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From Footprint to Handprint through Environmental Management Accounting: The Case of South Africa

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Abstract

Planet Earth is calling for mercy. Natural resources are consumed at an alarming rate, global warming is on the rise and water and air pollution are increasing. Industries that are at the forefront of depleting and polluting the environment are, therefore, called dirty industries for a reason. The purpose of this paper is to show how environmental management accounting (EMA) can assist dirty companies to become greener. A thematic analysis of the sustainability/integrated reports of 10 companies listed on the South African Johannesburg Stock Exchange (JSE) was done with the use of Atlas.ti version 9. During the first round 50 codes were identified which were collapsed to eight code groups. The analyses informed and guided the researcher as to where these companies have an environmental footprint that can be reduced. This research argues that to reduce their environmental footprint, companies need to employ Environmental Management Accounting Practices (EMAPs). Water and energy consumption; their carbon footprint (greenhouse gases) as well as other emissions; cost of energy; and waste were identified as sustainability issues in the companies selected. EMAPs such as Material Flow Cost Accounting (MFCA), Activity Based Costing (ABC), and Life Cycle Costing (LCC) to name but a few could be employed as it minimises waste and costs through the identification of monetary and physical flows of material, energy and water in the complete process, thereby highlighting certain inefficiencies.

Keywords: Carbon footprint, energy consumption, environmental management accounting Practices, waste, water consumption

1 Introduction

Planet Earth is strained as unsustainable practices continue; the population is growing, and natural resources are becoming depleted (Jatana & Currie, 2020). During the hard lockdown of the world in 2020 owing to COVID 19 one could almost see that the earth started breathing again. Wild animals moved around in deserted streets and the skies became blue, all because people worked from home and less emissions from vehicles and factories entered the atmosphere (Venter et al., 2020). The Insider (2020) presented two (2) photos of Venice, one in

January 2018 and a second one in April 2020. A remarkable difference is visible in the pollution levels (Figure 1).

Figure 1. Pollution in Venice January 2018 and April 2020

Source: Insider (2020)

The United Nations set Sustainable Development Goals (SDGs) to be achieved by 2030 (United Nations Development Programme, 2015). As a result, this paper focuses on sustainable consumption and production (goal #12), and climate action (Goal #13). The African Union (AU) joined the drive to save planet Earth and Agenda 2063: The Africa we want, came about (AU, 2015). Goal #7, namely, Environmentally sustainable and climate resilient economies and communities further aims to save Planet Earth.

Owing to pressure from various stakeholders, companies from dirty industries are working towards an environmental handprint rather than an environmental footprint (Szász & Seer, 2018). Giannetti et al. (2020) call for cleaner production to achieve the SDGs by 2030. According to Qin, Harrison and Chen (2019) governments should intervene and ensure that guidelines exist to implement national environmental plans. Da Silva et al. (2021) established that cleaner production practices employed in the textile industry promoted environmental, economic and operational benefits. Shi et al. (2021) argue that the supply chain; and production and consumption will become more integrated and connected due to an increase in globalisation. They furthermore indicated that, although challenging, cleaner production needs to be promoted and implemented. However, greenwashing which constitutes inaccurate and misleading claims about a company's impact on the environment (Cojoianu et al., 2020) still prevails despite the Environmental Protection Agency (EPA) initiatives on greenhouse gases (GHGs) and the United States Securities and Exchange Commission's (SEC) climate change disclosures (Cong et al., 2020). Integrating these two reporting mechanisms could improve their usefulness.

The research question for this paper is as follows: *To what extent can dirty industries benefit from the use of EMAPs, firstly, to save the environment and secondly to save on costs?*

In answering the research question, this paper investigates which information and initiatives are reported in the Sustainability/Integrated Reports of listed companies from so-called dirty industries. The aim is to identify the challenges they are experiencing and how EMAPs can

assist them to become greener industries. Gunarathne and Lee (2021) established that during the development of a cleaner production strategy EMAPs are, despite popularity gained, still employed in fragments, thereby limiting their usefulness. Burritt et al. (2019) indicated that environmental management accounting (EMA) employs a number of practices to assist managers with information for green decision-making, in other words how to decrease their environmental footprint. They argue that small changes rather than a reengineering of the accounting system should be considered. That is, EMA should first be employed on a small scale and if successful it can be broadened to provide top management with regular, useful information.

