline, but the emphasis is on ensuring that the accurate and honest data collection remains the same (Kabir, 2016). Semi-structured interviews were conducted with individuals, who construction companies in Gqeberha employ. The interviewees were selected based on their expertise, responsibility, and years of experience within the company. These interviewees consisted of the following construction industry professionals: contractors, project and construction managers. The criteria mentioned above were selected based on Ajayi's (2017) assertion that a participant would be deemed information-rich if their job description fell within them working for any contractor, civil or civil or structural engineer, architect, construction project manager, and site waste manager. The interviews were conducted in English, and they had a duration of about eight to fifteen minutes. The interviews were recorded and transcribed, to avoid any misinterpretation of the data.

Data Collection

This study used the non-probability sampling technique, to acquire five participants as it was not possible for the researcher to interview all the individual units within the population (Leedy and Ormrod, 2015). It was impossible to hold interviews in person; semi-structured interviews were conducted via video-call through the Microsoft Teams application. The interviews were recorded, through the application, before being exported and manually transcribed.

Table 1: Participant Details

Participant No.	**Age**	**Gender**	**Sector**	**Experience** (years)
1	32	Male	Private	8
2	40	Male	Public	15
3	28	Female	Private	4
4	33	Female	Public	11
5	39	Male	Private	12

Due to the large number of participants who turned down the request to participate in the video conference interviews, participants in this study were limited. The research interviews were conducted using video conferencing software during the data collection phase due to the level four(4) covid19 restrictions. The covid19 pandemic increased the number of video conferences, and telephonic meetings, among construction industry employees. Out of the twenty contractors that were approached to participate in this research, only five responded. Creswell (1998), proposes a sample size of five to twenty-five for a qualitative study using interviews. A study by Hennink *et al.* (2017), realised a saturation point at the 9th interview, where additional issues were not raised. Therefore, following Creswell's suggestion, the five participants used in this study are justifiable.

The would-be participants, that declined, stated that they were too busy to participate in any additional telephonic or video interviews becuase their schedules were already overwhelmed due to the pandemic, which limited in-person meetings within their work environment. A study on employee wellness and productivity, while working remotely during Covid-19, suggested that the high use of platforms such as Microsoft Teams, Zoom, and e-mail were best for productivity and social connection and the most frustrating (Shockley *et al.,*2020). Only participants who operated as principal contractors and registered with regulatory bodies such as the Construction Industry Development Board (CIDB), the National Home Builders Registration Council (NHBRC), and Master Builders South Africa (MBSA)were selected.

Ethical Considerations

The researchers ensured that the participants' confidentiality was protected and their consent was obtained to record the interview. The participants were also assured that the recorded information was kept confidential and that their personal information was not accessible by anyone except for the researcher.

RESULTS, ANALYSIS AND DISCUSSION

Results

A sample cosisting of five interviewees, was selected and interviewed to ascertain the root cause for contractors in Gqeberha to be so reliant on landfilling their construction waste. The paper used a qualitative study approach, because the researcher wanted to obtain the views and opinions of the interviewees. The data was then compared with the literature review.

Analysis and Discussions

This section dealt with the data analysis, where the research participants' which were exhibited through quotations, stated their opinions on construction waste management. The data was then analysed and compared with the content of the literature review in this research. The comparison's alignment, or lack thereof, would ultimately be used to conclude this research paper.