One of the EMAPs available to provide monetary and physical information regarding material, water and energy flows, is Material Flow Cost Accounting (MFCA). MFCA also highlights waste in the process (Chompu-Inwai et al., 2015). In the instance where a company aims to embark on greener production considering the cost thereof, lifecycle costing (LCC) is an option (Kazancoglu et al., 2020). A further practice that can be employed when a company wants to ensure the relevant costs of their environmental impacts are captured, is Activity-Based Costing (ABC) (Hsieh et al., 2020). According to Lee and Gunarathne (2019) other tools and techniques include water management accounting, energy accounting, sustainable business scorecard (SBSC), carbon management accounting and eco-control. They furthermore argue that all of these tools/techniques or practices need to be more emphasised in formal education of management accountants to ensure it is well-known and implemented.

The layout of the rest of the paper is: In the following section a literature review on dirty industries, waste and aspects around sustainability is presented. The methodology followed in this work is discussed thereafter, a presentation of the findings, conclusions, recommendations, and suggestions for future research.

1.1 Literature review

Three (3) of the dirtiest industries in the world according to (Worldatlas, n.d.) are mining and ore processing; chemical manufacturing; and product manufacturing. Product manufacturing companies often fail to employ the necessary environmental safety standards. Chemical manufacturing can produce toxic wastes and by-products and can, therefore, be a threat to the communities' health. In mining and ore processing companies the challenge is the production of large volumes of waste which contain pollutants like mercury, lead, and cadmium. On the positive side, new technologies can assist to curb the pollution generated from these industries.

According to Suska (2021) while companies do engage in pro-environment initiatives and projects, they still exert pressure on the natural environment owing to their specific type of core business. Some have greater water consumption needs for production and extraction processes resulting in the greater discharge of wastewater into the environment. High emissions of CO_2 can occur due to core activities, and extraction processes can contribute to relatively high production of waste. Consequently, areas that still need improvement are reducing carbon emissions and waste management (Suska, 2021). Chang, Canelas and Chen (2021) established that only one in four (4) construction companies' undertaken initiatives managed to decrease

their environmental impact. Seclen-Luna, Moya-Fernández and Pereira (2021) found that manufacturing companies may exert a positive connection between the development of innovation strategies and productivity; and environmental impact. They also argued for stricter regulation in environmental terms as compliance should result in cost savings, increased productivity and a reduction in the environmental impact through the incorporation of technological changes.

Although companies from the dirty industries are trying their best to decrease their environmental footprint there is always room for improvement. Environmental management accounting practices (EMAPs) may be able to assist them to become greener. MFCA for instance can assist companies to identify where losses occur and bring savings about, leading to more efficient use of materials, water and energy in turn resulting in improved economic and environmental performance (Burritt & Saka, 2006). Zeng, Zhou and Xiao (2019) argued that MFCA and Life cycle assessment (LCA) are based on the life cycle of a product. The difference, however, comes in, in the stages of the life cycle. MFCA only focuses on the production stage while LCA focuses on the whole lifespan of a product. This is why it would be important to take both practices into account when considering environmental performance. Furthermore, Activity-based costing (ABC) can be employed to ensure that each activity related to the environmental impact of the company is costed properly (Al-Mawali, 2021).

Based on the environmental impacts of dirty industries and the shortfalls still experienced, EMAPs may be able to assist them to become even greener.