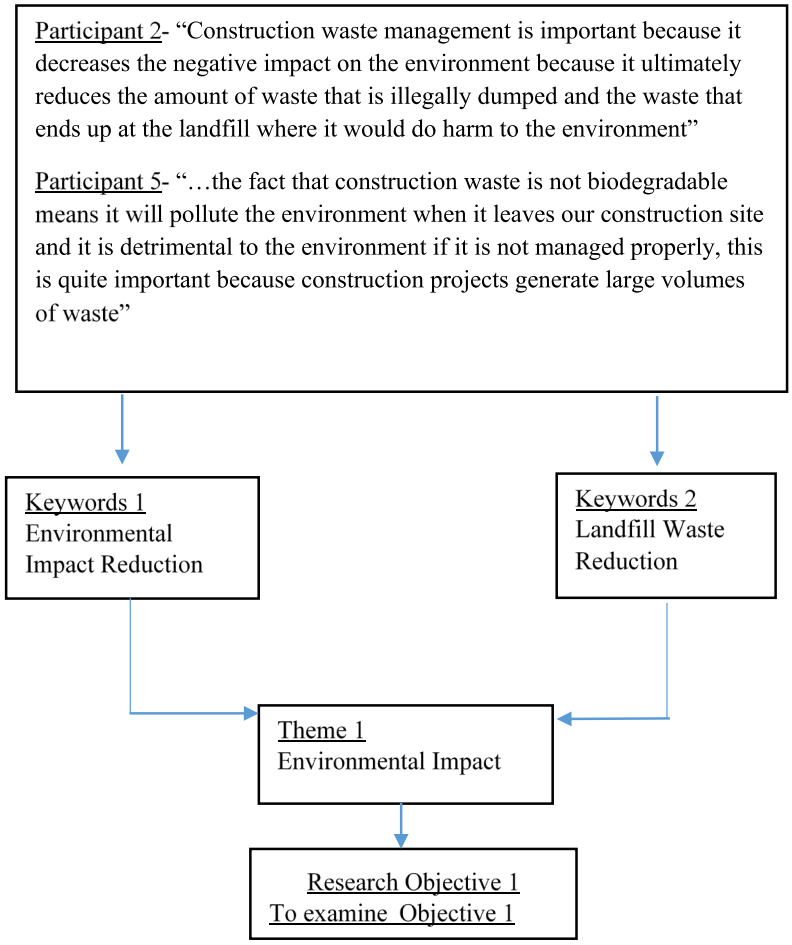

Figure 1: Thematic Analysis how knowledgeable are contractors on the importance of construction waste management(Objective 1).

Research Objective 1

Construction waste management is driven by the need to underscore humankind's activities in the environment. It is also an aspect of waste management concerned with minimising and managing construction waste by reducing, reusing, and recycling it (Dania *et al.,*(2007). CWM also aims to protect the hydrosphere and atmosphere from pollution and issues of land conservation and conservation of biological resources (Aleksanin 2019b). The goals, as mentioned above, of CWM, which is minimising and managing construction waste stated by Dana *et al.* (2007), together with protecting the hydrosphere and atmosphere from pollution as stated by Aleksanin (2019b), agree with the opinion of what CWM is, according to participant number 2 who stated the following:

"…Construction waste management is important as it decreases the negative impact on the environment because it ultimately reduces the amount of waste that is illegally dumped and the waste that ends up at the landfill where it would harm the environment" (Interview conducted with Participant 2).

Another Participant alluded to similar reasoning on the importance of construction waste and indicated that:

"…the fact that construction waste is not biodegradable means it will pollute the environment when it leaves our construction site, and it is detrimental to the environment if it is not managed properly" (Interview conducted with Participant 5).

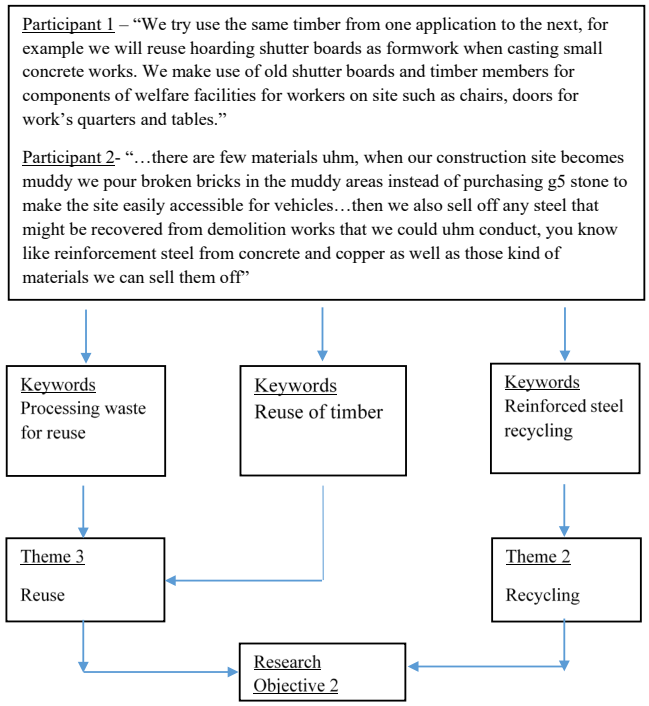

Figure 2: Thematic Analysis awareness of contractors of alternative construction management solutions (Objective 2).

Research Objective 2

The possible strategies for managing waste, in order of importance and desirability for maximum environmental sustainability, were summarised into the following strategies by Nagapan (2012): Prevention, Minimisation/Reduction, Reuse, Recycling, Recovery and Disposal. The primary data revealed that contractors practiced recycling and the on-site reuse of certain construction waste materials.

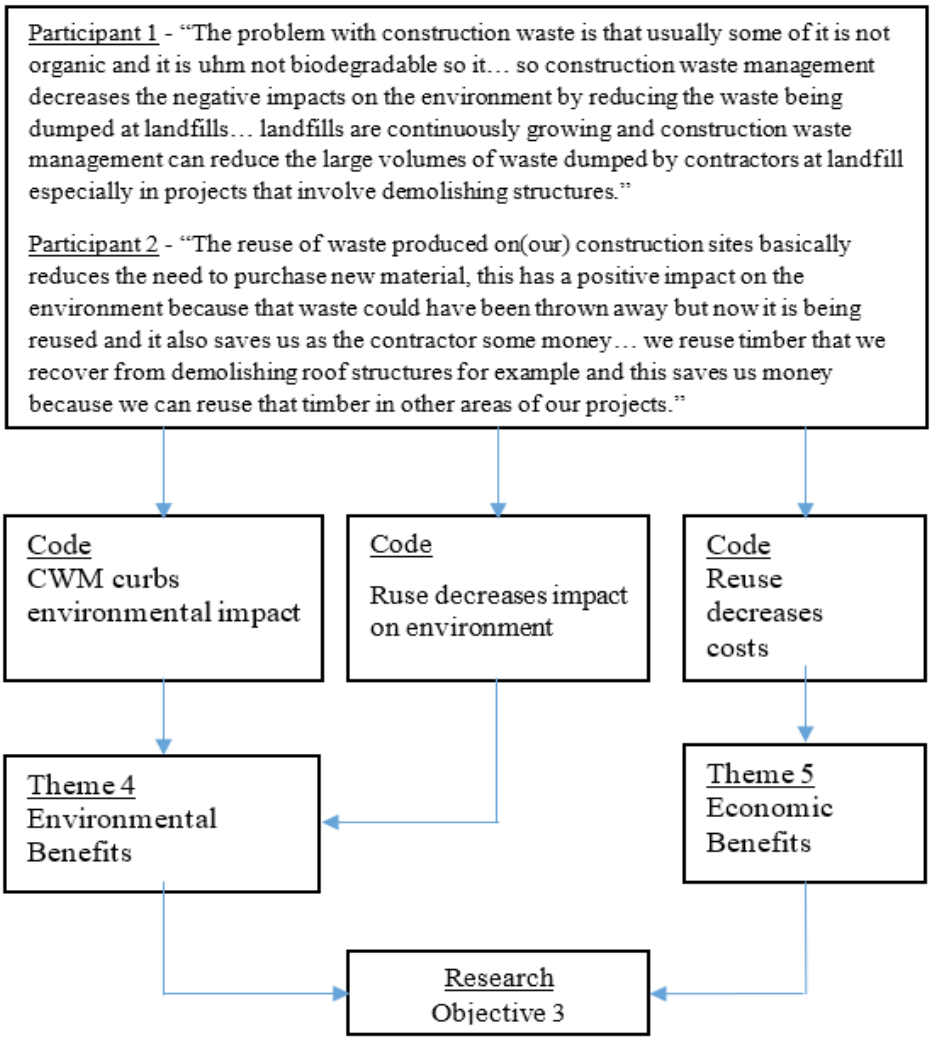

Figure 3: Thematic Analysis if contractors realise the potential positive impact of construction waste management (Objective 2).