2 Methods

Based on the research onion of Saunders, Lewis and Thornhill (2019) an interpretive philosophy was followed to generate human interest in the research (Dudovsky, 2018). Through an inductive approach analyses were done, culminating in a framework and recommendations for dirty industries. A literature survey was employed as a research strategy and a cross-sectional time horizon was followed. Secondary data were downloaded for analyses based on the top 10 dirty JSE industries that were identified (Pure Earth and Green Cross Switzerland, 2016) and the following industries were included in the research: Chemicals, Construction and Materials, Forestry and Paper, Mining, Oil and Gas producers, and Pharmaceuticals & Biotechnology.

Companies listed on the South African JSE that had Integrated/Sustainability reports on their websites for 2016 and 2020 were identified. Two (2) reports per company were chosen to determine whether there was any improvement in the companies' environmental performance between the two (2) years. Stratified random sampling were used to identify the 10 companies on which a thematic analysis was conducted. Ethical clearance was obtained for this research.

The selected companies and their underlying industries are given in Table 1.

Table 1. Companies and Industries Considered

Company	Industry
Bowler Metcalf Limited	Chemicals
Murray & Roberts Holdings Limited	Construction & Materials
Mondi Limited	Forestry & Paper
Arcelormittal South Africa Limited	Industrial Metals & Mining
Merafe Resources Limited	Industrial Metals & Mining
Anglo American Platinium Limited	Mining
Harmony Gold Mining Company Limited	Mining
Wesizwe Platinum Limited	Mining
MCMining Limited	Oil & Gas Producers
Adcock Ingram Holdings Limited	Pharmaceuticals & Biotechnology

Atlas.ti™ was used for the analysis of the Integrated/Sustainability reports downloaded from the companies' websites. Firstly, codes were generated which were based on keywords. The codes were used to generate quotations which were used to identify challenges and performance areas of the companies. The keywords included: carbon, climate change; consumption; conservation; energy/electricity; environment; pollution; respect for; and water. 50 Codes were generated and grouped into eight (8) group codes, namely, costs; energy; environment; pollution; recycling; sustainability; waste; and water. Quotations related to the codes were used to synthesise the findings.

3 Findings and discussion

It became clear during the analysis of the reports that although these dirty industries are harming the environment, they are also doing much to conserve the environment. The following quotes are from their integrated/sustainability reports, the ***emphases*** in the quotations right through was added by the researcher – Refer Table 2.

Table 2. General quotations from company statements

... the ***protection of the environment*** is a key consideration for Adcock Ingram ... committed to the sustainable management and ***conservation of the environment***. Throughout its operations ... focuses on ... ***minimising the potential impact on the environment***.	... focus on the areas where we believe we can most effectively contribute to SDG targets relating to socio-economic development, ***environmental protection*** and broader leadership in the mining sector.
Considering the sensitivity of the area in which the mine operates, the integration of concurrent rehabilitation and ***conservation of biodiversity*** into the life cycle of the mine became major business case drivers. Three key objectives were identified including: ... the integration of biodiversity management throughout the life cycle of the	Technology enabling sustainability. ... our integrated approach to technology, digitalisation and sustainability is accelerating our ability to ***protect the environment***, improve lives and livelihoods

mine; and using ***innovative mine design and concurrent rehabilitation*** to reduce closure liabilities and improve rehabilitation outcomes.	and build trust with our full breadth of stakeholders.

Figure 2 is a word cloud generated with the use of Atlas.ti™ indicting the frequency of codes in the sustainability/integrated reports of the 10 selected companies for the years 2016 and 2020. Water, energy, emissions, sustainability, environmental and waste seem to be the most important concepts discussed in the reports. Cost of energy and other cost related issues were also highlighted and although it is not showing in the WordCloud it is discussed as a finding.

Figure 2. Analysis of sustainability/integrated reports of 10 selected companies

Quotations from the integrated/sustainability reports which include the words climate change, costs, energy, pollution, water, and waste are discussed next.

3.1 Climate change

Climate change is a concern for all these companies, they acknowledge that they need to address certain aspects in their operations to conserve the environment (Table 3).

Table 3. Climate change's quotations from company statements

Pursue continual improvement in environmental performance issues, such as water stewardship, energy use and ***climate change***.	... Task Force on Climate-related Financial Disclosures (TCFD) ... to provide better information to investors across four key areas; ***climate change*** governance, risk, strategy and, metrics and targets.
... to helping address ***climate change*** is underpinned by our work to reduce our GHG emissions.	***Climate change*** risks and opportunities When assessing the risks and opportunities presented by ***climate change***, we use two time horizons.
Climate change: ... how we respond to the global warming challenges facing the world and our industry in particular	***Climate change*** risks are included in each operation's risk assessment. ... actively participates in discussions on ***climate change*** legislation via various industry organisations.

will be fundamental to our sustainability.	

Climate change should be on the agenda and in the strategy of each company to ensure there is a future for all. Companies acknowledge that they need to reduce their GHGs. One of the companies categorised the risks and opportunities into short- and long-term.

3.2 Costs

Most of the companies' reports analysed show a concern for the increase in energy costs as well as interruption of energy supply. The South African energy provider announces high increases annually which in turn has a negative impact on operational costs. Another cost indicated in the analyses is carbon tax – Refer Table 4.

Table 4. Costs' quotations from company statements

... ***higher electricity cost*** derived from an 8.8% tariff increase and much reduced economies of scale.	The pending ***carbon tax*** and ***increased cost of electricity*** may affect the sustainability of operations.
Punitive administered-price increases, in particular electricity, pose a real threat to the sustainability ... while a decision on partially restarting Saldanha – which would create hundreds of jobs – would be dependent on ***energy cost concerns***.	A R142 million (US$10 million) increase in water and electricity costs ... mainly due to the ***annual tariff increases***. Tariff increases were partially offset by electricity saving initiatives at all South African operations.

These companies have started with certain initiatives to try and minimise the effect of rising energy costs as well as carbon tax – Refer Table 5.

Table 5. Costs initiatives' quotations from company statements

The benefits ... of investing in ***energy efficient*** projects ... has shown to be extremely significant and the benefits ... will increase with future ***electricity price increases***.	Key benefits ... are ***increased electricity self-sufficiency***, ***lower energy costs*** and reduced environmental footprint of the mill
By year end, ... improvement projects had accounted for ***estimated energy savings*** of 5.8 million GJ, representing ***energy cost savings*** of approximately $90 million.	... we can use new technology to ***improve our cost efficiency*** in response to cost pressures, such as ***increases in electricity tariffs*** and labour costs.
Re-prioritising and re-enforcing ***energy efficiency*** and demand management initiatives ... such initiatives contributed to ***savings of*** almost R55 million.	

Although companies are already making use of new technology and other energy efficient initiatives, they could further benefit from using EMAPs. EMAPs have cost cutting effects since

ABC is used to identify those activities that do not contribute to the value of the company (CIMA, 2008).

3.3 Energy

Energy conservation, consumption and management as well as alternative energy sources are all mentioned in the reports analysed – Refer table 6.

Table 6. Energy quotations from company statements

Key areas of focus are water management; ***electricity consumption***; carbon emissions; and stakeholder education and awareness.	Improved mineral waste management can result in significant savings and ***reduced energy consumption.***
In 2016, a total of 320 ***energy efficiency*** and business improvement projects saved 5.8 million GJ in ***energy consumption***, ... The cumulative ***avoided energy costs*** ... over the past three years is estimated at $260 million based on 2016 energy prices.	***Energy consumption:*** Mine energy consumption is determined from utility bills ... captured manually by the organisation's environmental data capture team, who track consumption patterns. ... audited on an annual basis to ensure accuracy and consistency in the manner in which such data is communicated within the business.
Mining and processing activities result in the unavoidable disturbance of land, generation of mineral residue, **use of** fresh water and **energy**, ... We strive to minimise our footprint through our innovative technologies that are designed to support our approach to sustainable mining.	

Some of the more detailed initiatives to reduce energy consumption are highlighted next – refer Table 7.