The reuse of construction waste, usually indicates using the same material in construction more than once instead of using the material once and discarding it for the use of new virgin materials. Reusing is preferable over recycling as it requires very little processing because the material undergoes little to no change for reuse (Park and Tucker 2016).

This definition is in agreement with how participant 1 utilizes reuse in managing their construction waste as stated below:

> *"We try to use the same timber from one application to the next; for example, we will reuse hoarding shutter boards as formwork when casting small concrete works. We make use of old shutter boards and timber members for components of welfare facilities for workers on site such as chairs, doors for work's quarters, and tables." (Interview Participant 1)*

According to Ajayi *et al*. (2015), reuse is an important approach when rerouting construction waste away from landfills. He further states that reuse involves minimal alteration to the materials' chemical or physical state; this statement is in line with how participant 1 implements the reuse of their timber waste because the timber undergoes minimal alteration to its physical and chemical state, with the timber material being reused as timber material. These research participants displayed knowledge of recycling solutions, and one participant even mentioned recycling activities that their company practices. It can thus be concluded that contractors in Gqeberha were aware of alternative waste management practices.

Sub-Research Objective 3

Hwang *et al*. (2011) stated that CWM saves on costs and maximises profit for contracts. This is achieved by reducing the continuous unnecessary acquisition of new materials that could be substituted by recycled or reused waste materials, further reducing costs.

The previous sentence was in agreement with research participant 2, who stated the following:

> *"The reuse of waste produced on(our) construction sites reduces the need to purchase new material, this has a positive impact on the environment because that waste could have been thrown away, but now it is being reused, and it also saves us as the contractor some money… we reuse timber that we recover from demolishing roof structures for example, and this saves us money but also protects the environment because we can reuse that timber in other areas of our projects" (Interview Participant 2)*

The statement mentioned above is concurred by research participant 3, who stated that:

> *"We make sure to reuse or recycle timber instead of throwing it away; it would make no financial sense to buy something that we have readily available on-site."*

The above statements by participants 2 and 3 were in agreement with the Allen *et al*. (2019), who suggested that upon the demolition of a timber building, the large timber members from the demolished building, can be recycled into a frame for another building or the large member can be sawed into new boards for the new building. Participant 2, in the statement mentioned above, asserted that the reuse of waste produced on the construction sites reduced the need to purchase new material, which had a positive impact on the environment because the waste could have been thrown away. The statement also agrees with Ajayi *et al*. (2017), who mentioned that the reuse of waste materials is a quintessential approach to diverting waste from landfill sites.