Table 7. Energy initiatives from company statements

Back-up power supplies as well as on-site water storage facilities allow for continuous production during periods of interruption.	***Using more precise technologies***, less energy and water, ... reducing our environmental footprint for every ounce, carat and kilogram.
... committing to being carbon neutral across the operations by 2040, and roughly a third of the business by 2030, ... also aim to have made a 30% ***improvement in energy efficiency***, a 50% reduction in freshwater abstraction, and a 30% absolute reduction in greenhouse gas emissions.	***Technological innovation and digitalisation***, working hand in hand with our three sustainability pillars, are helping us achieve some of our most important objectives: keeping people out of harm's way; ***reducing energy*** and water usage;

Reduce energy consumption by 8%... Implementation of four ***priority projects*** to meet 2030 targets.	... installed a 90-kilowatt, ***grid-tied solar farm***, which produces enough energy to power all the mine's offices.
The ***off-gas boiler*** will, ... have a material impact on both our CO_2 emissions and our cost of electricity.	Several efforts are underway to include ***renewable energy*** in our energy portfolio...
... good progress has been made with the ***replacement of fluorescent lights*** with low energy lights ... ***day/night sensors***; the charging of forklifts outside peak demand times and the shutdown of chillers and cooling towers during weekends.	***FutureSmart™*** mining ... response to the global drive for a more productive and sustainable approach to mining – economically, socially and environmentally. ... broad innovative thinking and collaborative partnerships to find solutions to mining's most critical challenges: safety, productivity, water and energy.
... implement ***best-available technologies*** on an ongoing basis, particularly in regard to underground ventilation, fuel use and pumping. ... invested in the ***harnessing and re-use of energy***, such as waste-heat recovery.	Developed the ***Group environmental reporting standard*** and conducted an independent external assurance on energy and carbon indicators.
... that starts with reducing our products' carbon footprint. We're transitioning to ***low carbon energy*** and using our leading role in forestry management.	

The above are in line with Shrivastava and Vidhi (2020) who found that mining companies are making strides to improve on their environmental footprint, however, they cannot always decrease it owing to the nature of their business. Yet, since there is usually room for improvement, an EMAP such as MFCA may assist when the material and energy flows in a company are highlighted (Kovachev & Ross, 2009).

3.4 Pollution

Pollution of the air through greenhouse gases (GHGs) and water through effluents and toxic discharges are all part of the dirty industries' operations. The following extracts indicate what these industries are experiencing as well as their initiatives taken – Refer Table 8.

Table 8. Pollution quotations from company statements

Regarding ***surface water pollution***, rehabilitation has been prioritised.	Global stretch goals and visions Milestones and targets Climate change. ***To operate carbon-neutral mines***.
Effective mineral waste management reduces the aesthetic and land use challenges of mining, particularly during closure, as well as the potential for ***water and air pollution***.	The CarbonVaultTM programme aims to harness the natural powers of kimberlite ***to capture carbon from the atmosphere*** and lock it away for millions of years. ... This supports its commitment to achieving ***carbon neutral operations*** by 2030.

Group-level absolute and intensity-based ***greenhouse gas emission reduction*** targets have been set for the five years.	***Reducing our carbon footprint*** remains an important focus. In South Africa, we are well advanced in our efforts to seek augmenting national grid power with renewable alternatives.
... increasing pressure for decarbonisation by both climate activists and investors, and for companies to acknowledge, disclose and ***reduce their carbon emissions.***	

Most of these companies are cognisant of the effect their emissions have on the environment and are, therefore, working towards cleaner operations to reduce their polluting effects on the air, land and water. With MFCA that identifies flows of materials and energy (Kokubu & Tachikawa, 2013); and ABC (CIMA, 2008) identifying each and every activity during the operational processes of a company, positive results may be facilitated from the management accounting office.

3.5 Water

Water is a necessity for most of the production processes of dirty industries in a water scarce country like South Africa – Refer Table 9.

Table 9. Water quotations from company statements

Progress ... with the ***conservation of water***, ... repair of leaks, ongoing ***recycling of water*** and ***increasing borehole utilisation***.	***Water-saving projects*** ... saved 23 million m3 of water in 2016 (2015: 25 million m3), ... total new-water consumption decreased by 14% from 222 million m3 in 2015 to 191 million m3 in 2016.
... core focus areas is ***water conservation***, a critical concern for the mining industry globally. Our ambition is ... to ***eliminate fresh water*** from our mining processes, especially in the separation and transportation of ore and waste (tailings). ... examining how we can ***reduce the cost of dewatering*** while looking at the physical and chemical properties of the fine ore particles to understand why they cling so resolutely to water.	Sufficient, reliable supplies of water and electricity are essential to the safe, efficient conduct of our mining operations. ***Water is a scarce resource in South Africa***, and supply was further constrained by the drought last summer. ...implementing various measures to improve efficiency of use and ... ***proactively reducing water consumption by recycling***.
All process water at plant is sourced from shaft ***boreholes and fissure*** water. This water is re-used ... and circulated and diluted with fissure water to improve the quality of the water in the dam where a variety of birds nest. ... ***reverse osmosis plants*** treat water and supply underground employees with	... heavily reliant on water as an input to mining and processing activities. The ***responsible management of water*** is critical, given concerns around water security, water quality, rising costs and increasing regulation and scrutiny by authorities. ... made a positive contribution to water security around some

fresh, clean water for drinking which reduces shaft consumption.	operations by leveraging mining infrastructure for community use.
Water consumption: ... operate a ***closed water system*** with zero discharge to the natural environment.	***All employees are coached and trained*** regarding the efficient use of natural resources, reducing input material and waste.
Substituting fresh water with grey water. ... strives to use alternative water resources to fresh water in its processes. ... agreements with three municipalities, our operations ... use treated effluent, also known as grey water, ... freeing up potable water for use by local communities and providing adequate facilities for the treatment of sewage outflows from the communities.	

Using boreholes, greywater, reverse osmosis and closed water systems are some of the initiatives to conserve water. Again, MFCA can assist in highlighting the flow of water during the whole process of a company and may assist in reducing water consumption.

3.6 Waste and recycling

Waste is also a concern, whether it being waste of water, energy or materials it needs to be addressed. The following are extracts from the reports which indicated their waste risk, waste, and recycling initiatives. These quotes indicate that they know their risks and impacts and that through new technologies they are working towards becoming green – Refer Table 10.

Table 10: Water quotations from company statements

The CEL delivers programmes ... to achieve stable and capable processes that ***reduce variability and waste***;	These result in impacts on land through the establishment of tailings dams and waste rock piles and may also result in impacts on ***water if not managed effectively***.
... our efforts are focused on mineral residue as our most material ***waste-related risk.***	... investigating passive water treatment .. to reduce closure liability ***without generating additional waste.***
Reduction and/or recycling targets related to non-mineral waste have been set … operations aim to send ***zero waste to landfill*** by 2020.	Coal South Africa is piloting a mobile processing plant to ***recycle waste tyres***
… engage with the Recycling and Economic Development Initiative of South Africa on ***waste tyre recycling prospects***.	... invested in the ***harnessing and re-use of energy***, such as waste-heat recovery.

… field trials of ***waste dump rehabilitation*** early in the project helped to integrate conservation of biodiversity into the life cycle of the mine.	We plan for the lifecycle of the mine and beyond and use our own technologies for ***reducing waste*** and protecting the natural environment.
... implementing a ***new mineral residue management technical standard***, ... for tailings dams and water-retaining dams, and by the end of 2018 for waste rock piles. The new standard raises the bar in the level of care for our mineral residue facilities, as we seek to move beyond compliance towards best practice.	