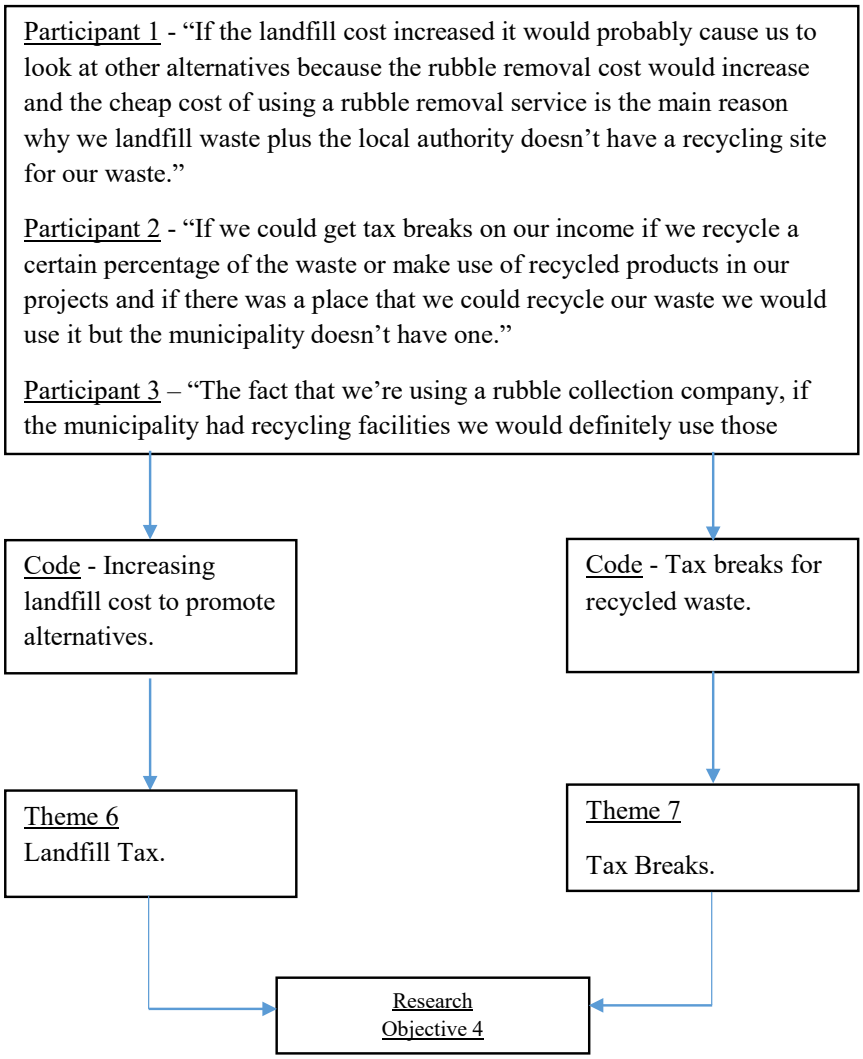

Figure 4: Thematic Analysis to scrutinise the presence or lack thereof of incentives and legislation to discourage the landfilling of construction waste(Objective 4).

Research Objective 4

Jain (2012) proposed that the government provide some sort of recycled construction product government subsidy to encourage alternative waste management solutions, and this was in agreement with research participant 2, who stated:

> *"If we could get tax breaks on our income if we recycle a certain percentage of the waste or make use of recycled products in our projects…."*

The literature review found very little motivation from the local authority, to encourage contractors to move away from landfilling their waste. As mentioned in their Integrated Waste Management Plan, the local authority has no recycling operations that cater to construction waste (Nelson Mandela Bay Municipality 2016). The absence of municipal recycling facilities, is further confirmed by research participant 2 when they said that they would make use of a municipal recycling facility if it were implemented, and this was seconded by research participant 3, who stated that they would utilise rubble removal companies to take their waste to municipal recycling facilities.

CONCLUSION

The article revealed that contractors were knowledgeable of the importance of construction waste management were aware of alternative construction waste management solutions, and they showed limited knowledge of the potential positive impact of construction waste management. Finally, it was established that interventions to curb landfilling construction waste were not present in the local municipality's waste management plan. It was confirmed that the lack of government legislation to discourage the landfilling of waste was confirmed as the main catalyst in the landfilling of waste. The primary data also stated that the lack of recycling facilities contributed to the abundance of waste landfills among contractors in Gqeberha.

RECOMMENDATIONS

Based on the primary data analysis and the contents of the review of related literature, the following recommendations can be made to decrease the amount of landfill waste produced by contractors in Gqeberha.

1. Contractors should further research and study the potential economic benefits of CWM.
2. Contractors must further their knowledge of CWM practices, particularly regarding minimisation and recovery. Additionally, contractors need to research applications of recycled brick aggregate as a substitute for the natural aggregates in concrete.
3. The local municipality should investigate the economic and environmental benefits of CWM.
4. The local municipality should research methods to discourage the landfilling of waste within the construction industry and other industries.

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