Preventing waste and committing to recycling can both have a positive effect on the environment. The selected companies are all turning to some kind of recycling and waste reduction initiatives – one of the benefits of ABC is that all activities are scrutinised (CIMA, 2008) and those activities not adding value and creating waste are identified. MFCA on the other hand identifies waste or non-products which can then also be prevented or minimised (Kokubu & Tachikawa, 2013).

On the strength of foregoing discussions and analyses a conceptual framework to assist dirty industries in moving ahead with their green initiatives has been synthesised. The framework is given in Figure 3.

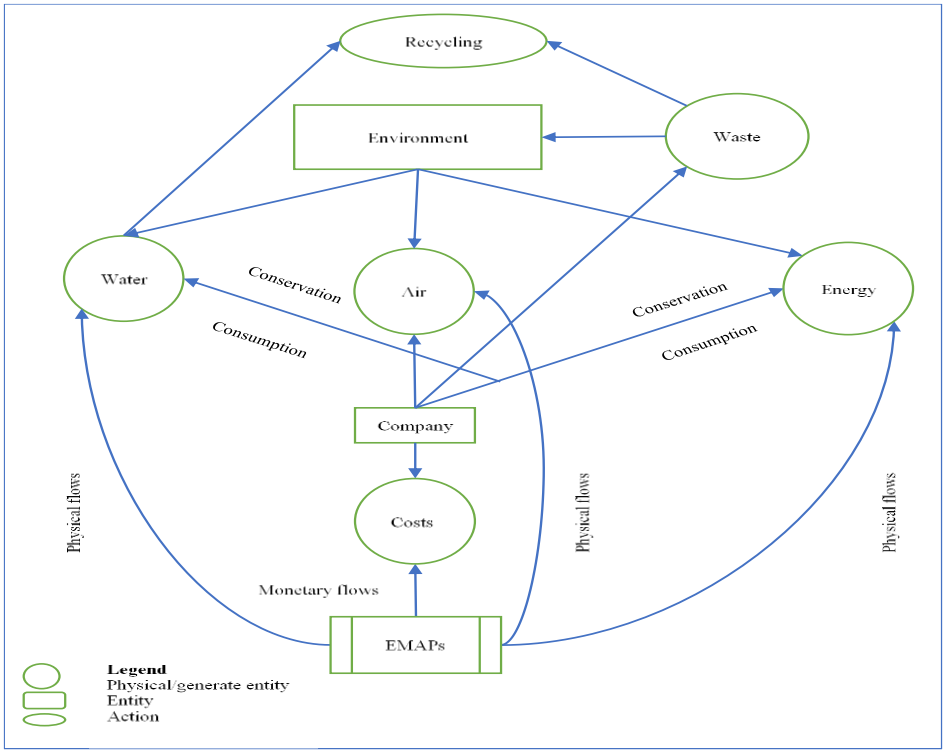

Figure 3. Conceptual Framework linking components of study

Aspects around the use of EMAPs linking costs to the company under consideration are given cognisance in the framework. Environmental aspects centred around the recycling of water,

waste, air quality, and the efficient use of energy in these industries are included in the framework. Emphases are on reducing consumptions and conserving the environment.

4 Conclusion

In this paper aspects around the effect of dirty industries with reference to South Africa as a developing economy were considered. Integrated/Sustainability reports of a number of companies on the JSE were extracted and analysed with respect to their treatment and initiatives around Climate change; Costs; Energy; Pollution; Water; and Waste and recycling. It was found that these companies are generally aware of their environmental footprint and are attempting to put measures in place to address these. These solutions are, however, centered around the use of scientific solutions, and lack measurements with respect to the costs involved. It is to this end that this paper augments these solutions by proposing the use of environmental management accounting with associated practices of MFCA and ABC.

Future work in this area may be pursued along a number of avenues: The **Error! Reference source not found.** framework is conceptual in nature and will have to be taken through the usual validation steps, for example, exercising it in one of more of the companies discussed in this paper. During these validations, discussions with other stakeholders, namely the communitiess in which these companies operate could also be conducted.

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